April 2013

DRAFT
Environmental Impact Report

Volume 1 of 3

For the
San Francisco Public Utilities Commission's

Regional Groundwater Storage and Recovery Project

Important Dates:

Draft EIR Publication Date:	April 10, 2013
Draft EIR Hearing Dates:	May 14, 2013 in San Mateo County
	May 16, 2013 in San Francisco
Draft EIR Public Comment Period:	April 10, 2013 through May 28, 2013

San Francisco Planning Department
Case No. 2008.1396E
State Clearinghouse No. 2005092026

SAN FRANCISCO
PLANNING DEPARTMENT

1650 Mission St.
Suite 400
San Francisco,
CA 94103-2479

Reception:
415.558.6378

Fax:
415.558.6409

Planning
Information:
415.558.6377

DATE: April 10, 2013

TO: Distribution List for the Regional Groundwater Storage and Recovery Project Draft EIR

FROM: Sarah B. Jones, Acting Environmental Review Officer

SUBJECT: Request for the Final Environmental Impact Report for the Regional Groundwater Storage and Recovery Project (Planning Department File No. 2008.1396E)

This is the Draft of the Environmental Impact Report (EIR) for Groundwater Storage and Recovery Project. A public hearing will be held on the adequacy and accuracy of this document. After the public hearing, our office will prepare and publish a document titled "Comments and Responses," which will contain a summary of all relevant comments on this Draft EIR and our responses to those comments. It may also specify changes to this Draft EIR. Those who testify at the hearing on the Draft EIR will automatically receive a copy of the Comments and Responses document, along with notice of the date reserved for certification; others may receive a copy of the Comments and Responses and notice by request or by visiting our office. This Draft EIR together with the Comments and Responses document will be considered by the Planning Commission in an advertised public meeting and will be certified as a Final EIR if deemed adequate.

After certification, we will modify the Draft EIR as specified by the Comments and Responses document and print both documents in a single publication called the Final EIR. The Final EIR will add no new information to the combination of the two documents except to reproduce the certification resolution. It will simply provide the information in one document, rather than two. Therefore, if you receive a copy of the Comments and Responses document in addition to this copy of the Draft EIR, you will technically have a copy of the Final EIR.

We are aware that many people who receive the Draft EIR and Comments and Responses have no interest in receiving virtually the same information after the EIR has been certified. To avoid expending money and paper needlessly, we would like to send copies of the Final EIR in Adobe Acrobat format on a CD to private individuals only if they request them. Therefore, if you would like a copy of the Final EIR, please fill out and mail the postcard provided inside the back cover to the Major Environmental Analysis division of the Planning Department within two weeks after certification of the EIR. Any private party not requesting a Final EIR by that time will not be mailed a copy. Public agencies on the distribution list will automatically receive a copy of the Final EIR.

Thank you for your interest in this project.

Regional Groundwater Storage and Recovery Project

Draft Environmental Impact Report
Volume 1 of 3

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Written comments should be sent to:

Sarah Jones, Acting Environmental Review Officer
Regional Groundwater Storage and Recovery Project
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

TABLE OF CONTENTS

Regional Groundwater Storage and Recovery Project Draft Environmental Impact Report

Volume 1

Volume 1 (continued)

Volume 2

Volume 3

Appendices

List of Figures

List of Tables

GLOSSARY

100-year flood – A flood that has a one percent chance of being equaled or exceeded each year.

A-weighted decibel (dBA) – Since the human ear is not equally sensitive to all sound frequencies within the entire spectrum, human response is factored into sound descriptions in a process called "A-weighting," expressed as "dBA." The dBA, or A-weighted decibel, refers to a scale of noise measurement that approximates the range of sensitivity of the human ear to sounds of different frequencies.

Acoustical louver – Horizontal slats on a building that are used as sound-attenuating features; that is, to keep noise from escaping.

Active fault – A fault that shows geologic evidence of movement within Holocene time (approximately the last 11,000 years).

Alluvium – Consists of unconsolidated mixtures of gravel, sand, clay, and silt typically deposited by streams.

Alquist-Priolo Earthquake Fault Zone – The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. In accordance with this act, the state geologist established regulatory zones called "earthquake fault zones" around the surface traces of active faults and published maps showing these zones. Within these zones, buildings for human occupancy cannot be constructed across the surface trace of active faults. Each earthquake fault zone extends approximately 200 to 500 feet on either side of the mapped fault trace.

Aquifer – Permeable subsurface materials (soil, sediments, and rock) that contain groundwater. Aquifers may be large or small, local or regional, shallow or deep, and confined or unconfined, depending on the subsurface geologic conditions. The permeable materials that surround an unconfined aquifer allow the water table to fluctuate in response to recharge (precipitation in the wet season) and discharge (evapotranspiration in the dry season). A confined aquifer is contained within impermeable materials and, as a result, the water table does not fluctuate.

There are three aquifer systems that are commonly referred to within the Westside Groundwater Basin, defined below:

> *Shallow Aquifer:* this aquifer is present in the northern part of the Basin, in the vicinity of Lake Merced and the southern portion of the Sunset district of San Francisco. The base of the Shallow Aquifer is defined as the top of the "-100 foot clay."
>
> *Primary Production Aquifer*: this aquifer is present throughout the Basin, overlying the "W-clay" where present. Where the W-clay is not present in locations to the south (in the South San Francisco area), the Primary Production Aquifer is divided into shallow and deep units separated by a clay unit at an elevation of approximately -300 feet mean sea level (msl).
>
> *Deep Aquifer*: this aquifer underlies the W-clay, and thus its extent is limited to the generally-known extent of that clay unit.

Asbestos – A common name for a group of naturally occurring fibrous silicate minerals that are made up of thin but strong, durable fibers. Asbestos is a known carcinogen and presents a public health hazard if it is present in the friable (easily crumbled) form. Naturally occurring asbestos would most likely be encountered in Franciscan ultramafic rock (primarily serpentinite) or Franciscan mélange.

Base flows – Flows in a river or stream that occur in the absence of any recent rainfall.

Beneficial uses – Uses of water defined in the State of California Water Code (Chapter 10 of Part 2 of Division 2), including but not limited to agricultural, domestic, municipal, industrial, power generation, fish and wildlife habitat, recreation, and mining.

Biological Opinion – Document issued under the authority of the federal Endangered Species Act stating the findings of the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service as to whether a federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

Brackish water – A mixture of freshwater and saltwater.

California Environmental Quality Act (CEQA) – Regulations set forth in California Public Resources Code Sections 21000-21178 that requires State and local agencies to identify and minimize significant environmental effects of a project.

Channel – A natural or artificial watercourse, with a defined bed and banks to confine and convey continuously or periodically flowing water.

Chloramine/chloraminated – Chloramine is a chemical disinfecting agent comprised of a combination of chlorine and ammonia. Water that has been disinfected with chloramines is "chloraminated."

Chlorination/dechlorination – A disinfection process that involves the addition of free chlorine, whether as chlorine gas or liquid sodium hypochlorite. Dechlorination is the process of removing chlorine from a substance such as water.

City Datum – City Datum is a measurement system that has been used at Lake Merced since at least 1926 and is used throughout this document for Lake Merced water levels. The City Datum does not represent the depth of the lake. An elevation of 0 feet City Datum is equal to 11.37 feet above mean sea level (NAVD 88). Thus, a lake level of -11.37 City Datum is equal to mean sea level, and negative lake elevations above this level are not below mean sea level.

Class I, II, and III Bicycle Facilities – A Class I bicycle facility (bike path) is an exclusive right-of-way that is physically separated from motor vehicles. A Class II bicycle facility (bike lane) provides preferential use of a paved area of roadway for bicyclists by establishing specific lines of demarcation between areas reserved for bicycles and motor vehicles. A Class III bicycle facility (bike route) is a roadway recommended for use by bicycles and shared with motor vehicles (with no marked lanes), designated by signs.

Colluvium – A loose deposit of rock debris accumulated through the action of gravity at the base of a cliff or slope.

Community Noise Equivalent Level (CNEL) – Because community receptors are more sensitive to unwanted noise intrusion during the evening and at night, State law requires that, for planning purposes, an artificial dBA increment be added to "quiet time" noise levels to form a 24-hour noise descriptor called the Community Noise Equivalent Level (CNEL). CNEL adds a 5-dBA "penalty" during the evening hours (7:00 p.m. to 10:00 p.m.) and a 10-dBA penalty during the night hours (10:00 p.m. to 7:00 a.m.).

Cone of depression – The area of groundwater level decline around a well caused by pumping.

Conjunctive Use – The coordinated and planned management of both surface and groundwater resources to maximize the efficient use of the resource; that is, the planned and managed operation of a groundwater basin and a surface water storage system combined through a coordinated conveyance infrastructure.

Connate water – Older, high salinity water that is trapped in sediments when they are deposited. Flow of connate waters into the South Westside Groundwater Basin would have an impact identical to seawater intrusion.

Cultural resource – A fragile and nonrenewable remain of human activity that is valued by or significantly representative of a culture or that contains significant information about a culture. Cultural resources encompass archaeological, traditional, and built environment resources, including landscapes or districts, sites, buildings, structures, objects, or cultural practices that are usually greater than 50 years of age and possess architectural, historic, scientific, or other technical value.

Cumulatively considerable – A CEQA term used to indicate whether or not a cumulative impact is significant.

Day-night noise level (L_{dn}) – Another 24-hour noise descriptor, called the day-night noise level (L_{dn}), is similar to CNEL. While both add a 10-dBA penalty to all nighttime noise events between 10:00 p.m. and 7:00 a.m., L_{dn} does not add the evening 5-dBA penalty. In practice, L_{dn} and CNEL usually differ by less than 1 dBA at any given location for transportation noise sources.

Deciduous trees – Trees that shed their leaves each year, typically in winter.

Design drought – A planning and operational tool that water supply agencies use to define a reasonable worse-case drought scenario based on local hydrology in order to establish design and operating parameters for the water system. Droughts more severe than the design drought would cause failure of supply within the water system.

Designed historic landscape – The National Register Bulletin 18 defines a designed historic landscape as "a landscape that has significance as a design or work of art; was consciously designed and laid out by a master gardener, landscape architect, architect, or horticulturalist to a design principle, or an owner or other amateur using a recognized style or tradition in response or reaction to a recognized style or tradition; has a historical association with a significant person, trend, event, etc., in landscape gardening or landscape architecture; or a significant relationship to the theory or practice of landscape architecture."

Discharge – The flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch, or spring. Also refers to the discharge of liquid effluent from a facility or to chemical emissions into the air through designated venting mechanisms.

Disinfection and Disinfection Byproducts – Disinfection is the treatment process used to inactivate and destroy disease-causing bacteria, viruses, and other waterborne microorganisms. Chlorine, a commonly and historically used disinfectant in drinking water, provides a high degree of public health protection from bacteria and viruses. However, in 1974 it was discovered that chlorine reacts with natural organic and inorganic matter in water to form disinfection byproducts. The major groups of disinfection byproducts produced by chlorination are trihalomethanes and haloacetic acids, and these byproducts have been shown to cause health effects in laboratory animals. Thus, based on numerous toxicological studies, the U.S. Environmental Protection Agency adopted the Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rules to lower the public health risk associated with potential exposure to disinfection byproducts.

Dissolved oxygen (DO) – The oxygen freely available in water, which is vital to fish and other aquatic life and for the prevention of odors. DO levels are considered an important indicator of a water body's ability to support desirable aquatic life. Secondary and advanced wastewater treatments are generally designed to ensure adequate DO in waste-receiving waters.

Disturbance – Any event or series of events that disrupt ecosystem, community, or population structure and alter the physical environment.

Diversion – The use of part of a stream flow as water supply; a channel for diverting water to sites where it can be used and disposed of. In terms of waste management, potentially recyclable material that has been diverted out of the waste disposal stream, and therefore not disposed of in landfills.

Dual Phase Extraction – A remedial technology that uses pumps to remove various combinations of contaminated groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface.

Earthquake faults – A discrete surface or zone separating two rock masses (or blocks of crust) across which one mass has slid past the other. These include:

> *Reverse faults* involve predominantly vertical movement in which the upper block moves upward in relation to the lower block.
>
> *Thrust faults* are low-angle reverse faults.
>
> *Blind-thrust* faults are low-angled subterranean faults that have no surface expression.
>
> *Range-front faults* are faults along the front of mountain ranges responsible for the uplift of the mountains.
>
> *Strike-slip faults* are vertical (or nearly vertical) fractures where the blocks have mostly moved horizontally.

Ecosystem – A geographically identifiable area that encompasses unique physical and biological characteristics. It is the sum of the plant community, animal community, and environment in a particular region or habitat.

Endangered species – Any species or subspecies of bird, mammal, fish, amphibian, reptile, or plant that is in serious danger of becoming extinct throughout all or a significant portion of its range. Federally-listed endangered species are officially designated by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service and published in the Federal Register. Species may also be listed under the California Endangered Species Act by the Department of Fish and Wildlife.

Endemic – The ecological state of being unique to a defined geographic location, such as an island, nation, or other defined zone, or habitat type; organisms that are indigenous to a place are not endemic to it if they are also found elsewhere.

Enhancement – Measures that develop or improve the quality or quantity of existing conditions or resources beyond a condition or level that would have occurred without an action (i.e., beyond compensation).

Environmental cases (hazardous materials) – Sites suspected of releasing hazardous substances or have had cause for hazardous materials investigations and are identified on regulatory agency lists. These are sites where soil and/or groundwater contamination is known or suspected to have occurred.

Ethnohistoric context – Combined historical and anthropological context.

Exclusion head – The theoretical groundwater level that must be maintained at a well location to prevent seawater intrusion from reaching the well location.

Expansive soils – These types of soils are characterized by their ability to undergo significant volume change (shrink and swell) due to variations in soil moisture content.

Fault creep – Movement along a fault that does not entail noticeable earthquake activity.

Floodplain – Land adjacent to a watercourse over which water flows in times of flood. The limits of the flood plain are defined by the peak level of a 1-in-100 year return period flood.

Flow – The volume of water passing a given point per unit of time.

Fossiliferous deposits – Fossil-containing deposits.

Franciscan mélange – Mélange is a mixture of rock materials of differing sizes and types typically contained within a sheared matrix.

Fugitive dust – "Fugitive" dust generally refers to the emission of fine soil particles that are released to the atmosphere from a construction site or agricultural field.

Groundwater flux – The rate at which water discharges from the aquifer.

Groundwater recharge – Inflow to aquifers from precipitation, infiltration, through-flow, and/or other means that replaces groundwater lost through pumping or other forms of discharge. The process of water being added to the saturated zone *or* the volume of water added by this process.

Habitat – The specific area or environment in which a particular type of animal or plant lives.

Hazardous materials – As defined in Section 25501(h) of the California Health and Safety Code, hazardous materials are materials that, because of their quantity, concentration, or physical or chemical characteristics, pose a substantial present or potential hazard to human health and safety or to the environment if released to the workplace or environment. Hazardous materials have been and are commonly used in commercial, agricultural, and industrial applications as well as in residential areas to a more limited extent.

Hazardous materials business plans – Businesses that handle specified quantities of chemicals are required to submit a hazardous materials business plan (HMBP) in accordance with community right-to-know laws. This plan allows local agencies to plan appropriately for a chemical release, fire, or other incident.

Hazardous waste – Any material that is relinquished, recycled, or inherently waste-like. Title 22 of the California Code of Regulations, Division 4.5, Chapter 11, contains regulations for the classification of hazardous wastes. A waste is considered a hazardous waste if it is toxic (causes human health effects), ignitable (has the ability to burn), corrosive (causes severe burns or damage to materials), or reactive (causes explosions or generates toxic gases) in accordance with the criteria established in Article 3. Article 4 lists specific hazardous wastes, and Article 5 identifies specific waste categories, including Resource Conservation and Recovery Act (RCRA) hazardous wastes, non-RCRA hazardous wastes, extremely hazardous wastes, and special wastes.

Heritage trees – Large, old, or historically important trees that receive local-jurisdiction protection.

Hetch Hetchy Aqueduct – The part of the regional water system consisting of the transmission facilities that convey water from Hetch Hetchy Reservoir, including pipelines and tunnels from the beginning of the Foothill Tunnel to the Alameda East Portal.

High-priority utility lines – As defined by Caltrans (1999), pipelines carrying: petroleum products; oxygen; chlorine; toxic or flammable gases; natural gas in pipelines greater than six inches diameter with normal operating pressures greater than 60 pounds per square inch gauge; and underground electricity supply lines, conductors, or cables with potential to ground more than 300 volts that do not have effectively grounded sheaths.

Hold Periods – Refers to the period when the SFPUC has neither directed "take" nor "put" of in-lieu groundwater. This would occur when the SFPUC Storage Account is full, but there is no shortage requiring the SFPUC to pump groundwater from Regional Groundwater Storage and Recovery Project wells. During Hold Periods, Project wells would remain inactive apart from well exercising and emergencies.

Hydrograph – A graph showing water levels with respect to time. A well hydrograph commonly shows water level.

Hydrology – The science that deals with the waters above and below land surfaces; their occurrence, circulation, and distribution, both in time and space; their biological, chemical, and physical properties; and their reaction with their environment, including their relation to living beings.

Impaired Water Bodies – Segments of a water body where it is known that water quality does not meet applicable water quality standards, and/or is not expected to meet applicable water quality standards, even after application of technology-based effluent limitations.

Impervious surfaces – A surface composed of any material that impedes or prevents the natural infiltration of water into the soil, such as paved streets, driveways, rooftops, and parking lots.

In-lieu Groundwater Recharge – The practice of providing surplus surface water to groundwater users, thereby leaving groundwater in storage for later use.

Inert solid waste material – Includes asphalt, concrete, rock, stone, brick, sand, soil, and fines.

Juvenile – A young or sexually immature animal.

Lateral spreading – A phenomenon where large blocks of intact, non-liquefied soil move downslope on a liquefied substrate of large aerial extent.

L_{eq} – Time variations in noise exposure are typically expressed in terms of a steady-state energy level (called L_{eq}) that represents the acoustical energy of a given measurement. $L_{eq(24)}$ is the steady-state energy level measured over a 24-hour period.

Level of Service (traffic) – A qualitative description of a transportation facility's performance based on average delay per vehicle, vehicle density, or volume-to-capacity ratios. Levels of service range from LOS A, which indicates free-flow or excellent conditions with short delays, to LOS F, which indicates congested or overloaded conditions with extremely long delays.

Liquefaction – A phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced, strong groundshaking. The susceptibility of a site to liquefaction is a function of the depth, density, and water content of the granular sediments and the magnitude of earthquakes likely to affect the site.

Mafic rocks – Igneous rocks containing a group of dark-colored minerals, composed chiefly of magnesium and iron.

Mineral Resource Zones – Areas mapped using the California Mineral Land Classification System to define areas where economically significant mineral deposits are either present or likely to occur based on the best available scientific data.

Mitigation – One or all of the following: (1) Avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating an impact over time by preservation and maintenance operations during the life of an action; and (5) compensating for an impact by replacing or providing substitute resources or environments.

Moieties – In reference to Costanoan (Ohlone) ethnohistory, either of two kinship groups based on unilateral descent that together make up a tribe or society.

Non-inert waste materials – Cardboard and paper, wood, metals, green waste, new gypsum wallboard, tile, porcelain fixtures, and other easily recycled materials.

Open-trench construction – A construction method for installing pipelines; open-trench construction involves the following steps: vegetation removal and grading or pavement cutting depending on the location; trench excavation and shoring to stabilize the sides of the trench if necessary; pipeline installation; trench backfilling and compacting; and surface restoration.

Overexcavation – A technique for the expedited corrective action of a limited release from an underground storage tank. Specifically, if a release is identified during the removal of a tank, the soil surrounding the tank pit area is often excavated to remove the contaminated materials.

Paleontological resource – The fossilized remains of plants and animals, including vertebrates (animals with backbones), invertebrates (e.g., starfish, clams, ammonites, and marine coral), and the fossils of microscopic plants and animals (microfossils).

Particulate Matter – Particulate matter is a class of air pollutants that consists of solid and liquid airborne particles in an extremely small size range. Particulate matter is typically measured in two size ranges: PM_{10} for particles less than 10 microns in diameter, and $PM_{2.5}$ for particles less than 2.5 microns in diameter.

Partner Agencies – Refers to the cities of Daly City and San Bruno and the California Water Service Company (CalWater) in its South San Francisco service area that would receive the new dry-year water supply from the Regional Groundwater Storage and Recovery Project.

Peak particle velocity (PPV) – To assess the potential for structural damage associated with vibration, the vibratory ground motion in the vicinity of the affected structure is measured in terms of peak particle velocity (PPV) in the vertical and horizontal directions (vector sum), typically in units of inches per second (in/sec).

Perched Water Bearing Zone – Water-bearing zone is an unconfined groundwater body supported or underlain by impermeable or slowly permeable materials.

Permitted hazardous materials uses – Facilities that use hazardous materials or handle hazardous wastes but comply with current hazardous materials and hazardous waste regulations.

Polychlorinated biphenyls (PCBs) – Known carcinogens that are mixtures of synthetic organic chemicals with physical properties ranging from oily liquids to waxy solids. Under the Toxic Substances Control Act, the U.S. Environmental Protection Agency began to impose bans on PCB manufacturing and sales on most PCB uses in 1978.

Potentially active fault – A fault that shows geologic evidence of movement during the Quaternary period (approximately the last 1.6 million years).

Predation – The act of preying on another animal or animals.

Prehistoric – Of, relating to or belonging to the era before recorded history, or 5,000 years before present. Paleontological resources are prehistoric resources.

Program Environmental Impact Report – One type of environmental review document identified under the California Environmental Quality Act that may be used to evaluate a plan or program that has multiple components (projects and actions) or to address a series of actions that are related.

Project – For purposes of this EIR, the Groundwater Storage and Recovery Project.

Propagation – To move or transmit something forward in space, especially as a light or sound wave.

Pump discharge rate – Flow rate of water delivered by pump from aquifer to surface.

Pumping lift – The distance water has to travel vertically from the pump to the surface.

Put Periods – Refers to the period of sufficient surface water supplies when the SFPUC directs the Partner Agencies to store water through the mechanism of in-lieu recharge. During "put" periods, Regional Groundwater Storage and Recovery Project wells would be normally turned off (except for emergencies), but regular exercising of wells would be conducted. Also referred to as "normal and wet (i.e., above average) rainfall years."

Rated capacity – Theoretical pump discharge rate established by the manufacturer for specified conditions.

Rearing habitat – An area where juvenile fish find food and shelter, e.g., in nursery areas of rivers, lakes, streams, and estuaries before migration.

Reference dose – The amount at which a daily exposure would likely not have deleterious non-cancer effects over a lifetime.

Regional water system – The entire SFPUC water system starting at Hetch Hetchy Reservoir and ending in San Francisco; the regional system includes all facilities serving the SFPUC wholesale and retail customers, except for the facilities that serve only retail customers in San Francisco. The SFPUC regional water system consists of a complex network of facilities covering a geographic range of about 160 miles, from the Sierra Nevada on the east to San Francisco on the west. The regional water system crosses seven counties—Tuolumne, Stanislaus, San Joaquin, Alameda, Santa Clara, San Mateo, and San Francisco. The regional water system includes over 280 miles of pipelines, over 60 miles of tunnels, 11 reservoirs, five pump stations, and two water treatment plants.

Riparian – The land adjacent to a natural watercourse such as a river or stream. Riparian areas support vegetation that provides important wildlife habitat, as well as important fish habitat when sufficient to overhang the bank.

Saltwater wedge – A wedge-shaped intrusion of saltwater into freshwater.

Scarp – A cliff formed by faulting, erosion, or landslides.

Scenic Highway Program – The State Scenic Highway Program lists highways that are either eligible for nomination as scenic highways or have been officially designated. Local governing bodies must nominate and apply to Caltrans in order for an eligible highway to be officially designated a Scenic Highway. Part of the application includes defining and identifying the scenic corridor of the highway, and adopting ordinances, zoning, and/or planning policies to preserve the scenic quality of the corridor or documenting that such regulations already exist. These ordinances and policies constitute the Corridor Protection Plan.

Scenic resource – Includes, but is not limited to, trees, rock outcroppings, and historic buildings that contribute to a scenic public setting.

Scenic roadways (local) – Local scenic routes are considered notable roadways with scenic values that offer views of creeks, hillsides, open space features, water bodies, and unique visual resources.

Secondary Maximum Contaminant Level (MCL) – The U.S. Environmental Protection Agency and Title 22 of the California Code of Regulations establish secondary MCLs to prevent drinking water that may appear colored or taste or smell bad, causing people to stop using water from their public water system. These contaminants are not considered to present a risk to human health at the Secondary MCL, but are enforceable by the State nonetheless.

Sedimentation – The deposition of material suspended in a stream system, whether in suspension (suspended load) or on the bottom (bedload).

Seiche – Earthquake-induced oscillating waves in an enclosed water body.

Sensitive receptors – Persons that are sensitive or more vulnerable to effects of (i.e., that "receive") excessive noise and/or poor air quality than the general population, usually analyzed in terms of land use types where such persons are typically located.

Serpentine – A naturally occurring group of minerals that can be formed when ultramafic rocks are metamorphosed during uplift to the earth's surface. Serpentinite is a rock consisting of one or more serpentine minerals. This rock type is commonly associated with ultramafic rock along earthquake faults. Small amounts of chrysotile asbestos, a fibrous form of serpentine minerals, are common in serpentinite.

Siltation – Sediment influx from either erosion or from sediment carried into a water body by inflowing rivers and tributaries.

Sliplining – Installing a new, smaller diameter pipe into an existing pipe to provide structural integrity.

Soil Vapor Extraction – A remedial technology that reduces concentrations of volatile constituents in petroleum products adsorbed to soils in the unsaturated (vadose) zone.

Spawning – Laying (and fertilizing) eggs in the process of reproduction.

Special-status biological resources – Includes special-status plants, animals, and natural communities, plus wetlands and other waters of the United States and State as defined by the U.S. Army Corps of Engineers, California Department of Fish and Wildlife, and the State Water Resources Control Board.

Special-status natural community – A natural habitat community that receives regulatory recognition from municipal, county, state, and/or federal entities such as the California Natural Diversity Database (CNDDB) because it is unique in its constituent components, restricted in distribution, supported by distinctive soil conditions, and/or considered locally rare.

Special-status species – Several species known to occur within the general region of the program area are accorded "special status" because of their recognized rarity or vulnerability to habitat loss or population decline. Some of these species receive specific protection in federal and/or state endangered species legislation. Others have been designated as "sensitive species" or "species of special concern" on the basis of adopted policies of federal, state, or local resource agencies. These species are referred to collectively as "special-status species."

Spill sites – Locations where a spill of hazardous materials has been reported to the State or federal regulatory agencies.

Stratigraphy – Geological and archaeological layers that make up an archaeological deposit.

Submersible pump – A submersible pump is a device that has a hermetically sealed motor and is designed to operate while submerged in a liquid (e.g., water) that is being pumped.

Subsidence – The gradual sinking of land surface (due to groundwater pumping, seismic activity, subsurface excavation, etc.).

Substrate – The materials found in streambeds or riverbeds (i.e., large and small boulders, stone, rubble, cobble, pebble, coarse and fine gravel, sand, silt, and clay). The surface upon which an organism grows or is attached.

Supervisory Control and Data Acquisition (SCADA) – A system using radio frequencies that allows the gathering of data and sending of commands to equipment at remote facilities.

Surface water – All water that is naturally open to the atmosphere (i.e., rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.).

Swales – Drainage areas where rain collects but does not stand as long, as in vernal pools.

Take Periods – Refers to the second year of a multi-year drought, following implementation of the Shortage Allocation Plan, when the SFPUC pumps groundwater from new Project wells connected to the SFPUC Regional Water System transmission lines, and directs the Partner Agencies to utilize stored groundwater by pumping new Project wells that connect to their individual water distribution systems. Also referred to as "dry (i.e., below average) rainfall years."

Terrestrial species – Types of species of animals and plants that live on or grow from the land.

Threatened species – Legal status afforded to plant or animal species that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range, as determined by the U.S. Fish and Wildlife Service, the National Marine Fisheries Service., or the California Department of Fish and Wildlife.

Threshold vibration damage – The lowest vibration amplitude at which cosmetic or minor damage occurs to buildings. This includes "threshold cracks" or "hair-sized" cracks in room walls.

Tiering (CEQA) – The coverage of general matters in broader EIRs with subsequent narrower EIRs or ultimately site-specific EIRs incorporating by reference the general discussions and concentrating solely on the issues specific to the EIR subsequently prepared.

Total maximum daily load – A Total Maximum Daily Load (TMDL) is a water quality attainment strategy required by the Clean Water Act for pollutants and water bodies where water quality standards are not currently met. The TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards, and an allocation of that load among the various sources of that pollutant.

Transverse ridges – Toe-like features found within a landslide mass that consist of thrusts of soil/debris that appear as linear to concave upslope features.

Tributary – A stream that contributes its water to another stream or body of water.

Ultramafic rocks – These rock units are formed in high-temperature environments well below the surface of the earth.

Vadose Zone – The unsaturated portion of the subsurface above the water table.

Vernal pools – Seasonal wetlands formed in gently undulating or rolling topography where the soil is underlain by a slowly permeable claypan or hardpan.

Viewshed – An area of land, water, or other urban or environmental element that is visible to the human eye from a fixed vantage point.

Visual character – The visual attributes of a particular land use setting. For urban areas, visual character is typically described on the neighborhood level or in terms of areas with common land use; intensity of development; socioeconomic conditions; and/or landscaping and urban design features. For natural and open space settings, visual character is most commonly described in terms of areas with common landscape attributes (such as landform, vegetation, water features, etc.).

Visual sensitivity – The overall measure of a site's susceptibility to adverse visual changes. Visual sensitivity is rated as high, moderate, or low and is determined based on the combined factors of visual quality, viewer types and volumes, and visual exposure to the proposed Project as described above.

Visual quality – The overall visual impression or attractiveness of a site or locale as determined by its aesthetic qualities (such as color, variety, vividness, coherence, uniqueness, harmony, and pattern).

Waste Discharge Requirements – A type of State discharge permit prepared and enforced by the local Regional Water Quality Control Board to control point source discharges to surface waters.

Water quality objectives – Numeric and narrative limits or bans on substances, water characteristics, and activities which impact water quality including discharges of waste materials, sediment, and pesticides; procedures which alter concentrations of dissolved oxygen, temperature, and turbidity; and any actions which generally increase in-stream toxicity and pollution.

Water quality standards – Water quality standards are legally binding norms that describe the desired ambient condition (i.e., level of protection) for a water body and consist of the following three principle elements: designated beneficial uses of the State's waters, water quality objectives, and anti-degradation policies.

Water rights – The legal right to the use of water. In the groundwater context, water rights are either "overlying," meaning used on the land overlying the well such as for irrigation at a golf course, or "appropriative," meaning that water from the well is exported for use elsewhere. Municipal water wells typically operate based on an appropriative water right.

Water Shortage Allocation Plan – The water shortage allocation plan for the Regional Water System for system wide shortages of up to 20 percent that was agreed to by the SFPUC and its wholesale customers as part of the 2009 Water Supply Agreement. The Water Shortage Allocation Plan allocates the available water supply based on the total amount of water in storage as of April 15 of each year. Depending on the level of the shortage, the available water supply is first allocated between SFPUC retail customers and the wholesale customer. The wholesale customers then allocate the wholesale share of the available water among themselves.

Waters of the State of California – Waters of the State of California are defined as "any surface water or groundwater, including saline waters, within the boundaries of the State" California Water Code Section 13050(e). These include nearly every surface or groundwater in California, or tributaries thereto, and include drainage features outside U.S. Army Corps of Engineers jurisdiction (e.g., dry and ephemeral/seasonal stream beds and channels, etc.), isolated wetlands (e.g., vernal pools, seeps, springs, and other groundwater-supplied wetlands, etc.), and storm drains, and flood control channels.

Waters of the United States – A broad federal definition that describes U.S. Army Corps of Engineers jurisdiction over deep-water habitats and special aquatic sites, including wetlands, as follows:

- The territorial seas with respect to the discharge of fill material.
- Coastal and inland waters, lakes, rivers, and streams that are navigable waters of the United States, including their adjacent wetlands.
- Tributaries to navigable waters of the United States, including wetlands.
- Interstate waters and their tributaries, including adjacent wetlands.

All other waters of the United States not identified above, such as isolated wetlands and lakes, intermittent streams, prairie potholes, and other waters that are not a part of a tributary system to interstate waters or navigable waters of the United States, the degradation or destruction of which could affect interstate commerce.

Watershed – A region or area bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water.

Well screen – A perforated section of the well casing which allows groundwater from the aquifer to be pumped into the well casing and then to the ground surface.

Wetland – A zone periodically or continuously submerged or having high soil moisture, which has aquatic and/or riparian vegetation components, and is maintained by water supplies significantly in excess of those otherwise available through local precipitation.

ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
$\mu g/m^3$	microgram per cubic meter
μm	micrometer
AAR	Alternatives Analysis Report
AB	California Assembly Bill
AASHTO	American Association of State Highway and Transportation Officials
ABAG	Association of Bay Area Governments
ACM	asbestos-containing materials
ADRR	Archaeological Data Recovery Report
af	acre-feet
Afm	acre-feet per month
afy	acre-feet per year
ALUC	Airport Land Use Commission
AMR	American Medical Response
APE	Area of Potential Effects
APN	Assessor's Parcel Number
ASCA	American Society of Consulting Arborists
ASCE	American Society of Civil Engineers
AT&T	American Telephone and Telegraph
ATCM	Airborne Toxic Control Measure
BA	Biological Assessment
BAAQMD	Bay Area Air Quality Management District
BACT	Best Available Control Technology
BART	Bay Area Rapid Transit
Basin Plan	Water Quality Control Plan for a particular watershed
BAWSCA	Bay Area Water Supply and Conservation Agency
BCDC	Bay Conservation and Development Commission

bgs	below ground surface
BLM	Bureau of Land Management
BMP	best management practice
BO	Biological Opinion
B.P.	before present
BSE	Basic Safety Earthquake
BSSC	Building and Seismic Safety Council
C-APE	CEQA Area of Potential Effects
C/CAG	City and County Association of Governments of San Mateo County
CAA	federal Clean Air Act
CAAQS	California ambient air quality standards
CAB	construction area boundary
Cal	calibrated
Cal EMA	California Emergency Management Agency
CAL FIRE	California Department of Forestry and Fire Protection
Cal Water	California Water Service Company
Cal/EPA	California Environmental Protection Agency
Cal/OSHA	California Division of Occupational Safety and Health
CalARP	California Accidental Release Program
CalRecycle	California Department of Resources, Recycling, and Recovery
Caltrans	California Department of Transportation
CAP	Bay Area Clean Air Plan
CARB	California Air Resources Board
CBC	California Building Code
CCAA	California Clean Air Act
CCAR	California Climate Action Registry
CCC	California Coastal Commission
CCR	California Code of Regulations
CCSF	City and County of San Francisco
CCTS	Central California Taxonomic System
CDC	California Department of Conservation

CDFW	California Department of Fish and Wildlife
CDP	census designated place
CDPH	California Department of Public Health
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CER	Conceptual Engineering Report
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CESA	California Endangered Species Act
CFC	California Fire Code
CFCW	California Fish and Wildlife Code
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	California Geological Survey
CH_4	methane
CHP	California Highway Patrol
CHRIS	California Historical Resources Information System
CHSC	California Health and Safety Code
CIWMA	California Integrated Waste Management Act
CIWMB	California Integrated Waste Management Board
cm	centimeter
CMA	Congestion Management Agency
CMP	Congestion Management Program
CNDDB	California Natural Diversity Database
CNEL	community noise equivalent level
CNPS	California Native Plant Society
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPUC	California Public Utilities Commission

CRHR	California Register of Historical Resources
CRLF	California red-legged frog
CRSMP	construction risk and soils management plan
CUPA	Certified Unified Program Agency
CWA	1972 federal Clean Water Act
cy	cubic yard(s)
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibel
DBH	diameter at breast height
DDT	dichlorodiphenyltrichloroethane
DEHP	di(2-ethylhexyl)phthalate
DOD	Department of Defense
DOE	Department of Energy
DOF	Department of Finance
DPM	diesel particulate matter
DSOD	California Division of Safety of Dams
DTSC	Department of Toxic Substances Control
DWR	California Department of Water Resources
DWSAP	Drinking Water Source Assessment and Protection Program
E/C RMP	Excavation/Construction Risk Management Plan
EAS	extended archaeological surveys
ECPs	Erosion Control Plans
EFZ	Earthquake Fault Zone
EIR	Environmental Impact Report
EMFAC	EMission FACtor model
EMSA	California Emergency Medical Services Authority
EP	Environmental Planning Division of the San Francisco Planning Department
EPCRA	Emergency Preparedness and Community Right-to-Know Act
ERO	Environmental Review Officer of the San Francisco Planning Department

ERT	Emergency Response Team
ESL	Environmental screening levels
ESZ	Ecological Sensitivity Zone
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
Fed/OSHA	Federal Occupational Safety and Health Administration
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FESA	Federal Endangered Species Act
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FPPA	Farmland Protection and Policy Act
FR	Federal Register
FTA	Federal Transit Administration
g	acceleration of gravity
GAMA	Groundwater Ambient Monitoring and Assessment Program
GGNC	Golden Gate National Cemetery
GGNRA	Golden Gate National Recreation Area
GHG	greenhouse gas
GIS	Geographic Information System
gpm	gallons per minute
GPR	ground-penetrating radar
GPS	global positioning system
GSR	Regional Groundwater Storage and Recovery Project
GWh	gigawatt hours
GWMP	South Westside Basin Groundwater Management Plan
GWPC	Great Western Power Company
H_2O	water vapor
HASP	Health and Safety Plan
HCP	Habitat Conservation Plan
HEPA	high-efficiency particulate air

HFA	hydrofluorosilicic acid
HHWP	Hetch Hetchy Water & Power
HI	Hazard Index
HMBP	Hazardous Materials Business Plan
hp	horsepower
HVAC	heating/ventilation/air conditioning
Hz	hertz
I-280	Interstate 280
I-380	Interstate 380
IBC	International Building Code
INA	information not available
ITP	incidental take permit
kW	kilowatt
kWh	kilowatt-hours
L_{dn}	day-night sound level
LEED	Leadership in Energy and Environmental Design
L_{eq}	equivalent sound level
LIDAR	Light Detection and Ranging
L_{max}	maximum sound level
L_{min}	minimum sound level
LOS	level of service
LOX	liquid oxygen
LS	Less than Significant
LSM	Less than Significant with Mitigation
LUST	Leaking Underground Storage Tank
L_{xx}	percentile-exceeded sound levels
m	meter
MBTA	Migratory Bird Treaty Act
MCL	maximum contaminant level
MEI	maximally exposed individual
MG	million gallon

mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mgd	million gallons per day
MLD	most likely descendant
MLT	Middle/Late Transition
MMT	million metric tons
mph	miles per hour
MPS	multiple property submission
MRZ	Mineral Resource Zone
MSE	mechanically stabilized earth
msl	mean sea level
MT	metric tons
MTBE	methyl tert-butyl ether
MTC	Metropolitan Transportation Commission
MUNI	San Francisco Municipal Railway
MVEB	motor vehicle emissions budget
MW	megawatt
N_2O	nitrus oxide
NA	not applicable
NAAQS	national ambient air quality standards
NAHC	Native American Heritage Commission
NAVD	North American Vertical Datum
NCA	National Cemetery Administration
NCRS	Natural Resources Conservation Service
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NI	No Impact
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOA	naturally occurring asbestos
NOAA	National Oceanic and Atmospheric Administration

NOP	Notice of Preparation of an Environmental Impact Report
NO_X	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPPA	Native Plant Protection Act
NPS	National Park Service
NRA	National Recovery Act
NRCS	National Resources Conservation Service
NRHP	National Register of Historic Places
NSMCSD	North San Mateo County Sanitation District
NSR	New Source Review
NTU	nephelometric turbidity unit
NWIC	Northwest Information Center
NWP	nationwide permit
O_3	ozone
OAP	Ozone Attainment Plan
OEHHA	California Office of Environmental Health Hazard Assessment
OEM	Office of Emergency Management
OES	State Office of Emergency Services
OHP	California Office of Historic Preservation
OPR	Office of Planning and Research
PCA	Possible Contaminating Activity
PCB	polychlorinated biphenyl
PEIR	Program EIR
PG	professional geologist
PG&E	Pacific Gas and Electric Company
Phase I ESA	Phase I Environmental Site Assessment
$PM_{2.5}$	particulate matter 2.5 microns or less in diameter
PM_{10}	particulate matter 10 microns or less in diameter
ppb	parts per billion
ppm	parts per million
PPV	peak particle velocity

PRC	California Public Resources Code
PSD	Prevention of Significant Deterioration
psig	pounds per square inch
PSM	Potentially Significant, Mitigable
PV	photovoltaic
PVC	polyvinyl chloride
PWMP	Peninsula Watershed Management Plan
RACM	reasonably available control measures
RCN	Regional Cable Network
RCRA	Resource Conservation and Recovery Act
REB	Resource Efficient Building
REL	reference exposure level
RMP	risk management plan
ROG	reactive organic gas
ROW	right of way
RPG	registered professional geologist
RPS	California's Renewable Portfolio Standard
RWQCB	Regional Water Quality Control Board
SAAQS	state ambient air quality standards
SamTrans	San Mateo County Transit District
SARA	Superfund Amendments and Reauthorization Act
SB	Senate Bill
SCADA	Supervisory Control and Data Acquisition
SDC	Seismic Design Category
sf	square feet
SFBAAB	San Francisco Bay Area Air Basin
SFBRWQCB	San Francisco Bay Area Regional Water Quality Control Board
SFCC	San Francisco City Charter
SFDE	San Francisco Department of the Environment
SFGW Project	San Francisco Groundwater Project
SFO	San Francisco International Airport

SFPUC	San Francisco Public Utilities Commission
SFWD	San Francisco Water Department
SHPO	State Historic Preservation Officer
SIL	significant impact level
SIP	state implementation plan
SLIC	Spills, Leaks, Investigations, and Cleanup
SMARA	Surface Mining and Reclamation Act of 1975
SMCFCD	San Mateo County Flood Control District
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
SO_2	sulfur dioxide
SPCC	Spill Prevention, Control, and Countermeasure
SR	State Route
SR 82	State Route 82
SSF/SB WQCP	South San Francisco-San Bruno Water Quality Control Plant
SU	Significant and Unavoidable
SUM	Significant and Unavoidable with Mitigation
SVP	Society of Vertebrate Paleontology
SWIS	Solid Waste Information System
SWPPP	stormwater pollution prevention plan
SWRCB	State Water Resources Control Board
TAC	toxic air contaminants
TCM	transportation control measure
TDS	total dissolved solids
TIN	Triangular Irregular Network
TMDL	total maximum daily load
TOCs	total organic compounds
TPHd	total petroleum hydrocarbons as diesel
TPHg	total petroleum hydrocarbons as gasoline
TPZ	tree protection zone
TSCA	Toxic Substances Control Act
TTLC	total threshold limit concentration

U.S. 101	U.S. Highway 101
U.S. EPA	U.S. Environmental Protection Agency
UCMP	University of California, Berkeley, Museum of Paleontology
UPS	uninterruptible power supply
USA North	Underground Service Alert North
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UST	underground storage tank
UWMP	Urban Water Management Plan
V/C	volume-to-capacity ratio
VA	U.S. Department of Veterans Affairs
VFD	variable frequency drive
VOC	volatile organic compound
WDR	Waste Discharge Requirement
WMP	Watershed Management Plan
WSE	Water surface elevation
WSIP	Water System Improvement Program
WTP	water treatment plant
WWTP	wastewater treatment plant

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1 EXECUTIVE SUMMARY

Sections	Tables
1.1 Introduction and Purpose of the Project 1.2 Overview of the Regional Water System 1.3 Project Background and Objectives 1.4 Project Description 1.5 Summary of Project Impacts and Mitigation Measures 1.6 Alternatives to the Proposed Project 1.7 Areas of Controversy 1.8 References	1-1 Summary of Impacts and Mitigation Measures

1.1 INTRODUCTION AND PURPOSE OF THE PROJECT

The San Francisco Public Utilities Commission (SFPUC) proposes the Regional Groundwater Storage and Recovery (GSR) Project (proposed Project or Project) to increase water supply reliability during dry years or in emergencies by increasing water storage in the Westside Groundwater Basin during wet and normal years for subsequent recapture during dry years. The proposed Project is located in San Mateo County and is sponsored by the SFPUC in coordination with its partner agencies, the cities of Daly City and San Bruno and the California Water Service Company (Cal Water) in its South San Francisco service area (collectively referred to as Partner Agencies). This new dry-year water supply would be blended with water from the regional water system and made available to the Partner Agencies, other wholesale customers overlying the southern portion of the Westside Groundwater Basin (defined in Section 1.4.1 [Project Location]) and SFPUC retail water customers. The proposed Project is part of the SFPUC's Water System Improvement Program (WSIP).

Under the San Francisco Administrative Code, Chapter 31, the San Francisco Planning Department's Environmental Planning Division is responsible for conducting the environmental review of all City and County of San Francisco (CCSF) projects pursuant to the requirements of the California Environmental Quality Act (CEQA). Thus, the San Francisco Planning Department, through its Environmental Planning Division, is the lead agency responsible for preparing this Environmental Impact Report (EIR) in compliance with CEQA; the SFPUC is the project sponsor. This EIR is being prepared for the public and decision-makers to disclose the potential physical impacts of the Project so that an informed judgment can be made about the Project's environmental consequences.

1.2 OVERVIEW OF REGIONAL WATER SYSTEM

This overview of the regional water system provides background information and context for the proposed Project. The discussion includes a description of the existing water system and the SFPUC's WSIP.

1.2.1 Existing Regional Water System

The CCSF, through the SFPUC, owns and operates a regional water system that extends from the Sierra Nevada to San Francisco and serves retail and wholesale customers in San Francisco, San Mateo, Santa Clara, Alameda, and Tuolumne Counties. The regional water system consists of water conveyance, treatment and distribution facilities. The regional system includes over 280 miles of pipelines, over 60 miles of tunnels, 11 reservoirs, five pump stations and two water treatment plants. The source of the water supply is a combination of local supplies from streamflow and runoff in the Alameda Creek watershed and in the San Mateo Creek and Pilarcitos Creek watersheds (referred to together as the Peninsula watersheds), along with imported supplies from the Tuolumne River watershed. Local watersheds provide about 15 percent of total supplies, with the Tuolumne River providing the remaining 85 percent.

The SFPUC serves about one-third of its water supplies directly to retail customers, primarily in San Francisco, and about two-thirds of its water supplies to wholesale customers by contractual agreement. The wholesale customers are largely represented by the Bay Area Water Supply and Conservation Agency (BAWSCA), which consists of 26 member agencies in Alameda, San Mateo, and Santa Clara Counties[1]. Some of these wholesale customers have other sources of water in addition to what they receive from the SFPUC, while others rely completely on the SFPUC for supply.

1.2.2 SFPUC Water System Improvement Program

On October 30, 2008, the SFPUC adopted a systemwide program, the WSIP (also known as the "Phased WSIP Variant") (SFPUC Resolution No. 08-200). The WSIP is a comprehensive program designed to improve the regional system with respect to water quality, seismic response and water delivery based on a planning horizon through the year 2030. The WSIP also aims to improve the regional system with respect to water supply to meet water delivery needs in the service area through the year 2018. The proposed program area spans seven counties – Tuolumne, Stanislaus, San Joaquin, Alameda, Santa Clara, San Mateo, and San Francisco. The GSR Project is one of the WSIP groundwater projects.

The overall goals of the WSIP are to: maintain high-quality water; reduce vulnerability to earthquakes; increase delivery reliability and improve the ability to maintain the system; meet customer water supply needs; enhance sustainability in all system activities; and achieve a cost effective, fully operational

[1] The Cordilleras Mutual Water Association is an additional wholesale customer that receives water from the SFPUC, but is not a BAWSCA member. It is a small water association serving 18 single-family homes in San Mateo County.

system. To further these program goals, the WSIP also includes objectives that address system performance in the areas of water quality, seismic reliability, delivery reliability and water supply (San Francisco Planning Department 2008a).

To address the potential environmental impacts of the WSIP in compliance with CEQA, the San Francisco Planning Department prepared a Program EIR (PEIR) on the WSIP, which the San Francisco Planning Commission certified in October 2008 (San Francisco Planning Department 2008a; San Francisco Planning Department 2008b). The PEIR evaluated the environmental impacts of the WSIP water supply strategy and system operations at a project level of detail, and evaluated the environmental impacts of the WSIP facility improvement projects at a program level of detail. When the SFPUC approved the WSIP in 2008, it made CEQA Findings on the program and adopted a statement of overriding considerations and a mitigation monitoring and reporting program (SFPUC Resolution No. 08-200) on the program and projects.

This project-level EIR on the GSR Project tiers from the WSIP PEIR and also incorporates by reference the relevant analyses presented in the PEIR with respect to the WSIP's impacts and mitigation measures that apply to the GSR Project. The PEIR (State Clearinghouse No. 2005092026) is available for public review at the San Francisco Planning Department, 1650 Mission Street, San Francisco, CA 94103, and is on the Planning Department's website at http://www.sfplanning.org/index.aspx?page=1829. The PEIR is also available at the San Mateo Main Library, 55 West 3rd Avenue, San Mateo, CA 94402. CEQA permits tiering from a program-level EIR in order to allow agencies to broadly consider the environmental effects of a series of actions and/or policies, and then to provide a more detailed examination of a project's impacts in a subsequent project-level EIR. The GSR Project was defined as part of the WSIP and was analyzed in the PEIR as a WSIP groundwater project. This project-level EIR provides more detailed information about the GSR Project, its impacts and project-specific mitigation measures, as well as alternatives to the Project. This EIR summarizes and incorporates by reference the PEIR evaluation of the impacts associated with the WSIP water supply strategy and system operations, including the PEIR analysis and conclusions regarding impacts on the SFPUC's watersheds and the WSIP's growth inducement impacts. The PEIR analysis of WSIP water supply and growth-inducement impacts accounted for the proposed Project in sufficient detail; therefore no further evaluation of these aspects of the proposed Project is required.

1.2.2.1 Description of the WSIP

The WSIP involves improvements to the regional water system with respect to water quality, seismic response and water delivery based on a planning horizon through the year 2030. The WSIP also includes phased implementation of a water supply strategy to meet projected water demand through the year 2018. The WSIP includes full implementation of the proposed WSIP facility improvement projects to ensure that the public health, seismic safety and delivery reliability goals are achieved as soon as possible.[2] Under the WSIP, the SFPUC established the year 2018 as an interim mid-term planning horizon for its water supply strategy. Thus, the SFPUC made a decision about a water supply strategy to serve its customers through 2018, and is deferring a decision regarding long-term water supply after 2018 and through 2030 until it undertakes further water supply planning and demand analysis.

The WSIP includes the following key program elements:

- Full implementation of all of the 17 proposed WSIP facility improvement projects described in the PEIR.
- Water supply delivery of 265 million gallons per day (mgd) (average annual target delivery) to regional water system customers through 2018, with water supplies originating from the Tuolumne, Alameda, and Peninsula watersheds. This includes 184 mgd for the wholesale customers (including nine mgd for the cities of San Jose and Santa Clara) and 81 mgd for the retail customers.
- Development of 20 mgd of conservation, recycled water and groundwater within the SFPUC service area (10 mgd in the retail service area and 10 mgd in the wholesale service area).
- Dry-year transfer from the Modesto and/or Turlock Irrigation Districts of about two mgd coupled with the GSR Project (previously listed as the Westside Groundwater Basin conjunctive-use project) to meet the drought year goal of limiting rationing to no more than 20 percent on a systemwide basis.
- Reevaluation of 2030 demand projections, potential regional water system purchase requests and water supply options by 2018, as well as a separate SFPUC decision in 2018 regarding regional water system water deliveries after 2018.
- Financial incentives to limit water sales to an annual average of 265 mgd from the watersheds.

Under the WSIP, the SFPUC will deliver to customers up to 265 mgd from the SFPUC watersheds on an average annual basis. While average annual deliveries from the SFPUC watersheds would be limited to 265 mgd, such that there would be no increase in diversions from the Tuolumne River to serve additional demand, there would be a small increase in average annual Tuolumne River diversions of about two mgd over existing conditions in order to meet delivery and drought reliability goals through 2018.

The SFPUC must maintain water deliveries to all its customers for the protection of public health and safety. Therefore, under the WSIP, the SFPUC will work with its customers to develop financial incentives to limit water sales to an average annual amount of 265 mgd from the watersheds through 2018. With the projected 20 mgd of conservation, recycled water, and groundwater projects, the WSIP water supply strategy would meet average daily demand of 285 mgd in 2018.

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[2] The size and design of the WSIP facility improvement projects are driven by the SFPUC's system performance objectives and would not change as a result of the water supply decision included as part of the WSIP (see SFPUC Resolution No. 08-0200).

As part of adoption of the WSIP, the SFPUC has committed to implementing the mitigation measures identified for the WSIP in the PEIR, including measures addressing impacts that may result from increases in deliveries from the SFPUC watersheds over the total annual average of 265 mgd in the event that conservation, recycled water and groundwater projects are not completed prior to the increase in customer demand (SFPUC Resolution No. 08-200).

1.2.2.2 WSIP Systemwide Operation Strategy

The WSIP also provides a future operating strategy for the regional water system, which addresses the condition of the physical facilities and infrastructure while accounting for factors that affect the system including fluctuating customer demand, meteorological and hydrological conditions, facility and infrastructure capacity and maintenance requirements, and institutional parameters. The operating strategy addresses four components of system operation: water supply and storage, water quality, water delivery, and asset management.

Day-to-day operation of the regional water system under the WSIP would be similar to existing operations, but would provide for additional facility maintenance activities and improved emergency preparedness. This would allow the SFPUC to meet its WSIP objectives and provide for increased system reliability and additional flexibility for scheduling repairs and maintenance. The proposed operations strategy would also include a multistage drought response program. Under the WSIP, regional water system operations would continue to comply with all applicable institutional and planning requirements including complying with all water quality, environmental and public safety regulations; maximizing the use of water from local watersheds; assigning a higher priority to water delivery over hydropower generation; and meeting all downstream flow requirements.

1.2.2.3 Summary of Impacts and Mitigation Measures Associated with the WSIP Water Supply and System Operations Strategy

The WSIP would result in changes in reservoir levels and associated changes in downstream flows in rivers and creeks in the three affected watersheds, potentially affecting groundwater, water quality, fisheries, and terrestrial biological resources. In the event that deliveries to customers exceed 265 mgd (average annual), streamflow changes in the Tuolumne River watershed could affect fisheries and terrestrial biological resources. In the Alameda Creek and Peninsula watersheds, the WSIP, which includes restoring the historical storage capacities of Calaveras and Lower Crystal Springs Reservoirs, could affect reservoir levels, downstream flows, fisheries, and terrestrial biological resources. In addition, the WSIP proposes to develop groundwater supplies in the northern portion of the Westside Groundwater Basin as well as a conjunctive-use program in the southern portion of the Westside Groundwater Basin (the GSR Project).

The WSIP impacts identified in the PEIR that are potentially significant but mitigable, potentially significant and unavoidable, and significant and unavoidable are listed below. As set forth in the PEIR, the San Francisco Planning Department determined the environmental impacts on all resources not listed below would be less than significant and no mitigation measures for these impacts would be required (see WSIP PEIR Chapter 5, Environmental Setting and Impacts, for further discussion of the impact analysis on the WSIP's water supply strategy; see PEIR Chapter 6, Mitigation Measures, for a list of the mitigation measures associated with these impacts).

Potentially Significant but Mitigable WSIP Water Supply and System Operations Impacts

- **Fisheries Resources:** Tuolumne River (only when average annual deliveries from the watersheds exceed 265 mgd); Alameda Creek.
- **Terrestrial Biological Resources:** Tuolumne River (below La Grange Dam - only when average annual deliveries exceed 265 mgd; and impacts on alluvial features that support meadow and riparian habitat from O'Shaughnessy Dam to Don Pedro Reservoir); Calaveras Reservoir; Alameda Creek; Calaveras Creek; Upper and Lower Crystal Springs Reservoir.
- **Groundwater:** Pumping overdraft; change in water levels in Lake Merced and other surface water features; seawater intrusion due to decreased groundwater levels; contamination of drinking water.

Potentially Significant and Unavoidable WSIP Water Supply and System Operations Impacts

- **Fisheries:** Upper and Lower Crystal Springs Reservoir. Based on the best available information at that time, the PEIR made the conservative determination that the WSIP would result in potentially significant and unavoidable impact on fishery resources in Crystal Springs Reservoir related to inundation of spawning habitat upstream of the reservoir (see PEIR Chapter 5, Section 5.5.5, Impact 5.5.5-1). The project-level fisheries analysis in the EIR on the Lower Crystal Springs Dam Improvements project modified certain PEIR impact determinations based upon more detailed site-specific data and analysis (San Francisco Planning Department 2010). Project-level conclusions supersede the contrary impact conclusions in the PEIR and the project-level analysis determined that impacts on fishery resources due to inundation effects would be less than significant.
- **Growth Inducement:** SFPUC service area.

Significant and Unavoidable WSIP Water Supply and System Operations Impacts

- **Streamflow:** Alameda Creek below Alameda Creek Diversion Dam. Based on the best available information at that time, the PEIR made the conservative determination that the WSIP would result in a significant and unavoidable impact related to flow along Alameda Creek below the Alameda Creek Diversion Dam ("Alameda Creek Hydrologic Impact") (see PEIR Chapter 5, Section 5.4.1, Impact 5.4.1-2). The project-level analysis in the Calaveras Dam Replacement Project EIR modifies this PEIR impact determination to be less than significant based upon more detailed site-specific data and analysis (San Francisco Planning Department 2011). Project-level conclusions supersede the contrary impact conclusions in the PEIR.

1.2.2.4 Alternatives to the WSIP

The PEIR evaluated seven alternatives to the WSIP because of their ability to meet most of the WSIP's goals, their ability to reduce one or more of the significant impacts associated with program implementation, their potential feasibility, and their collective ability to provide a reasonable range of alternatives to foster informed decision-making and public participation. Analysis of the No Program Alternative was included as required by CEQA. The seven WSIP alternatives are summarized in Chapter 7, Alternatives, of this EIR; PEIR Chapters 9, CEQA Alternatives, and 14, Master Responses, respectively, present a more detailed summary of these alternatives and are incorporated into this EIR by reference.

1.3 PROJECT BACKGROUND AND OBJECTIVES

1.3.1 Project Background

The proposed GSR Project, as one of the WSIP projects, would support the WSIP goals and system performance objectives. The proposed Project would help achieve the WSIP goals because it would provide dry-year supply to increase water delivery reliability and meet customer water supply needs. In addition, the proposed Project would provide increased regional operational flexibility to restore water service during unplanned outages and/or a loss of water source. Without the Project, the SFPUC has determined that it could not meet its goals for dry-year delivery reliability (San Francisco Planning 2008a).

1.3.2 Project Goals and Objectives

The proposed Project would increase the volume of groundwater in storage by allowing the southern portion of the Westside Groundwater Basin to recharge naturally during normal and wet years. The increased volume of groundwater in storage would occur through a reduction in groundwater pumping by the Partner Agencies; this reduction in groundwater pumping would be made possible by increased surface water deliveries to the Partner Agencies from the regional water system in those years. This "conjunctive" or cooperative use of the basin would allow recapture of the naturally stored water during dry years.

The primary goal for the Project is to provide an additional dry-year water supply. Specific objectives of the Project are to:

- Conjunctively manage the southern portion of the Westside Groundwater Basin through the coordinated use of SFPUC surface water and groundwater pumped by the Partner Agencies;
- Provide supplemental SFPUC surface water to the Partner Agencies in normal and wet years, with a corresponding reduction of groundwater pumping by these agencies to allow for in-lieu recharge of the southern portion of the Westside Groundwater Basin;
- Increase the dry-year and emergency pumping capacity of the southern portion of the Westside Groundwater Basin by 7.2 million gallons per day (mgd); and

- Provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8.5-year design drought cycle[3].

1.4 PROJECT DESCRIPTION

1.4.1 Project Location

The proposed Project would be located in northern San Mateo County, overlying the southern portion of the Westside Groundwater Basin. The Westside Groundwater Basin extends from western San Francisco south into San Mateo County. The Basin has an area of approximately 40 square miles and underlies San Francisco, Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame. For purposes of discussion in this EIR, the Westside Groundwater Basin has been administratively divided at the San Francisco-San Mateo County line. Although this is a not a physical boundary, there are differences in conditions between the northern and southern portions of the Westside Groundwater Basin. The chief distinction is that in the northern portion of the Basin, groundwater levels remain above sea level and groundwater currently discharges to the ocean, whereas decades of pumping by the Partner Agencies and irrigators in the southern portion of the Basin have lowered groundwater levels to between 15 and 195 feet below sea level, effectively freeing up vacated aquifer storage space for the proposed conjunctive use of the Basin (LSCE 2010). The northern portion of the Basin that lies within San Francisco County is referred to in this EIR as the North Westside Groundwater Basin. Likewise, the southern portion of the Basin that lies within San Mateo County is referred to herein as the South Westside Groundwater Basin.

The Project would be located within the water service areas for the cities of Daly City, San Bruno, and Millbrae, as well as Cal Water, which includes portions of South San Francisco, Colma, and unincorporated San Mateo County. Groundwater production well facilities would be constructed and owned by the SFPUC in the cities of Daly City, Colma, South San Francisco, San Bruno, Millbrae, and unincorporated San Mateo County. Well facilities would be connected to existing water distribution pipelines owned by the Partner Agencies and the SFPUC.

1.4.2 Groundwater Storage and Recovery

The Regional Groundwater Storage and Recovery (GSR) Project (proposed Project or Project) proposes to increase water supply reliability during dry years or in emergencies, by increasing water storage in the South Westside Groundwater Basin during wet and normal years for subsequent recapture during dry years. The proposed Project consists of this groundwater storage and recovery, with construction and operation of groundwater production wells and associated distribution and treatment facilities to recover

[3] The SFPUC measures water supply reliability using an 8.5-year design drought. The proposed Operating Agreement between the SFPUC and Partner Agencies contemplates use of the dry-year supplies made available by the Project starting in the second year of the design drought. Therefore, the estimated 60,500 acre feet (af) of new groundwater storage is assumed to be used over 7.5 years of the design drought, operating at a maximum capacity of 7.2 mgd.

the stored groundwater. An Operating Agreement would guide overall groundwater management and surface water deliveries associated with the proposed Project.

The SFPUC supplies surface water to the Partner Agencies from its regional water system. The Partner Agencies currently supply potable water to their retail customers through a combination of groundwater from the South Westside Groundwater Basin and purchase of SFPUC surface water. The proposed Project would provide supplemental SFPUC surface water to the Partner Agencies during normal and wet years. During normal and wet years, the Partner Agencies would reduce their groundwater pumping by a comparable amount to increase the amount of groundwater in storage through natural, or in-lieu, recharge during these periods. During normal and wet years, the volume of groundwater in the South Westside Groundwater Basin would increase due to natural recharge and reduced groundwater pumping by the Partner Agencies. During dry years, the Partner Agencies and the SFPUC would pump the stored groundwater using 16 new well facilities. This new dry-year water supply would be blended with water from the regional water system, and would thereby increase the available water supply to all regional water system customers.

1.4.3 Project Construction

The proposed Project consists of the construction and operation of up to 16 new well facilities within the South Westside Groundwater Basin and an upgrade to the existing Daly City Westlake Pump Station. This EIR also includes the evaluation of three additional well facilities (19 in total), which the SFPUC also proposes as alternates in case one of the 16 preferred well facilities cannot be constructed because either: (1) the SFPUC is unable to secure access or necessary easements; (2) the well facility cannot be successfully operated because groundwater quality or groundwater yield does not meet Project requirements; or (3) the well facility is otherwise determined by the SFPUC to be infeasible. Under any of these circumstances, the SFPUC would eliminate that well site from the Project (and properly decommission the well if it had already been constructed) and construct and operate one of the three other proposed alternate well facilities. Therefore, this EIR evaluates construction of 19 well facilities (16 preferred and three alternate sites) and operation of only 16 well facilities. The preferred well facilities would be at Sites 1-16; the three alternate well facilities would be at Sites 17 (Alternate), 18 (Alternate), and 19 (Alternate). Therefore, the 16 well facilities to be operated could be at any of the 19 well facility locations.

For Sites 5, 6, and 7, two treatment scenarios are analyzed in this EIR. One scenario, referred to herein at "on-site treatment", involves the installation of treatment equipment at each of these well facility sites (as described below).Water drawn from each well would be treated at that site and delivered to the distribution system. The second scenario – preferred by the SFPUC – would involve wells at each of the three sites, but a single consolidated treatment facility at Site 6. Referred to as "consolidated treatment at Site 6," in this preferred scenario water drawn from Sites 5 and 7 would be conveyed via pipeline to Site 6 for treatment there and delivery into the distribution system.

Each well facility would contain a well pump station, distribution piping, and utility connections. Most well facilities would also provide disinfection designed to inactivate harmful pathogens using chlorine and ammonia. At certain sites, additional treatment (i.e., pH adjustment, fluoridation and/or iron/manganese removal) has been incorporated into the design of the facility to meet both regulatory and water quality targets in the finished water for all agencies.

The proposed well facilities have been designed and sited so that wells are in proximity to treatment systems and existing distribution systems (the regional water system and the local distribution systems of the Partner Agencies) to minimize energy use and the overall facility footprint. This EIR also analyzes the environmental impacts associated with the installation of water pipelines, sanitary sewers, storm drains, and electrical service from each well facility site to existing systems. In some cases, alternate pipeline routes connecting a well facility to the existing water distribution system are also analyzed.

Of the 16 preferred well facility sites evaluated in this EIR, four well facilities would connect to Daly City's distribution system; three to San Bruno's distribution system; two to Cal Water's distribution system; and seven to the regional water system. If, however, any of the 16 preferred wells cannot be feasibly constructed or operated, then the alternate well facilities may need to be connected to alternate distribution systems, so that the SFPUC and the Partner Agencies can receive the water allotted to each under the proposed Operating Agreement. The alternate well facilities would connect to either to Cal Water's distribution system or the regional water system.

1.4.4 Project Operations

Under the Project, the SFPUC and Partner Agencies would operate the 16 new well facilities with an annual average pumping capacity of 7.2 million gallons per day (equivalent to 8,100 acre-feet [af] per year) to provide a supplemental dry-year water supply. During dry-year conditions, Partner Agencies would also pump from their own existing wells up to annual average rates consistent with the pumping limitations expressed in the proposed Operating Agreement between the SFPUC and the Partner Agencies, as explained later in this section.

The SFPUC would supply the Partner Agencies with water from the regional water system during normal and wet years to reduce their need to pump groundwater. This reduction in pumping would allow the aquifer to recharge naturally. During dry years, the Partner Agencies would pump groundwater from proposed Project wells in addition to their existing wells to meet demands. This water would be distributed to San Francisco and other wholesale customers in northern San Mateo County through existing SFPUC transmission lines and the three Partner Agency water distribution systems. These existing distribution systems are located and sized appropriately to accommodate the additional groundwater that would be produced as part of the proposed Project (MWH et al. 2008).

The SFPUC would maintain an accounting of the storage volumes in the SFPUC Storage Account. The SFPUC would track the amount of water that has been stored during normal and wet years (Put Periods), and the amount of water pumped from the SFPUC Storage Account (Take Periods). When the SFPUC Storage Account is full, but there is no shortage of water that requires the SFPUC to pump groundwater from Project wells, then neither storage nor recovery would take place (Hold Periods). Accruals in the SFPUC Storage Account would be recorded based on metered, in-lieu surface water deliveries and corresponding metered decreases in groundwater pumping. The Project would be operated so that the SFPUC Storage Account would be increased up to 60,500 af (about 20 billion gallons).

Operation of the Project by the SFPUC and the Partner Agencies would be governed by an Operating Agreement. The proposed Operating Agreement describes the operation of Project wells; Put, Hold and Take Periods; and the role of the Operating Committee established by the Operating Agreement for purposes of groundwater basin management. The proposed Operating Agreement provides that the Project wells may be operated under the following circumstances:

- Beginning in the second dry year of a multiple year drought;
- During emergencies;
- During system rehabilitation, scheduled maintenance or malfunctioning of the water system; and
- Upon recommendation of the Operating Committee established by the Operating Agreement for purposes of Basin management[4].

1.5 SUMMARY OF PROJECT IMPACTS AND MITIGATION MEASURES

Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, of this EIR presents the environmental impact analyses for all CEQA topic areas and provides mitigation measures that would reduce significant impacts to a less-than-significant level, where feasible. A summary of all impacts and mitigation measures is provided in Table 1-1 (Summary of Impacts and Mitigation Measures). Text for the more extensive and longer mitigation measures is not included in this table; however the table refers the reader to the appropriate EIR analysis section for the full mitigation text and explanation. The categories used to designate impact significance in Table 1-1 are:

- **No Impact (NI).** An impact is considered not applicable (no impact) if there is no potential for impacts or if the environmental resource does not occur within the Project area or the area of potential effect. For example, there would be no impact related to tree removal if no trees would be removed at a facility site.
- **Less than Significant Impact (LS)**. This determination applies if the potential exists for some limited impact, but not for a substantial adverse effect that qualifies under the significance criteria as a significant impact.
- **Less than Significant Impact with Mitigation (LSM)**. This determination applies if the Project would result in an adverse effect that meets the significance criteria, but feasible mitigation is available that would reduce the impact to a less-than-significant level.
- **Significant Impact (S)**. A "significant effect" is defined by Section 15382 of the CEQA Guidelines as "a substantial, or potentially substantial, adverse change in any of the physical

[4] Over time, the Operating Committee may need to respond to issues to ensure appropriate management of the groundwater basin. Depending on what actions, if any, are proposed in the future, additional CEQA review may be required.

conditions within the project area affected by the project including land, air, water, minerals, flora, fauna, ambient noise, and objects of aesthetic significance. An economic or social change by itself shall not be considered a significant effect on the environment … [but] may be considered in determining whether the physical change is significant."

- **Significant and Unavoidable Impact with implementation of feasible Mitigation (SUM).** This determination applies if the Project would result in an adverse effect that meets the significance criteria and mitigation is available to lessen the impact, but the residual effect after implementation of the measure would remain significant. The impact would, therefore, be significant and unavoidable with mitigation.

- **Significant and Unavoidable Impact for which feasible mitigation is not available (SU)**. This determination applies if the Project would result in an adverse effect that meets the significance criteria, but for which there appears to be no feasible mitigation available to reduce the impact to a less-than-significant level. The impact would, therefore, be significant and unavoidable.

The impact level of significance shown in Table 1-1 (Summary of Impacts and Mitigation Measures) represents the highest level of significance for that impact (i.e., out of all 19 sites). Sites numbers for all significant and unavoidable impacts are listed in the table. Appendix C (Summary of Impacts Table) provides significance levels for each impact, at each individual site. Mitigation measures listed in the table include the site number for which the measure would be required to reduce significant impacts.

As discussed in Chapter 6, Other CEQA Issues, Section 6.1 (Growth Inducement), the proposed Project is one of several capital improvement projects that make up the SFPUC's WSIP. Implementation of the WSIP would support growth in the SFPUC service area, thereby contributing indirectly to environmental impacts caused by that growth. Because the proposed Project is part of the WSIP and would contribute to the WSIP's growth-inducement impact, the GSR Project would therefore contribute to the significant and unavoidable program-level impacts associated with growth inducement.

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Section 5.2 Land Use			
Impact LU-1. Project construction would have a substantial impact on the existing character of the vicinity and could substantially disrupt or displace existing land uses or land use activities.	S	**M-LU-1: Maintain Internal Cemetery Access (Site 7 [Consolidated Treatment at Site 6] and Site 14).**Prior to commencing construction at either Site 7 (where treatment for Site 7 is consolidated at Site 6) or at Site 14, the SFPUC or its construction contractor shall develop an access plan to be implemented during construction to ensure that access is available for visitors to all portions of the Woodlawn Memorial Park and Golden Gate National Cemetery within a reasonable period of time upon their arrival at the cemetery. The access plan shall include, for example, trench plating and alternative routing for visitors. The plan shall also address measures to maintain access for cemetery operations and maintenance. A copy of the access plan shall be submitted to the owner or operator of the Woodlawn Memorial Park and the Golden Gate National Cemetery prior to commencing construction, and they also shall be provided with the name of, and contact information for, a person identified to act as a liaison during construction at these sites. **M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).**Refer to the discussion of Impact TR-1 in Section 5.6, Transportation and Circulation. **M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).** Refer to the discussion of Impact NO-1 in Section 5.7, Noise and Vibration[5]. **M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).** Refer to the discussion of Impact NO-3 in Section 5.7, Noise and Vibration. **M-AQ-2a: BAAQMD Basic Construction Measures (All Sites).** Refer to the discussion of Impact AQ-2 in Section 5.8, Air Quality. **M-AQ-3: Construction Health Risk Mitigation (Site 5 On-site Treatment).** Refer to the discussion of Impact AQ-3 in Section 5.8, Air Quality.	SUM Sites 1, 3, 4, 5 (On-site Treatment) 9, 12, 14, 16, 18 (Alternate) and 19 (Alternate)
Impact LU-2. Project operations would result in substantial long-term or permanent impacts on the existing character or disrupt or displace land uses.	S	**M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station).** Refer to the discussion of Impact NO-5 in Section 5.7, Noise and Vibration.	LSM
Impact C-LU-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to land use.	S	**M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate])**. Refer to the discussion of Impact NO-1 in Section 5.7, Noise and Vibration. **M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate])**. Refer to the discussion of Impact NO-3 in Section 5.7, Noise and Vibration. **M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station).** Refer to the discussion of Impact NO-5 in Section 5.7, Noise and Vibration.	SUM Sites 9, 12, and 19
Section 5.3 Aesthetics			
Impact AE-1. Project construction would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.	S	**M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate].** The SFPUC shall require the contractor to ensure that construction-related activity is as clean and inconspicuous as practical by storing construction materials and equipment at areas of the construction site that are generally away from public view, and by removing construction debris promptly at regular intervals.	SUM Site 7 Consolidated Treatment at Site 6 and On-site Treatment options

[5] Impact NO-1 is not significant for Sites 5 and 15, but they are included in the title of the mitigation measure because Mitigation Measure M-NO-1 is required under Impact NO-3.

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
		M-AE-1b[6]: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]) The SFPUC shall identify trees to be protected and retained during construction and minimize potential impact to these trees by implementing the following measures: • Construction activities within the dripline of trees to be retained adjacent to construction area boundaries or adjacent to pipeline routes shall be avoided. • A qualified arborist shall identify the location of exclusion fencing to be installed around trees to be retained. • Prior to the start of construction, the SFPUC or its contractor shall install exclusion fencing around the dripline of trees to be retained and within 50 feet of any grading or construction activity. • Prior to construction, the SFPUC shall verify that the temporary construction fencing is installed and approved by a qualified arborist. Any encroachment within these areas must first be approved by a qualified arborist and the SFPUC. Temporary fencing shall be continuously maintained by the contractor until all construction activities near the trees are completed. No construction activities shall occur within the exclusion fencing. • For trees on slopes, exclusion fencing shall consist of a silt fence that will be installed at the upslope base of the tree to prevent soil from moving into the root zone (defined as the extent of the tree dripline) if work is performed upslope of any protected trees. • Pruning of trees to be retained shall be completed by either a certified arborist or by the contractor under supervision of either an International Society of Arboriculture qualified arborist, American Society of Consulting Arborists consulting arborist, or a qualified horticulturalist. **M-AE-1c: Develop and Implement a Tree Replanting Plan (Site 12).**The SFPUC shall develop and implement a tree replanting plan to address the removal of trees along El Camino Real at Site 12. The tree replanting plan shall include planting locations (which may include non-SFPUC properties), native tree and shrub species (consistent with those near the well facility site), planting ratios, and irrigation requirements. Tree replanting activities occurring on SFPUC properties or right-of-way shall be consistent with the requirements of the SFPUC's Integrated Vegetation Management Policy (SFPUC 2007). The planting ratio for replacement trees shall be a minimum of 1:1, or in substantial compliance with the City of South San Francisco's tree preservation ordinance (Chapter 13.30.080, Replacement of Protected Trees).. Replanting shall occur the first year after completion of construction. The SFPUC shall monitor the replacement trees annually for five years after project completion to ensure that the trees survive; if necessary, the SFPUC shall implement additional measures, such as replanting for trees that did not survive. **M-AE-1d: Construction Area Screening (Site 15).**The SFPUC and its contractors shall screen the construction area at the facility site at Site 15. Screening shall be designed to minimize view of construction equipment and construction activities from views from Sneath Lane and the surrounding areas. Vehicles and other construction equipment shall be parked in the screened construction area at night and when equipment is not actively being used for pipeline construction along Sneath Lane. **M-AE-1e: Tree Removal and Replacement (Site 7).**Prior to the removal of any trees within the construction area boundary at Site 7, the SFPUC shall determine if any trees within the Town-designated tree mass can be retained without causing conflicts with construction equipment and/or safety risks during construction at this site. A qualified arborist shall conduct the tree retention survey. Any trees found not to conflict with construction activities or create a safety risks shall be protected during construction. For each tree to be removed, the SFPUC shall plant replacement trees on-site to the extent allowable by its Integrated Vegetation Management Policy (Section 13.006) (SFPUC 2007). Each replacement tree shall be in a minimum 15-gallon container and shall be of species listed in the vegetation management policy. The on-site plantings shall be located such that the visual continuity of the existing tree mass is restored to the extent feasible. To the extent tree replacement on-site is not feasible, replacement trees shall be planted off-site in substantial compliance with the Town of Colma's Tree Cutting and Removal ordinance. In all cases, the planting ratio shall be a minimum of 1:1 (i.e., one tree planted for each tree removed). Replanting shall occur within the first year after completion of construction. The SFPUC shall monitor plantings annually for five years after project completion to ensure that the replacement planting(s) has developed and that the	

[6] Impact AE-1 is not significant for Sites 3, 4, 7, 10, 11, 13, 14, and 17 (Alternate), however the sites are listed here because tree protection measures are required to reduce impacts to trees protected by local tree preservation ordinances as described under Impact BR-4 as discussed in the Biological Resources section.

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
		trees survive. If necessary, the SFPUC shall implement additional measures (e.g., replanting, installation of irrigation) to address continued survival of the plantings, and shall re-plant additional trees should a significant amount of the original plantings not survive during the monitoring period. **M-CR-1a: Minimize Construction-related Impacts on Elements of the Historical Resource at Site 14.** Refer to the discussion of Impact CR-1 in Section 5.5, Cultural and Paleontological Resources.	
Impact AE-2. Project construction would not create a new source of substantial light that would adversely affect day or nighttime views in the area.	LS	No mitigation required.	LS
Impact AE-3. Project operation would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.	S	**M-AE-3a: Implement Landscape Screening (Sites 4, 7, and 18 [Alternate]).** The SFPUC shall develop and implement a landscape-screening plan to screen views of the well facility. The landscape plan shall include native trees and shrubs common to the surrounding areas. The landscape plan shall include plant species, planting specifications, and irrigation requirements necessary to screen the well facility. The SFPUC shall monitor landscape plantings annually for five years after project completion to ensure that sufficient ground coverage has developed and that the shrubs survive. If necessary, the SFPUC shall implement additional measures (e.g., replanting, temporary irrigation) to address continued survival of the plantings, and shall replant additional shrubs should a significant amount of the plantings not survive during the monitoring period. **M-CR-5a: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14.** Refer to the discussion of Impact CR-5 in Section 5.5, Cultural and Paleontological Resources. **M-CR-5b: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 15.** Refer to the discussion of Impact CR-5 in Section 5.5, Cultural and Paleontological Resources.	LSM
Impact AE-4. Project operation would not create a new source of substantial light that would adversely affect day or nighttime views in the area.	LS	No mitigation required.	LS
Impact C-AE-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to scenic resources and visual character.	S	**M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate]).** Refer to the discussion of Impact AE-1 in Section 5.3, Aesthetics. **M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]).** Refer to the discussion of Impact AE-1 in Section 5.3, Aesthetics. **M-AE-1c: Develop and Implement a Tree Replanting Plan (Site 12).**Refer to the discussion of Impact AE-1 in Section 5.3, Aesthetics.	LSM
Section 5.4 Population and Housing - ***None. No impacts would occur.***			

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Section 5.5 Cultural and Paleontological Resources			
Impact CR-1. Project construction could cause an adverse change in the significance of a historical resource.	S	**M-CR-1a: Minimize Construction-related Impacts to Elements of the Historical Resource at Site 14.** Refer to the discussion of Impact CR-1 in Section 5.5, Cultural and Paleontological Resources. **M-NO-2: Reduce Vibration Levels during Construction of Pipelines (Sites 3, 4, 12, 15, and 18 [Alternate]).** Refer to the discussion of Impact NO-2 in Section 5.7, Noise and Vibration. **M-CR-1b: Minimize Construction-related Impacts on Elements of the Historical Resource at Site 15.** Refer to the discussion of Impact CR-1 in Section 5.5, Cultural and Paleontological Resources.	LSM
Impact CR-2. Project construction could cause an adverse change in the significance of an archaeological resource.	S	**M-CR-2: Discovery of Archaeological Resources (All Sites except West Lake Pump Station).**Refer to the discussion of Impact CR-2 in Section 5.5, Cultural and Paleontological Resources.	LSM
Impact CR-3. Project construction could result in a substantial adverse effect by destroying a unique paleontological resource or site.	S	**M-CR-3: Suspend Construction Work If a Paleontological Resource Is Identified (All Sites except Site 9 and Westlake Pump Station).** If a paleontological resource (fossilized invertebrate, vertebrate, plant or micro-fossil) is discovered during construction at any of the proposed well facility sites, all ground disturbing activities within 50 feet of the find shall be temporarily halted but may be diverted to areas beyond 50 feet from the discovery to continue working. An appointed representative of the SFPUC shall notify a qualified paleontologist, who will document the discovery as needed, evaluate the potential resource, and assess the nature and significance of the find. Based on the scientific value or uniqueness of the find, the paleontologist may record the find and allow work to continue, or recommend salvage and recovery of the material, if the SFPUC determines that the find cannot be avoided. The paleontologist shall make recommendations for any necessary treatment that is consistent with the SVP Guidelines (SVP 2012) and currently accepted scientific practices. If required, treatment for fossil remains may include preparation and recovery of fossil materials so that they can be housed in an appropriate museum or university collection and may also include preparation and publication of a report describing the find. The paleontologist's recommendations shall be subject to review and approval by the ERO or designee. The SFPUC shall be responsible for ensuring that treatment is implemented and reported to the San Francisco Planning Department. If no report is required, the SFPUC shall nonetheless ensure that information on the nature, location and depth of all finds is readily available to the scientific community through university curation or other appropriate means.	LSM
Impact CR-4. Project construction could result in a substantial adverse effect related to the disturbance of human remains.	S	**M-CR-4: Accidental Discovery of Human Remains (All Sites except Westlake Pump Station).** The treatment of any human remains and associated or unassociated funerary objects discovered during soil-disturbing activities shall comply with applicable State laws. Such treatment would include immediate notification of the San Mateo County Coroner and, in the event of the coroner's determination that the human remains are Native American, notification of the NAHC, which would appoint a Most Likely Descendant (MLD) (PRC Section 5097.98). A qualified archaeologist, the SFPUC and MLD shall make all reasonable efforts to develop an agreement for the treatment, with appropriate dignity, of any human remains and associated or unassociated funerary objects (CEQA Guidelines Section 15064.5[d]). The agreement would take into consideration the appropriate excavation, removal, recordation, analysis, custodianship, and final disposition of the human remains and associated or unassociated funerary objects. The PRC allows 48 hours to reach agreement on these matters. If the MLD and the other parties could not agree on the reburial method, the SFPUC shall follow Section 5097.98(b) of the PRC, which states that "the landowner or his or her authorized representative shall reinter the human remains and items associated with Native American burials with appropriate dignity on the property in a location not subject to further subsurface disturbance." All archaeological work performed under this mitigation measure shall be subject to review by the ERO or designee.	LSM
Impact CR-5. Project facilities could cause an adverse change in the significance of a historical resource.	S	**M-CR-5a: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14.** Refer to the discussion of Impact CR-5 in Section 5.5, Cultural and Paleontological Resources. **M-CR-5b: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 15.** Refer to the discussion of Impact CR-5 in Section 5.5, Cultural and Paleontological Resources.	LSM

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Impact C-CR-1. Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains.	S	**M-CR-2: Discovery of Archaeological Resources (All Sites except Westlake Pump Station).** Refer to the discussion of Impact CR-2 in Section 5.5, Cultural and Paleontological Resources. **M-CR-3: Suspend Construction Work If a Paleontological Resource Is Identified (All Sites except Site 9 and Westlake Pump Station).** Refer to the discussion of Impact CR-3 in Section 5.5, Cultural and Paleontological Resources. **M-CR-4: Accidental Discovery of Human Remains (All Sites except Westlake Pump Station).** Refer to the discussion of Impact CR-4 in Section 5.5, Cultural and Paleontological Resources.	LSM
Section 5.6 Transportation and Circulation			
Impact TR-1. The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system.	S	**M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])**[7]**.**Refer to the discussion of Impact TR-1 in Section 5.6, Transportation and Circulation.	LSM
Impact TR-2. The Project would temporarily impair emergency access to adjacent roadways and land uses during construction.	S	**M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).** Refer to the discussion of Impact TR-1 in Section 5.6, Transportation and Circulation.	LSM
Impact TR-3. The Project would temporarily decrease the performance and safety of public transit, bicycle, and pedestrian facilities during construction.	S	**M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).** Refer to the discussion of Impact TR-1 in Section 5.6, Transportation and Circulation.	LSM
Impact TR-4. Project operations and maintenance activities would not conflict with an applicable plan or policies regarding performance of the transportation system or alternative modes of transportation.	LS	No mitigation required.	LS
Impact C-TR-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to transportation and circulation.	S	**M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).** Refer to the discussion of Impact TR-1 in Section 5.6, Transportation and Circulation. **M-C-TR-1: Coordinate Traffic Control Plan with other SFPUC Construction Projects (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).**Prior to construction, the SFPUC and its contractors shall coordinate with other SFPUC construction projects in the region and update traffic control plans to avoid overlapping construction schedules or, if not practical, to minimize impacts to congestion, emergency access, and alternative modes of transportation.	LSM

[7] Impact TR-1 is not significant for Site 2, but it is included here because a Traffic Control Plan is required under Impact TR-2.

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Section 5.7 Noise and Vibration			
Impact NO-1. Project construction would result in noise levels in excess of local standards.	S	**M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).**[8] Refer to the discussion of Impact NO-1 in Section 5.7, Noise and Vibration.	SUM Sites 1, 4, 9, 12, 16, 18 (Alternate), and 19 (Alternate)
Impact NO-2. Project construction would result in excessive groundborne vibration.	S	**M-NO-2: Reduce Vibration Levels during Construction of Pipelines (Sites 3, 4, 12, 15, and 18 [Alternate]).**The SFPUC shall require that the construction contractor not use vibratory compaction equipment within 25 feet of structures adjacent to Sites 3, 4, 12, 15, and 18 (Alternate).Non-vibratory compaction or controlled low strength materials (CLSM) backfill may be used in lieu of vibratory compaction equipment at these locations.	LSM
Impact NO-3. Project construction would result in a substantial temporary increase in ambient noise levels.	S	**M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).** Refer to the discussion of Impact NO-1 in Section 5.7, Noise and Vibration. **M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate])**.Refer to the discussion of Impact NO-3 in Section 5.7, Noise and Vibration.	SUM Sites 1, 3, 4, 5 (On-site Treatment), 9, 12, 14, 16, 18 (Alternate), and 19 (Alternate)
Impact NO-4. Project construction would not result in a substantial temporary increase in ambient noise levels along construction haul routes.	LS	No mitigation required.	LS
Impact NO-5. Operation of the Project would result in exposure of people to noise levels in excess of local noise standards or result in a substantial permanent increase in ambient noise levels in the Project vicinity.	S	**M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)**.Refer to the discussion of Impact NO-5 in Section 5.7, Noise and Vibration.	LSM
Impact C-NO-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to noise.	S	**M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).** Refer to the discussion of Impact NO-1 in Section 5.7, Noise and Vibration. **M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]).** Refer to the discussion of Impact NO-3 in Section 5.7, Noise and Vibration. **M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station).** Refer to the discussion of Impact NO-5 in Section 5.7, Noise and Vibration.	SUM Sites 12 and 19 (Alternate)

[8] Impact NO-1 is not significant for Sites 5 and 15, but they are included here because a Noise Control Plan is required under Impact NO-3.

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Section 5.8 Air Quality			
Impact AQ-1. Construction of the Project would not conflict with or obstruct implementation of applicable air quality plans.	LS	No mitigation required.	LS
Impact AQ-2. Emissions generated during construction activities would violate air quality standards and would contribute substantially to an existing air quality violation.	S	**M-AQ-2a: BAAQMD Basic Construction Measures (All Sites).** Refer to the discussion of Impact AQ-2 in Section 5.8, Air Quality. **M-AQ-2b: NO_X Reduction during Construction of Alternate Sites.** If one to three wells at Sites 1 through 16 are drilled but found to be unusable for any reason, and one to three well facilities are therefore constructed at alternate sites, the SFPUC shall reduce NO_x emissions by 20 percent during construction at the alternate site or sites. To meet this performance standard, the SFPUC shall develop and implement a plan demonstrating that the off-road equipment (i.e., equipment rated at more than 50 horsepower that is owned or leased by the contractor or subcontractors) to be used in constructing the wells and facilities at the alternate sites would achieve a fleet-wide average 20-percent NO_x reduction compared to the most recent CARB fleet average. Acceptable options for reducing emissions include the use of late model engines (i.e., meeting U.S. EPA Tier 3 standards or later), low-emission diesel products, alternative fuels that have lower NO_x emissions, engine retrofit technology, after-treatment products, add-on devices, and/or other options as such become available.	LSM
Impact AQ-3. Project construction would expose sensitive receptors to substantial pollutant concentrations.	S	**M-AQ-3: Construction Health Risk Mitigation (Site 5 On-site Treatment).** The SFPUC shall require the construction contractor to utilize, during the construction of Site 5 (On-site Treatment), off-road equipment (more than 50 horsepower) with late model engines meeting U.S. EPA Tier 4 (Interim), or utilize a combination of Tier 2 or Tier 3 engines with add-on devices that consist of level 3 diesel particulate filters.	LSM
Impact AQ-4. Project construction activities would not create objectionable odors affecting a substantial number of people.	LS	No mitigation required.	LS
Impact AQ-5. Project operations would not violate air quality standards or contribute substantially to an existing air quality violation.	LS	No mitigation required.	LS
Impact AQ-6. Project operations would not expose sensitive receptors to substantial pollutant concentrations.	LS	No mitigation required.	LS
Impact AQ-7. Project operations would not create objectionable odors affecting a substantial number of people.	LS	No mitigation required.	LS
Impact C-AQ-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality.	S	**M-AQ-2a: BAAQMD Basic Construction Measures (All Sites).** Refer to the discussion of Impact AQ-2 in Section 5.8, Air Quality. **M-AQ-2b: NOx Reduction during Construction of Alternate Sites.** Refer to the discussion of Impact AQ-2 in Section 5.8, Air Quality.	LSM

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Section 5.9 Greenhouse Gas Emissions			
Impact GG-1. Project construction would generate GHG emissions, but not at levels that would have a significant impact on the environment.	LS	No mitigation required.	LS
Impact GG-2. Project operations would generate GHG emissions, but not at levels that would result in a significant impact on the environment.	LS	No mitigation required.	LS
Impact C-GG. The proposed Project would not result in a cumulatively considerable contribution to GHG emissions.	LS	No mitigation required.	LS
Section 5.10 Wind and Shadow - ***None. No impacts would occur.***			
Section 5.11 Recreation			
Impact RE-1. The Project would not remove or damage existing recreational resources during construction	LS	No mitigation required.	LS
Impact RE-2. The Project would deteriorate the quality of the recreational experience during construction.	S	**M-AQ-2a: BAAQMD Basic Construction Measures (All Sites).** Refer to the discussion of Impact AQ-2 in Section 5.8, Air Quality.	LSM
Impact RE-3. The Project would not impair access to recreational resources during construction.	LS	No mitigation required.	LS
Impact RE-4. The Project would not damage recreational resources during operation.	LS	No mitigation required.	LS
Impact RE-5. The Project would not deteriorate the quality of the recreational experience during operation.	LS	No mitigation required.	LS
Impact RE-6. Operation of the Project would not remove or damage recreational resources, impair access to, or deteriorate the quality of the recreational experience at Lake Merced.	LS	No mitigation required.	LS

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Impact C-RE-1. Construction and operation of the proposed Project would not result in significant cumulative impacts on recreational resources.	LS	No mitigation required.	LS
Impact C-RE-2. Operation of the Project would not result in significant cumulative impacts on recreational resources at Lake Merced.	LS	No mitigation required.	LS
Section 5.12 Utilities and Service Systems			
Impact UT-1. Project construction could result in potential damage to or temporary disruption of existing utilities during construction.	S	**M-UT-1a: Confirm Utility Line Information (All Sites)**. Prior to excavation and/or other ground-disturbing construction activities, the SFPUC or its contractor(s) shall locate overhead and underground utility lines, such as natural gas, electricity, sewer, telephone and waterlines, that may be encountered during excavation work. Pursuant to State law, the SFPUC or its contractor(s) shall notify USA North. Information regarding the size and location of existing utilities shall be confirmed before excavation and other ground-disturbing activities commence. These utilities shall be highlighted on all construction drawings. Utilities may be located by customary techniques such as geophysical methods and hand excavation. **M-UT-1b: Safeguard Employees from Potential Accidents Related to Underground Utilities (All Sites).** While any excavation is open, the SFPUC or its contractor(s) shall protect, support, or remove underground utilities as necessary to safeguard employees. As part of contractor specifications, the contractor(s) shall be required to provide updates on planned excavations for the upcoming week and to specify when construction will occur near any high-priority utility lines that are identified. At the beginning of each week when this work will take place, the SFPUC construction managers shall conduct meetings with contractor staff, as required by the California Occupational Safety and Health Administration (CalOSHA), to record all protective and avoidance measures regarding such excavations. **M-UT-1c: Notify Local Fire Departments (All Sites).** In the event that construction activities result in damage to high-priority utility lines, including leaks or suspected leaks, the SFPUC or its contractor(s) shall immediately notify local fire departments to protect worker and public safety. **M-UT-1d: Emergency Response Plan (All Sites)**. Prior to commencing construction activities, the SFPUC shall develop an emergency response plan that outlines procedures to follow in the event of a leak or explosion resulting from a utility rupture. The emergency response plan shall identify the names and phone numbers of PG&E staff who would be available 24 hours per day in the event of damage or rupture of the high-pressure PG&E natural gas pipelines. The plan shall also detail emergency response protocols including notification, inspection and evacuation procedures; any equipment and vendors necessary to respond to an emergency, such as an alarm system; and routine inspection guidelines. **M-UT-1e: Advance Notification (All Sites).** The SFPUC or its contractor(s) shall notify all affected utility service providers in advance of Project excavation and/or other ground-disturbing activities. The SFPUC or its contractor(s) shall make arrangements with these entities regarding the protection, relocation, or temporary disconnection of services prior to the start of excavation and other ground-disturbing activities. The SFPUC or its contractor(s) shall coordinate with the appropriate utility service providers to ensure advance notification to residents, owners and businesses in the Project area of a potential utility service disruption two to four days in advance of construction. The notification shall provide information about the timing and duration of the potential service disruption. **M-UT-1f: Protection of Other Utilities during Construction (All Sites).** Detailed specifications shall be prepared as part of the design plans to include procedures for the excavation, support and fill of areas around subsurface utilities, cables and pipes. If it is not feasible to avoid an overhead utility line during construction, the SFPUC or its contractor(s) shall coordinate with the affected utility owner to either temporarily or permanently support the line, to de-energize the line while temporarily supporting the overhead line, or to temporarily re-route the line. **M-UT-1g: Ensure Prompt Reconnection of Utilities (All Sites).** The SFPUC or its contractor(s) shall promptly notify utility providers to reconnect any disconnected utility lines as soon as it is safe to do so.	LSM

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
		M-UT-1h: Avoidance of Utilities Constructed or Modified by Other SFPUC Projects (All Sites). The final construction drawings for the Project shall reflect any changes in utility locations, as well as the locations of any new utilities installed during construction of other SFPUC projects in San Mateo County whose disturbance areas overlap with the Project area. **M-UT-1i: Coordinate Final Construction Plans with Affected Utilities (All Sites).** The SFPUC or its contractor(s) shall coordinate final construction plans and specifications with affected utility providers.	
Impact UT-2. Project construction would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects.	LS	No mitigation required.	LS
Impact UT-3. Project construction would not result in adverse effects on solid waste landfill capacity.	LS	No mitigation required.	LS
Impact UT-4. Project construction could result in a substantial adverse effect related to compliance with federal, State, and local statutes and regulations pertaining to solid waste.	S	**M-UT-4: Waste Management Plan (All Sites).** Refer to the discussion of Impact UT-4 in Section 5.12, Utilities and Service Systems.	LSM
Impact UT-5. Project operation would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, or require or result in the construction of new, or expansion of existing, wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects.	LS	No mitigation required.	LS
Impact C-UT-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to utilities and service systems.	S	**M-UT-1a: Confirm Utility Line Information (All Sites).** Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems. **M-UT-1b: Safeguard Employees from Potential Accidents Related to Underground Utilities (All Sites).** Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems. **M-UT-1c: Notify Local Fire Departments (All Sites).** Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems. **M-UT-1d: Emergency Response Plan (All Sites).** Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems. **M-UT-1e: Advance Notification (All Sites).** Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems. **M-UT-1f: Protection of Other Utilities during Construction (All Sites).** Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems. **M-UT-1g: Ensure Prompt Reconnection of Utilities (All Sites).** Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems. **M-UT-1h: Avoidance of Utilities Constructed or Modified by Other SFPUC Projects (All Sites).** Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems.	LSM

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
		M-UT-1i: Coordinate Final Construction Plans with Affected Utilities (All Sites). Refer to the discussion of Impact UT-1 in Section 5.12, Utilities and Service Systems. **M-UT-4: Waste Management Plan (All Sites).** Refer to the discussion of Impact UT-4 in Section 5.12, Utilities and Service Systems.	
Section 5.13 Public Services - ***None. No impacts would occur.***			
Section 5.14 Biological Resources			
Impact BR-1. Project construction would adversely affect candidate, sensitive, or special-status species.	S	**M-BR-1a: Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors (All Sites).** Refer to the discussion of Impact BR-1 in Section 5.14, Biological Resources. **M-BR-1b: Protection Measures for Special-status Bats during Tree Removal or Trimming (Sites 1, 3, 4, 7, 10, 11, 12, 15, and 16).** Refer to the discussion of Impact BR-1 in Section 5.14, Biological Resources. **M-BR-1c: Protection Measures during Structure Demolition for Special-status Bats (Site 1).**Refer to the discussion of Impact BR-1 in Section 5.14, Biological Resources. **M-BR-1d: Monarch Butterfly Protection Measures (Sites 1, 3, 7, 10, and 12).**Refer to the discussion of Impact BR-1 in Section 5.14, Biological Resources.	LSM
Impact BR-2. Project construction could adversely affect riparian habitat or other sensitive natural communities.	S	**M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites).** Refer to the discussion of Impact HY-1 in Section 5.16, Hydrology and Water Quality. **M-BR-2: Avoid Disturbance to Riparian Habitat (Site 1).** Refer to the discussion of Impact BR-2 in Section 5.14, Biological Resources.	LSM
Impact BR-3. The Project would impact jurisdictional wetlands or waters of the United States.	S	**M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites).** Refer to the discussion of Impact HY-1 in Section 5.16, Hydrology and Water Quality.	LSM
Impact BR-4. Project construction would conflict with local tree preservation ordinances.	S	**M-BR-4a: Identify Protected Trees (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]).**Refer to the discussion of Impact BR-4 in Section 5.14, Biological Resources. **M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]).** Refer to the discussion in Impact BR-4 in Section 5.14, Biological Resources and in Impact AE-1 in Section 5.2, Aesthetics. **M-BR-4b: Protected Tree Replacement (Sites 4, 7, 9, 12, 15, and 18 [Alternate]).**Refer to the discussion of Impact BR-4 in Section 5.14, Biological Resources.	LSM
Impact BR-5. Project operations could adversely affect candidate, sensitive, or special-status species.	S	**M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station).** Refer to the discussion of Impact NO-5 in Section 5.7, Noise and Vibration.	LSM
Impact BR-6. Operation of the Project would not adversely affect species identified as candidate, sensitive, or special-status wildlife species in local or regional plans, policies, or regulations, or by the CDFW or USFWS.	LS	No mitigation required.	LS

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Impact BR-7. Operation of the Project could adversely affect sensitive habitat types associated with Lake Merced.	S	**M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced.** Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality. **M-HY-9b: Lake Level Management for Lake Merced**. Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality. **M-BR-7: Lake Level Management for Water Level Increases for Lake Merced.** Refer to the discussion of Impact BR-7 in Section 5.14, Biological Resources.	LSM
Impact BR-8. Operation of the Project could adversely affect wetland habitats and other waters of the United States associated with Lake Merced.	S	**M-BR-8: Lake Level Management for No-Net-Loss of Wetlands for Lake Merced.** Refer to the discussion of Impact BR-8 in Section 5.14, Biological Resources. **M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced.** Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality. **M-HY-9b: Lake Level Management for Lake Merced**. Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality.	LSM
Impact BR-9. Operation of the Project could adversely affect native wildlife nursery sites associated with Lake Merced.	S	**M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced.** Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality. **M-BR-7: Lake Level Management for Water Level Increases for Lake Merced.** Refer to the discussion of Impact HY-7 in Section 5.16, Hydrology and Water Quality.	LSM
Impact C-BR-1. Construction and operation of the proposed Project could result in significant cumulative impacts related to biological resources.	S	**M-BR-1a: Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors (All Sites).** Refer to the discussion of Impact BR-1 in Section 5.14, Biological Resources. **M-BR-1b: Protection Measures for Special-status Bats during Tree Removal or Trimming (Sites 1, 3, 4, 7, 10, 11, 12, 15, and 16).** Refer to the discussion of Impact BR-1 in Section 5.14, Biological Resources. **M-BR-1c: Protection Measures during Structure Demolition for Special-status Bats (Site 1).** Refer to the discussion of Impact BR-1 in Section 5.14, Biological Resources. **M-BR-1d: Monarch Butterfly Protection Measures (Sites 1, 3, 7, 10, and 12).** Refer to the discussion of Impact BR-1 in Section 5.14, Biological Resources. **M-BR-2: Avoid Disturbance to Riparian Habitat (Site 1).** Refer to the discussion of Impact BR-2 in Section 5.14, Biological Resources. **M-BR-4a: Identify Protected Trees (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]).**Refer to the discussion of Impact BR-4 in Section 5.14, Biological Resources. M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14,, 15, 17 [Alternate]) **M-BR-4b: Protected Tree Replacement (Sites 4, 7, 9, 12, 15, and 18 [Alternate]).** Refer to the discussion of Impact BR-4 in Section 5.14, Biological Resources. **M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites).** Refer to the discussion of Impact HY-1 in Section 5.16, Hydrology and Water Quality.	LSM
Impact C-BR-2. The Project would result in cumulative construction or operational impacts related to special-status species, riparian habitat, sensitive communities, wetlands or waters of the United States, or compliance with local policies and ordinances protecting biological resources at Lake Merced.	S	**M-BR-7: Lake Level Management for Water Level Increases for Lake Merced.** Refer to the discussion of Impact HY-7 in Section 5.16, Hydrology and Water Quality. **M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced.** Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality. **M-HY-9b: Lake Level Management for Lake Merced**. Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality.	LSM

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Section 5.15 Geology and Soils			
Impact GE-1. The Project would not be located on a geologic unit or soil that is unstable, or that would become unstable during construction.	LS	No mitigation required.	LS
Impact GE-2. The Project would not substantially change the topography or any unique geologic or physical features of the site(s).	LS	No mitigation required.	LS
Impact GE-3. The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides.	S	**M-GE-3: Conduct Site-Specific Geotechnical Investigations and Implement Recommendations (All Sites)**. Refer to the discussion of Impact GE-3 in Section 5.15, Geology and Soils.	LSM
Impact GE-4. The Project would be located on a geologic unit or soil that is unstable, or that would become unstable.	S	**M-GE-3: Conduct Site-Specific Geotechnical Investigations and Implement Recommendations (All Sites).** Refer to the discussion of Impact GE-3 in Section 5.15, Geology and Soils.	LSM
Impact GE-5. The Project would not be located on corrosive or expansive soil, creating substantial risks to life or property.	LS	No mitigation required.	LS
Impact C-GE-1. Construction and operation of the proposed Project could result in significant impacts related to soils and geology.	LS	No mitigation required.	LS
Section 5.16 Hydrology and Water Quality			
Impact HY-1. Project construction activities would degrade water quality as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals during construction.	S	**M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites).**Refer to the discussion of Impact HY-1 in Section 5.16, Hydrology and Water Quality.	LSM
Impact HY-2. Discharge of groundwater could result in minor localized flooding, violate water quality standards and/or otherwise degrade water quality.	S	**M-HY-2: Management of Well Development and Pump Testing Discharges (All Sites, Except Westlake Pump Station).** Refer to the discussion of Impact HY-2 in Section 5.16, Hydrology and Water Quality.	LSM

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Impact HY-3. Project operation would not alter drainage patterns in such a manner that could result in degraded water quality or cause on- or off-site flooding.	LS	No mitigation required.	LS
Impact HY-4. Project operation would not impede or redirect flood flows.	LS	No mitigation required.	LS
Impact HY-5. Project operation would not result in a violation of water quality standards or in the degradation of water quality from the discharge of groundwater during well maintenance.	LS	No mitigation required.	LS
Impact HY-6. Project operation would decrease the production rate of existing nearby irrigation wells due to localized groundwater drawdown within the Westside Groundwater Basin such that existing or planned land use(s) may not be fully supported.	S	**M-HY-6: Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation.** Refer to the discussion of Impact HY-6 in Section 5.16, Hydrology and Water Quality.	SUM
Impact HY-7. Project operation would not result in substantial land subsidence due to decreased groundwater levels in the Westside Groundwater Basin where the historical low water levels are exceeded.	LS	No mitigation required.	LS
Impact HY-8. Project operation would not result in seawater intrusion due to decreased groundwater levels in the Westside Groundwater Basin.	LS	No mitigation required.	LS
Impact HY-9. Project operation could have a substantial, adverse effect on water quality that could affect the beneficial uses of Lake Merced.	S	**M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced.** Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality. **M-HY-9b: Lake Level Management for Lake Merced.** Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality.	LSM
Impact HY-10. Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Pine Lake.	LS	No mitigation required.	LS
Impact HY-11. Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Colma Creek, San Bruno Creek, Lomita Channel, or Millbrae Creek.	LS	No mitigation required.	LS

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Impact HY-12. Project operation would not cause a violation of water quality standards due to mobilization of contaminants in groundwater from changing groundwater levels in the Westside Groundwater Basin.	LS	No mitigation required.	LS
Impact HY-13. Project operation would not result in degradation of drinking water quality or groundwater quality relative to constituents for which standards do not exist.	LS	No mitigation required.	LS
Impact HY-14. Project operation may have a substantial adverse effect on groundwater depletion in the Westside Groundwater Basin over the very long term.	S	**M-HY-14: Prevent Groundwater Depletion**. Refer to the discussion of Impact HY-14 in Section 5.16, Hydrology and Water Quality.	LSM
Impact C-HY-1. Project construction could result in a cumulatively considerable contribution to cumulative impacts on surface water hydrology and water quality.	S	**M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites).** Refer to the discussion of Impact HY-1 in Section 5.16, Hydrology and Water Quality. **M-HY-2: Management of Well Development and Pump Testing Discharges (All Sites except Westlake Pump Station).** Refer to the discussion of Impact HY-2 in Section 5.16, Hydrology and Water Quality.	LSM
Impact C-HY-2. Operation of the proposed Project would result in a cumulatively considerable contribution to cumulative impacts related to well interference.	S	**M-HY-6: Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation.** Refer to the discussion of Impact HY-7 in Section 5.16, Hydrology and Water Quality.	SUM
Impact C-HY-3. Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to subsidence.	LS	No mitigation required.	LS
Impact C-HY-4. Operation of the proposed Project would not have a cumulatively considerable contribution to seawater intrusion.	LS	No mitigation required.	LS
Impact C-HY-5. Operation of the proposed Project could have a cumulatively considerable contribution to cumulative impacts on beneficial uses of surface waters.	S	**M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced.** Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality. **M-HY-9b: Lake Level Management for Lake Merced**. Refer to the discussion of Impact HY-9 in Section 5.16, Hydrology and Water Quality.	LSM

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
Impact C-HY-6. Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality standards	LS	No mitigation required.	LS
Impact C-HY-7. Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality degradation.	LS	No mitigation required.	LS
Impact C-HY-8. Operation of the proposed Project would have a cumulatively considerable contribution to a cumulative impact related to groundwater depletion effect.	S	**M-HY-14: Prevent Groundwater Depletion.** Refer to the discussion of Impact HY-14 in Section 5.16, Hydrology and Water Quality.	LSM
Section 5.17 Hazards and Hazardous Materials			
Impact HZ-1. The Project would not create a significant hazard to the public or the environment related to transport, use, or disposal of hazardous materials during construction.	LS	No mitigation required.	LS
Impact HZ-2. The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction.	S	**M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites).** Refer to the discussion of Impact HY-1 in Section 5.16, Hydrology and Water Quality. **HZ-2a: Preconstruction Hazardous Materials Assessment (All Sites).**Within three months prior to construction, the SFPUC shall retain a qualified environmental professional to conduct a regulatory agency database review to update and identify hazardous materials sites within 0.25 mile of a well facility site and to review appropriate standard information sources to determine the potential for soil or groundwater contamination at the project sites. Should this review indicate a high likelihood of encountering contamination at the proposed facility sites, follow-up sampling shall be conducted to characterize soil and groundwater quality prior to construction to provide necessary data for the site health and safety plan (Mitigation Measure M-HZ-2b) and hazardous materials management plan (Mitigation Measure M-HZ-2c). If needed, site investigations or remedial activities shall be performed at facility sites in accordance with applicable laws and regulations. **M-HZ 2b: Health and Safety Plan (All Sites).**The construction contractor shall, prior to construction, prepare a site-specific health and safety plan in accordance with federal OSHA regulations (29 CFR 1910.120) and Cal-OSHA regulations (8 CCR Title 8, Section 5192) to address worker health and safety issues during construction. The health and safety plan shall identify the potentially present chemicals, health and safety hazards associated with those chemicals, all required measures to protect construction workers and the general public from exposure to harmful levels of any chemicals identified at the site (including engineering controls, monitoring, and security measures to prevent unauthorized entry to the work area), appropriate personal protective equipment, and emergency response procedures. The health and safety plan shall designate qualified individuals responsible for implementing the plan and for directing subsequent procedures in the event that unanticipated contamination is encountered. **M-HZ-2c: Hazardous Materials Management Plan (All Sites).**Refer to the discussion of Impact HZ-2 in Section 5.17, Hazards and Hazardous Materials.	LSM
Impact HZ-3. The Project would result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during construction.	S	**M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites).** Refer to the discussion of Impact HY-1 in Section 5.16, Hydrology and Water Quality.	LSM

TABLE 1-1
Summary of Impacts and Mitigation Measures

Impact	Level of Significance Prior to Mitigation	Mitigation Measure(s)	Level of Significance After Mitigation
		M-HZ-2c: Hazardous Materials Management Plan (All Sites). Refer to the discussion of Impact HZ-2 in Section 5.17, Hazards and Hazardous Materials.	
Impact HZ-4. The Project would not create a hazard to the public or environment from the routine transport, use, or disposal of hazardous materials or accidental release of hazardous materials during operation.	LS	No mitigation required.	LS
Impact HZ-5. The Project would not result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during operation.	LS	No mitigation required.	LS
Impact HZ-6. The Project would not result in a safety hazard for people residing or working in the vicinity of a public use airport.	LS	No mitigation required.	LS
Impact HZ-7. The Project would not expose people or structures to a significant risk of loss, injury, or death involving fires.	LS	No mitigation required.	LS
Impact C-HZ-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials.	S	**M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites).** Refer to discussion of Impact HY-1 in Section 5.16, Hydrology and Water Quality. **M-HZ-2a: Preconstruction Hazardous Materials Assessment (All Sites).** Refer to the discussion of Impact HZ-2 in Section 5.17, Hazards and Hazardous Materials **M-HZ 2b: Health and Safety Plan (All Sites).** Refer to the discussion of Impact HZ-2 in Section 5.17, Hazards and Hazardous Materials **M-HZ-2c: Hazardous Materials Management Plan (All Sites).** Refer to the discussion of Impact HZ-2 in Section 5.17, Hazards and Hazardous Materials	LSM
Section 5.18 Minerals and Energy Resources			
Impact ME-1. The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during construction.	LS	No mitigation required.	LS
Impact ME-2. The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during operation.	LS	No mitigation required.	LS
Impact C-ME-1. Construction and operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to mineral and energy resources.	LS	No mitigation required.	LS
Section 5.19 Agriculture and Forest Resources - ***None. No impacts would occur.***			

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1.6 ALTERNATIVES TO THE PROPOSED PROJECT

Chapter 7, Alternatives, of this EIR evaluates five alternatives to the proposed Project:

- **Alternative 1: No Project Alternative.** The SFPUC would not construct well facilities and the conjunctive use of the South Westside Groundwater Basin would not occur. Under the No Project Alternative, a GSR dry-year water supply would not be available to the SFPUC, its wholesale customers, or the Partner Agencies, as planned for and approved in the Phased WSIP.
- **Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield.** Alternative 2A was selected for analysis because it would reduce significant biological, and water quality impacts associated with declining lake levels at Lake Merced due to Project pumping during dry years. Under this alternative, the SFPUC would construct only 14 wells and well facilities (instead of 16 wells under the proposed Project) to reduce impacts associated with declining lake levels at Lake Merced due to Project pumping during dry years by approximately 54 percent. This alternative would not construct wells or well facilities at Sites 1 and 4, and without wells as these sites, pumping near Lake Merced would be reduced. To maintain the overall Project yield at 7.2 mgd, pumping would be redistributed to 11 wells at Sites 5 through 15. Pumping at each of Sites 5 through 15 would increase by approximately 20 percent compared to the proposed Project.
- **Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield**. Alternative 2B was selected for analysis because it would reduce significant biological, and water quality impacts associated with declining lake levels at Lake Merced due to Project pumping during dry years, but would not include any redistribution of pumping as Alternative 2A does. Under this alternative, the SFPUC would construct only 14 wells and well facilities (instead of 16 wells under the proposed Project) to reduce impacts associated with declining lake levels at Lake Merced due to Project pumping during dry years. This alternative would not construct wells or well facilities at Sites 1 and 4, and without wells at Sites 1 and 4, Project pumping would be reduced by 1.0 mgd and the overall Project yield would be 6.2 mgd. This alternative would decrease pumping near Lake Merced by approximately 54 percent.
- **Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield:** Alternative 3A was selected for analysis because it would reduce the significant well interference impacts of the Project during dry years at existing irrigation wells that are located at the Colma-area cemeteries. Under this alternative, the SFPUC would construct only 14 wells and well facilities (instead of 16 wells under the proposed Project). The 14 wells would be located at the same preferred sites as the Project; however, Alternative 3A would not include a well or well facility at Sites 7 or 8 in Colma. Without wells at Sites 7 and 8, Project pumping would be reduced by approximately 1.2 mgd. To maintain the overall Project yield at 7.2 mgd, pumping would be redistributed to the nine wells at Sites 1 through 4 and Sites 11 through 15. Project pumping at each of these sites would increase by approximately 31 percent compared to the proposed Project. Pumping at Sites 5, 6, 9, and 10 would be the same as the Project, because they are near Colma; pumping at Site 16 would be

the same as the Project, because groundwater availability is restricted there as compared to the other preferred sites. The alternative would decrease pumping in the Colma area by approximately 32 percent.

- **Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield:** Alternative 3B was selected for analysis because it would reduce the significant well interference impacts of the Project at existing irrigation wells for cemeteries in the Colma area due to Project pumping during dry years, but unlike Alternative 3A, it would not include any redistribution of pumping. Under Alternative 3B, the SFPUC would construct only 14 wells and well facilities (instead of 16 wells under the proposed Project). The 14 wells would be located at the same preferred sites as the Project; however, Alternative 3B would not include a well or well facility at Sites 7 or 8 in Colma. Without wells at Sites 7 and 8, pumping would be reduced by approximately 1.2 mgd, and the overall Project yield would be 6.0 mgd. The alternative would decrease pumping near Colma by approximately 32 percent.

Although the No Project Alternative would avoid construction-related impacts of the proposed Project, it would not achieve any of the Project objectives, and it would not fulfill the SFPUC's basic mission of providing a reliable water supply for its customers, because a new source of dry-year and/or emergency pumping capacity would be unavailable for SFPUC customers.

The alternatives analysis determined that Alternative 2A (Reduce Lake Merced Impacts and Maintain Project Yield) would eliminate construction impacts at two sites. Construction impacts at the other sites would be the same as those of the proposed Project. During operations, Alternative 2A would reduce the severity of well interference impacts on five existing irrigation wells near Lake Merced, but would increase well interference impacts at 12 existing irrigation wells compared to the Project, due to redistribution of pumping to GSR wells toward Colma-area existing irrigation wells. Impacts of Alternative 2A would be less severe than those of the proposed Project, with the exception of increased well interference impacts at some wells, and Alternative 2A would achieve the Project objectives and would support the SFPUC's goal of providing a reliable dry-year groundwater supply during the 8.5-year design drought cycle.

The alternatives analysis determined that Alternative 2B (Reduce Lake Merced Impacts and Reduce Project Yield) would also eliminate construction impacts at two sites. Construction impacts at the other sites would be the same as those of the proposed Project. Alternative 2B would meet most of the Project objectives, but it would not fully support the SFPUC's goal to supply water reliably to customers in the event of emergencies and drought because of the reduced yield associated with Alternative 2B.

The alternatives analysis determined that Alternative 3A (Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield) would eliminate construction impacts at two sites. Construction impacts at the other sites would be the same as those of the proposed Project. During operations, Alternative 3A would reduce the severity of well interference impacts on 10 existing irrigation wells at cemeteries in Colma, but would increase well interference impacts at seven existing irrigation wells compared to the Project and increase impacts to Lake Merced, due to redistribution of pumping to GSR wells away from the Colma area. The operational impacts of Alternative 3A would be less severe than the Project or Alternatives 2A or 2B, with the exception of increased impacts on Lake Merced. Alternative 3A would fully achieve the Project objectives and support the SFPUC's basic goal of providing a reliable dry-year and emergency groundwater supply during the 8.5-year design drought cycle.

The alternatives analysis determined that Alternative 3B (Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield) would eliminate construction impacts at two sites. Construction impacts at the other sites would be the same as those of the proposed Project. During operations, Alternative 3B would reduce the severity of well interference impacts on five existing irrigation wells at cemeteries in Colma as compared to the Project. As a result, two existing irrigation wells in Colma would not experience significant impacts, as they would under the proposed Project. The alternative would meet most of the Project objectives, but would not provide the full 7.2-mgd dry-year and emergency pumping capacity needed during the 8.5-year design drought. The alternative would result in an approximately 1.2-mgd shortfall during each year of a severe drought.

None of the alternatives would reduce all the significant and unavoidable impacts of the proposed Project. Alternatives 2A, 2B, 3A, and 3B would cause significant and unavoidable impacts related to construction at one or two fewer sites than the Project; however, significant and unavoidable construction-period impacts would still occur at up to other facility sites, as they would under the proposed Project. In addition, such impacts, although significant and unavoidable, would be temporary and would only last through the 16-month construction period. Alternatives 3A and 3B would cause significant and potentially unavoidable well interference impacts during operation at one or two fewer existing irrigation wells than the Project; however, significant and unavoidable well interference impacts would still occur at 11 or 12 existing irrigation wells, as they would under the proposed Project. Alternative 3A would cause slightly greater impacts to Lake Merced. The No Project Alternative would not cause significant and unavoidable construction impacts (since no construction would occur), but water levels at Lake Merced would continue to fluctuate as they do now under varying hydrologic conditions, and during a drought as severe as the design drought, lake levels would decline to a level that could have adverse water quality effects at Lake Merced. Because permanent operational impacts are considered more severe than temporary construction-period impacts, Alternative 3B (Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Yield) is considered the environmentally superior alternative, in that it would have significant and unavoidable well interference impacts at fewer sites than the proposed Project or Alternatives 2A, 2B or 3A.

1.7 AREAS OF CONTROVERSY

Several areas of potential controversy were identified during the scoping period. Environmental concerns raised during scoping include construction-related impacts from traffic and access issues, potential impacts of climate change, and an array of groundwater issues, which included potential impacts to private wells and the long-term productivity of these wells, impacts to the water level at Lake Merced, impacts to groundwater quality, and sustainability of the groundwater basin. During the scoping meeting, held on July 9, 2009, attendees commented on the scope of the Draft EIR. Written comments were also received during the scoping period (between June 24 and July 28, 2009). A scoping report was prepared that summarizes the comments received on the project, including a transcript of oral testimony at the July 2009 scoping session (see Appendix B [Scoping Summary Memorandum]). Refer to Table 2-2 (Summary of Scoping Comments) in Chapter 2, Introduction and Background, for an overview of the environmental concerns raised during the scoping period.

1.8 REFERENCES

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2 INTRODUCTION AND BACKGROUND

Sections	Figures	Tables
2.1 Introduction 2.2 Project Background 2.3 Purpose of this EIR 2.4 Public Review 2.5 Organization of the Draft EIR 2.6 References	2-1 Project Vicinity Map 2-2 Overview of SFPUC Regional Water System & Water Supply Watersheds 2-3 SFPUC Water Service Area, San Francisco, and SFPUC Wholesale Customers	2-1 WSIP Goals and Objectives 2-2 Summary of Scoping Comments

2.1 INTRODUCTION

The Regional Groundwater Storage and Recovery (GSR) Project (proposed Project or Project) proposes to increase water supply reliability during dry years or in emergencies, by increasing water storage in the Westside Groundwater Basin during wet and normal years for subsequent recapture during dry years and emergencies. The proposed Project would be located in San Mateo County and is sponsored by the San Francisco Public Utilities Commission (SFPUC) in coordination with its partner agencies, which include the cities of Daly City and San Bruno, and the California Water Service Company (Cal Water) in its South San Francisco service area (collectively referred to as Partner Agencies).

The SFPUC currently supplies surface water to the Partner Agencies from its regional water system. The Partner Agencies supply potable water to their retail customers through a combination of groundwater from the South Westside Groundwater Basin and purchase of SFPUC surface water. The proposed Project would provide supplemental SFPUC surface water to the Partner Agencies during normal and above-average rainfall years (referred to throughout this Environmental Impact Report [EIR] as "wet" years). During these years, the Partner Agencies would reduce their groundwater pumping by a comparable amount to increase the amount of groundwater in storage through natural (in-lieu) recharge. During normal and wet years, the volume of groundwater in the South Westside Groundwater Basin would increase due to the combination of natural recharge and reduced groundwater pumping by the Partner Agencies. During dry years, the Partner Agencies and the SFPUC would pump the stored groundwater using 16 new well facilities in addition to the Partner Agencies' existing wells. This new dry-year water supply would be blended with water from the regional water system and distributed to San Francisco and other wholesale customers in northern San Mateo County through existing SFPUC transmission lines or the three Partner Agency water distribution systems, thereby increasing the available water supply to all regional water system customers. The existing distribution systems are located and sized appropriately to accommodate the additional groundwater that would be produced as part of the proposed Project. Figure 2-1 (Project Vicinity Map), shows the proposed Project location in northern San Mateo County and the Westside Groundwater Basin.

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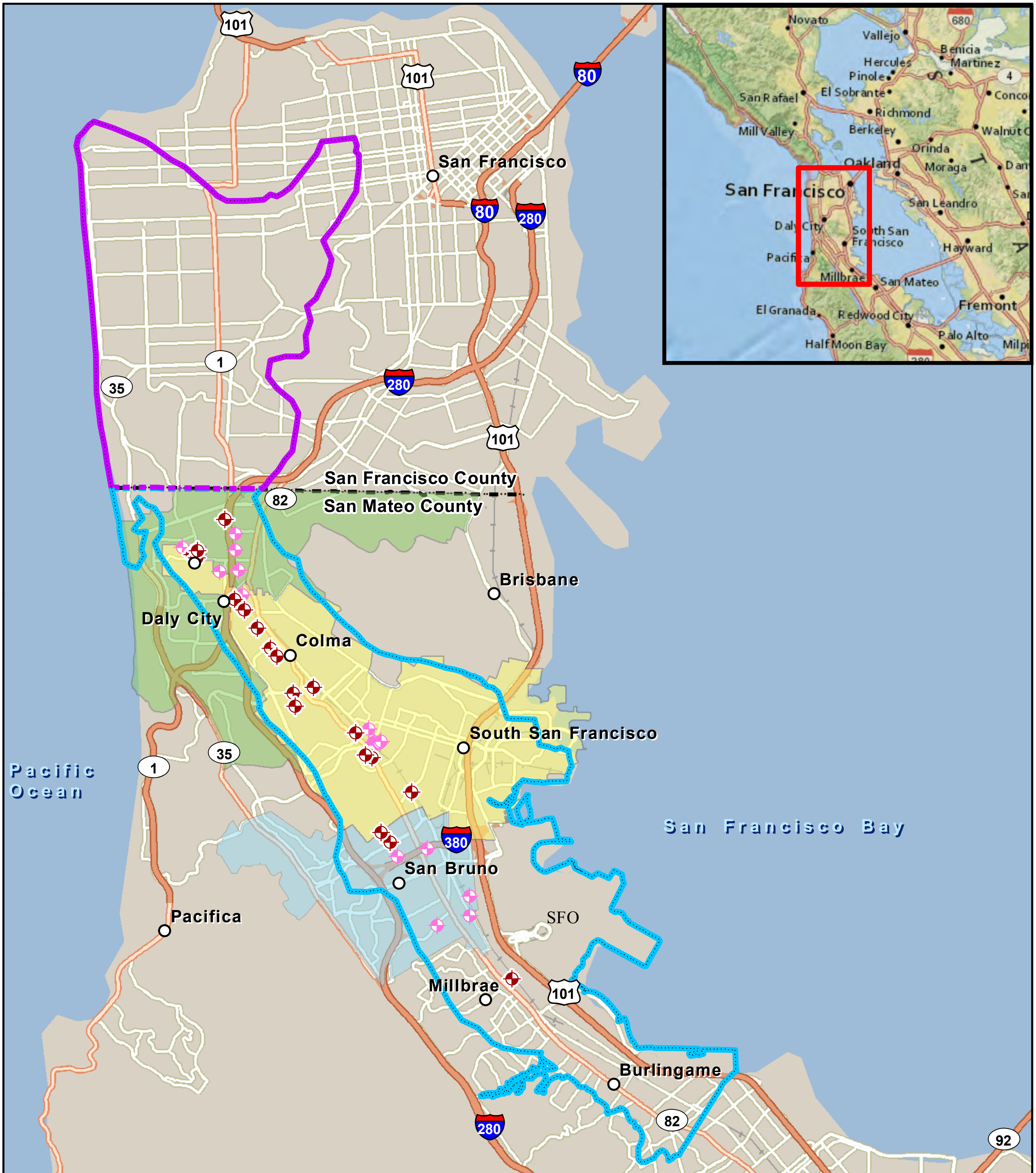


Legend

- Partner Agency Wells
- Proposed Project Well Facility Sites
- County Boundary
- Cal Water Service Co. Service Area
- Daly City Water Service Area
- San Bruno Water Service Area
- North Westside Groundwater Basin[1]
- South Westside Groundwater Basin[1]

0 0.5 1 2

Scale Miles

1 " = 2 miles

Project Vicinity Map

Regional Groundwater Storage and Recovery Project

Figure 2-1

Source: San Mateo County 2010, modified by GHD 2012.

[1]The Westside Groundwater Basin has been administratively divided at the San Francisco-San Mateo County line.

The proposed Project is part of the SFPUC's Water System Improvement Program (WSIP). The purpose of the WSIP is to increase the reliability of the regional water system with respect to seismic response, water delivery, and water quality through the year 2030, as well as water supply to meet water delivery needs in the service area through the year 2018.

Under the San Francisco Administrative Code, Chapter 31, the San Francisco Planning Department's Environmental Planning (EP) Division is responsible for conducting environmental review of all City and County of San Francisco (CCSF) projects pursuant to the requirements of the California Environmental Quality Act (CEQA). The San Francisco Planning Department is, therefore, the lead agency responsible for preparing this EIR; the Project sponsor is the SFPUC. This document constitutes the Draft EIR for the proposed Project and was prepared to fulfill the requirements of CEQA.

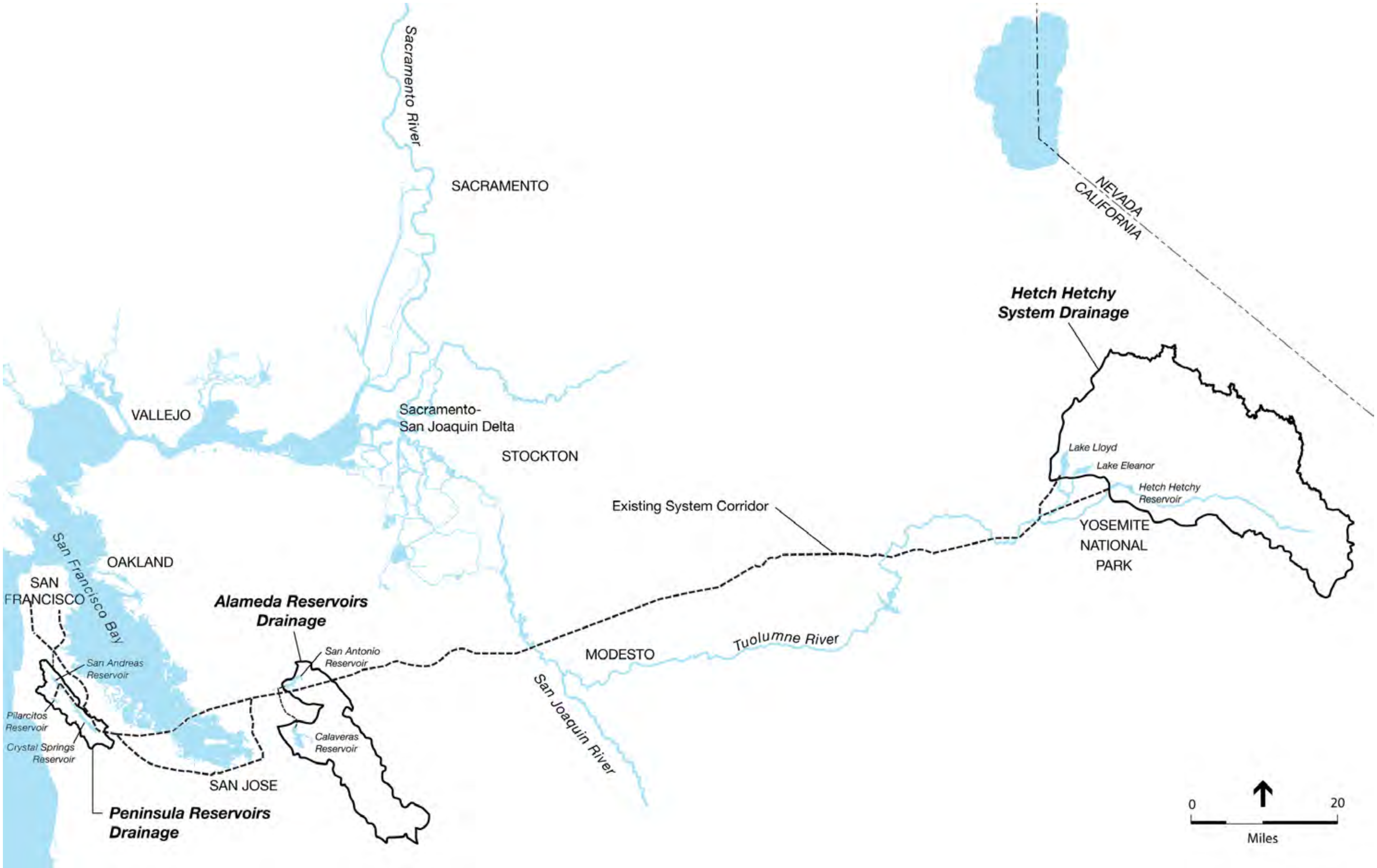
2.2 PROJECT BACKGROUND

2.2.1 Regional Water System Overview

The CCSF, through the SFPUC, owns and operates the regional water system that extends from the Sierra Nevada to San Francisco and serves over 2.4 million people in San Francisco, San Mateo, Santa Clara, Alameda and Tuolumne counties. The regional water system consists of water conveyance, treatment, and distribution facilities, and delivers water to retail and wholesale customers. The existing regional water system includes over 280 miles of pipelines, over 60 miles of tunnels, 11 reservoirs, five pump stations, and two water treatment plants. The SFPUC delivers up to an annual average of about 265 million gallons per day (mgd) of water to its customers. The source of the water supply is a combination of local supplies from streamflow and runoff in the Alameda Creek watershed and in the San Mateo and Pilarcitos creeks watersheds (referred to together as the Peninsula watersheds), augmented with imported supplies from the Tuolumne River watershed. Local watersheds provide about 15 percent of total supplies and the Tuolumne River provides the remaining 85 percent. Figure 2-2 (Overview of the Regional Water System & Water Supply Watersheds), illustrates the general location of the regional water system and water supply watersheds.

The SFPUC serves about one-third of its water supplies directly to retail customers, primarily in San Francisco, and about two-thirds of its water supplies to wholesale customers by contractual agreement. The wholesale customers are largely represented by the Bay Area Water Supply and Conservation Agency (BAWSCA) shown in Figure 2-3 (SFPUC Water Service Area, San Francisco, and SFPUC Wholesale Customers)[1]. Some of these wholesale customers have other sources of water in addition to what they receive from the regional water system, while others rely completely on the SFPUC for supply.

[1] The Cordilleras Mutual Water Association is also a wholesale customer receiving water from the SFPUC, but it is not a BAWSCA member and is not shown in Figure 2-3 (SFPUC Water Service Area, San Francisco, and SFPUC Wholesale Customers). It is a small water association serving 18 single-family homes located in San Mateo County.



Overview of SFPUC Regional Water System & Water Supply Watersheds

Regional Groundwater Storage and Recovery Project

Figure 2-2

Source: SF Planning Dept 2008

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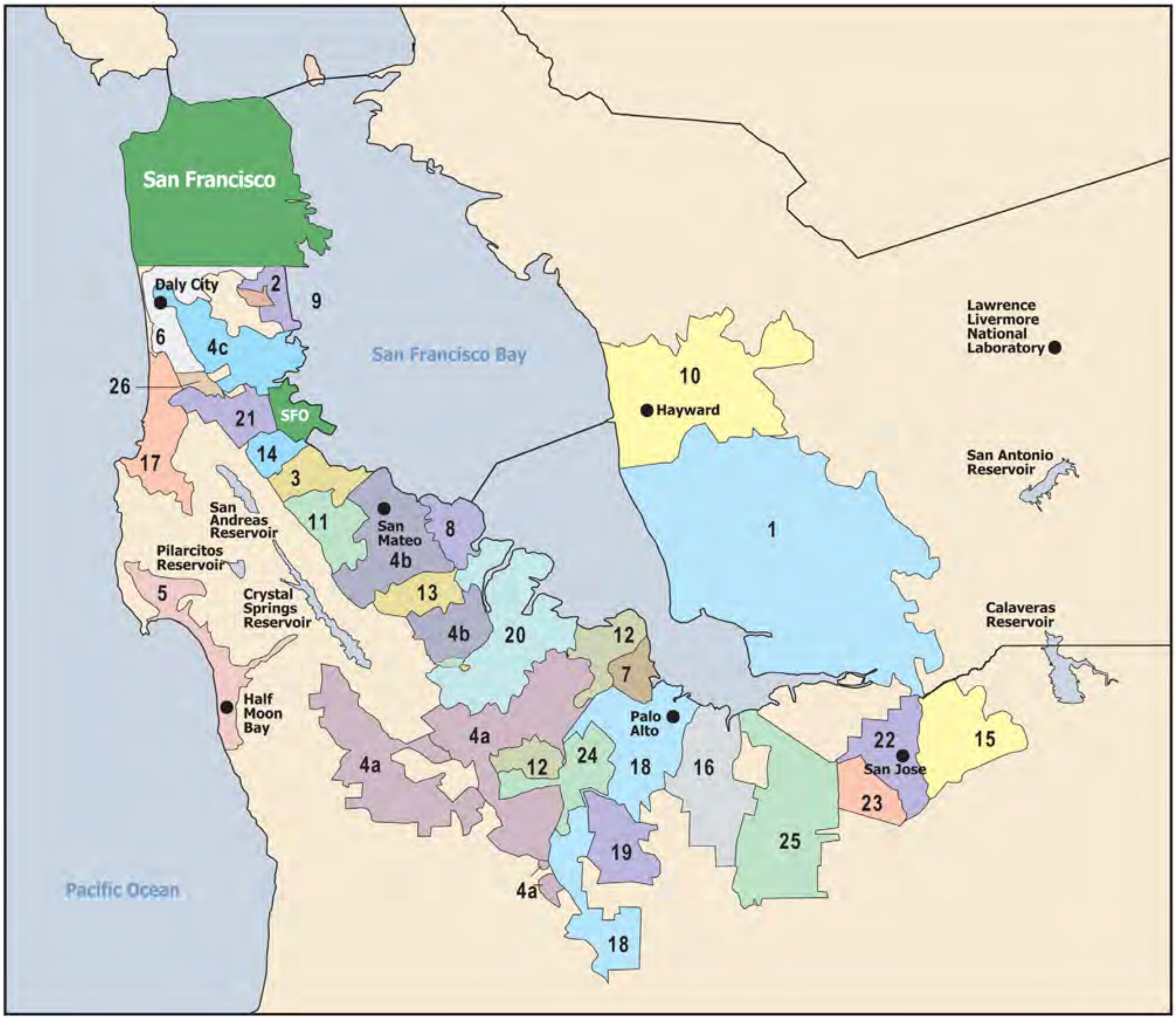

1 Alameda County Water District
2 City of Brisbane
3 City of Burlingame
4a Cal Water Service Co. – Bear Gulch
4b Cal Water Service Co. – Mid-Peninsula
4c Cal Water Service Co. – SSF
5 Coastside County Water District
6 City of Daly City
7 East Palo Alto
8 Estero Municipal Improvement District
9 Guadalupe Valley Municipal Improvement District
10 City of Hayward
11 Town of Hillsborough
12 City of Menlo Park
13 Mid-Peninsula Water District
14 City of Millbrae
15 City of Milpitas
16 City of Mountain View
17 North Coast Water District
18 City of Palo Alto
19 Purissima Hills Water District
20 City of Redwood City
21 City of San Bruno
22 City of San Jose
23 City of Santa Clara
24 Stanford University
25 City of Sunnyvale
26 Westborough Water District

Note: CWS – California Water Service Company
Portions of Coastside County Water District not served by the SFPUC Regional water system

SFPUC Water Service Area
San Francisco and SFPUC
Wholesale Customers

Regional Groundwater Storage
and Recovery Project

Source: BAWSCA 2012

Figure 2-3

2.2.2 SFPUC Water System Improvement Program

On October 30, 2008, the SFPUC adopted the WSIP (SFPUC 2008). The adopted WSIP aims to improve the regional water system with respect to water quality, seismic response, and water delivery based on a planning horizon through the year 2030. The WSIP also aims to improve the regional system with respect to water supply to meet water delivery needs in the service area through the year 2018. The proposed program area spans seven counties – Tuolumne, Stanislaus, San Joaquin, Alameda, Santa Clara, San Mateo, and San Francisco.

The WSIP includes a water supply strategy, modifications to system operations, and construction of a series of facility improvement projects. The proposed Project includes new groundwater facilities and would implement the WSIP water supply strategy during drought years. The overall goals of the WSIP are to maintain high-quality water; reduce vulnerability to earthquakes; increase delivery reliability and improve the ability to maintain the system; meet customer purchase requests in nondrought and drought periods; enhance sustainability in all system activities; and achieve a cost-effective, fully operational system (see Table 2-1 [WSIP Goals and Objectives]).

To further these program goals, the WSIP also includes objectives that address system performance in the areas of water quality, seismic reliability, delivery reliability, and water supply.

To address the potential environmental impacts of the WSIP, the San Francisco Planning Department prepared a Program EIR (PEIR), which was certified by the San Francisco Planning Commission on October 30, 2008 (San Francisco Planning Department 2008). The PEIR evaluated the environmental impacts of the WSIP's water supply component at a project-level of detail, as well as evaluating the environmental impacts of the WSIP's facility improvement projects at a program-level of detail. This EIR tiers from the PEIR; the analyses of the WSIP that are relevant to this Project are incorporated by reference into this EIR, as noted throughout the EIR. All WSIP-related impacts to which this Project contributes have been examined at a sufficient level of detail in the PEIR, enabling those effects to be mitigated or avoided through mitigation measures that are also imposed on this Project as part of the SFPUC's approval of the WSIP.

TABLE 2-1
WSIP Goals and Objectives

Program Goal	System Performance Objective
Water Quality - *maintain high quality water*	• Design improvements to meet current and foreseeable future federal and State water quality requirements. • Provide clean, unfiltered water originating from Hetch Hetchy Reservoir and filtered water from local watersheds. • Continue to implement watershed protection measures.
Seismic Reliability – *reduce vulnerability to earthquakes*	• Design improvements to meet current seismic standards. • Deliver basic service to the three regions in the service area (East/South Bay, Peninsula, and San Francisco) within 24 hours after a major earthquake. Basic service is defined as average winter-month usage, and the performance objective for the regional system is 229 mgd. The performance objective is to provide delivery to at least 70 percent of the turnouts (i.e., water diversion connecting points from the regional system to customers) in each region, with 104, 44, and 81 mgd delivered to East/South Bay, Peninsula, and San Francisco regions, respectively. • Restore facilities to meet average-day demand of up to 300 mgd within 30 days after a major earthquake.
Delivery Reliability – *increase delivery reliability and improve the ability to maintain the system*	• Provide operational flexibility to allow planned maintenance shutdown of individual facilities without interrupting customer service. • Provide operational flexibility to minimize the risk of service interruption due to unplanned facility upsets or outages. • Provide operational flexibility and system capacity to replenish local reservoirs as needed. • Meet estimated average annual demand of up to 300 mgd under the conditions of one planned shutdown of a major facility for maintenance concurrent with one unplanned facility outage due to a natural disaster, emergency, or facility failure/upset.
Water Supply – *meet customer water needs in non-drought and drought periods*	• Meet average annual water demand of 265 mgd from the SFPUC watersheds for retail and wholesale customers during non-drought years for system demands through 2018. • Meet dry-year delivery needs through 2018 while limiting rationing to a maximum 20 percent systemwide reduction in water service during extended droughts. • Diversify water supply options during non-drought and drought periods. • Improve use of new water sources and drought management, including groundwater, recycled water, conservation, and transfers.

TABLE 2-1
WSIP Goals and Objectives

Program Goal	System Performance Objective
Sustainability – *enhance sustainability in all system activities*	• Manage natural resources and physical systems to protect watershed ecosystems. • Meet, at a minimum, all current and anticipated legal requirements for protection of fish and wildlife habitat. • Manage natural resources and physical systems to protect public health and safety.
Cost-effectiveness – *achieve a cost-effective, fully operational system*	• Ensure cost-effective use of funds. • Maintain gravity-driven system. • Implement regular inspection and maintenance program for all facilities.

Source: SFPUC 2008

2.2.3 Relation of the Project to Regional Water System Facilities and Partner Agencies' Water Supply and Distribution Facilities

The proposed Project would be located in northern San Mateo County. Under the Project, the SFPUC would construct well facilities in the South Westside Groundwater Basin, together with water treatment systems and connections to existing water distribution systems. These new well facilities would be in addition to the existing well and water distribution facilities that are currently operated in northern San Mateo County by the Partner Agencies. The Partner Agencies currently pump groundwater from their facilities to meet a portion of their potable demand; the remainder of their potable supply comes through existing local connections to the regional water system.

Under the Project, the SFPUC would supply the Partner Agencies with supplemental water from the regional water system during normal and wet years to reduce the Partner Agencies' need to pump groundwater. This reduction in pumping would allow the aquifer to recharge naturally. During dry years, the Partner Agencies would return to pumping groundwater from their existing wells. The SFPUC and the Partner Agencies would operate and maintain Project facilities connected to their respective water distribution systems. These existing distribution systems are located and sized appropriately to accommodate the additional groundwater that would be produced as part of the proposed Project. This new dry-year water supply would be made available to both the Partner Agencies and to certain SFPUC retail customers and other wholesale customers, as well as to retail customers in San Francisco, thereby increasing the available surface water supply to all regional water system customers.

Refer to Chapter 3, Project Description Section 3.3 (Existing Groundwater Use in the Westside Groundwater Basin), for a summary of existing groundwater use by the Partner Agencies, cemeteries, and golf clubs overlying the groundwater basin.

2.2.4 Relation to Other WSIP Projects and Local Groundwater Management Plan

In addition to the GSR Project, there are other projects that are part of the larger WSIP proposed in the Westside Groundwater Basin: the San Francisco Groundwater Supply Project, the Harding Park Recycled Water Project, the San Francisco Westside Recycled Water Project, and the Lake Merced Water Levels Restoration Project.

The San Francisco Groundwater Supply Project would provide an average of 4 mgd of groundwater to San Francisco's municipal supply. The Draft EIR for the San Francisco Groundwater Supply Project was published for public review on March 13, 2013 (San Francisco Planning Department 2013). Groundwater for that project would be pumped from the North Westside Groundwater Basin, whereas the GSR Project wells would be located in the South Westside Groundwater Basin[2]. Also, the purpose of the GSR Project is to provide a dry-year water supply, whereas the San Francisco Groundwater Supply Project would operate during normal and wet years, as well as dry years. More detail regarding the purpose of the proposed GSR Project is provided in Chapter 3, Project Description, Section 3.2 (Project Goals and Objectives).

The Harding Park Recycled Water Project currently provides 1.3 mgd of recycled water for irrigation purposes and the San Francisco Westside Recycled Water Project would provide 2.8 mgd of recycled water for irrigation purposes, thus reducing demand on potable water supplies. Some of the properties proposed for irrigation with recycled water are located on lands overlying the Westside Groundwater Basin. The Harding Park Recycled Water Project EIR was certified by the City of Daly City in 2009 (Daly City 2009); the project is operational. A Revised Notice of Preparation for the San Francisco Westside Recycled Water Project was released in 2010 (San Francisco Planning Department 2010).

The Lake Merced Water Levels Restoration Project is located within the Westside Groundwater Basin. The purpose of the project is to provide a supplemental source of water, such as treated stormwater, to address raising the level of Lake Merced in San Francisco. Since approval of the WSIP, the City of Daly City has studied the viability of a Vista Grande Drainage Basin Improvement Project, which is a separate project intended to reduce or eliminate flooding in the Vista Grande watershed, reduce erosion along Lake Merced, and provide other benefits such as habitat enhancement and lake level augmentation at Lake Merced. Daly City identified several potential alternatives to manage stormwater flows in the Vista Grande Stormwater Basin in order to reduce flooding from the Vista Grande Drainage Canal, as shown in their *Draft Vista Grande Drainage Basin Alternatives Analysis Report Executive Summary* (Daly City 2011). The Alternatives Analysis Report recommended the South Lake Merced Alternative, which proposes to divert stormwater flow from the Vista Grande Drainage Canal to Lake Merced. Daly City is proceeding with

[2] The Westside Groundwater Basin has been administratively divided at the San Francisco County-San Mateo County line. The portion of the basin that lies within San Francisco County is referred to as the North Westside Groundwater Basin. The portion of the basin that lies within San Mateo County is referred to as the South Westside Groundwater Basin. The terms are not intended to imply physical boundary.

CEQA environmental review of this alternative, along with the National Park Service as lead agency under the National Environmental Policy Act. The Notice of Preparation/Notice of Intent to Prepare a Joint EIR/EIS for the Vista Grande Drainage Basin Improvement Project was issued on February 28, 2013 (Daly City 2013). The Draft EIR/EIS is anticipated to be published in late 2013. The SFPUC is cooperating with Daly City on the Vista Grande Drainage Basin Improvement Project and is not pursuing the Lake Merced Water Levels Restoration Project independently at this time, because the Vista Grande Drainage Basin Improvement Project, if approved, would accomplish substantially similar goals for better managing Lake Merced water levels, thereby achieving the purpose of the Lake Merced Water Levels Restoration Project.

The City of San Bruno recently adopted the *South Westside Basin Groundwater Management Plan* (GWMP), and the GWMP was accepted by Cal Water in July 2012 (San Bruno et al. 2012). The goal of the GWMP is to ensure a sustainable, high quality, reliable water supply at a fair price for beneficial uses achieved through local groundwater management. The GWMP defines the Basin management objectives, which are intended to maintain or enhance long-term groundwater levels and quality, and minimize land subsidence, along with actions to be taken to accomplish these management goals. The basic management objectives are defined through management areas and sub-areas, public input, monitoring, adaptive management and enforcement. The GSR Project seeks to support the GWMP by providing a conjunctive use project that would increase the volume of groundwater in storage through a reduction in groundwater pumping by the Partner Agencies made possible by increased surface water deliveries from the regional water system in normal and wet years. The GSR Project would help meet a goal of the GWMP to ensure a sustainable, high-quality, reliable water supply at a fair price for beneficial uses achieved through local groundwater management.

The Groundwater Storage element of the GWMP includes measures that could be considered to mitigate groundwater overdraft conditions, although the South Westside Groundwater Basin is not currently considered to be in a state of overdraft. The GWMP includes identification of actions to be implemented in the event that groundwater level monitoring indicates that the South Westside Groundwater Basin is in overdraft conditions, and it includes a local conjunctive use project in the South Westside Groundwater Basin as one of the management actions. Actions also include consideration of the development, implementation, and maintenance of programs and projects to recharge aquifers and the support of regional groundwater banking operations that would be beneficial to the South Westside Basin and the region. As noted in the GWMP, conjunctive use would likely take the form of an in-lieu recharge project where imported water or recycled water would replace groundwater use to offset future groundwater pumping during times of reduced imported water supplies.

2.3 PURPOSE OF THIS EIR

The San Francisco Planning Department is the lead agency for implementation of CEQA for all projects sponsored by the CCSF or conducted within San Francisco. The Environmental Planning Division (EP) of the San Francisco Planning Department has prepared this EIR for the SFPUC's proposed Project. The purpose of the EIR is to provide information about any potentially significant adverse environmental effects of the proposed Project, to identify reasonable and feasible methods to minimize any potentially significant adverse effects, and to describe and analyze feasible alternatives to the proposed Project. The EIR has been prepared as a project EIR in compliance with CEQA Guidelines Section 15161. The EIR tiers from the PEIR for the WSIP, which was certified by the San Francisco Planning Commission on October 30, 2008 (San Francisco Planning Department 2008). The analyses of the WSIP that are relevant to this Project are incorporated by reference into this EIR.

2.3.1 Draft EIR

This Draft EIR is a public information document for use by governmental agencies and the public. This Draft EIR will be circulated for public review, with hearings held to solicit comments from the public and governmental agencies on the environmental analysis and completeness of information presented in this Draft EIR (refer to Section 2.4 [Public Review]).

2.3.2 Responses to Comments and Final EIR

Following the public review and comment period, EP will prepare responses to the written and verbal comments received from the public and governmental agencies. The Draft EIR will be revised, as appropriate and, together with the Response to Comments document, will constitute the Final EIR. The Response to Comments document will be distributed to all commenters and individuals requesting a copy. The San Francisco Planning Commission will then consider EIR certification (CEQA Guidelines Section 15090) during a public hearing. Once certified, the EIR will serve as a source of information to assist the SFPUC in determining whether to approve the proposed Project. CEQA also requires the adoption of findings prior to approval of a Project where a certified EIR identifies significant environmental effects that would be caused by the Project (CEQA Guidelines Sections 15091 and 15092).

2.4 PUBLIC REVIEW

2.4.1 Scoping Process

The process of determining the appropriate scope, focus, and content of an EIR is known as "scoping." As the first step in the scoping process, the San Francisco Planning Department published a *Notice of Preparation of an Environmental Impact Report* (NOP) on June 24, 2009, announcing the anticipated preparation of a Draft EIR for the GSR Project. The scoping period began on June 24, 2009, with the issuance of the NOP and written comments on the NOP were accepted through July 28, 2009. The NOP summarized the goals, objectives, and elements of the Project. It also presented the San Francisco Planning Department's determination that the Project may have significant effects on the environment and that an EIR must be prepared. The NOP also described the EIR scoping process and provided information on a public scoping meeting. The scoping process, notification procedures, and outcome of the scoping meeting are described below. The NOP is included in Appendix A of this EIR.

In accordance with CEQA Guidelines, Section 15083, the San Francisco Planning Department held a public scoping meeting on July 9, 2009, to solicit input from governmental agencies and the public to assist the Department in determining the appropriate scope and focus of the Project's environmental impact analysis and information to be contained in the EIR, including mitigation measures, and potential alternatives to the Project. The meeting was held at the South San Francisco Municipal Services Building in South San Francisco and was attended by approximately 33 individuals.

Notices of the public scoping meeting were placed in local newspapers to inform the general public of the meeting. Additionally, the San Francisco Planning Department sent the NOP, including the scoping meeting notice, to approximately 1,500 interested parties, including landowners and tenants within 300 feet of proposed Project facilities, and 32 public agencies. The meeting included a presentation on the scope of the Project and the environmental review process, followed by public comment.

A *Scoping Summary Memorandum* (included in Appendix B) was prepared to summarize the scoping process, notification procedures, outcome of the scoping meeting and comments received. A transcript of the scoping meeting is included in the *Scoping Summary Memorandum*.

2.4.2 Public and Agency Comments on the NOP

Verbal comments were received from six individuals at the scoping meeting. During the 35-day scoping period, comment letters were received from nine individuals and organizations and eight comment letters were received from State, regional, and local agencies. One letter was received after the close of the scoping period and also was considered in preparing this EIR. The *Scoping Summary Memorandum* contains a record of the comments received.

The environmental concerns raised during the scoping period are summarized in Table 2-2 (Summary of Scoping Comments), which also references the section in this Draft EIR where the concerns are addressed.

TABLE 2-2
Summary of Scoping Comments

Environmental Concerns Raised during Scoping	Section where Concern is Addressed in this EIR
Details of operation strategy	Chapter 3, Project Description, Section 3.8 (Operations and Maintenance)
Construction-related traffic and site access during construction	Section 5.6, Transportation and Circulation
Impacts of climate change	Section 5.9, Greenhouse Gas Emissions Section 5.16, Hydrology and Water Quality
Describe groundwater use by irrigators, including future needs	Section 5.16, Hydrology and Water Quality
Ground settlement or subsidence	Section 5.16, Hydrology and Water Quality
Aquifer recharge	Section 5.16, Hydrology and Water Quality
Damage to private wells and long-term productivity	Section 5.16, Hydrology and Water Quality
Mobilization of contaminants in the groundwater	Section 5.16, Hydrology and Water Quality
Impacts to the water level at Lake Merced	Section 5.16, Hydrology and Water Quality
Impacts to quality of potable water	Section 5.16, Hydrology and Water Quality

2.4.3 Draft EIR Public Review

2.4.3.1 Public Review

Publication of this Draft EIR marks the beginning of a 45-day public review period, from April 10, 2013 to May 28, 2013. Written comments may be directed to the following address until close of business (5:00 p.m.) on May 28, 2013.

San Francisco Planning Department
Attn: Sarah Jones, AICP, Acting Environmental Review Officer
GSR Project Draft EIR
1650 Mission Street, Suite 400
San Francisco, CA 94103

By facsimile to: (415) 558-6409
By email to: timothy.johnston@sfgov.org

This Draft EIR is available on the Planning Department website at
http://www.sf-planning.org/index.aspx?page=1829.

Hard copies of the Draft EIR are also available for public review at the following locations:

San Francisco Planning Department
1650 Mission Street, 1st Floor
Planning Information Counter
San Francisco, CA 94103

San Francisco Public Library
100 Larkin Street
San Francisco, CA 94103

Daly City Public Library
40 Wembley Drive
Daly City, CA 94015

Westlake Library
275 Southgate Avenue
Daly City, CA 94015

Colma Town Hall
1198 El Camino Real
Colma, CA 94014

South San Francisco Library
840 West Orange Street
South San Francisco, CA 94080

San Mateo Public Library
55 West 3rd Street
San Mateo, CA 94044

San Bruno Public Library
701 Angus Avenue West
San Bruno, CA 94066

Millbrae Public Library
1 Library Avenue
Millbrae, CA 94030

2.4.3.2 *Public Hearings*

Public hearings on the Draft EIR to accept written or verbal comments are scheduled as follows.

Tuesday, May 14, 2013 at 6:30 p.m.
South San Francisco Municipal Services Building
Community Room
33 Arroyo Drive
South San Francisco, California

Thursday, May 16, 2013 at 12:00 p.m. or later
San Francisco Planning Commission
City Hall, 1 Dr. Carleton B. Goodlett Place
Commission Chambers, Room 400
San Francisco, CA 94102
(Call 415-558-6422 the week of the hearing for more specific hearing time.)

2.5 ORGANIZATION OF THE DRAFT EIR

The Draft EIR consists of three volumes. Volume 1 contains Chapters 1 through Chapter 5, Section 5.5. Volume 2 contains Chapter 5, Section 5.6 through Chapter 8, and Volume 3 contains the appendices. The organization of the Draft EIR is as follows:

- Chapter 1 provides an **Executive Summary** of the Draft EIR. The executive summary includes a brief description of the Project and summarizes construction and operational impacts that the Project would have on environmental resources, along with mitigation measures to reduce those impacts, where feasible. Significant unavoidable impacts of the Project are also identified. Alternatives that would reduce or avoid the significant environmental impacts of the Project are briefly described and the impacts they would have are compared to the significant impacts of the Project. Areas of controversy are identified.
- Chapter 2, **Introduction and Background,** provides project background information and describes the environmental review process and the organization of the EIR.
- Chapter 3 provides the **Project Description**, including all Project components (both construction and operational phases) and provides a list of permits and approvals that are anticipated for the Project.
- Chapter 4, **Plans and Policies**, describes the Project's consistency with relevant land use plans and policies.
- Chapter 5, **Environmental Setting, Impacts, and Mitigation Measures**, describes existing resources in the Project area, describes the environmental regulations and policies applicable to the Project, identifies impact significance criteria and identifies and analyzes potential impacts of the Project. Mitigation Measures for significant impacts are also identified. Chapter 5 is broken down into the following resource area sections:

  - Land Use (Section 5.2)
  - Aesthetics (Section 5.3)
  - Population and Housing (Section 5.4)
  - Cultural and Paleontological Resources (Section 5.5)
  - Transportation and Circulation (Section 5.6)
  - Noise and Vibration (Section 5.7)
  - Air Quality (Section 5.8)
  - Greenhouse Gas Emissions (Section 5.9)
  - Wind and Shadow (Section 5.10)
  - Recreation (Section 5.11)
  - Utilities and Service Systems (Section 5.12)
  - Public Services (Section 5.13)
  - Biological Resources (Section 5.14)
  - Geology and Soils (Section 5.15)
  - Hydrology and Water Quality (Section 5.16)
  - Hazards and Hazardous Materials (Section 5.17)
  - Mineral and Energy Resources (Section 5.18)
  - Agriculture and Forest Resources (Section 5.19)

- Chapter 6, **Other CEQA Issues**, discusses areas of controversy, growth inducement, cumulative impacts, significant environmental effects that cannot be avoided if the Project is implemented, and describes the significant irreversible effects associated with the Project.

- Chapter 7, **Alternatives**, describes the alternatives to the Project and compares their impacts to those of the proposed Project. This chapter also summarizes alternatives that were considered but screened from further analysis.

- Chapter 8 lists the **EIR Authors and Consultants**.

- Appendices provide information in support of the above chapters and have been bound separately in Volume 3. The appendices are:

  A. Notice of Preparation
  B. Scoping Summary Memorandum
  C. Summary of Impacts Table
  D. WSIP PEIR Water Supply Impact and Mitigation and Consistency
  E. GSR Final Air Quality Technical Report
  F. Special-status Species Tables
  G. Geotechnical Reports
  H. Groundwater Technical Reports
  I. Calculations for GSR Energy Use Impacts
  J. Lake Merced Vegetation Change Analysis Methodology
  K. Lake Merced Water Quality Data and Graphs

2.6 REFERENCES

Bay Area Water Supply & Conservation Agency (BAWSCA). 2012. *BAWSCA Members Map*. Website accessed on February 2, 2013 at: http://bawsca.org/docs/Member_Map.pdf.

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Daly City, City of. 2011. *Vista Grande Drainage Basin Alternatives Analysis Report Project Executive Summary (Draft)*. Prepared by Jacobs Associates. February 7.

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San Bruno, California Water Service Company, City of Daly City, and San Francisco Public Utilities Commission. 2012. *South Westside Basin Groundwater Management Plan*. Prepared by WRIME. July.

San Francisco Planning Department. 2008. *Final Program Environmental Impact Report on the San Francisco Public Utilities Commission's Water System Improvement Program*, San Francisco Planning Department File No. 2005.0159E; State Clearinghouse No. 2005092026. October.

San Francisco Planning Department. 2010. *Revised Notice of Preparation of an Environmental Impact Report on the San Francisco Westside Recycled Water Project*.

San Francisco Planning Department. 2013. *Draft Environmental Impact Report on the San Francisco Groundwater Supply Project*. March.

San Francisco Public Utilities Commission (SFPUC). 2008. *Resolution 08-0200, Water System Improvement Program California Environmental Quality Act Findings: Findings of Fact, Evaluation of Mitigation Measures and Alternatives, and Statement of Overriding Considerations*. October.

San Mateo County. 2010. *Water Supply GIS Data*. Received April 13, 2012.

3 PROJECT DESCRIPTION

Sections	Tables

3.1 PROJECT LOCATION

The proposed Groundwater Storage and Recovery (GSR) Project (proposed Project or Project) would be located in northern San Mateo County, overlying the southern portion of the Westside Groundwater Basin, as shown in Figure 2-1 (Project Vicinity Map), in Chapter 2, Introduction and Background.

The Project would be located within the water service areas for the cities of Daly City and San Bruno, as well as the California Water Service Company (Cal Water), which includes portions of South San Francisco, Colma, and unincorporated San Mateo County. These water providers are referred to herein as "Partner Agencies" for this Project. Groundwater production well facilities would be constructed and owned by the San Francisco Public Utilities Commission (SFPUC) in the cities of Daly City, Colma, South San Francisco, San Bruno, Millbrae, and unincorporated San Mateo County. Well facilities would be connected to existing water distribution pipelines owned by the Partner Agencies and the SFPUC. The SFPUC and the Partner Agencies would operate and maintain proposed well facilities connected to their respective water systems. Existing Partner Agency wells all are located within San Mateo County.

3.2 PROJECT GOALS AND OBJECTIVES

As described in Chapter 2, Introduction and Background, the proposed Project is part of the SFPUC's Water System Improvement Program (WSIP). The overall WSIP goals (refer to Table 2-1 [WSIP Goals and Objectives]) for the regional water system include:

- Maintain high-quality water;
- Reduce vulnerability to earthquakes;
- Increase water delivery reliability;
- Meet customer water supply needs;
- Enhance sustainability; and
- Achieve a cost-effective, fully operational system.

The proposed Project would help achieve the WSIP goals because it would provide dry-year supply to increase water delivery reliability and meet customer water supply needs. In addition, the Project would provide increased regional operational flexibility to respond and restore water service during unplanned outages and/or a loss of a water source. Without the Project, the SFPUC could not meet its goals for dry-year delivery reliability (incorporated by reference from the WSIP Program Environmental Impact Report [PEIR]) (San Francisco Planning Department 2008; SFPUC 2008).

The proposed Project would increase the volume of groundwater in storage by allowing the South Westside Groundwater Basin to recharge naturally during normal and wet years. The increased volume of groundwater in storage would occur through a reduction in groundwater pumping by the Partner Agencies; this reduction in groundwater pumping would be made possible by increased surface water deliveries to the Partner Agencies from the regional water system in those years. This "conjunctive" or cooperative use of the basin would allow the SFPUC and Partner Agencies to pump the naturally accumulated and stored water during dry years.

The SFPUC measures water supply reliability using an 8.5-year "design drought." A design drought is a planning and operations tool used by water agencies to define a reasonable worst-case drought scenario in order to establish design and operating parameters for the water system. The WSIP uses a design drought based on the hydrology of the six years of the worst historical drought (1987-1992) on record, plus the 2.5 years of the 1976-1977 drought, for a combined total of an 8.5-year design drought sequence. The proposed Operating Agreement between the SFPUC and Partner Agencies (see Section 3.8.1 [Operating Agreement]) contemplates use of the dry-year supplies made available by the Project starting in the second year of the design drought. Therefore, the estimated 60,500 af of new groundwater storage is assumed to be used over 7.5 years of the design drought, operating at a maximum average annual capacity of 7.2 million gallons per day (mgd).

The primary goal for the Project is to provide an additional dry-year water supply. Specific objectives of the Project are to:

- Conjunctively manage the South Westside Groundwater Basin through the coordinated use of SFPUC surface water and groundwater pumped by the Partner Agencies;
- Provide supplemental SFPUC surface water to the Partner Agencies in normal and wet years, with a corresponding reduction of groundwater pumping by these agencies, which then allows for in-lieu recharge of the South Westside Groundwater Basin;
- Increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by an average annual 7.2 mgd; and
- Provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8.5-year design drought cycle.

3.3 EXISTING GROUNDWATER USE IN THE WESTSIDE GROUNDWATER BASIN

The Westside Groundwater Basin extends from western San Francisco south into San Mateo County. The Basin has an area of approximately 40 square miles and underlies portions of San Francisco, Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame. The Westside Groundwater Basin has been administratively divided at the San Francisco-San Mateo County line. Although this is not a physical boundary, there are differences in conditions between the northern and southern portions of the Westside Groundwater Basin. The chief distinction is related to groundwater levels. In the northern portion of the Basin, groundwater levels are generally above sea level and groundwater flow is primarily westerly to the ocean, except near Lake Merced, where the flow is to the south. However, decades of groundwater pumping in the southern portion of the Basin have lowered groundwater levels to between 15 and 195 feet below sea level, effectively freeing up vacated aquifer storage space that could be used for the proposed conjunctive use of the Basin (LSCE 2010). The northern portion of the Basin that lies within San Francisco County is referred to in this EIR as the North Westside Groundwater Basin. Likewise, the southern portion of the Basin that lies within San Mateo County is referred to herein as the South Westside Groundwater Basin.

In the North Westside Groundwater Basin, groundwater is extracted for the purpose of irrigation (e.g., in Golden Gate Park and the San Francisco Zoo) and for augmentation of lakes (e.g., Pine Lake in Stern Grove and Golden Gate Park lakes). In the South Westside Groundwater Basin, groundwater is extracted for the purpose of municipal use (by the Partner Agencies) and irrigation at cemeteries, golf clubs, and residences. Table 3-1 (Estimated Existing Groundwater Use in the Westside Groundwater Basin) indicates the estimated existing groundwater use in the Basin.

TABLE 3-1
Estimated Existing Groundwater Use in the Westside Groundwater Basin

Type of Groundwater Use	Estimated Use (mgd)		
	North Westside Groundwater Basin	South Westside Groundwater Basin	Total
Municipal use for potable water	0	6.84[a]	6.84
Irrigation and other non-potable uses[b]	1.51	1.39	2.90
Total	**1.51**	**8.23**	**9.74**

Notes:

(a) Existing municipal groundwater pumping is estimated as the median of Partner Agencies' pumping for the period from 1959 to 2009 (SFPUC 2011); municipal pumping varies from year to year.

(b) Taken from s/Jenks 2012; irrigation and lake augmentation pumping varies from year to year.

3.4 PROPOSED PROJECT

The proposed Project consists of groundwater storage and recovery in the South Westside Groundwater Basin, including the operation of groundwater production wells and associated distribution and treatment facilities. As summarized below, an Operating Agreement between the SFPUC and the Partner Agencies (see Section 3.8.1 [Operating Agreement]) would guide overall groundwater and surface water deliveries associated with the proposed Project. This section includes a description of these proposed Project components[1].

3.4.1 Groundwater Storage and Recovery

The SFPUC supplies surface water to the Partner Agencies from its regional water system. The Partner Agencies currently supply potable water to their retail customers through a combination of groundwater from the South Westside Groundwater Basin and purchase of SFPUC surface water. The proposed Project would provide supplemental SFPUC surface water to the Partner Agencies during normal and wet years. During these years, the Partner Agencies would reduce their groundwater pumping by a comparable amount to increase the amount of groundwater in storage through natural, or in-lieu, recharge.

During normal and wet years, the volume of groundwater in the South Westside Groundwater Basin would increase due to natural recharge and reduced groundwater pumping by the Partner Agencies, eventually reaching an increased storage volume of up to 60,500 af (about 20 billion gallons). During dry

[1] Much of the information in this chapter regarding the location and design of the well facility sites and routine operating strategies is based on information contained in the Final Alternatives Analysis Report, Groundwater Conjunctive Use Project (MWH 2007) or the Groundwater Conjunctive Use Project Conceptual Engineering Report (MWH et al. 2008).

years, the Partner Agencies and the SFPUC would pump the stored groundwater as needed to supplement other supplies. This new dry-year water supply would thereby increase the available water supply to all regional water system customers.

As part of the Project, an Operating Agreement would be implemented by the SFPUC and the Partner Agencies to guide the conjunctive use of groundwater and surface water. Specifically, the agreement would address:

- Water accounting;
- Ownership principles;
- The operation, maintenance, and replacement of well facilities;
- Levels of groundwater pumping and provision of supplemental surface water; and
- The allocation of costs.

The Operating Agreement is further discussed later in this chapter in Section 3.8.1 (Operating Agreement).

The identification of a dry year for the purpose of initiating groundwater pumping under the Project would be based upon whether or not a water shortage has been identified for a given fiscal year during the SFPUC's annual determination of the supply of water available to the regional water system under its Water Shortage Allocation Plan (WSA)[2]. This identification would be made as part of the SFPUC's annual April 15 estimate of water supply available to the regional water system, with shortage allocations taking effect on July 1st, the start of the fiscal year. As a result of this timing, Project pumping would not occur until the second year of a drought. Approximately 20 percent of years are projected to be dry years when the Project would be in groundwater recovery mode (SFPUC 2009b).

Figure 3-1 (Groundwater Storage and Recovery Schematic Diagram) provides a schematic diagram of how groundwater storage and recovery typically operates. The figure illustrates the increase in groundwater storage expected from a reduction in pumping when supplemental water is delivered, as well as the decrease in groundwater storage projected from an increase in pumping during dry years.

Figure 3-2 (Source of Proposed Water Supply for Partner Agencies) illustrates how the Project would change the source of water supply for the Partner Agencies. During normal and wet years, the portion of water supply coming from the SFPUC to the Partner Agencies would increase compared to the existing

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[2] In the July 2009 Water Shortage Allocation Plan (WSA), the SFPUC and its wholesale customers adopted a plan to allocate water between retail and wholesale customers during system wide shortages of 20 percent or less. The specific amount of rationing required by each wholesale customer, including the Partner Agencies, is determined either by agreement of the wholesale customers themselves or, in the absence of such agreement, by the SFPUC after discussion with the wholesale customers.

condition because the Partner Agencies would limit their pumping during these years. During dry years, the portion of water supply coming from groundwater would increase.

The "Groundwater from the GSR Well Facilities" on Figure 3-2 would be piped to each Partner Agency's distribution system and the SFPUC Regional Transmission System. The SFPUC Regional Distribution System downstream of the GSR Wells would thus have a blend of surface water and groundwater during dry years that would be delivered to the City of Brisbane, the Guadalupe Valley Municipal Improvement District, the City of San Francisco, San Francisco International Airport, and possibly the City of Millbrae.

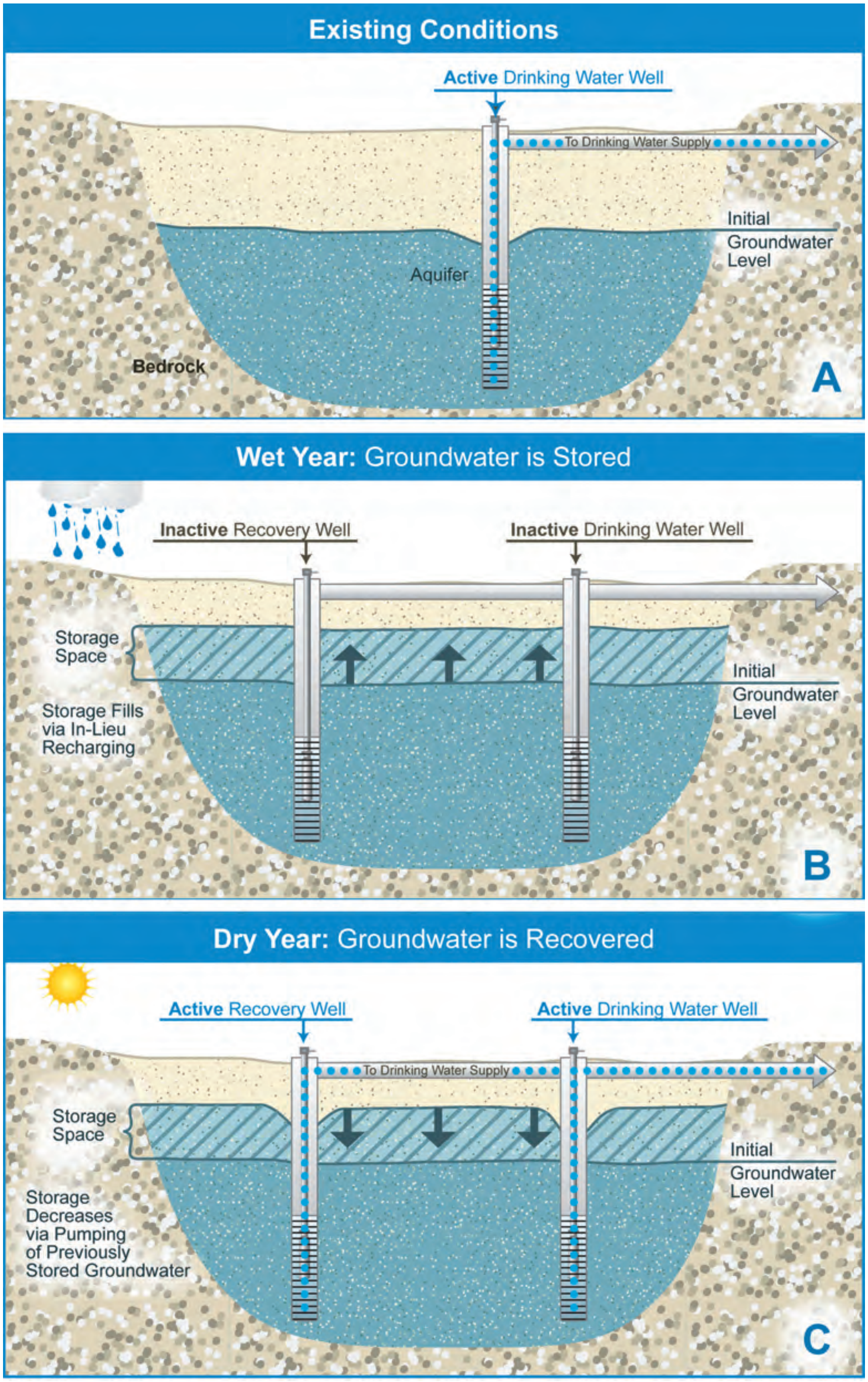

Figure (A) reflects the existing groundwater conditions, showing available storage space above the aquifer. In (B) the upward arrows represent the filling of the storage space with groundwater during wet years; in (C) the downward arrows represent the decline in stored water during dry years. The “Drinking Water Wells” represent the existing wells operated by the Cities of San Bruno and Daly City and California Water Service Company. The “Recovery Wells” represent the new wells that are proposed as part of the Project.

Groundwater Storage and Recovery Schematic Diagram

Regional Groundwater Storage and Recovery Project

Figure 3-1

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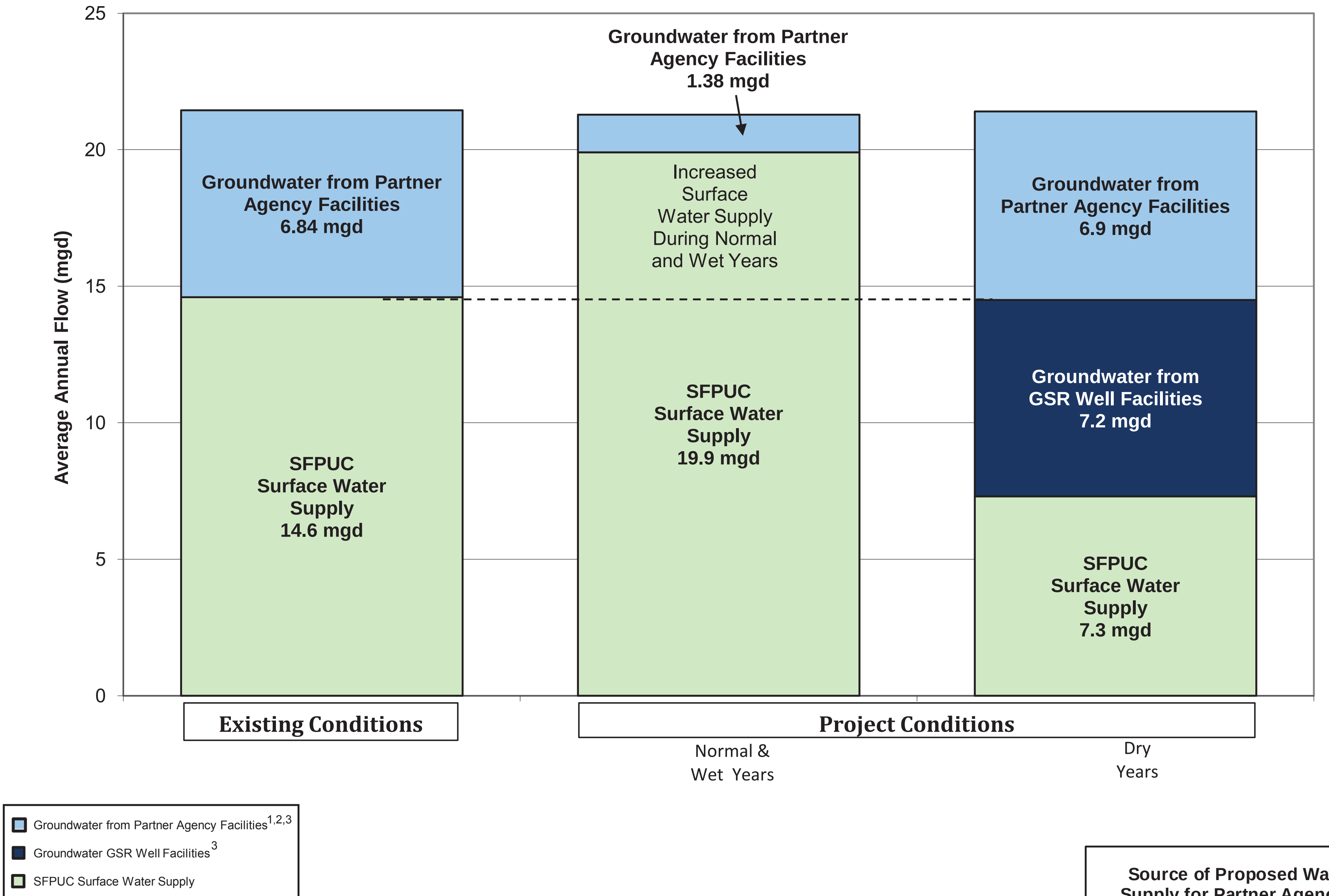


[1] Groundwater from Partner Agency facilities during normal and wet years could vary from 1.38 mgd to 1.9 mgd.

[2] Partner Agency water supply facilities that are operated by the City of Daly City, City of San Bruno, and Cal Water.

[3] The specific volumes shown are based on historic rainfall and hydrology records, but actual volumes in any given year would depend on several factors, including: 1) the final location and capacity of the project well facilities, the volume of water in the SFPUC Storage Account and 3) direction from the Operating Committee regarding which wells should be used (SFPUC 2011; MWH 2008).

Source of Proposed Water Supply for Partner Agencies

Regional Groundwater Storage and Recovery Project

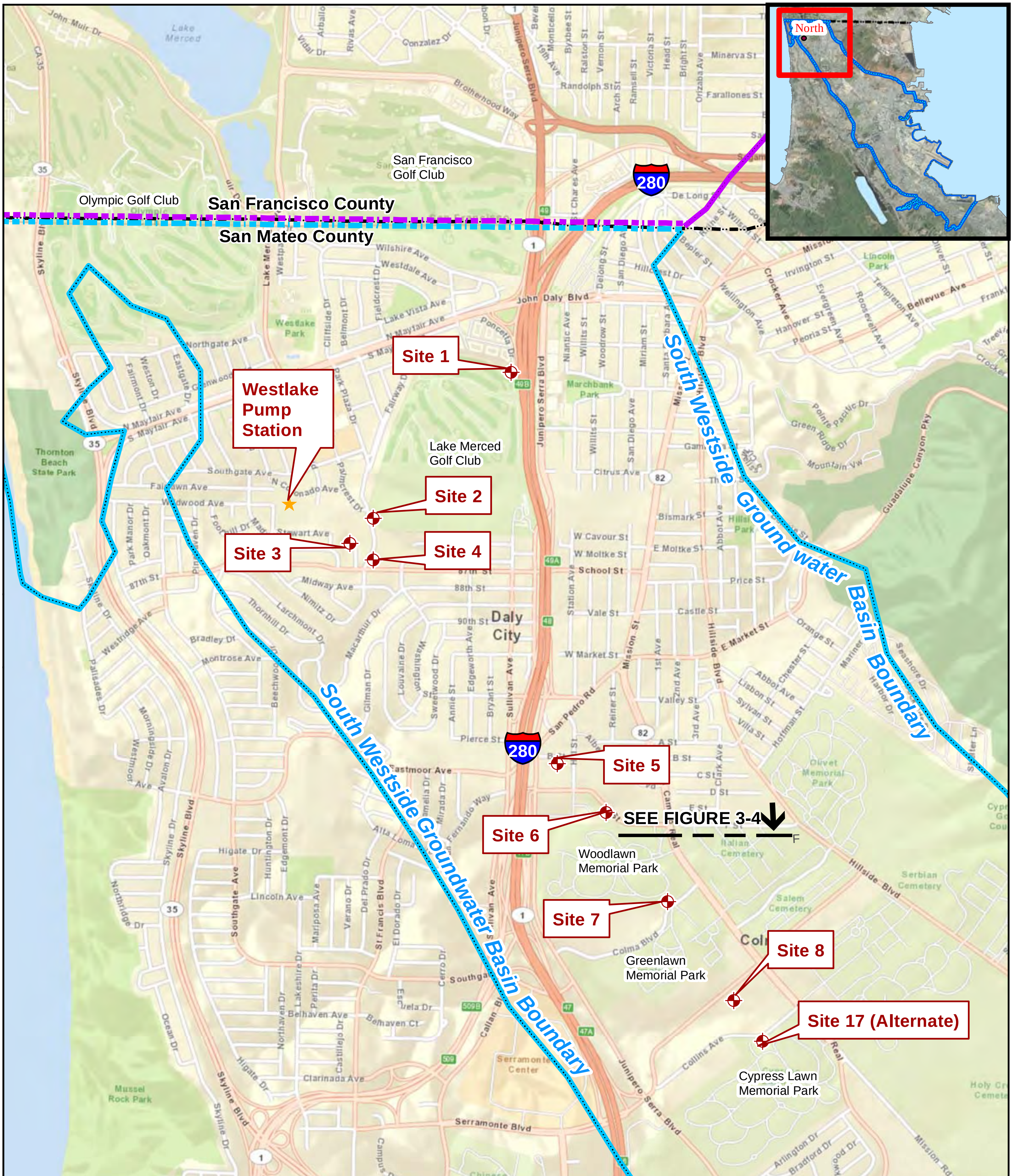
Figure 3-2

3.4.2 Production Wells and Associated Facilities

The proposed Project consists of the construction and operation of up to 16 new well facilities within the South Westside Groundwater Basin and an upgrade to the existing Westlake Pump Station (see Figures 3-3, 3-4, and 3-5, location maps). This EIR, however, includes the evaluation of three additional well facilities (for a total of 19) that could be developed in the instance where one of the 16 preferred well facilities cannot be constructed or operated because either: (1) the SFPUC is unable to secure access or necessary easements; (2) the well facility cannot be successfully operated because groundwater quality or groundwater yield do not meet Project requirements; or (3) the well facility is otherwise determined by the SFPUC to be infeasible. Under any of these circumstances, the SFPUC would eliminate that well site from the Project (and properly decommission the well, if it had already been constructed) and construct and operate one of the three other well facilities on alternate sites. Therefore, this EIR evaluates construction of 19 well facilities, of which 16 are preferred sites at this time and three are alternate well facilities, and operation of only 16 well facilities. The decision to construct and operate alternate well facilities would occur when the SFPUC determines that the proposed well facilities are infeasible, as described above, which could be during initial implementation of the Project or later. The preferred well facilities would be at Sites 1 through 16; the three alternate well facilities would be at Sites 17 (Alternate), 18 (Alternate), and 19 (Alternate). Therefore, the 16 well facilities to be operated could be at any of the 19 well facility locations.

Together, the 16 proposed well facilities would have an annual average pumping capacity of 7.2 mgd (equivalent to 8,100 acre-feet per year [afy]), a peak pumping capacity of 8.3 mgd, and would be used as a supplemental dry-year supply. During dry years, Partner Agency water deliveries from the regional water system would be comprised of reduced surface water deliveries and groundwater pumped from Project wells, as identified in the Operating Agreement. The Partner Agencies' pumping from their existing wells would not exceed the annual average rates consistent with the pumping limits expressed in the Operating Agreement. SFPUC retail water deliveries from the regional water system would be comprised of surface water and groundwater from the proposed GSR Project wells.

Of the preferred 16 well facility sites evaluated in this EIR, four well facilities would connect to Daly City's distribution system; three to San Bruno's distribution system; two to Cal Water's distribution system; and seven to the regional water system. These are the preferred connections; if, however, not all of the preferred 16 new wells can be feasibly connected to the proposed distribution systems due to groundwater quality or yield issues, or if one or more of the alternate well facility sites are operated, or if the distribution system cannot successfully be connected to the new source because of system pressure or demand issues, then well facilities may need to be connected to alternate distribution systems. To account for this potential outcome, this EIR evaluates connections to alternate water distribution systems at 14 well facility sites; these connections are listed in the detailed descriptions under Sections 3.4.2.2 (Well Facility Types) and 3.4.3 (Facility Sites) of this Chapter. The decision to construct a connection to an alternate distribution system could occur at any time that the SFPUC determines that the preferred connections are infeasible, as described above, which could be during initial implementation of the Project or later. A list of the 19 well facility sites and the Westlake Pump Station site is provided in Table 3-2 (Facility Site Names and Locations) and shown on Figures 3-3, 3-4, and 3-5.



Legend

- Proposed Project Well Facility Sites
- County Boundary
- Westlake Pump Station
- North Westside[1] Groundwater Basin
- South Westside[1] Groundwater Basin

0 1,000 2,000
Scale Feet
1 " = 2,000 '

Project Location Map-North

Regional Groundwater Storage and Recovery Project

Figure 3-3

[1]North and south groundwater basin divide is an artificial construct.

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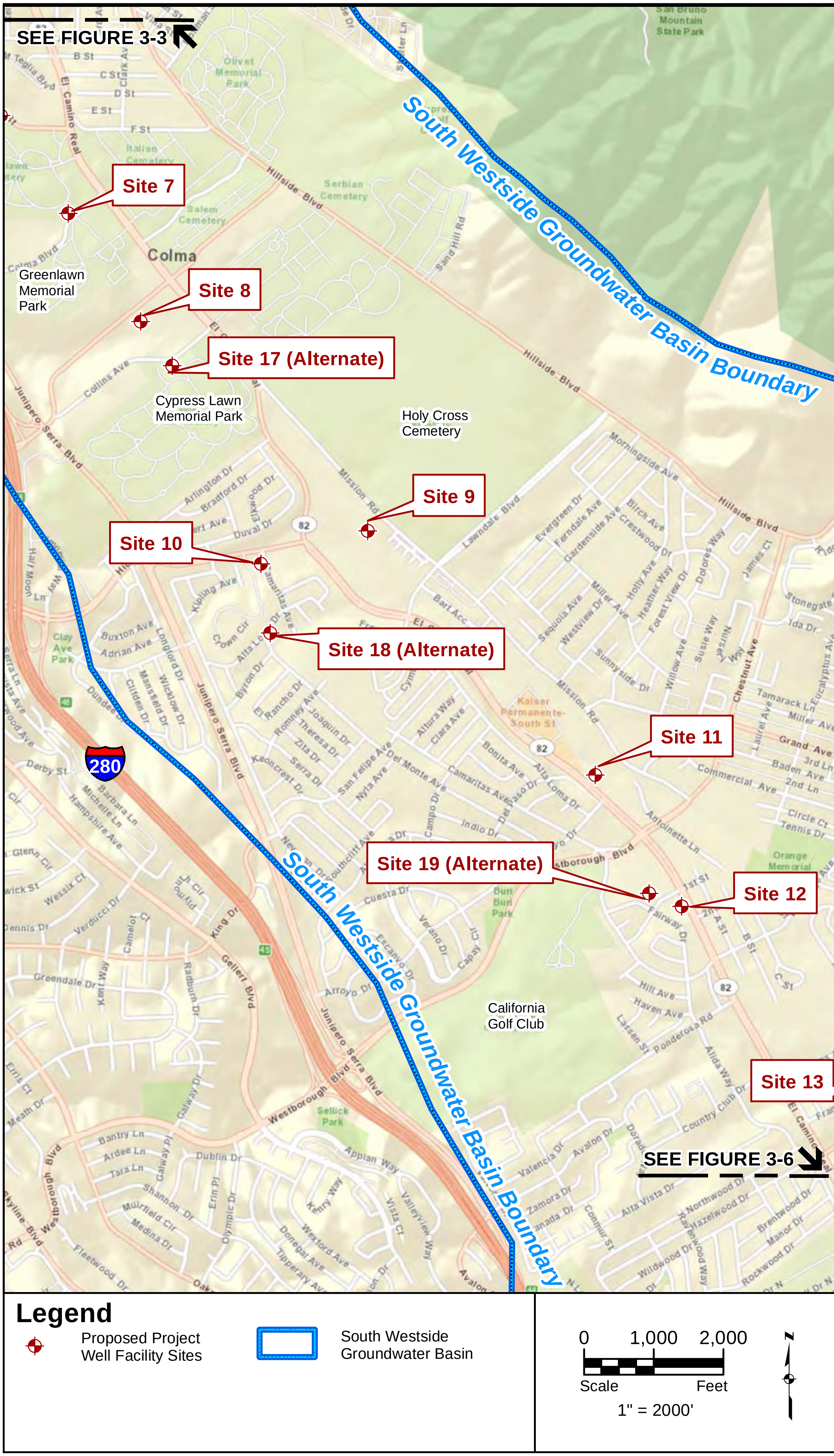

Project Location Map-Central

Regional Groundwater Storage and Recovery Project

Figure 3-4

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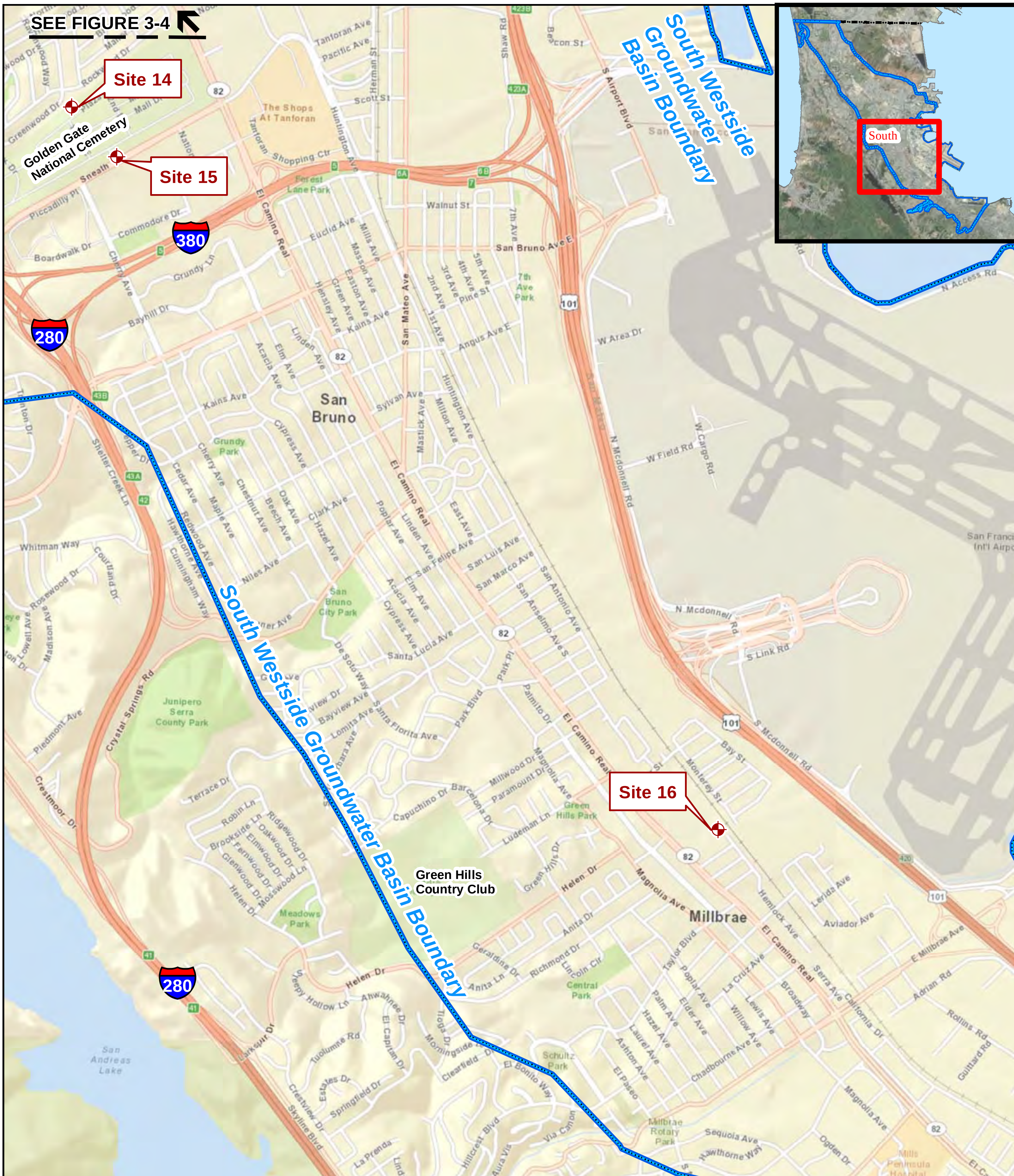


Legend

Proposed Project Well Facility Sites

South Westside Groundwater Basin

0 1,000 2,000

Scale Feet

1" = 2000'

N

Project Location Map-South

Regional Groundwater Storage and Recovery Project

Figure 3-5

TABLE 3-2
Facility Site Names and Locations[(a)]

Site	Site Name	Location
Site 1	Lake Merced Golf Club	Daly City
Site 2	Park Plaza Meter	Daly City
Site 3	Ben Franklin Intermediate School	Unincorporated San Mateo County (Broadmoor)
Site 4	Garden Village Elementary School	Unincorporated San Mateo County (Broadmoor)
Westlake Pump Station	Westlake Pump Station	Daly City and Unincorporated San Mateo County (Broadmoor)
Site 5	Right-of-Way at Serra Bowl	Daly City
Site 6	Right-of-Way at Colma BART[(b)]	Daly City
Site 7	Right-of-Way at Colma Boulevard	Colma
Site 8	Right-of-Way at Serramonte Boulevard	Colma
Site 9	Treasure Island Trailer Court	South San Francisco
Site 10	Right-of-Way at Hickey Boulevard	South San Francisco
Site 11	South San Francisco Main Area	South San Francisco
Site 12	Garden Chapel Funeral Home	South San Francisco
Site 13	South San Francisco Linear Park	South San Francisco
Site 14	Golden Gate National Cemetery	San Bruno
Site 15	Golden Gate National Cemetery	San Bruno
Site 16	Millbrae Corporation Yard	Millbrae
Site 17 (Alternate)	Standard Plumbing Supply	Colma
Site 18 (Alternate)	Alta Loma Drive	South San Francisco
Site 19 (Alternate)	Garden Chapel Funeral Home	South San Francisco

Notes:

(a) This EIR evaluates 16 proposed and three alternate well facility sites, even though a maximum of 16 well facilities would ultimately be operated by the agency to which the water is distributed.

(b) BART = Bay Area Rapid Transit

Each well facility would include a well pump station, underground distribution piping, and above or underground utility connections. Most well facilities would also have disinfection units designed for microbial inactivation, unless they are near an existing disinfection unit that can accommodate the additional volume of groundwater, in which case the well would connect to the existing unit. At certain sites, additional treatment (i.e., for pH adjustment, fluoridation, nitrate, Volatile Organic Compounds

[VOCs], and/or iron/manganese removal) would be incorporated into the design of the facility to meet both regulatory and water quality targets in the finished water for all agencies. The treatment facilities that would be included in the design of each well facility are listed in the detailed descriptions in Sections 3.4.2.2 (Well Facility Types) and 3.4.3 (Facility Sites) of this Chapter.

The proposed well facilities have been sited so that wells are close to treatment systems and close to existing distribution systems (the regional water system and the local distribution systems of the Partner Agencies), resulting in a more energy efficient system.

3.4.2.1 Well Facility Characteristics

Site-specific well facility characteristics for the 19 potential well facility sites are listed in Table 3-3 (Site-specific Facility Characteristics). These characteristics include the proposed well facility (i.e., building) type, pump type and pumping capacity, water distribution system connection point and alternate connection point (if any), groundwater disinfection location, and the method that would be used to achieve water quality goals specific to the SFPUC and each of the Partner Agencies (i.e., blending with surface water or other treatment).

3.4.2.2 Well Facility Types

Well facility design includes consideration of regulatory, operational, maintenance, and technical information. Four well facility types are included in the proposed Project:

- Well with fenced enclosure,
- Well with building,
- Well plus chemical treatment building, and
- Well plus chemical treatment and filtration building.

The type of well facility proposed for each of the sites is listed in Table 3-3 (Site-specific Facility Characteristics) and is described in detail below. Figures 3-6, 3-7, and 3-8 provide conceptual layouts for these facilities.

Where no well facility building is proposed, only the wellhead, electric panel, a fence, and possibly a screening wall, would be located aboveground. A conceptual site plan of this type of facility is illustrated on Figure 3-6 (Well Building and Fenced Enclosure Conceptual Layout).

Where buildings to enclose the well facility are proposed, the buildings would be about 15 feet above finished grade and constructed of board-formed concrete and metal panels, except at Sites 14 and 15, which would require special architectural features to integrate visually with the surrounding landscape. The exterior building colors would be gray or earth tone with anti-graffiti coating. A galvanized decorative gate would provide access into the building.

TABLE 3-3
Site-specific Facility Characteristics

Site	Site Name	Facility Type[(a)]	Pump Type/ Capacity (gpm)[(b)]	Proposed Connection Point	Alternate Connection Point	Proposed On-site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site 1	Lake Merced Golf Club	1,480-square-foot facility with well plus chemical treatment	Aboveground Vertical Turbine/ 300-600	SFPUC	Daly City	Disinfection, pH adjustment fluoridation	At site	Treatment for iron/manganese not required
Site 2	Park Plaza Meter	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	Daly City	None	No on-site treatment	Westlake Pump Station	Treatment for iron/manganese not required
Site 3	Ben Franklin Intermediate School	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	Daly City	None	No on-site treatment	Westlake Pump Station	Treatment for iron/manganese not required
Site 4	Garden Village Elementary School	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	Daly City	None	No on-site treatment	Westlake Pump Station	Treatment for iron/manganese not required
Westlake Pump Station	Westlake Pump Station	Pump station and treatment upgrade	Up to 3 new booster pumps	Daly City	None	Disinfection, fluoridation	At site	Treatment for iron/manganese not required
Site 5 (Consolidated Treatment at Site 6)[(c)]	Right-of-Way at Serra Bowl	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	SFPUC	None	No on-site treatment	At Site 6	Treatment at Site 6

TABLE 3-3
Site-specific Facility Characteristics

Site	Site Name	Facility Type[(a)]	Pump Type/ Capacity (gpm)[(b)]	Proposed Connection Point	Alternate Connection Point	Proposed On-site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site 6 (Consolidated Treatment at Site 6)[(c)]	Right-of-Way at Colma BART	2,990-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 300-600	SFPUC	Cal Water	Disinfection, pH adjustment fluoridation, iron/manganese removal	At site	Treatment
Site 7 (Consolidated Treatment at Site 6)[(c)]	Right-of-Way at Colma Boulevard	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	SFPUC	None	No on-site treatment	At Site 6	Treatment at Site 6
Site 5 (On-site Treatment)	Right-of-Way at Serra Bowl	2,095-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 300-600	SFPUC	Daly City	Disinfection, pH adjustment, fluoridation, iron/manganese removal	At site	Treatment
Site 6 (On-site Treatment)	Right-of-Way at Colma BART	2,090-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 300-600	SFPUC	Cal Water	Disinfection, pH adjustment, fluoridation, iron/manganese removal	At site	Treatment for iron/manganese not required
Site 7 (On-site Treatment)	Right-of-Way at Colma Boulevard	2,090-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 300-600	SFPUC	Cal Water	Disinfection, pH adjustment, fluoridation, iron/manganese removal	At site	Treatment for iron/manganese not required

TABLE 3-3
Site-specific Facility Characteristics

Site	Site Name	Facility Type[a]	Pump Type/ Capacity (gpm)[b]	Proposed Connection Point	Alternate Connection Point	Proposed On-site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site 8	Right-of-Way at Serramonte Boulevard	2,095-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine 300-600	Cal Water	SFPUC	Disinfection, pH adjustment (if needed)[d], fluoridation, iron/manganese removal	At site	Treatment
Site 9	Treasure Island Trailer Court	2,095-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 200-500	SFPUC	None	Disinfection, pH adjustment fluoridation, iron/manganese removal	At site	Treatment
Site 10	Right-of-Way at Hickey Boulevard	2,095-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 200-500	Daly City	SFPUC	Disinfection, pH adjustment (if needed)[d], fluoridation, iron/manganese removal	At site	Treatment
Site 11	South San Francisco Main Area	2,095-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 200-500	Cal Water	SFPUC	Disinfection, pH adjustment (if needed)[d] fluoridation, iron/manganese removal	At site	Treatment

TABLE 3-3
Site-specific Facility Characteristics

Site	Site Name	Facility Type[(a)]	Pump Type/ Capacity (gpm)[(b)]	Proposed Connection Point	Alternate Connection Point	Proposed On-site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site 12	Garden Chapel Funeral Home	1,495-square-foot facility with well plus chemical treatment	Aboveground Vertical Turbine/ 200-500	SFPUC	Other SFPUC	Disinfection, pH adjustment	At site	Blending[(e)]
Site 13	South San Francisco Linear Park	2,095-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 200-500	San Bruno	Cal Water	Disinfection, fluoridation, iron/manganese removal	At site	Treatment
Site 14	Golden Gate National Cemetery	700-square-foot building enclosure with well	Submersible Vertical Turbine/ 300-600	San Bruno	SFPUC	No on-site treatment	At Site 15	Treatment at Site 15
Site 15	Golden Gate National Cemetery	2,095-square-foot facility with well plus chemical treatment and filtration	Aboveground Vertical Turbine/ 300-600	San Bruno	SFPUC	Disinfection, pH adjustment (if needed)[(d)], fluoridation, iron/manganese removal	At site	Treatment
Site 16	Millbrae Corporation Yard	1,480-square-foot facility with well plus chemical treatment	Aboveground Vertical Turbine/ 100-200	SFPUC	Other SFPUC	Disinfection, pH adjustment, fluoridation	At site	Treatment for iron/manganese not required

TABLE 3-3
Site-specific Facility Characteristics

Site	Site Name	Facility Type[a]	Pump Type/ Capacity (gpm)[b]	Proposed Connection Point	Alternate Connection Point	Proposed On-site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site 17 (Alternate)	Standard Plumbing Supply	1,495-square-foot facility with well plus chemical treatment	Aboveground Vertical Turbine/ 300-600	Cal Water	SFPUC	Disinfection, pH adjustment (if needed)[d], fluoridation	At site	Treatment for iron/manganese not required
Site 18 (Alternate)	Alta Loma Drive	1,495-square-foot facility with well plus chemical treatment	Aboveground Vertical Turbine/ 200-500	SFPUC	Cal Water	Disinfection, pH adjustment (if needed) [d], fluoridation	At site	Treatment for iron/manganese not required
Site 19 (Alternate)	Garden Chapel Funeral Home	Well with fenced enclosure	Submersible Vertical Turbine/ 200-500	SFPUC	Other SFPUC	No on-site treatment	At Site 12	Blending[e]

Notes:

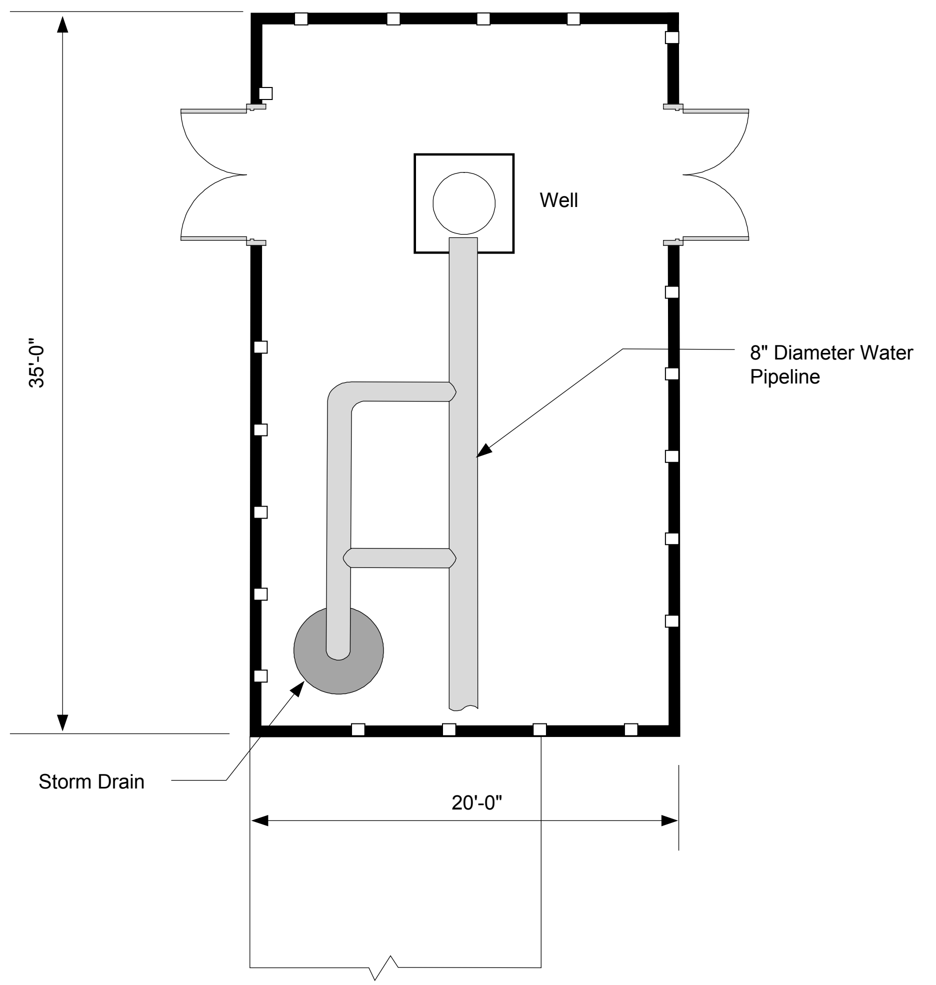
(a) Well station types are described in this section and shown on Figures 3-6, 3-7, and 3-8.

(b) "gpm" is gallons per minute.

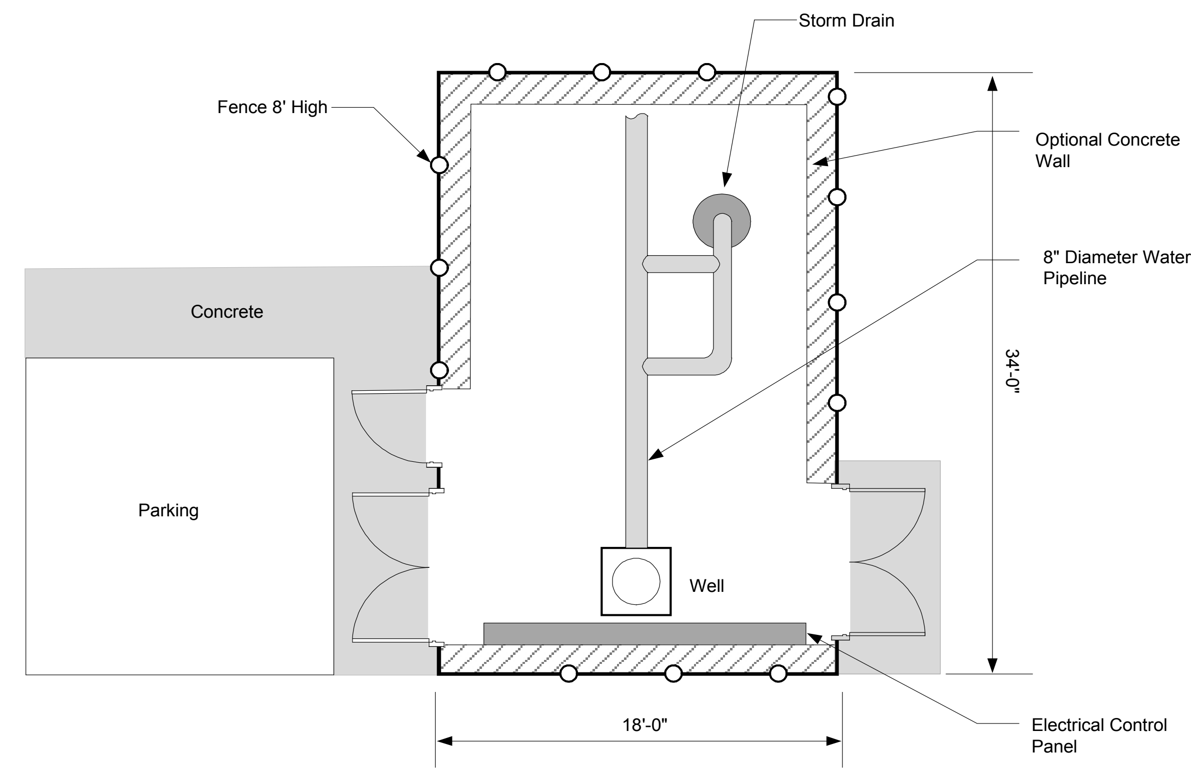
(c) Consolidated Treatment at Site 6 means that groundwater water from Sites 5 and 7 would be conveyed to a single water treatment facility at Site 6. No treatment facilities would be constructed at Site 5 or at Site 7 under this scenario. Please refer to Section 3.4.3 (Facility Sites), for a detailed explanation of the consolidated treatment option.

(d) pH adjustment only needed if alternate connection point is used.

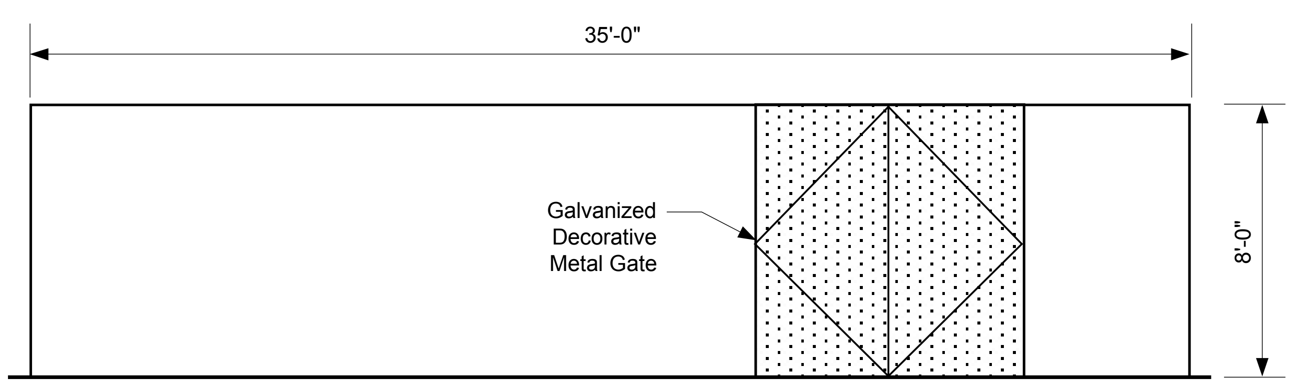
(e) Blending is mixing groundwater with other potable supply water. If nitrate concentrations in Project wells or Partner Agency wells increase above target levels due to the Project, this would be addressed through blending or other treatment to ensure that all drinking water standards for nitrate are met.



Typical Well with Building Enclosure
(Plan View)



Typical Well with Fenced Enclosure
(Plan View)



Typical Well with Building
(East Elevation)

Source: San Francisco Public Works 35% Design Sheets

Well Building and Fenced Enclosure Conceptual Layout

Regional Groundwater Storage and Recovery Project

Figure 3-6

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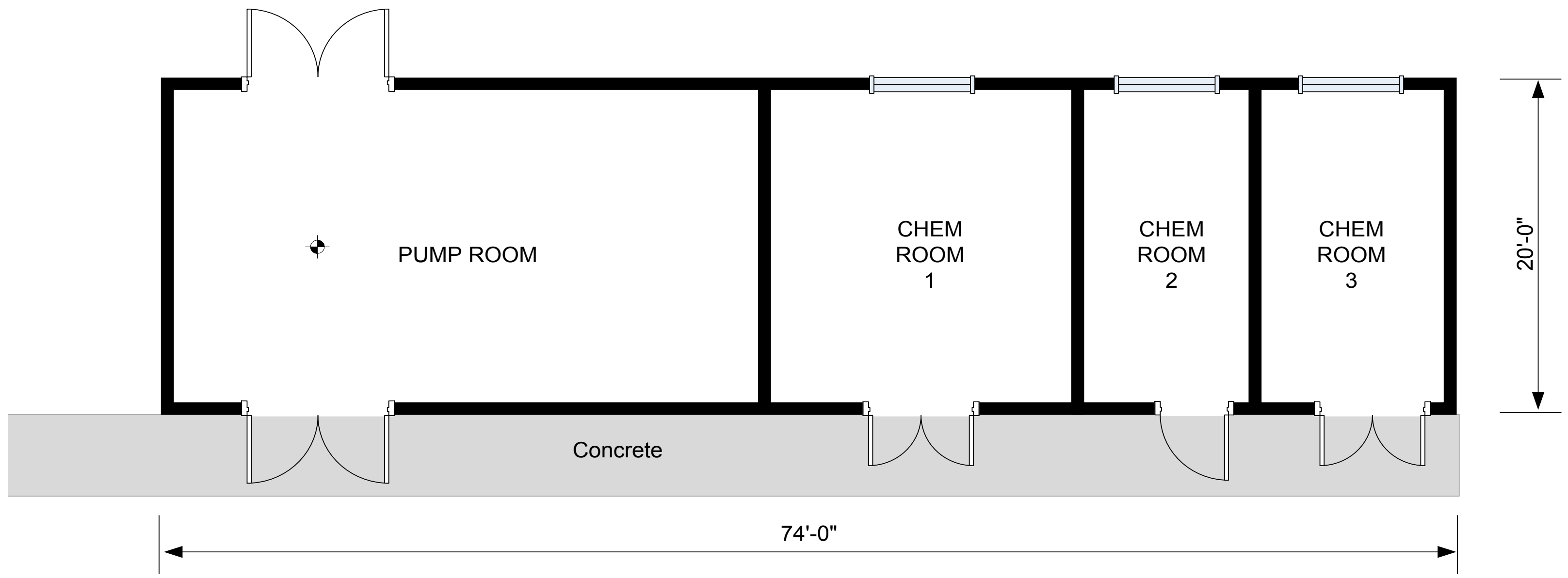
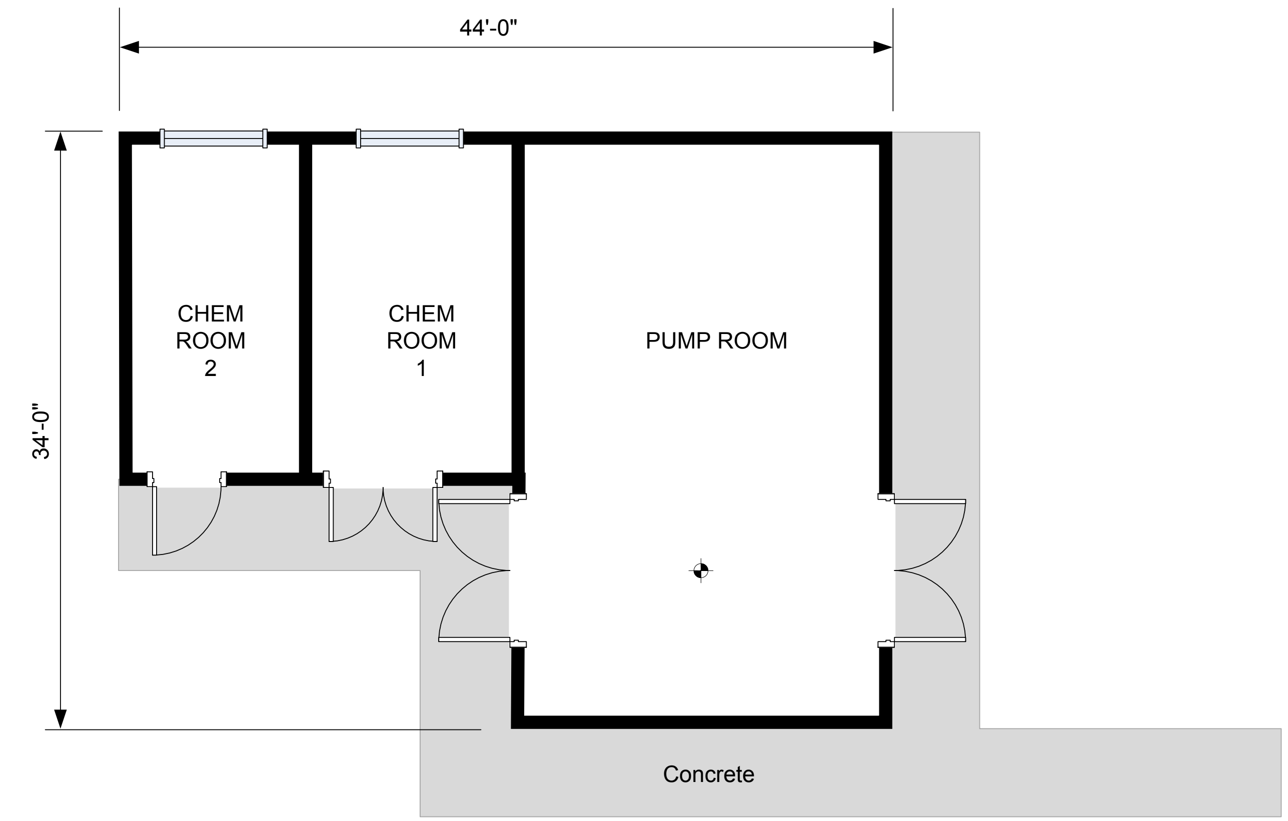
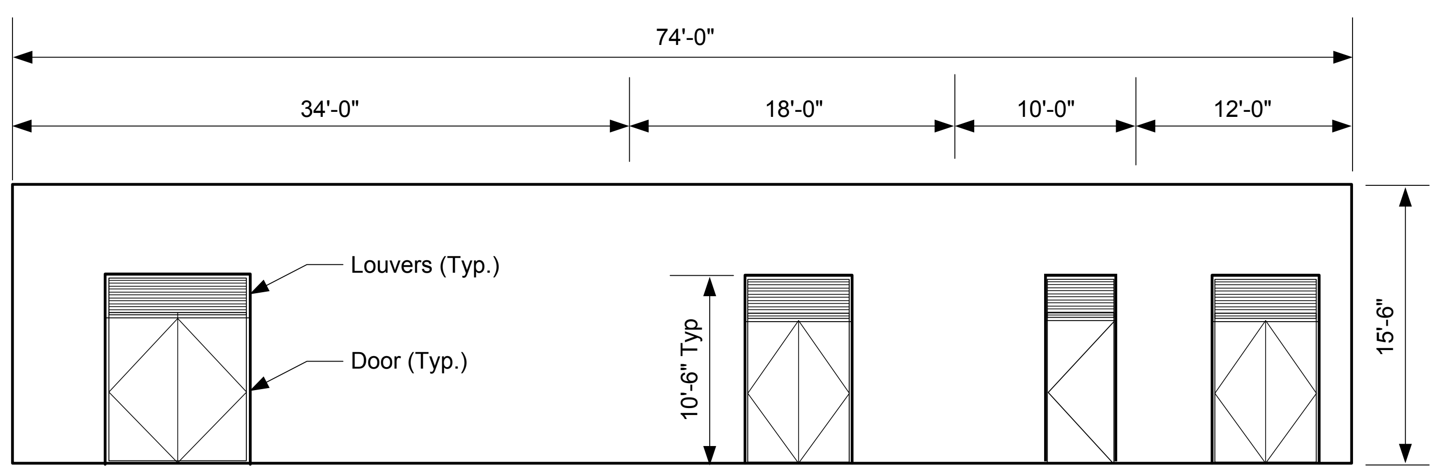


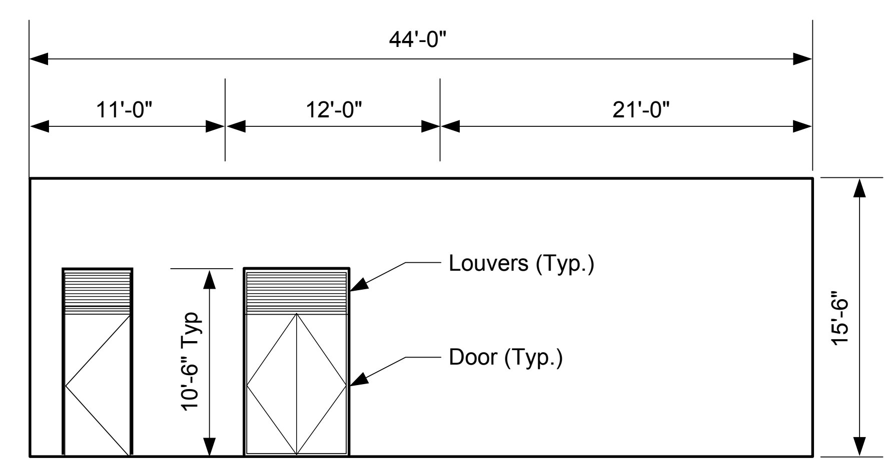
Typical Well Plus Chemical Treatment Four-Room Facility
(Plan View)



Typical Well Plus Chemical Treatment Three-Room Facility
(Plan View)



Typical Well Plus Chemical Treatment Four-Room Facility
(Elevation)



Typical Well Plus Chemical Treatment Three-Room Facility
(Elevation)

Note: Pump room would include the proposed well and pipelines similar to that shown on Figure 3-6.

Source: San Francisco Public Works 35% Design Sheets

Well Plus Chemical Treatment Building Conceptual Layouts

Regional Groundwater Storage and Recovery Project

Figure 3-7

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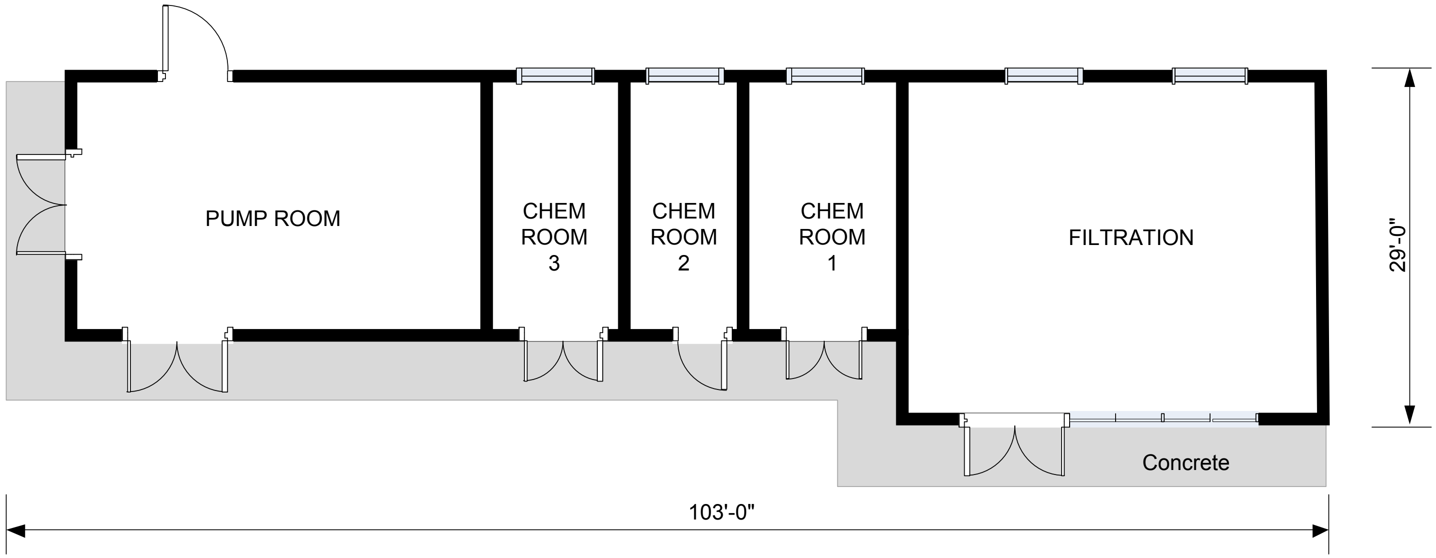
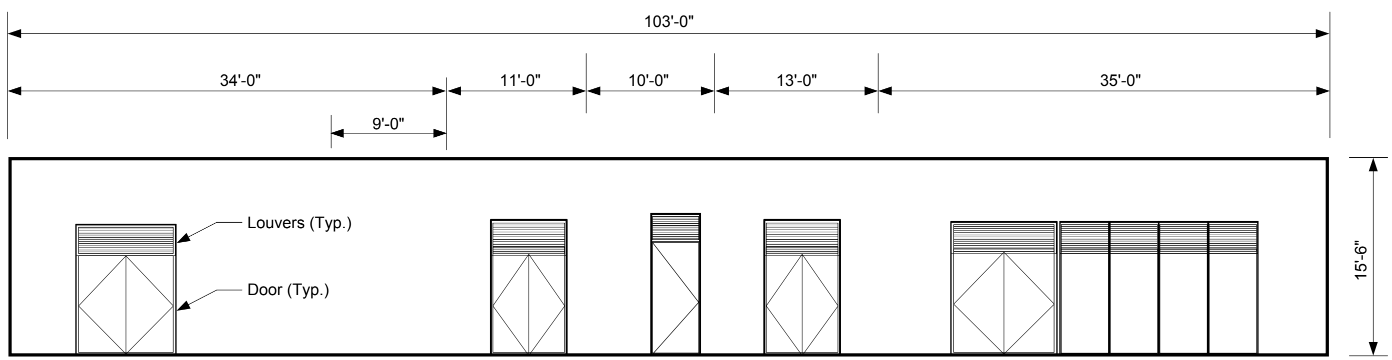


Typical Well Plus Chemical Treatment Five-Room Facility
(Plan View)



Typical Well Plus Chemical Treatment Five-Room Facility
(Elevation)

Note: Pump room would include the proposed well and pipelines similar to that shown on Figure 3-6.

Source: San Francisco Public Works 35% Design Sheets

Well Plus Chemical Treatment and Filtration Building Conceptual Layouts

Regional Groundwater Storage and Recovery Project

Figure 3-8

The building sizes would range from 700 to 2,990 square feet depending on the treatment needs for each well or if treatment would be consolidated at a single site for two or more wells.

Where the building's air system would be connected to the outside air for intake and exhaust, acoustical louvers would be installed to help reduce noise produced inside the building from reaching the exterior of the building. The building would also include noise-reducing features such as standard weatherproofed steel doors and roofing materials with sound-reducing qualities. A limited amount of sound absorbing material would be included inside the well buildings to minimize reverberant buildup of noise[3].

All facilities would include permanent outdoor lighting. Lights would either be mounted on the building or pole-mounted within the well facility site. All lighting would meet Title 24 of the California Code of Regulations standards including shielding, manual switch operation with automatic shut-off, and energy requirements. Lighting would be added near the main entrance of the well facility for security purposes and adjacent to the parking and service area at the rear of the building, if needed. Lighting would be used only when nighttime access is required. All lights would be switch operated with automatic shut-off.

Well with Fenced Enclosure

The conceptual layout for the "well with fenced enclosure" well facility type would include either an eight-foot-high, black vinyl-coated fence with one-inch mesh or an eight-foot-high metal picket fence with ¾-inch black pickets to house the wellhead, pump, piping, and associated electrical controls that would be located in a weather-proof control panel (see Figure 3-6 [Well Building and Fenced Enclosure Conceptual Layout]). An optional concrete wall may be added as illustrated in Figure 3-6.

A waste line for overboard water would be connected from the well to the nearest storm drain for disposing of pumped water ("overboard water") that would be generated during each well start-up, testing cycle, well rehabilitation, or other maintenance.

Well with Building

The "well with building" well facility type includes a 35- by 20-foot (700 square feet) building to house the wellhead, pump, piping, and associated electrical controls, as illustrated on Figure 3-6. The building height would be about eight feet above finished grade. A waste line for overboard water would be connected to the nearest storm drain.

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[3] A reverberation, or "reverb," is created when a sound is produced in an enclosed space causing a large number of echoes to build up and then slowly decay as the sound is absorbed by the walls and air.

Well plus Chemical Treatment

There are two conceptual layouts for a well with a chemical treatment building, as illustrated on Figure 3-7 (Well Plus Chemical Treatment Building Conceptual Layouts). The building's horizontal dimensions would be approximately 44 by 34 feet (1,495 square feet), or 75 by 20 feet (1,500 square feet), depending on the number of chemical treatment rooms needed at the site. The building would house the wellhead, pump, piping, and associated electrical and control equipment. The building would also provide for disinfection and fluoridation. The chemical treatment rooms would store disinfection chemicals, as needed, for treatment to address the quality of the groundwater and the receiving water systems.

In addition to the pump room, which would house the well head and mechanical and electrical equipment, chemical treatment facilities would require two or three separate chemical rooms. One room would contain a storage tank for sodium hypochlorite (for disinfection) and sodium hydroxide (for pH adjustment), if needed. The second room would contain a storage tank for ammonia (for disinfection) and a third room would accommodate fluoridation. Sodium fluoride would be used for fluoridation as required to meet Title 22 of the California Code of Regulations. The volume of chemical storage is shown in Table 3-4 (Maximum Volume of Chemical Storage).

Each tank is intended to provide a chemical storage capacity of 14 to 21 days (with an additional 15 percent safety factor) and the total volume of chemicals in each room would be kept at or below 1,000 gallons. The proposed storage capacity allows for chemical delivery to occur every two to three weeks. Space for a chlorine contact tank has been designated in the site layouts, in case disinfection is required. The chemical storage tanks would be placed on top of a pedestal and above a grate-covered chemical containment pit. The depth of the pit would be sized to provide 110 percent of the total storage volume.

A waste line for overboard water would be connected to the sanitary sewer and/or storm drain. This waste line would not drain any chemical storage areas. The facility would include a sink which would be connected to the sanitary sewer system. Water for the sink would come from a small potable water supply line.

TABLE 3-4
Maximum Volume of Chemical Storage

Site	Aqueous ammonia (gal) (Disinfection)	Sodium hypochlorite (gal) (Disinfection)	Sodium hydroxide (gal) (pH Adjustment)	Sodium fluoride (gal) (Fluoridation)	Filter media (cubic feet) (Iron/ Manganese Removal)
Sites 2, 3, 4, 5 (Consolidated Treatment at Site 6), 7 (Consolidated Treatment at Site 6), 14, 19 (Alternate)	N/A	N/A	N/A	N/A	N/A
Site 9	120	550	300	50	360
Sites 16 and 18 (Alternate)	120	200	200	50	0
Sites 1 and 17 (Alternate)	120	550	100	50	0
Sites 5 (On-site Treatment), 6 (On-site Treatment), 7 (On-site Treatment)	120	300	100	50	360
Sites 8 and 10	120	300	100[(a)]	50	360
Site 11	120	200	100[(a)]	50	360
Site 13	120	200	0	50	360
Site 12	120	550	100	0	0
Site 15	120	550	100[(a)]	50	360
Site 6 (Consolidated Treatment at Site 6)	300	1,000	1,000	100	960
Westlake Pump Station	120	600	0	200	0

Note:

(a) Sodium hydroxide storage only required if alternate connection is used.

Well plus Chemical Treatment and Filtration

There are two conceptual layouts for well stations with chemical treatment and filtration associated with iron/manganese removal, as shown in Figure 3-8 (Well Plus Chemical Treatment and Filtration Building Conceptual Layouts). The dimensions of the building would be approximately 91 by 23 feet (2,095 square feet), or 103 by 29 feet (2,990 square feet), depending upon the size of the filtration system needed and the number of rooms at the site. The chemical treatment rooms would be similar to those described above for the well plus chemical treatment type facility. An additional filtration room would be located only at well facilities that require iron and/or manganese removal. This well station type would be larger than the other types to provide space for the filtration vessels. The filtration system would consist of a series of vertical pressure vessels that utilize a proprietary media, plus possibly potassium permanganate[4] to remove silica. The volume of chemical storage is shown in Table 3-4 (Maximum Volume of Chemical Storage). The backwash water from the system would connect with a waste line to be connected to a nearby sanitary sewer. It is anticipated that filters would be backwashed, on average, once a day for five minutes at approximately 350 gallons per minute (gpm) per filter (MWH et al. 2008). Depending on the quantity of water being treated, the treatment facilities would have six to 16 filters, which would result in a discharge of approximately 0.01 to 0.03 mgd per well.

A waste line for overboard water would be connected to the sanitary sewer and/or storm drain. This waste line would not drain any chemical storage areas. The facility would include a wash sink which would be connected to the sanitary sewer system. Water for the sink would be conveyed through a small potable water supply pipeline.

Seismic Design Requirements

Well facility design would conform to the 2010 California Building Code and the SFPUC's *General Seismic Requirements for Design of New Facilities and Upgrade of Existing Facilities, Revision 2* (SFPUC 2009d). The SFPUC's General Seismic Requirements for Design of New Facilities and Upgrade of Existing Facilities set forth criteria for the seismic design of facilities and components of WSIP facility improvement projects. Under these design requirements, each facility is evaluated for its necessity in meeting the water service delivery goals and assigned a seismic performance class for the purpose of determining appropriate seismic design criteria. The SFPUC has classified the proposed facilities as "Important" (Class II), which is defined as facilities that may experience damage, but should be capable of restoration to service within 30 days (SFPUC 2009d).

3.4.2.3 Well Pumps

The pump type and pumping capacity for each well facility site are listed in Table 3-3 (Site-specific Facility Characteristics). The SFPUC proposes installing either submersible vertical turbine pumps or aboveground vertical turbine pumps in the wells. Wells enclosed in buildings would be equipped with aboveground vertical turbine pumps. Wells that are in fenced enclosures (i.e., without buildings) would be equipped with submersible pumps to minimize noise. Conceptual well profiles for the two well pump types are shown in Figures 3-9 (Typical Well Profile for Above Ground Motor Driven Pump) and 3-10 (Typical Well Profile for Submersible Motor Driven Pump).

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[4] If potassium permanganate is required in the filtration system to remove silica, the volumes needed would be minimal.

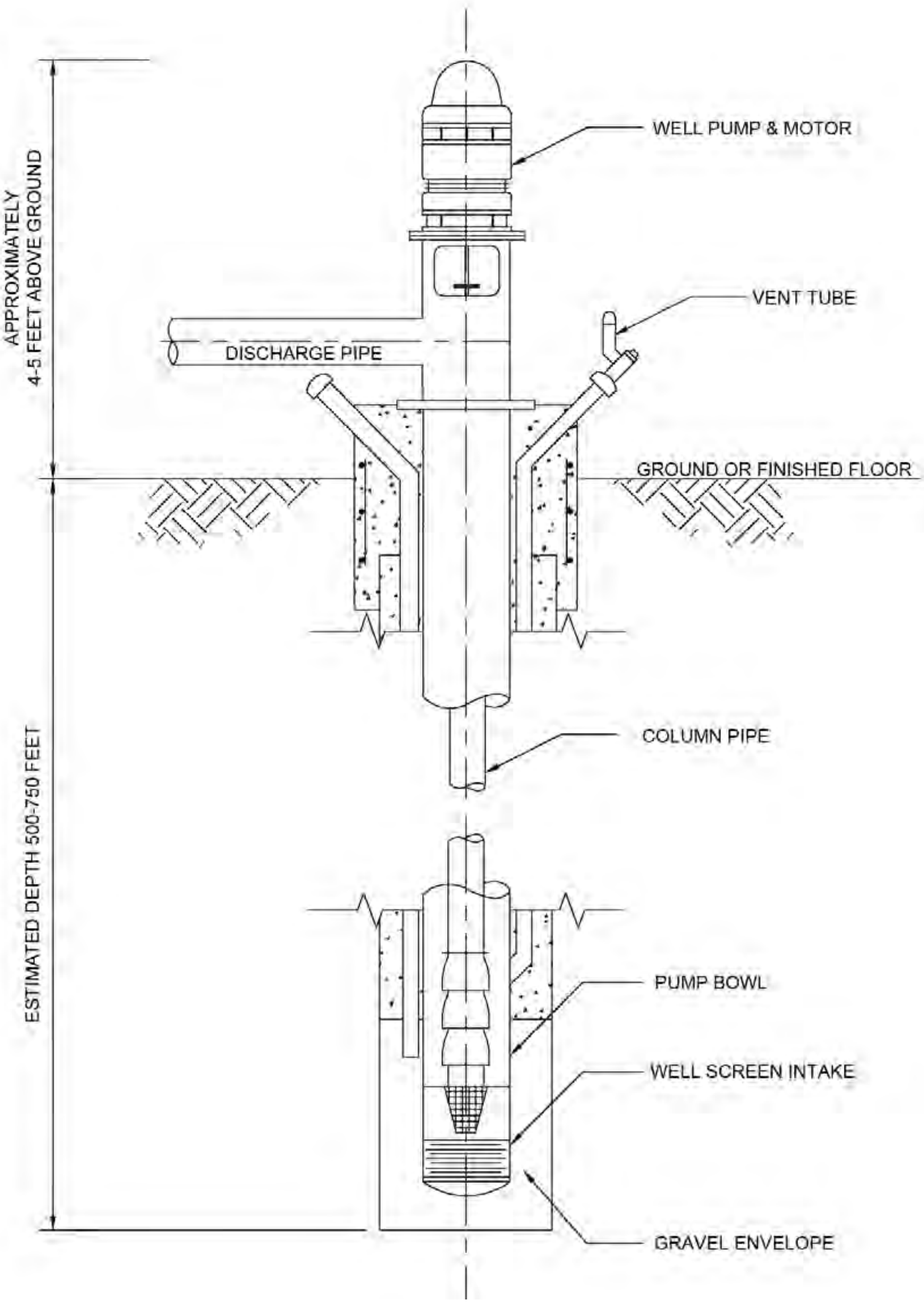
3.4.2.4 *Water Connection, Sanitary Sewer, and Storm Drain Piping*

Underground piping would be installed at each well site to connect the well to the local water distribution system or to the regional water system, or to connect the well to a neighboring facility for treatment. As explained in the introduction to Section 3.4.2 (Production Wells and Associated Facilities), connections to alternate distribution systems are also identified to provide the Project with design flexibility to accommodate access issues and utility conflicts.

Underground piping would connect well facilities to the local storm drain system and/or the sanitary sewer system to allow discharge of overboard well water, chloraminated water, or filter backwash. Chloraminated water would be dechlorinated and sent to the storm drain or, if not treated, sent to the local sanitary sewer system. The determination of where to send the chloraminated water would be based on operational constraints such as the duration and volume of the discharge and the distance to the closest sanitary sewer. Backwash from the iron/manganese removal facilities would also be sent to the local sanitary sewer system.

Ductile iron pipe would be installed to convey water from the well facility to the regional water system. The pipeline would be encased with polyethylene (plastic sheeting wrapped and taped around the pipe) as a corrosion control measure. Other similarly effective measures, such as other pipeline coating or passive cathodic protection, would be used as well.

The total pipe length required for all 19 well facility sites, including the proposed distribution system connections (whichever one is longer), would be approximately 19,000 feet of six-inch and eight-inch pipe. The location and type of piping is shown on each of the site plans (see Figures 3-11 through 3-40). Table 3-5 (Pipeline Lengths by Facility Site) presents the approximate pipeline lengths for each site.



Not to Scale

Typical Well Profile for Above Ground Motor Driven Pump

Regional Groundwater Storage and Recovery Project

Source: MWH 2008

Figure 3-9

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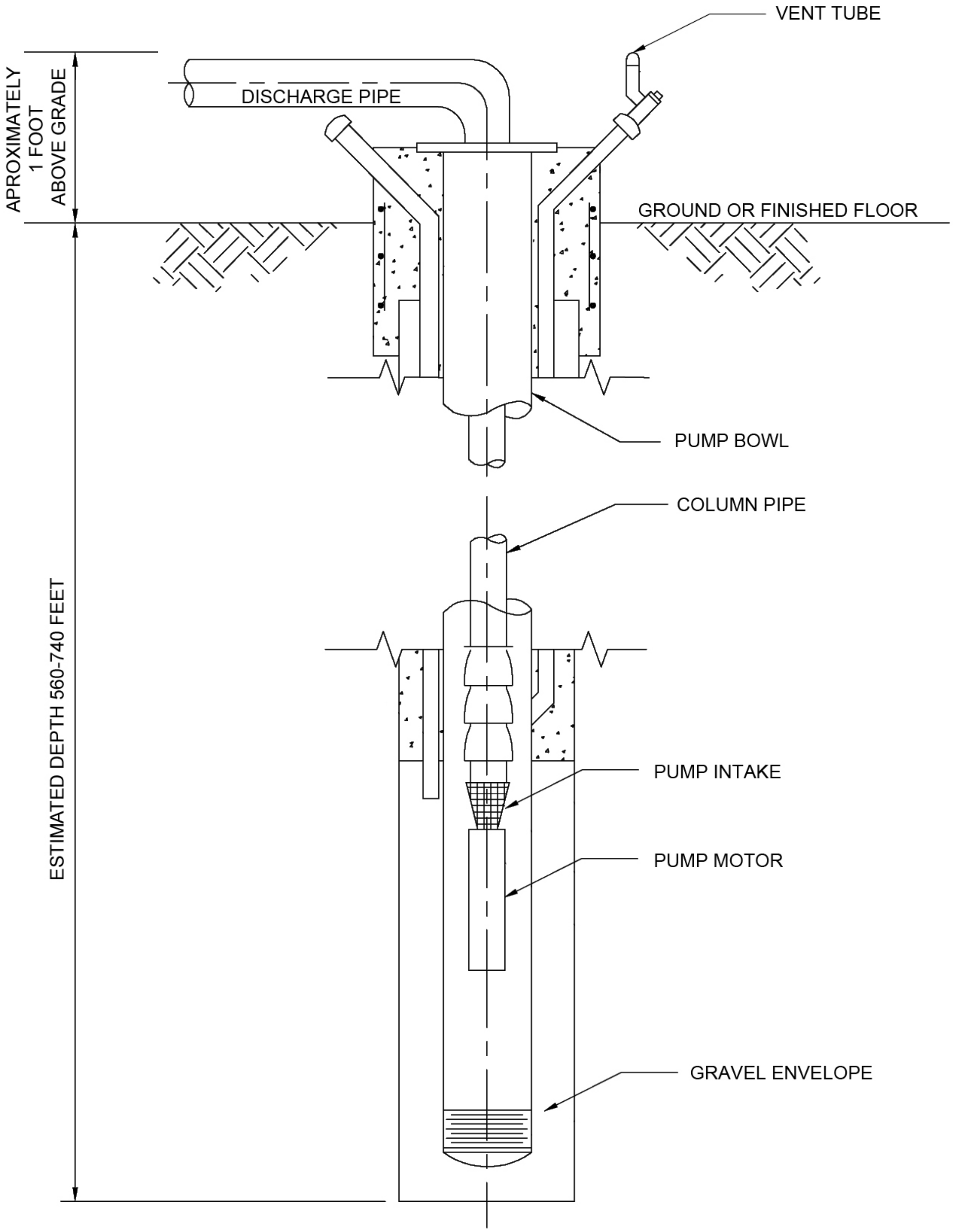


Not to Scale

Typical Well Profile for Submersible Motor Driven Pump

Regional Groundwater Storage and Recovery Project

Figure 3-10

Source: MWH 2008

TABLE 3-5
Pipeline Lengths by Facility Site[a]

Site	Approximate Pipeline Lengths (feet)			
	Proposed Water Connection Pipeline	Alternate Water Connection Pipeline	Sanitary Sewer Pipeline	Storm Drain Pipeline
Site 1	125	175	55	65
Site 2[b]	315	None	None	125
Site 3[b]	375	None	None	470
Site 4[b]	670	None	None	330
Westlake Pump Station	None	None	None	None
Site 5 (Consolidated Treatment at Site 6)[c]	1,120	None	None	370
Site 6 (Consolidated Treatment at Site 6)[c]	115	525	130	110
Site 7 (Consolidated Treatment at Site 6)[c]	1,780	None	None	170
Site 5 (On-site Treatment)	145	165	110	370
Site 6 (On-site Treatment)	115	525	130	110
Site 7 (On-site Treatment)	75	145	170	170
Site 8	145	125	85	220
Site 9	245	None	185	170
Site 10	200	100	145	110
Site 11	205	160	965	145
Site 12	925	90	355	355
Site 13	1,835	185	495	145
Site 14	1,785	None	None	1,110
Site 15	670	680	100	155
Site 16	40	700	290	105
Site 17 (Alternate)	105	20	70	75
Site 18 (Alternate)	130	120	140	155
Site 19 (Alternate)[d]	1,450	150	None	190

Notes:

(a) Pipelines listed in the table are illustrated on site plans for each site – Figures 3-11 through Figure 3-40.

(b) The water connection pipeline for Sites 2, 3, and 4 indicates the length of pipeline needed to connect to the existing Daly City pipeline for conveyance to the Westlake Pump Station.

(c) Water connection pipelines for Site 5 (Consolidated Treatment at Site 6) and Site 7 (Consolidated Treatment at Site 6) indicate the pipeline length necessary to deliver water to Site 6 for treatment.

(d) The water connection pipeline for Site 19 (Alternate) indicates the pipeline length needed to deliver water to the treatment facility at Site 12 and to then deliver water to the regional water system following treatment.

3.4.2.5 *Site Access and Security*

Permanent access to the well sites would be needed for servicing the well and pumping equipment and for normal daily operations. The permanent access would be provided via a new concrete driveway from a public street or other normally accessible roadway (except at Site 14 where the new driveway would use grass pavers). Where there is existing access, no new access would be constructed. Locations of proposed new access driveways and existing access driveways for each of the sites are shown on the proposed site plans (Figures 3-11 through 3-40). Parking would be accommodated in and around the well facilities and may include one designated parking space at each site.

Security fencing would be provided at all sites except Site 14. The proposed security fence would be either a black vinyl-coated eight-foot-high with one-inch mesh or an eight-foot-high black metal picket fence. The location of the fencing is shown on the site layouts. The fence would include a locked gate for access. No on-site fuel storage would be required at the well sites.

3.4.2.6 *Site SCADA Systems*

All well station and related facilities would be integrated into the SFPUC's and Partner Agencies' existing Supervisory Control and Data Acquisition (SCADA) systems. A new controller would be provided at each facility for local control. SCADA systems allow remote access to gather data and send commands to equipment at the facilities. The SCADA system would consist of a computer and communications software to allow for remote data gathering and operations of well facilities via telephone lines.

3.4.2.7 *Power Supply Requirements*

The power required at each well station was primarily determined by the size of the well pump motor. Power requirements for appurtenances such as SCADA equipment, flow meters, pressure transmitters, level transmitters, chemical metering pumps, eye wash equipment, lights, and receptacles are small in comparison and are identified under auxiliary equipment in Table 3-6 (Electrical Energy Demand for Facility Sites during Dry Years). Electric energy demands vary by well site, also shown in Table 3-6.

TABLE 3-6
Electrical Energy Demand for Facility Sites during Dry Years

Site	Energy Demand		
	Well Pumps (KVA)[a]	Auxiliary Equipment (KVA)	Total for One Year of Pumping (millions of kWH)[b]
Site 1	168	15	1.6
Site 2	84	15	0.8
Site 3	84	15	0.8
Site 4	84	15	0.8
Westlake Pump Station	84	15	0.8
Site 5 (Consolidated Treatment at Site 6)	126	15	1.2
Site 6 (Consolidated Treatment at Site 6)	168	15	1.6
Site 7 (Consolidated Treatment at Site 6)	126	15	1.2
Site 5 (On-site Treatment)	126	15	1.2
Site 6 (On-site Treatment)	168	15	1.6
Site 7 (On-site Treatment)	126	15	1.2
Site 8	126	15	1.2
Site 9	84	15	0.8
Site 10	105	15	1.0
Site 11	84	15	0.8
Site 12	84	15	0.8
Site 13	84	15	0.8
Site 14	168	15	1.6
Site 15	126	15	1.2
Site 16	126	15	1.2
Total[c]			17.4
Site 17 (Alternate)	126	15	1.2
Site 18 (Alternate)	105	15	1.0
Site 19 (Alternate)	84	15	0.8

Notes:

(a) KVA is kilovolt amperes.

(b) kWH is kilowatt hours.

(c) Total energy demand is for the 16 well facilities and does not include the alternate well facilities, because only 16 wells would ultimately be operated.

When the Project is pumping during a dry year, the wells may operate up to 24 hours a day, 365 days a year. At such a rate, the SFPUC estimates that energy demands would be approximately 17 million kilowatt-hours (kWh) for the year (see Appendix I, [Calculations for GSR Energy Use Impacts]). During normal and wet years, when the wells are not operating, energy requirements would be minimal. Permanent electrical power at the well stations would be hydroelectrically generated power supplied by the SFPUC Power Enterprise, distributed via the Pacific Gas & Electric Company (PG&E) system. Each well facility would contain a motor control center with a step-down transformer, a variable frequency drive for operational flexibility, and panel board to serve the well pumps, lighting, receptacle, controls, and instrumentation loads.

3.4.2.8 Stand-by Power Requirements

In the event of a regional or local emergency or a planned/unplanned shutdown of the regional water system or of any Partner Agency distribution facility, the Project well facilities may be operated until service is restored regardless of year type (i.e., wet/normal/dry).

All well stations would have provisions for a drive-up portable generator connection, so that in the event of a power failure the well pumps could continue to run in a dry year or be used as a temporary alternate water supply (in a normal or wet year). The portable emergency generator would operate when the SFPUC or Partner Agencies need to operate the pumps during power outages. The portable diesel generators would be trailer-mounted models with built-in sound reduction and spill containment features.

3.4.3 Facility Sites

This section describes the site layouts and system connections for each of the 16 preferred and three alternate well sites and for the Westlake Pump Station upgrade[5]. The summary tables under each heading describe the components proposed for each well facility. The text accompanying each summary table provides information about the geographic location of the well facility, the water treatment proposed for the site, the location of electrical power to the site, the location of temporary and permanent access to the site and any unique project elements for the site. The proposed site layouts are shown in Figures 3-11 through 3-40. The site layouts show the construction area boundary, site access, and the proposed pipelines, including the proposed and alternate water connections. The well locations, the well facility footprint, and the permanent paving and parking locations are also shown. Construction activities, including grading, tree trimming and removal, temporary access, and construction staging areas are described in Section 3.5 (Project Construction). For more specific information regarding individual site ownership and easement rights, refer to Section 3.10 (Property Rights Acquisition).

[5] Estimated system connections are shown as accurately as possible given the limitations of the preliminary engineering design. Exact locations would be determined when each well site is surveyed during future design phases. The SFPUC's site plans are flexible; however, any changes in future design phases would be made within the identified construction area boundary for each site.

Site 1: Lake Merced Golf Club

Layout Type	Well plus chemical treatment facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline length	125 feet
Alternate Water Connection	Daly City
Pipeline length	175 feet
Storm Drains & Sanitary Sewer pipelines	120 feet
Pavement Size	1,280 square feet
Building Size	1,480 square feet

Site 1 would be located in Daly City on the northeast corner of the Lake Merced Golf Club west of Interstate 280 (I-280) on land owned by the Golf Club. The site layout is shown in Figure 3-11. The proposed Project includes a new production well and continued operation of an existing water quality monitoring well. The existing restroom located on the well facility site would be demolished. The SFPUC would financially compensate the Lake Merced Golf Club for the loss of the restroom. The treatment processes at the site would include disinfection, fluoridation, and pH adjustment.

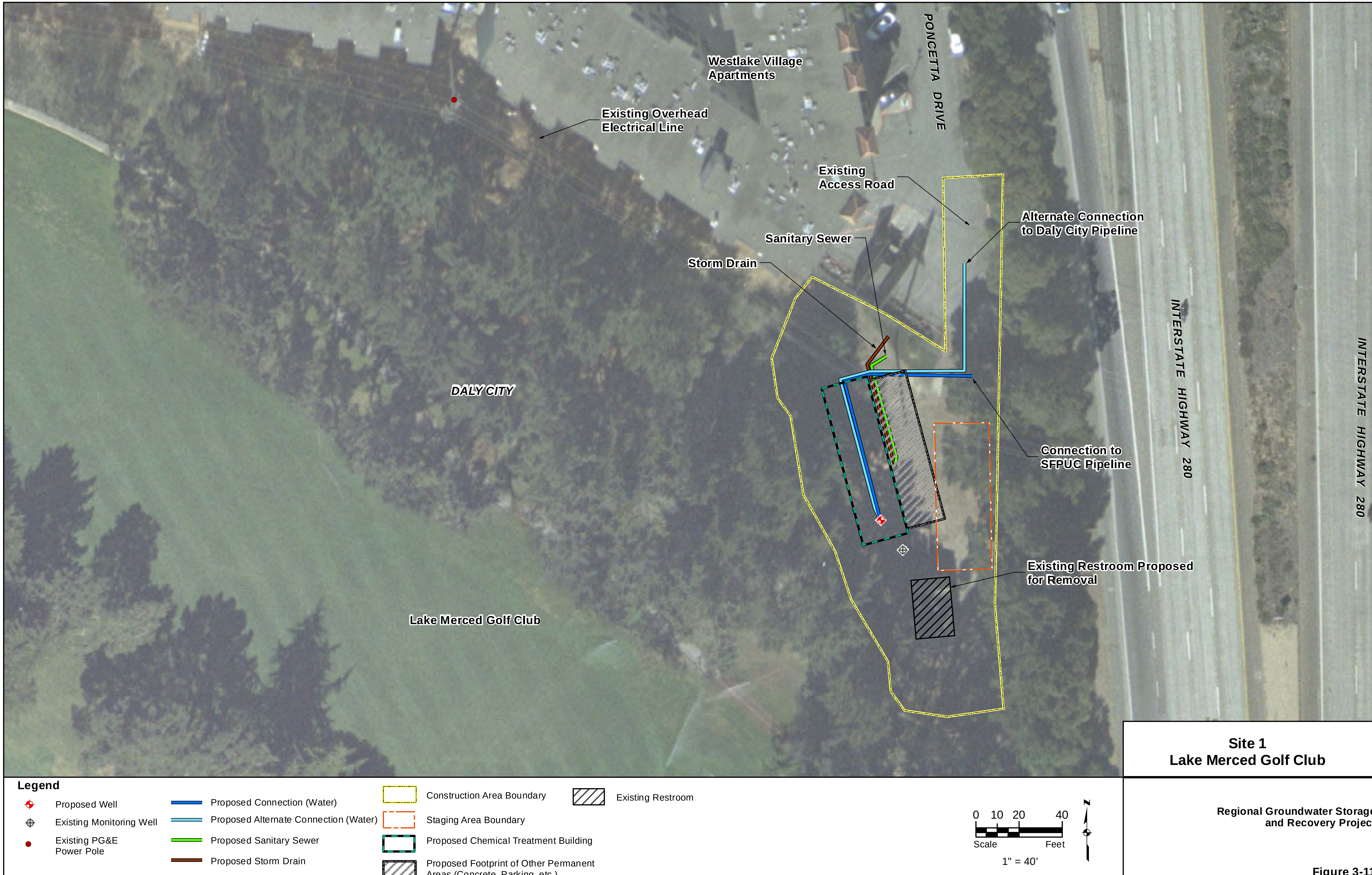
Electrical power would be provided to the site by connecting to existing PG&E overhead electric lines that traverse the site. Temporary construction access and permanent access to Site 1 would be from Poncetta Drive and an existing on-site access driveway. No new access improvements would be required.

Site 2: Park Plaza Meter

Layout Type	Well with fenced enclosure
Pump Type	Submersible vertical turbine
Proposed Water Connection	Daly City
Pipeline Length	315 feet
Alternate Water Connection	None
Storm Drains	125 feet
Pavement Size	612 square feet
Building Size	N/A

Site 2 would be located near the southwest portion of Lake Merced Golf Club, east of Park Plaza Drive, in Daly City on SFPUC property. The site layout is shown in Figure 3-12. The proposed Project at Site 2 includes conversion of an existing test well to a production well and continued operation of an existing water quality monitoring well. No on-site treatment processes are proposed, because extracted groundwater would be conveyed to the Westlake Pump Station for disinfection and fluoridation via existing pipelines. Figure 3-13 shows the location of Daly City's Westlake Pump Station relative to Site 2.

Electrical power would be provided to Site 2 through a new underground connection to an existing PG&E power pole located approximately 40 feet to the north. Temporary construction access and permanent site access would be from an existing golf club access road off of Park Plaza Drive. The on-site access driveway would be improved from the existing golf club road to the well facility.



Site 1
Lake Merced Golf Club

Regional Groundwater Storage and Recovery Project

Figure 3-11

Source: SFPUC and Kennedy/Jenks

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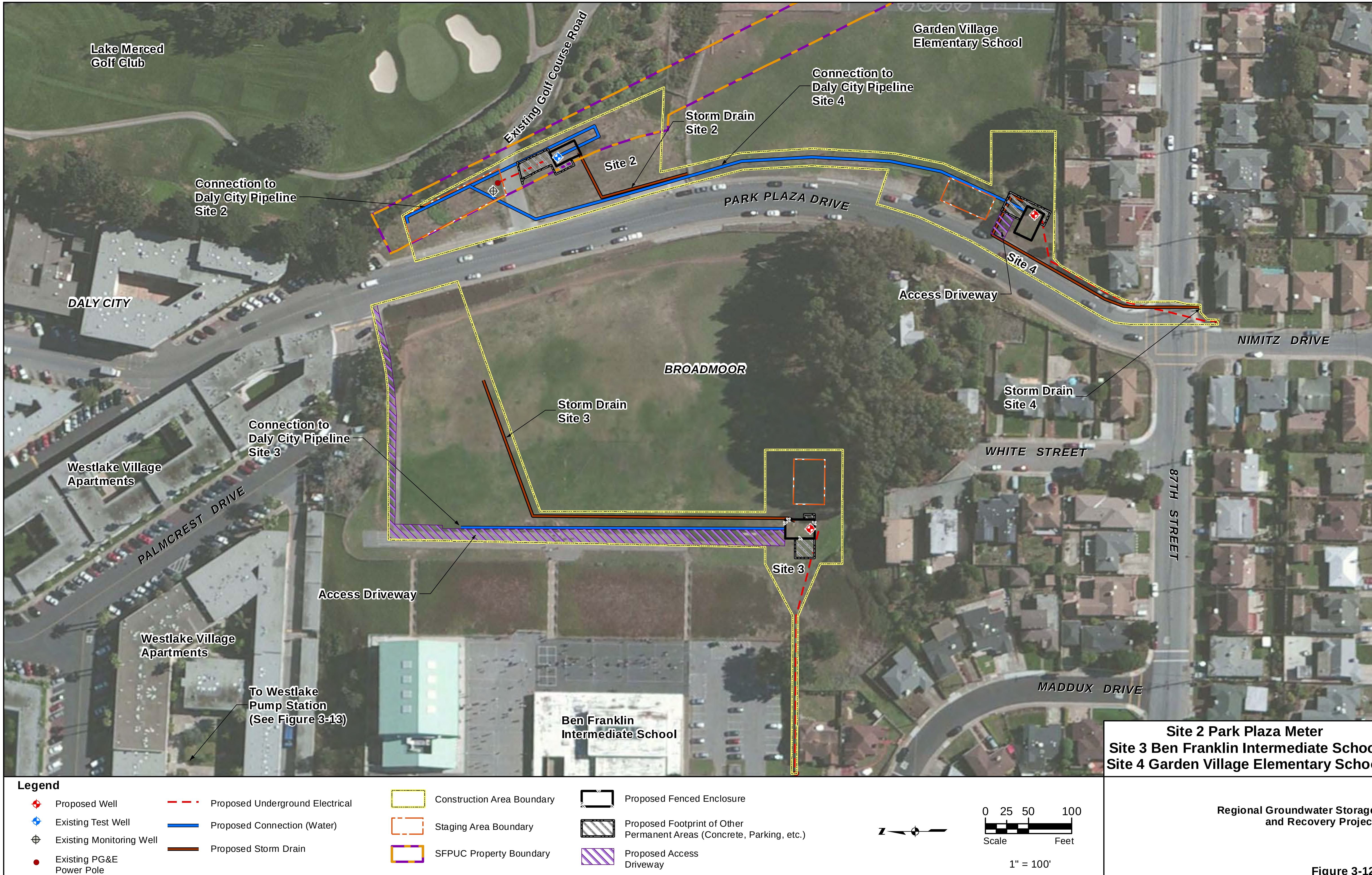

Site 2 Park Plaza Meter
Site 3 Ben Franklin Intermediate School
Site 4 Garden Village Elementary School

Regional Groundwater Storage and Recovery Project

Figure 3-12

Source: SFPUC and Kennedy/Jenks

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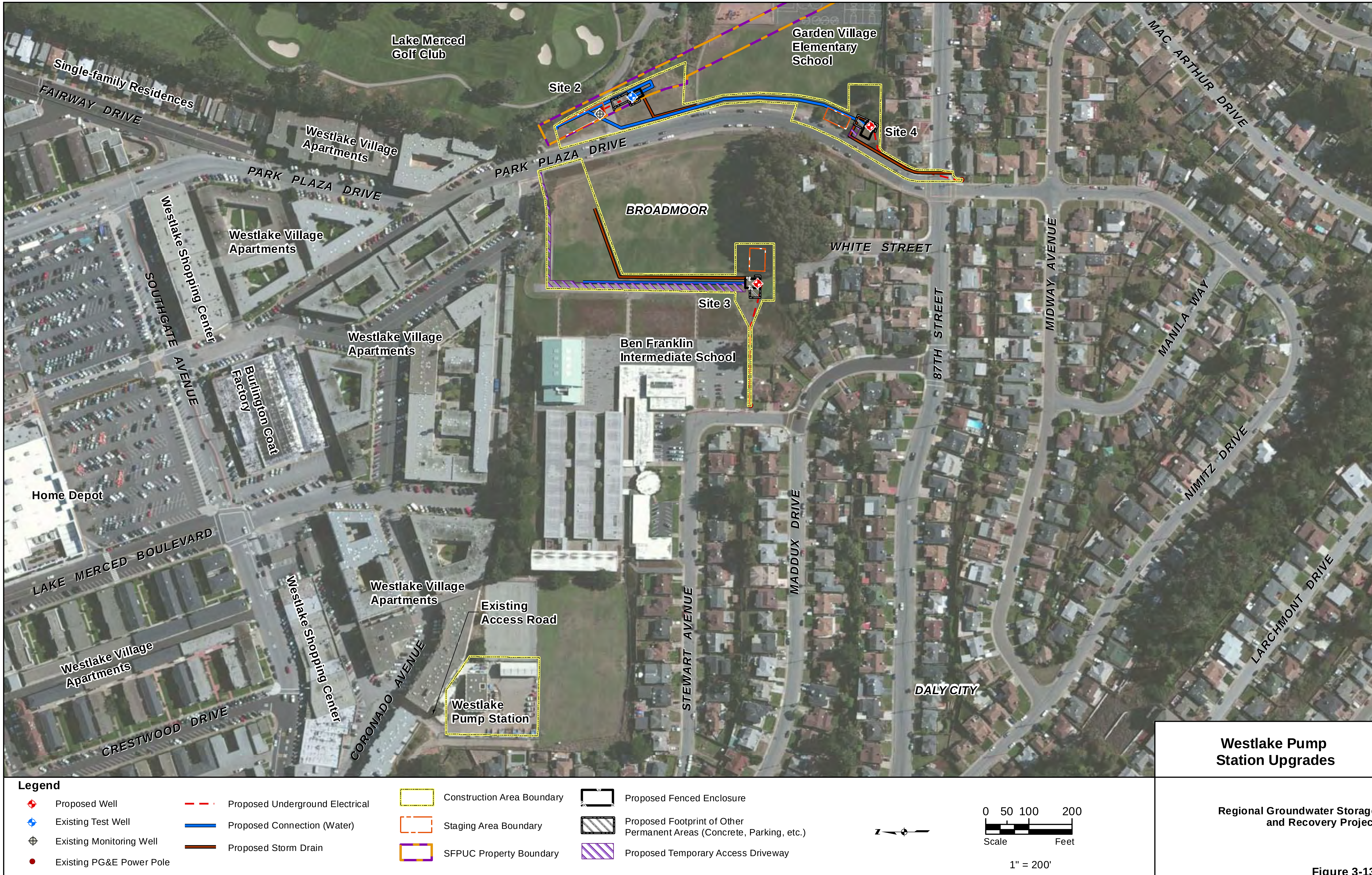

Westlake Pump Station Upgrades

Regional Groundwater Storage and Recovery Project

Figure 3-13

Source: SFPUC and Kennedy/Jenks

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Site 3: Ben Franklin Intermediate School

Layout Type	Well with fenced enclosure
Pump Type	Submersible vertical turbine
Proposed Water Connection	Daly City
Pipeline Length	375 feet
Alternate Water Connection	None
Storm Drains	470 feet
Pavement Size	612 square feet
Building Size	N/A

Site 3 would be located in Broadmoor in unincorporated San Mateo County, west of Park Plaza Drive on property owned by the Jefferson Elementary School District. The site layout is shown in Figure 3-12. The site would be located on the southwest portion of an athletic field at Ben Franklin Intermediate School. The proposed Project at Site 3 includes a new production well. No on-site treatment processes are proposed, because extracted groundwater would be conveyed via existing pipelines to the Westlake Pump Station for disinfection and fluoridation. Figure 3-13 shows the location of Daly City's Westlake Pump Station relative to Site 3.

Electrical power to Site 3 would be via a new underground connection to an existing PG&E power pole located approximately 150 feet to the west.

The well facility would be constructed over two summers, when the neighboring schools are not in session. Temporary construction access and permanent access to Site 3 would follow the route shown on Figure 3-12 from Park Plaza Drive along the path at the northern edge of the athletic field and along the running track at Ben Franklin School. No permanent access improvements are proposed, other than restoration of the path and running track to at least their general pre-existing conditions at the completion of each construction season. The existing baseball backstop would be repaired or replaced and the turf along the pipeline route would be replaced following construction. The SFPUC would notify the Jefferson Elementary School District of construction activities a minimum of nine months in advance of any construction on school grounds to allow the District to plan for school ground closures. Prior to the start of the school year, the SFPUC would restore the site for school use.

Site 4: Garden Village Elementary School

Layout Type	Well with Fenced Enclosure
Pump Type	Submersible Vertical Turbine
Proposed Water Connection	Daly City
Pipeline Length	670 feet
Alternate Water Connection	None
Storm Drains	330 feet
Pavement Size	612 square feet
Building Size	N/A

Site 4 would be located in Broadmoor in unincorporated San Mateo County, east of Park Plaza Drive, on property owned by San Mateo County. The site layout is shown in Figure 3-12. Site 4 is adjacent to the playing field of the Garden Village Elementary School and single-family residences. The proposed Project at Site 4 includes a new production well. No on-site treatment processes are proposed, because the extracted groundwater would be conveyed via existing pipelines to the Westlake Pump Station for disinfection and fluoridation. Figure 3-13 shows the location of Daly City's Westlake Pump Station relative to Site 4.

Electrical power to Site 4 would be via a new underground connection to an existing PG&E power pole located approximately 270 feet to the southwest.

An existing baseball backstop would be temporarily relocated during construction; after construction is complete it would be returned to its original location. Turf along the pipeline route would be replaced following construction. The SFPUC would notify the Jefferson Elementary School District of construction activities a minimum of nine months in advance of any construction on school grounds to allow the District to plan for any partial school ground closures.

Temporary construction access and permanent access would be from Park Plaza Drive. The on-site driveway would be improved from Park Plaza Drive to the well facility.

Westlake Pump Station Upgrade

The existing Westlake Pump Station is owned and operated by the City of Daly City. It is located partially in Daly City and partially in unincorporated San Mateo County, south of Coronado Avenue, on property owned by the City of Daly City. The site is shown in Figure 3-13. The Westlake Pump Station is adjacent to the back (west) of the Ben Franklin Intermediate School and multi-family residences. The existing Westlake Pump Station site includes an existing well and treatment facilities (disinfection and fluoridation), and serves as a corporation yard for the Daly City Water and Wastewater Resources Department.

The proposed Project includes upgrades to the Westlake Pump Station to serve the well facilities at Sites 2, 3, and 4, including new fluoride, chlorine, and ammonia chemical storage tanks, replaced or upgraded chemical metering pumps, a resized transformer, and up to three new booster pumps to deliver the additional water into the Daly City distribution system. All Project facilities would be located within the existing pump station building.

Temporary construction access and permanent access would be from Coronado Avenue, from an existing driveway through the Westlake Apartments and from an existing on-site driveway within the Westlake Pump Station. No new access improvements would be required.

Sites 5, 6, and 7: Right-of-Way at Serra Bowl, Right-of-Way at Colma BART, and Right-of-Way at Colma Boulevard

Sites 5, 6, and 7 would be located in close proximity to one another in southern Daly City and northern Colma. The SFPUC proposes consolidated treatment at Site 6, meaning that groundwater from Sites 5 and 7 would be conveyed to a centralized treatment facility at Site 6, which is the SFPUC's preferred configuration for the Project. However, the SFPUC has also identified an option to construct on-site treatment facilities at each of Sites 5, 6, and 7 as a contingency in case consolidating treatment at Site 6 is found to be infeasible due to, for example, the difficulty of constructing the pipelines from Sites 5 or 7 to Site 6 due to the presence of existing underground infrastructure or other currently unforeseen underground constraints. If so, then on-site treatment at Sites 5 or 7 may be needed. The decision to construct on-site treatment facilities, rather than consolidated treatment at Site 6, would occur prior to construction at any of the three sites and would be based on site constraints.

The facilities necessary at each site for both the consolidated and on-site treatment options are discussed in detail below. The facilities necessary at each site for the consolidated treatment option are illustrated on Figures 3-14 through 3-17. Figure 3-14 illustrates Sites 5, 6, and 7 together with consolidated treatment at Site 6, and Figures 3-15 through 3-17 illustrate the individual sites. Figure 3-18 illustrates Sites 5, 6, and 7 with on-site treatment, and Figures 3-19 through 3-21 illustrate the individual sites. The figures are located following the discussion of each option.

Sites 5, 6, and 7 with Consolidated Treatment at Site 6

With consolidated treatment at Site 6, Sites 5 and 7 would have only a fenced enclosure and would convey groundwater via new pipelines to Site 6 for treatment. This is the SFPUC's preferred configuration for the Project. However, due to the potential for currently unforeseen underground constraints, this configuration may not be technically feasible.

Site 5 (Consolidated Treatment at Site 6): Right-of-Way at Serra Bowl

Layout Type	Well with fenced enclosure
Pump Type	Submersible vertical turbine
Proposed Water Connection	See Site 6
Alternate Water Connection	See Site 6
Pipeline to Site 6	1,120 feet
Storm Drains	370 feet
Pavement Size	1,955 square feet
Building Size	N/A

Site 5 (Consolidated Treatment at Site 6) would be located south of B Street between Junipero Serra Boulevard and Hill Street in Daly City on SFPUC property. The site would be adjacent to the Serra Bowl parking lot, commercial uses, and a single-family residence. The site layout is shown on Figure 3-15. The proposed Project at Site 5 (Consolidated Treatment at Site 6) includes conversion of an existing test well to a production well and continued use of an existing water quality monitoring well. Water from Site 5 (Consolidated Treatment at Site 6) would be conveyed to Site 6 for treatment before addition of the water to the SFPUC distribution system. Treatment facilities at Site 6 include disinfection, pH adjustment, fluoridation, and iron/manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 200 feet to the north.

Temporary construction access and permanent access to Site 5 (Consolidated Treatment at Site 6) would be from B Street, via an existing driveway. The on-site access driveway would be improved from B Street to the well facility.

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Source: SFPUC and Kennedy/Jenks

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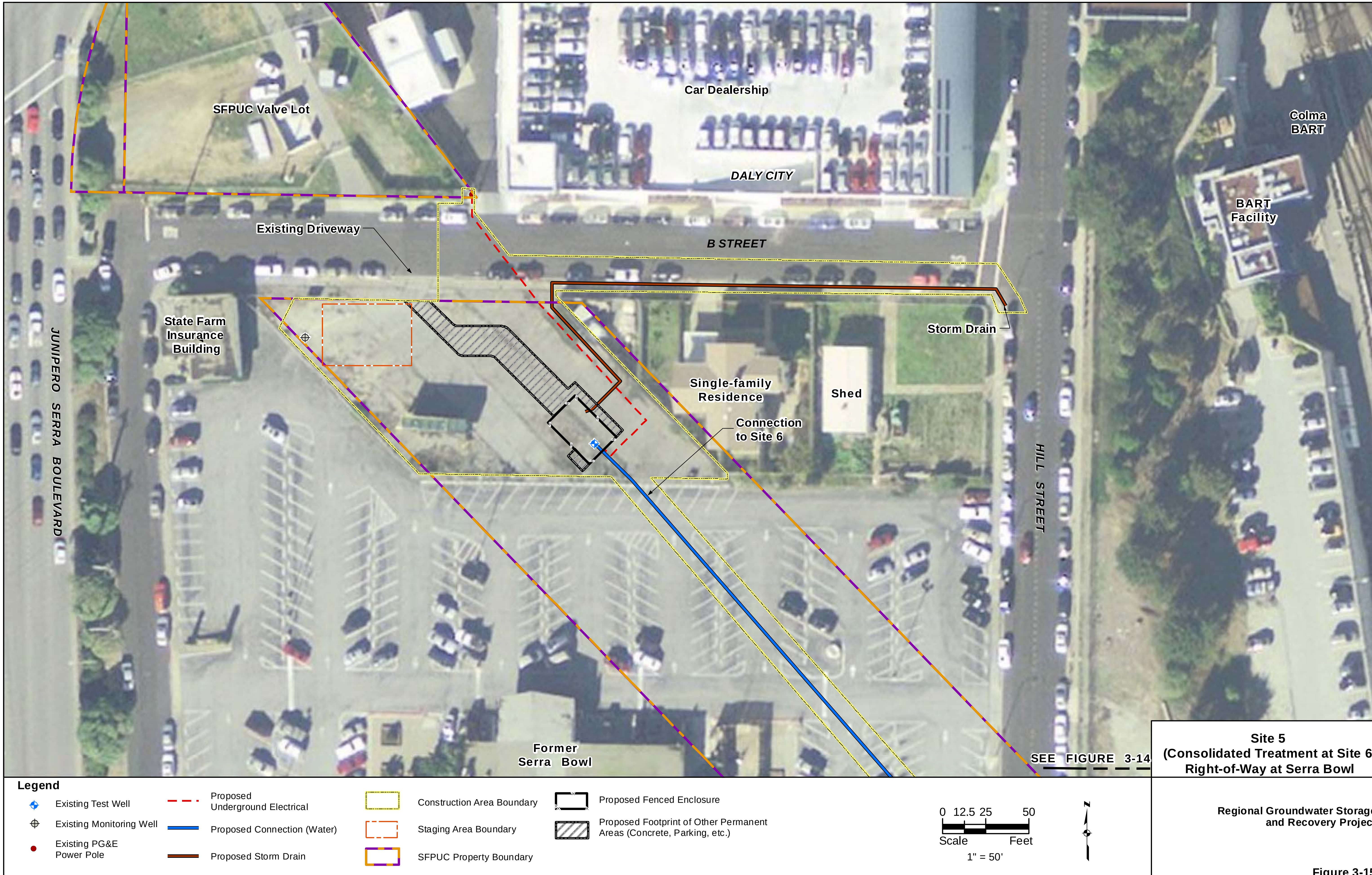

Site 5 (Consolidated Treatment at Site 6) Right-of-Way at Serra Bowl

Regional Groundwater Storage and Recovery Project

Figure 3-15

Source: SFPUC and Kennedy/Jenks

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Site 6 (Consolidated Treatment at Site 6): Right-of Way at Colma BART

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	115 feet
Alternate Water Connection	Cal Water
Pipeline Length	525 feet
Sanitary Sewer & Storm Drain Pipelines	240 feet
Pavement Size	3,535 square feet
Building Size	2,990 square feet

Site 6 (Consolidated Treatment at Site 6) would be located west of D Street across from the Colma Bay Area Rapid Transit (BART) Station in Daly City on SFPUC property. The site layout is illustrated in Figure 3-16. The proposed Project at Site 6 (Consolidated Treatment at Site 6) includes conversion of an existing test well to a production well. Treatment at Site 6 (Consolidated Treatment at Site 6) includes disinfection, pH adjustment, fluoridation, and iron and/or manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 135 feet to the east.

Temporary construction access and permanent access would be from D Street. A new on-site driveway would be constructed from D Street to the well facility. There would be a permanent loss of two on-street parking spaces on D Street to accommodate the new driveway.

Site 7 (Consolidated Treatment at Site 6): Right-of Way at Colma Boulevard

Layout Type	Well with fenced enclosure
Pump Type	Submersible vertical turbine
Proposed Water Connection	See Site 6
Pipeline to Site 6	1,780 feet
Alternate Water Connection	See Site 6
Storm Drains	170 feet
Pavement Size	612 square feet
Building Size	N/A

Site 7 (Consolidated Treatment at Site 6) would be located north of Colma Boulevard in Colma on SFPUC property. The site layout is illustrated in Figure 3-17. The site would be adjacent to a maintenance building and an unoccupied mausoleum for the Greenlawn Memorial Park and behind the Woodlawn Memorial Park and a Home Depot Pro store. The proposed Project at Site 7 (Consolidated Treatment at Site 6) includes a new production well and continued operation of an existing water quality monitoring well. Water from the site would be conveyed to Site 6 for treatment prior to addition to the SFPUC distribution system. Treatment at Site 6 includes disinfection, pH adjustment, fluoridation, and iron/manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 200 feet to the southeast.

Temporary construction access and permanent access to the site would be from Colma Boulevard and an existing driveway that serves the Greenlawn Memorial Park maintenance building. A new on-site driveway would be improved from the maintenance building driveway to the well facility.

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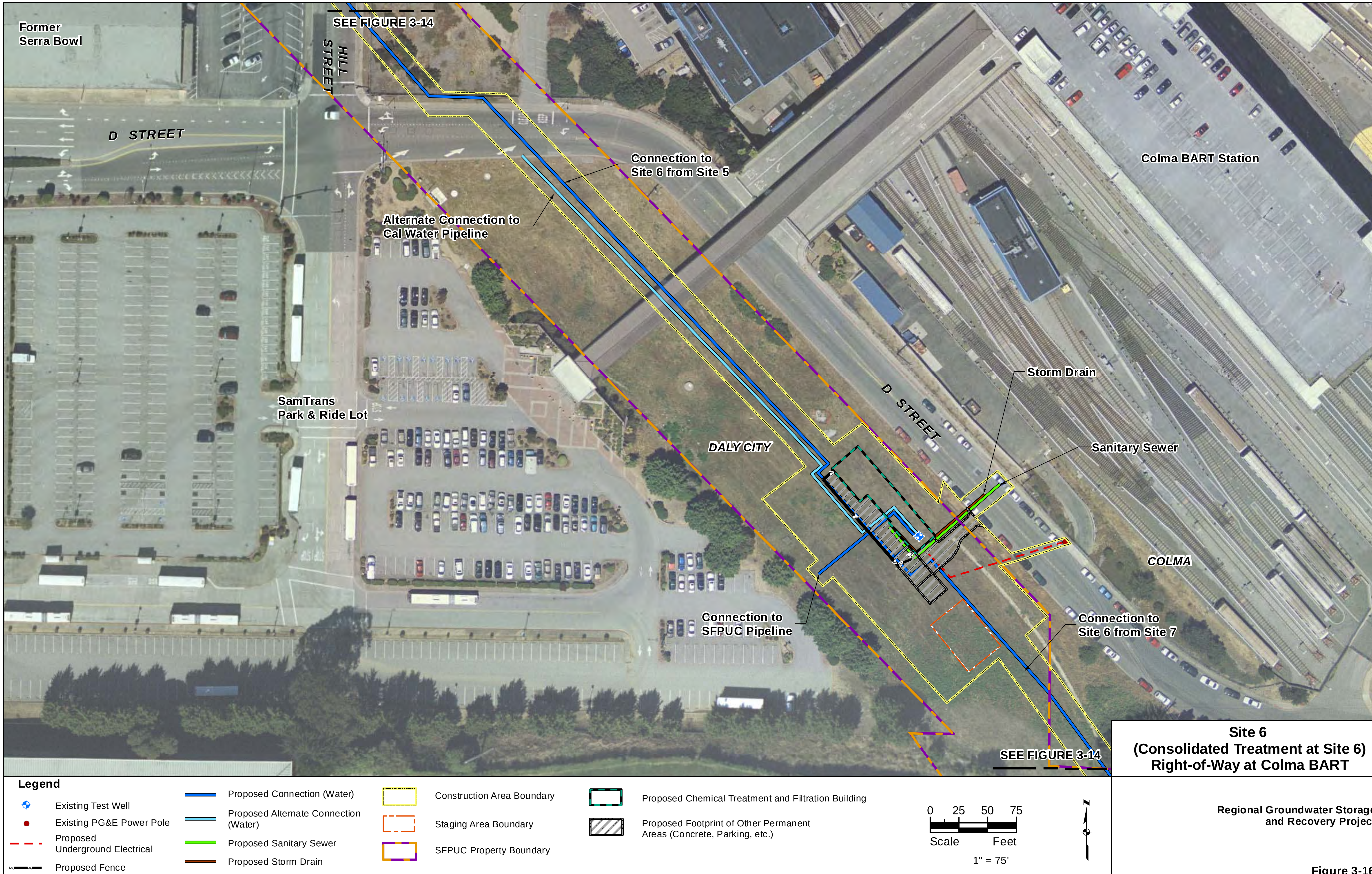

Site 6
(Consolidated Treatment at Site 6)
Right-of-Way at Colma BART

Regional Groundwater Storage
and Recovery Project

Figure 3-16

Source: SFPUC and Kennedy/Jenks

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Site 7
(Consolidated Treatment at Site 6)
Right-of-Way at Colma Blvd.

Regional Groundwater Storage and Recovery Project

Figure 3-17

Source: SFPUC and Kennedy/Jenks

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Sites 5, 6, and 7 with On-site Treatment

The Project includes an option for on-site treatment at Sites 5, 6, and 7. With on-site treatment, Sites 5 and 7 would not be connected to Site 6. If consolidated treatment at Site 6 (the SFPUC's preferred configuration for the Project) is found to be infeasible due to, for example, the difficulty of constructing the pipelines from Sites 5 or 7 to Site 6 due to the presence of existing underground infrastructure or other currently unforeseen constraints, then on-site treatment at Sites 5 or 7 may be needed. Figure 3-18 illustrates Sites 5, 6 and 7 with on-site treatment. Treatment at individual sites is illustrated on Figures 3-19 through 3-21.

Site 5 (On-site Treatment): Right-of-Way at Serra Bowl

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	145 feet
Alternate Water Connection	Daly City
Pipeline Length	165 feet
Sanitary Sewer & Storm Drains	470 feet
Pavement Size	1,955 square feet
Building Size	2,095 square feet

Site 5 (On-site Treatment) would be located south of B Street between Junipero Serra Boulevard and Hill Street in Daly City on SFPUC property. The site would be adjacent to the Serra Bowl parking lot, a commercial office, and a single-family residence. The site layout is shown on Figure 3-19. The proposed Project at Site 5 (On-site Treatment) includes conversion of an existing test well to a production well and the continued use of an existing water quality monitoring well. Treatment facilities at Site 5 (On-site Treatment) would include disinfection, pH adjustment, fluoridation, and iron/manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 200 feet to the north.

Temporary construction access and permanent access would be from B Street via an existing driveway. The on-site driveway would be improved from B Street to the well facility.

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Legend

- Proposed Well
- Existing Test Well
- Existing Monitoring Well
- Existing PG&E Power Pole
- Proposed Underground Electrical
- Proposed Connection (Water)
- Proposed Alternate Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment & Filtration Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)

Sites 5, 6, & 7 (On-site Treatment)

Regional Groundwater Storage and Recovery Project

Figure 3-18

Source: SFPUC and Kennedy/Jenks

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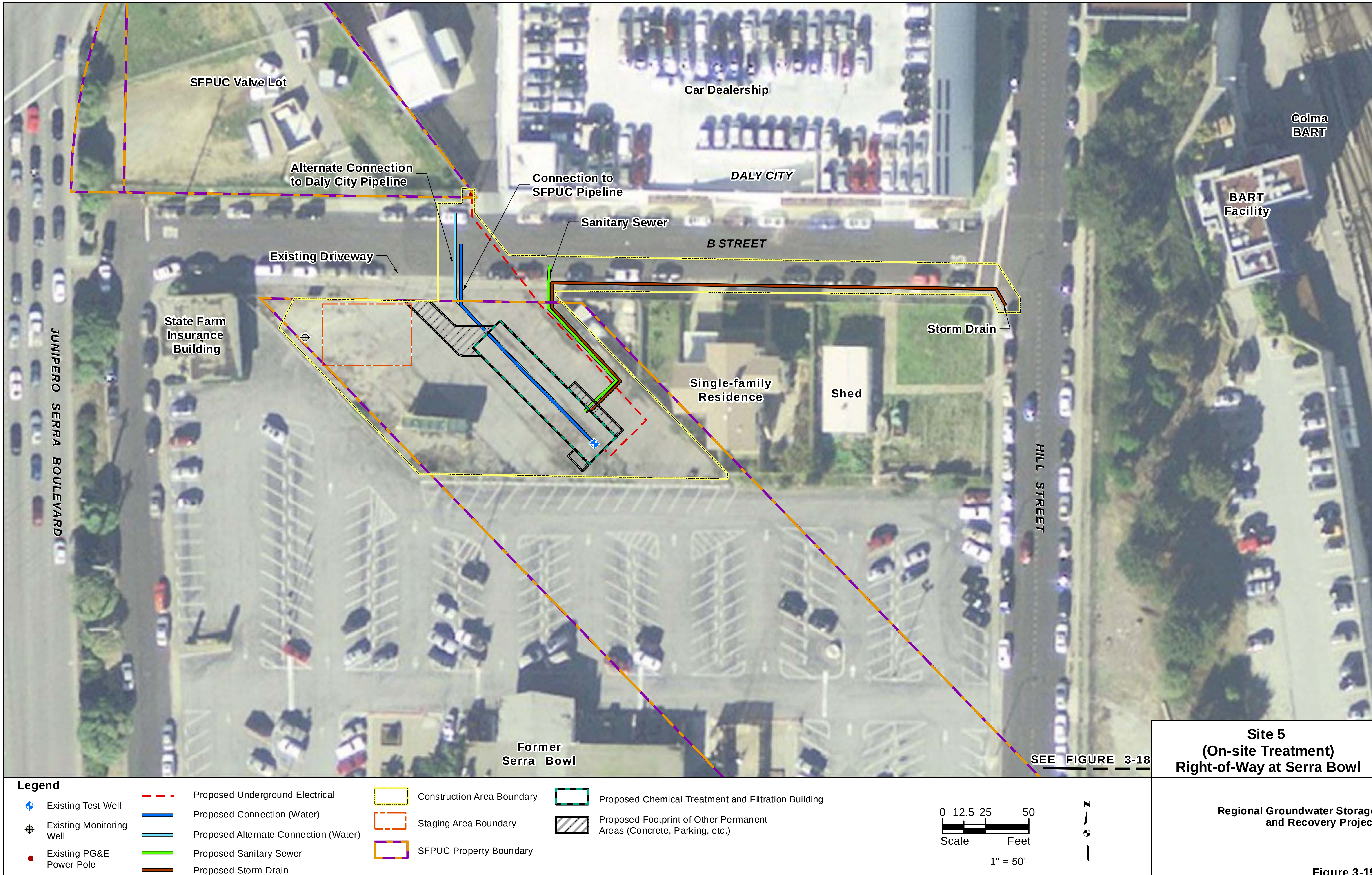

Site 5 (On-site Treatment) Right-of-Way at Serra Bowl

Regional Groundwater Storage and Recovery Project

Figure 3-19

Source: SFPUC and Kennedy/Jenks

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Site 6 (On-site Treatment): Right-of Way at Colma BART

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	115 feet
Alternate Water Connection	Cal Water
Pipeline Length	525 feet
Sanitary Sewer & Storm Drains	240 feet
Pavement Size	3,535 square feet
Building Size	2,095 square feet

Site 6 (On-site Treatment) would be located west of D Street across from the Colma BART Station in Daly City on SFPUC property. The site layout is illustrated in Figure 3-20. The proposed Project at Site 6 (On-site Treatment) includes conversion of an existing test well to a production well. Treatment at Site 6 (On-site Treatment) would include disinfection, pH adjustment, fluoridation, and iron/manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 135 feet to the east.

Temporary construction access and permanent access would be from D Street. A new on-site driveway would be constructed from D Street to the well facility. There would be a permanent loss of two on-street parking spaces to accommodate the new driveway.

Site 7 (On-site Treatment): Right-of Way at Colma Boulevard

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	75 feet
Alternate Water Connection	Cal Water
Pipeline Length	145 feet
Sanitary Sewer & Storm Drains	340 feet
Pavement Size	205 square feet
Building Size	2,095 square feet

Site 7 (On-site Treatment) would be located north of Colma Boulevard in Colma on SFPUC property. The site layout is illustrated in Figure 3-21. The site would be adjacent to a maintenance building and unoccupied mausoleum for the Greenlawn Memorial Park and behind the Woodlawn Memorial Park and a Home Depot Pro store. The proposed Project at Site 7 (On-site Treatment) includes a new production well and continued operation of an existing water quality monitoring well. Treatment facilities at Site 7 (On-site Treatment) would include disinfection, pH adjustment, fluoridation, and iron/manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 200 feet to the southeast.

Temporary construction access and permanent access to the site would be from Colma Boulevard and an existing driveway that serves the Greenlawn Memorial Park maintenance building. A new on-site driveway would be improved from the maintenance building driveway to the well facility.

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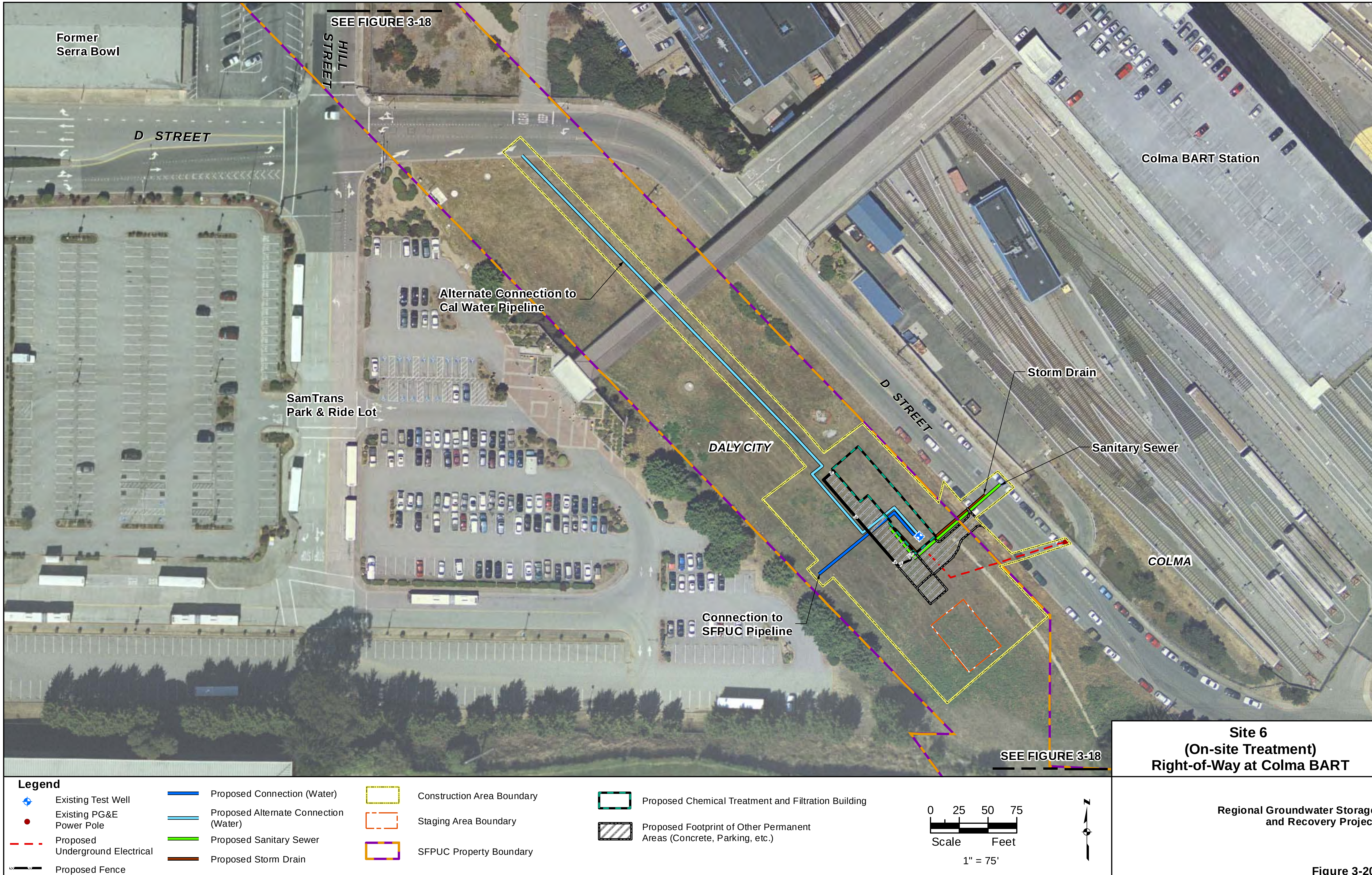

Site 6 (On-site Treatment) Right-of-Way at Colma BART

Regional Groundwater Storage and Recovery Project

Figure 3-20

Source: SFPUC and Kennedy/Jenks

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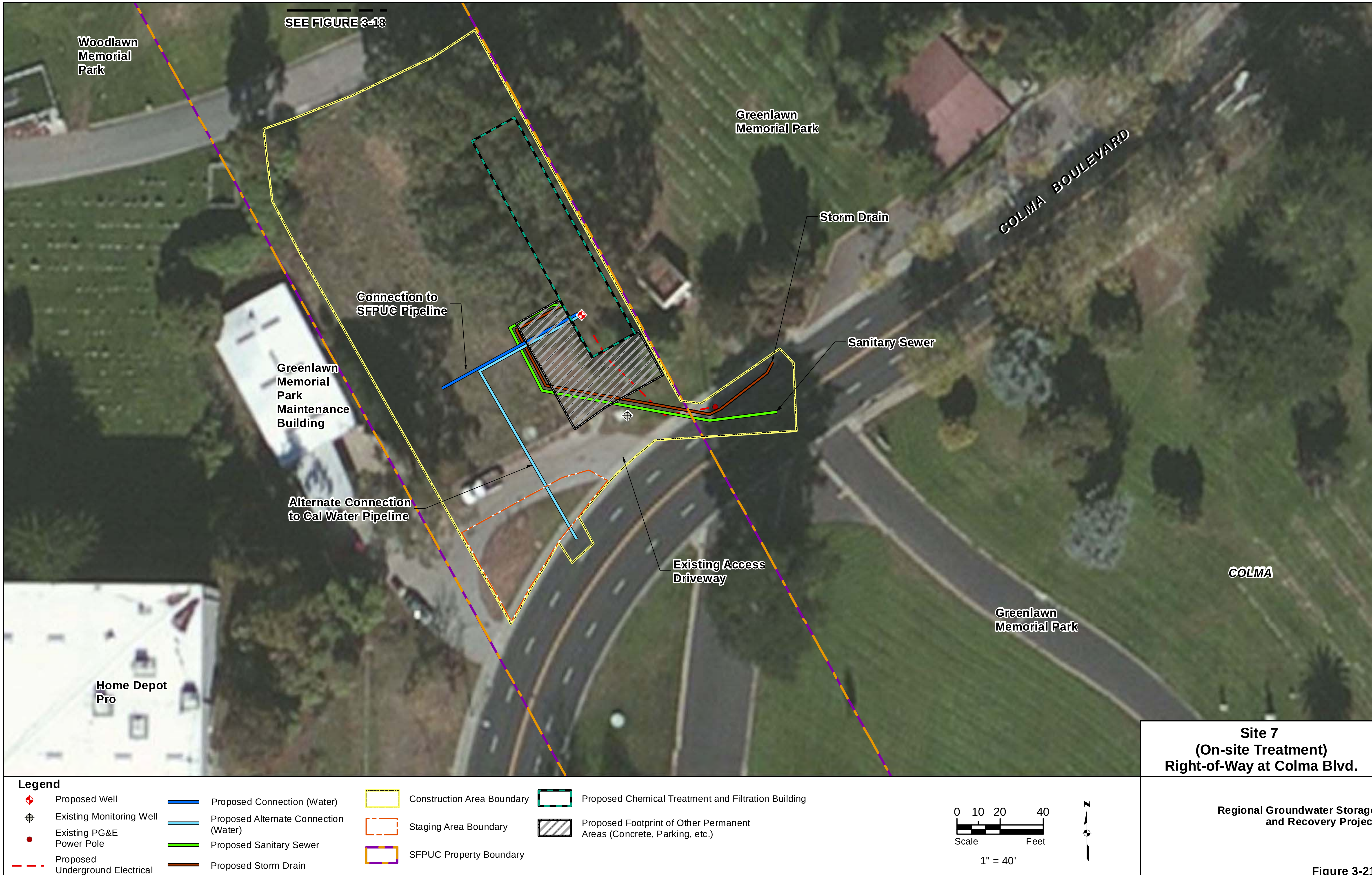

Site 7 (On-site Treatment) Right-of-Way at Colma Blvd.

Regional Groundwater Storage and Recovery Project

Figure 3-21

Source: SFPUC and Kennedy/Jenks

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Site 8: Right-of-Way at Serramonte Boulevard

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	Cal Water
Pipeline Length	145 feet
Alternate Water Connection	SFPUC
Pipeline Length	125 feet
Sanitary Sewer & Storm Drains	305 feet
Pavement Size	2,815 square feet
Building Size	2,095 square feet

Site 8 would be located south of Serramonte Boulevard in Colma on SFPUC property. The site layout is shown on Figure 3-22. The site would be located between Kohl's Department Store and a car dealership. The proposed Project at Site 8 includes conversion of a test well to a production well and continued operation of an existing water quality monitoring well. The treatment processes at the site would include disinfection, pH adjustment (if needed), fluoridation, and iron and/or manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E pad-mounted transformer located approximately 170 feet to the east, adjacent to the loading and supply docks for Kohl's Department Store.

Temporary construction access and permanent access would be through the existing Kohl's parking lot off Serramonte Boulevard. A new on-site driveway would be constructed from the edge of the Kohl's parking lot to the well facility.

Site 9: Treasure Island Trailer Court

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	245 feet
Alternate Water Connection	None
Sanitary Sewer & Storm Drains	355 feet
Pavement Size	3,205 square feet
Building Size	2,095 square feet

Site 9 would be located east of the intersection of El Camino Real and Hickey Boulevard in South San Francisco on SFPUC property. The access route and site layout are shown on Figures 3-23 and 3-24. The site would be located adjacent to the Treasure Island trailer court and across the Colma Creek Diversion Channel from residential and commercial land uses. The facility would be elevated above the 100-year flood elevation level. The proposed Project at Site 9 includes a new production well and continued use of an existing water quality monitoring well. The treatment processes at the site would include disinfection, pH adjustment, fluoridation, and iron and/or manganese removal.

Electrical power would be provided to the site through a new aboveground connection to an existing PG&E power pole located approximately 590 feet east of the site.

Temporary construction access and permanent access would be along an existing San Mateo County Flood Control District (SMCFCD) access road that starts at Mission Road and extends along the Colma Creek Diversion Channel as illustrated on Figure 3-23. The SMCFCD access road is gated and is not open to the public. An on-site driveway would be improved from the SMCFCD access road to the well facility.

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Site 8
Right-of-Way at Serramonte Blvd.

Legend

- Existing Test Well
- Existing Monitoring Well
- Existing PG&E Transformer
- Proposed Underground Electrical
- Proposed Fence
- Proposed Connection (Water)
- Proposed Alternate Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment and Filtration Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)

0 35 70
Scale Feet
1" = 70'

N

Regional Groundwater Storage and Recovery Project

Figure 3-22

Source: SFPUC and Kennedy/Jenks

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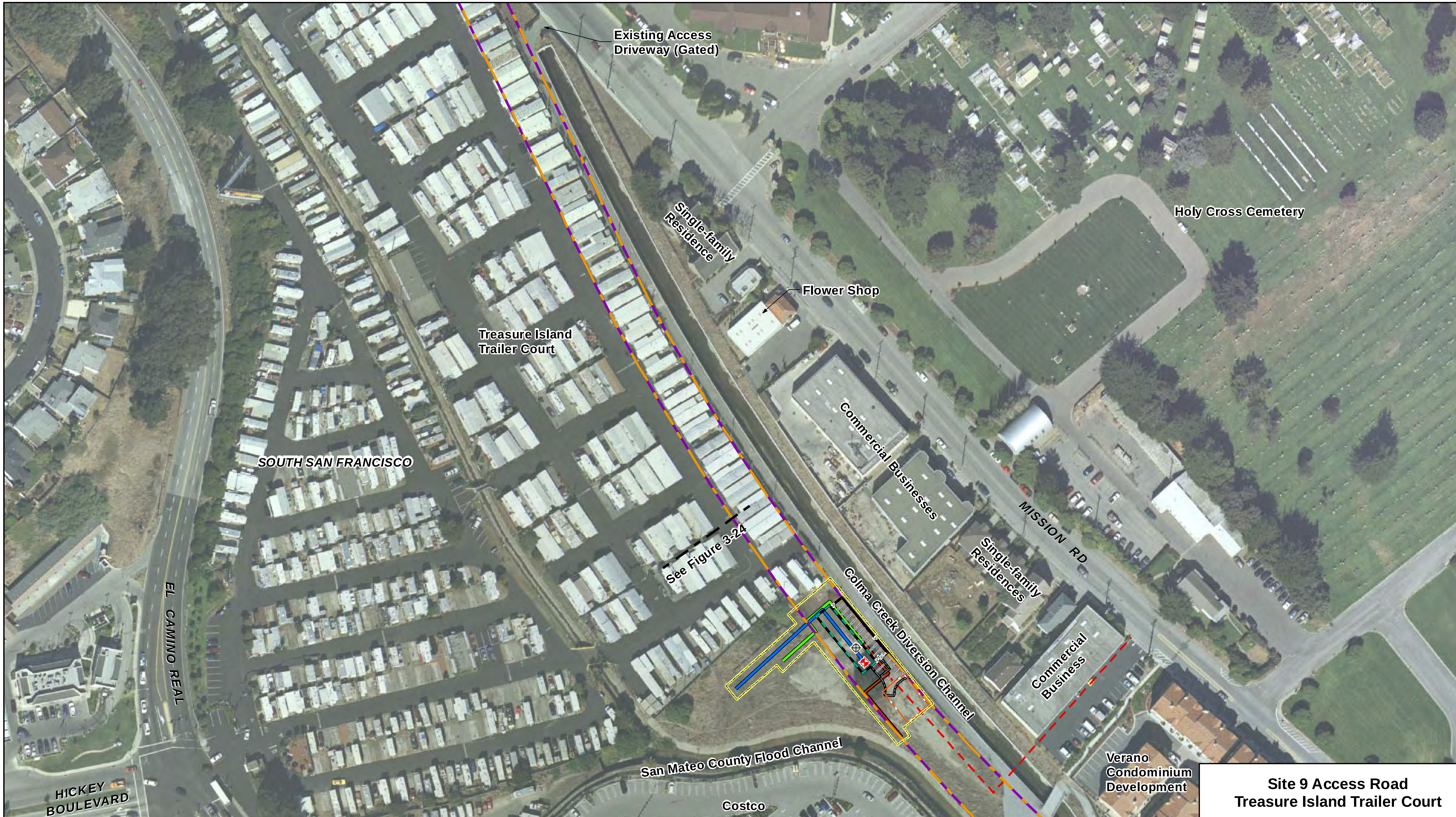

Legend

- Proposed Well
- Existing Monitoring Well
- Proposed Overhead Electrical
- Proposed Fence
- Proposed Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment and Filtration Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)

0 30 60 120
Scale Feet
1 " = 120 '

N

Site 9 Access Road
Treasure Island Trailer Court

Regional Groundwater Storage and Recovery Project

Figure 3-23

Source: SFPUC and Kennedy/Jenks

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Site 9
Treasure Island Trailer Court

Regional Groundwater Storage and Recovery Project

Figure 3-24

Source: SFPUC and Kennedy/Jenks

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Site 10: Right-of-Way at Hickey Boulevard

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	Daly City
Pipeline Length	200 feet
Alternate Water Connection	SFPUC
Pipeline Length	100 feet
Sanitary Sewer & Storm Drains	255 feet
Pavement Size	2,995 square feet
Building Size	2,095 square feet

Site 10 would be located south of Hickey Boulevard and west of Camaritas Avenue in South San Francisco on SFPUC property. The site layout is shown on Figure 3-25, and the proposed landscape plan is shown on Figure 3-26. The site would be located across Camaritas Avenue from the Winston Manor Shopping Center. The proposed Project at Site 10 includes conversion of an existing test well to a production well and continued use of an existing water quality monitoring well. Drought tolerant native and or climate-adapted landscape trees, shrubs, and grasses would be planted around the perimeter of the building when construction is complete. The treatment processes at the site would include disinfection, pH adjustment (if needed), fluoridation, and iron and/or manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 65 feet to the north. Temporary construction access and permanent access to the well facility would be from Camaritas Avenue. A new on-site driveway would be constructed from Camaritas Avenue to the well facility. There would be a permanent loss of two on-street parking spaces on the west side of Camaritas Avenue to accommodate the new driveway.

Site 11: South San Francisco Main Area

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	Cal Water
Pipeline Length	205 feet
Alternate Water Connection	SFPUC
Pipeline Length	160 feet
Sanitary Sewer & Storm Drains	1,110 feet
Pavement Size	3,675 square feet
Building Size	2,095 square feet

Site 11 would be located east of El Camino Real, north of its intersection with Arroyo Drive, in South San Francisco on SFPUC property. The site layout is shown on Figures 3-27 and 3-28. The site would be adjacent to a BART ventilation structure and a Kaiser Medical Center garage and parking lot. The proposed Project at Site 11 includes a new production well and continued use of an existing water quality monitoring well. The treatment processes at the site would include disinfection, pH adjustment (if needed), fluoridation, and iron and/or manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 75 feet to the east.

Temporary construction access and permanent access would be from an existing BART access road from Antoinette Lane as illustrated on Figure 3-27. An on-site driveway would be improved from the BART access road to the well facility.

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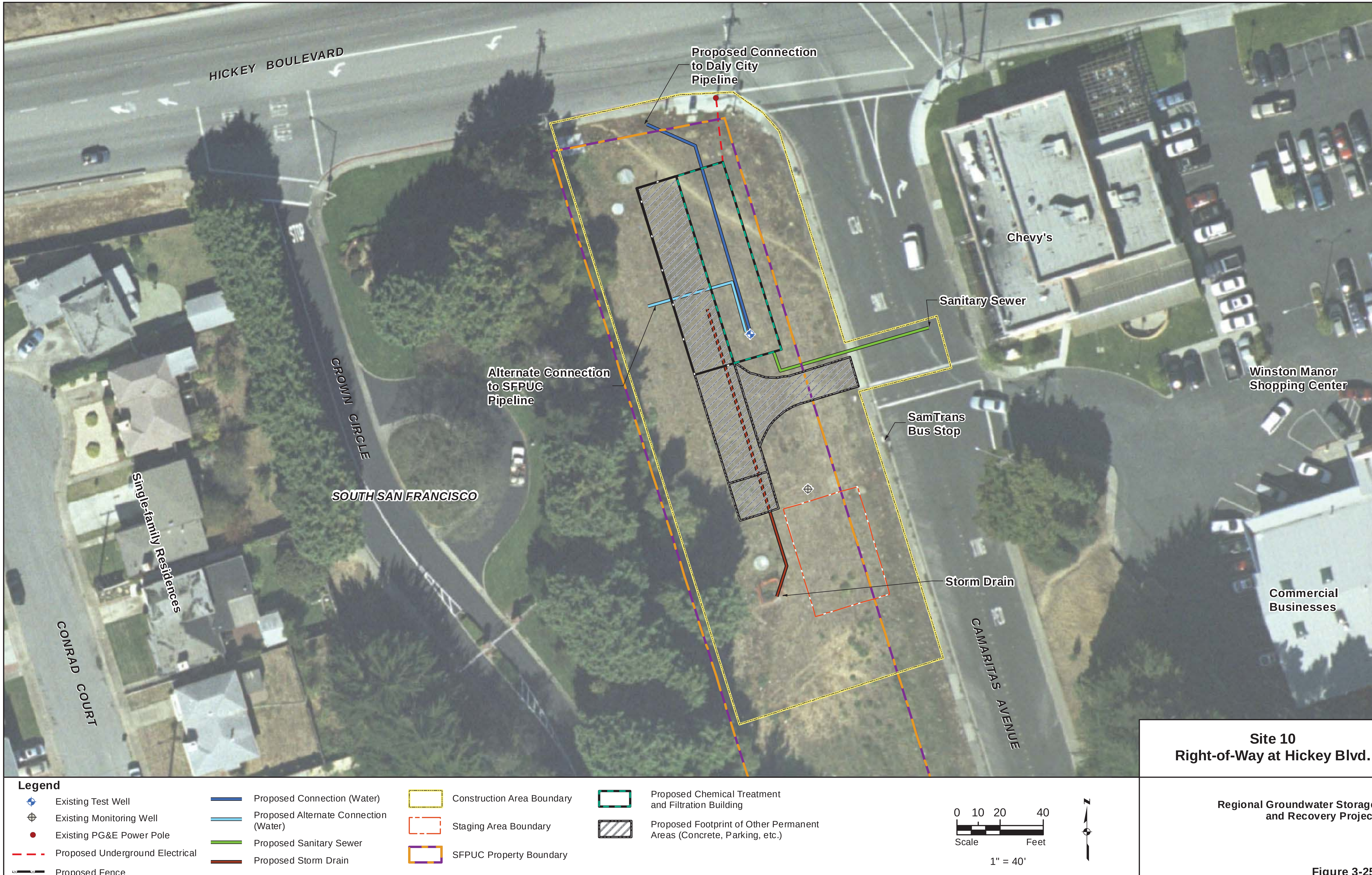

Site 10
Right-of-Way at Hickey Blvd.

Regional Groundwater Storage and Recovery Project

Figure 3-25

Source: SFPUC and Kennedy/Jenks

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Site 10
Right-of-way at Hickey Blvd.
Landscape Plan

Regional Groundwater Storage and Recovery Project

Figure 3-26

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Site 11 Pipeline and Access Road
South San Francisco Main Area

Figure 3-27

Source: SFPUC and Kennedy/Jenks

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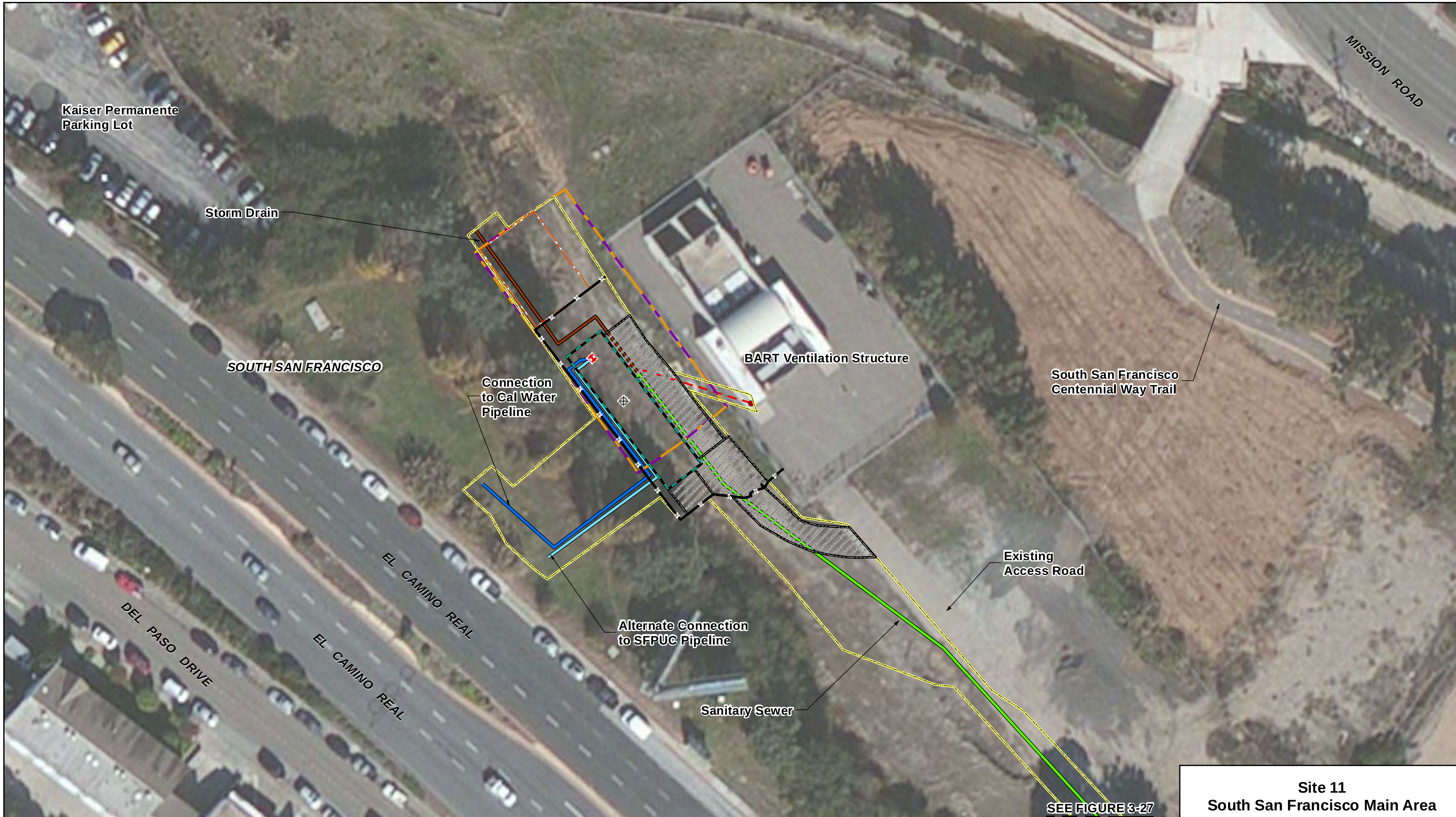

Site 11
South San Francisco Main Area

Legend

- Proposed Well
- Existing Monitoring Well
- Existing PG&E Power Pole
- Proposed Underground Electrical
- Proposed Fence
- Proposed Connection (Water)
- Proposed Alternate Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment and Filtration Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)

0 12.5 25 50
Scale Feet
1" = 50'

N

Regional Groundwater Storage and Recovery Project

Figure 3-28

Source: SFPUC and Kennedy/Jenks

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Site 12: Garden Chapel Funeral Home

Layout Type	Well plus chemical treatment facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	925 feet
Alternate Water Connection	Other SFPUC
Pipeline Length	90 feet
Sanitary Sewer & Storm Drains	710 feet
Pavement Size	1,665 square feet
Building Size	1,495 square feet

Site 12 would be located west of El Camino Real and south of Southwood Drive in South San Francisco on SFPUC property. The site layout is shown on Figures 3-29 and 3-30. The site would be adjacent to a parking lot for the Garden Chapel Funeral Home. The proposed Project at Site 12 includes a new production well and continued use of an existing water quality monitoring well. The treatment processes at the site would include disinfection and pH adjustment.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 75 feet to the west.

Temporary construction access and permanent access would be from Southwood Drive and the existing Garden Chapel Funeral Home driveway. The on-site access driveway would be improved from the funeral home parking lot to the well facility

Site 13: South San Francisco Linear Park

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	San Bruno
Pipeline Length	1,835 feet
Alternate Water Connection	Cal Water
Pipeline Length	185 feet
Sanitary Sewer & Storm Drains	640 feet
Pavement Size	3,450 square feet
Building Size	2,095 square feet

Site 13 would be located south of South Spruce Avenue in South San Francisco on SFPUC property. The site layout is shown on Figures 3-31 and 3-32. The landscape plan for Site 13 is illustrated on Figure 3-33. The site would be situated between the South San Francisco Centennial Way Trail (bicycle and pedestrian path) and commercial land uses fronting on South Spruce Avenue. The proposed Project at Site 13 includes conversion of an existing test well to a production well and continued use of an existing water quality monitoring well. Drought tolerant native and/or climate-adapted landscape would be planted around the perimeter of the building when construction is complete. The treatment processes at the site would include disinfection, fluoridation, and iron and/or manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 225 feet to the northwest.

Temporary construction access and permanent access would be from South Spruce Avenue via an existing driveway. The on-site driveway would be improved from South Spruce Avenue to the well facility.

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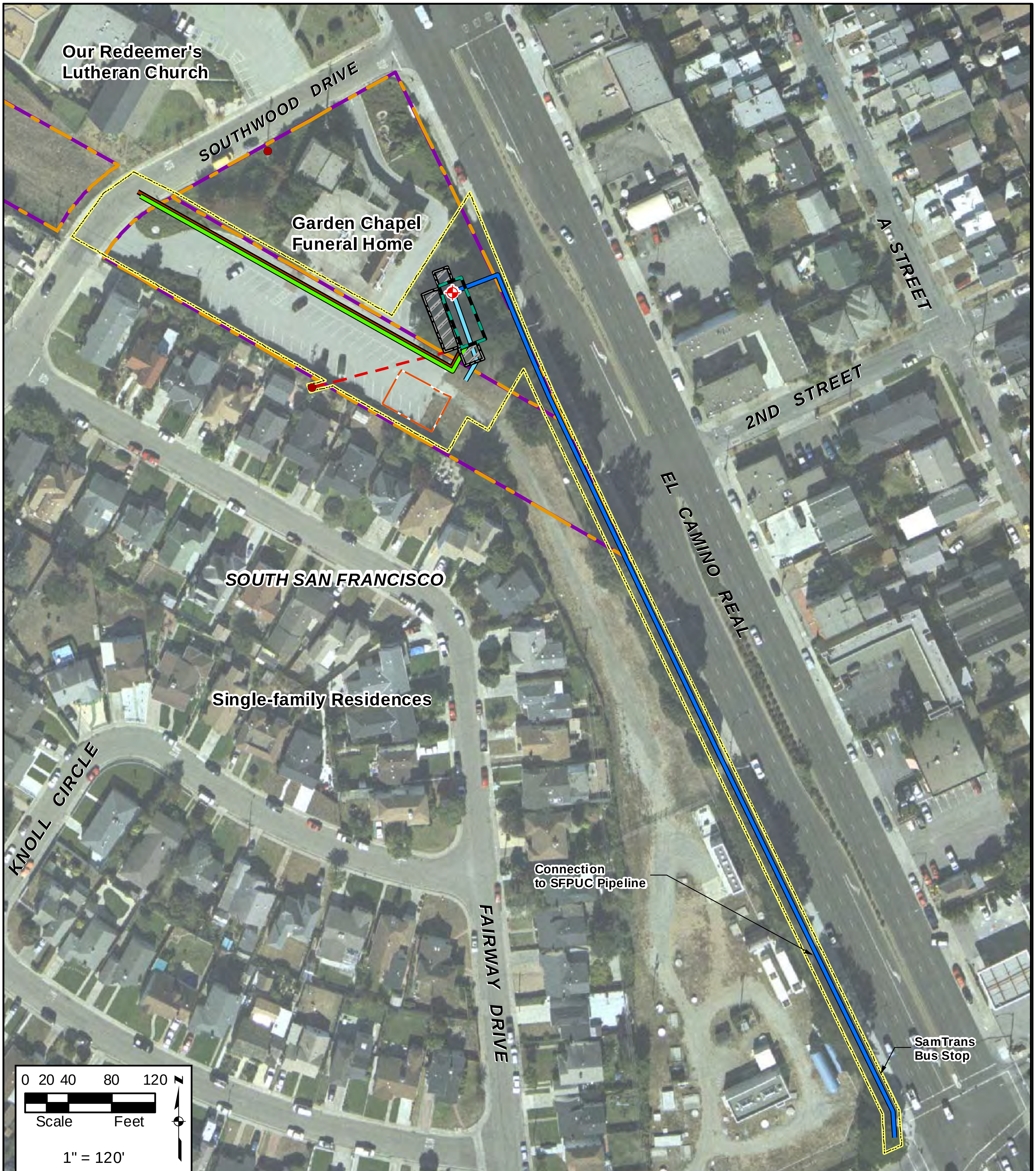

Legend

- Proposed Well
- Existing Monitoring Well
- Existing PG&E Power Pole
- Proposed Underground Electrical
- Proposed Fence
- Proposed Connection (Water)
- Proposed Alternate Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)

Site 12 with Pipelines

Regional Groundwater Storage and Recovery Project

Figure 3-29

Source: SFPUC and Kennedy/Jenks

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Source: SFPUC and Kennedy/Jenks

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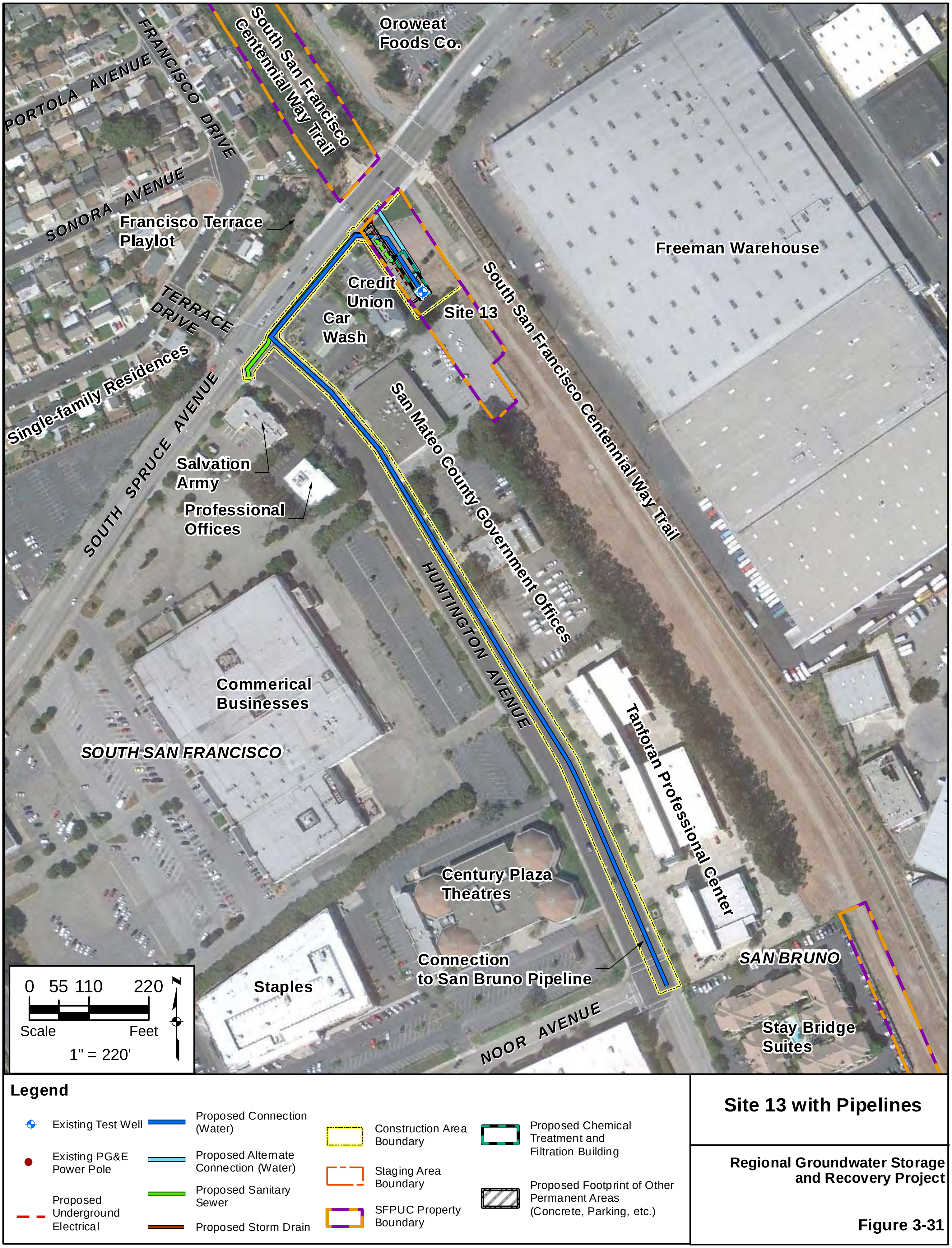

Site 13 with Pipelines

Regional Groundwater Storage and Recovery Project

Figure 3-31

Source: SFPUC and Kennedy/Jenks

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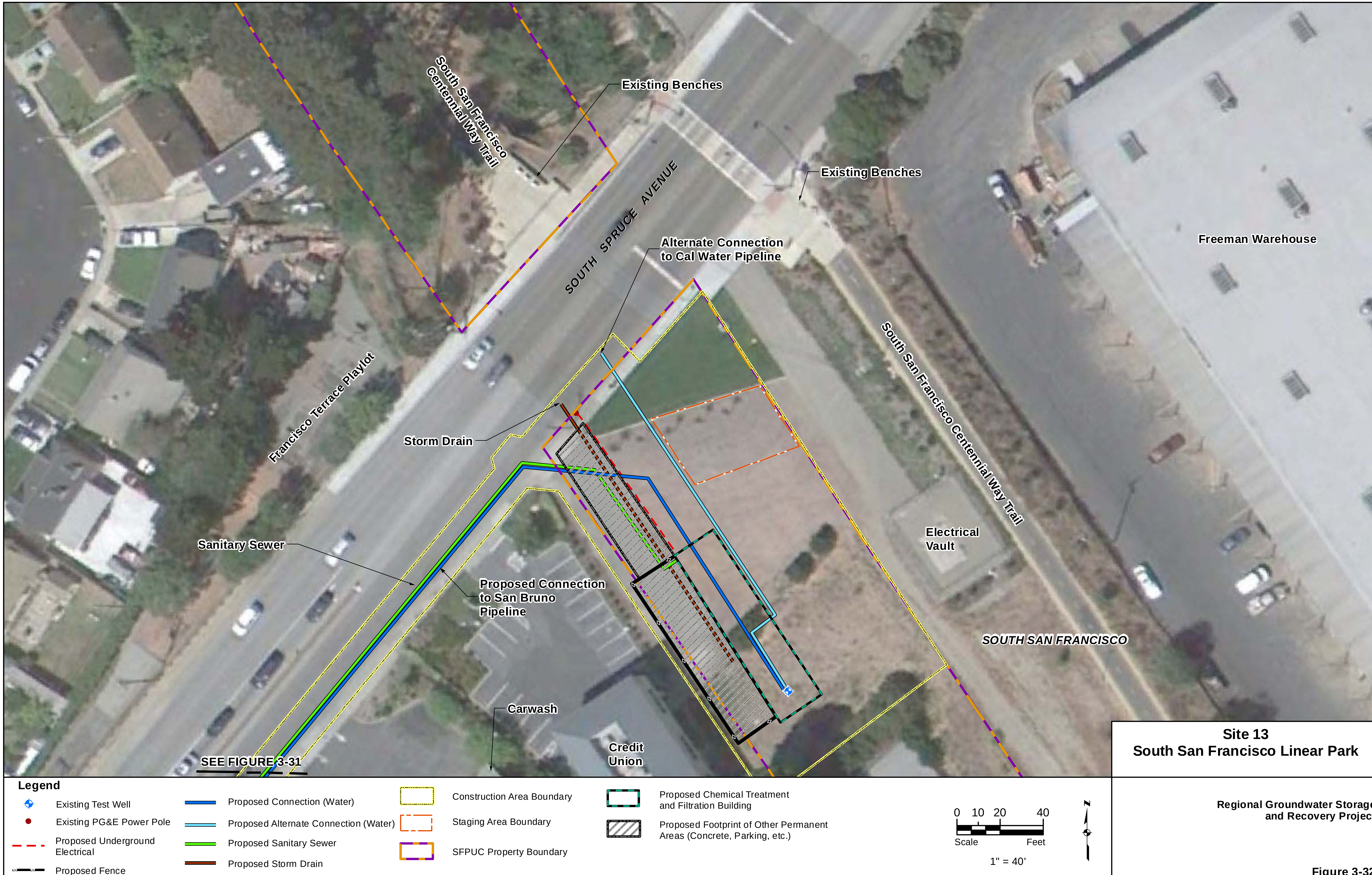

Source: SFPUC and Kennedy/Jenks

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Site 13
South San Francisco Linear Park
Landscape Plan

Regional Groundwater Storage and Recovery Project

Figure 3-33

Site 14: Golden Gate National Cemetery (GGNC)

Layout Type	Well with building
Pump Type	Submersible Vertical Turbine
Proposed Water Connection	San Bruno
Pipeline Length	1,785 feet
Alternate Water Connection	See Site 15
Sanitary Sewer Pipeline	1,110 feet
Grass Pavers	1,720 square feet
Building Size	700 square feet

Site 14 would be located north of Sneath Lane in the GGNC in San Bruno on land owned by the U.S. Department of Veterans Affairs (VA). The site layout is shown on Figures 3-34 and 3-35. The well facility would be located on an existing SFPUC easement in the northern portion of the cemetery. The proposed Project at Site 14 includes a new production well. The Project may also include demolition of an existing, unused pump station, tank, and well located nearby within the cemetery[6]. Demolition would include closure and abandonment of the existing well according to California Well Standards and removal of the pump station, the tank, and any aboveground piping (California Department of Water Resources 1991).

The VA manages the cemetery through its National Cemetery Administration. Construction of new structures and/or demolition at the GGNC would need approval from the VA (see Section 3.9 [Required Permits and Approvals]).

Water pumped from the well at Site 14 would be conveyed to Site 15 for treatment. Treatment processes at Site 15 would include disinfection, pH adjustment (if needed), fluoridation, and iron and/or manganese treatment. If Site 14 is constructed and the well facility at Site 15 is found to be infeasible, a treatment facility would still be constructed at Site 15 to treat water from Site 14.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 40 feet to the west.

Temporary construction access or permanent access would be from Sneath Lane and existing cemetery roads owned and maintained by GGNC. A new on-site driveway would be constructed from the internal cemetery road network to the well facility. The driveway surface would be constructed of grass pavers[7].

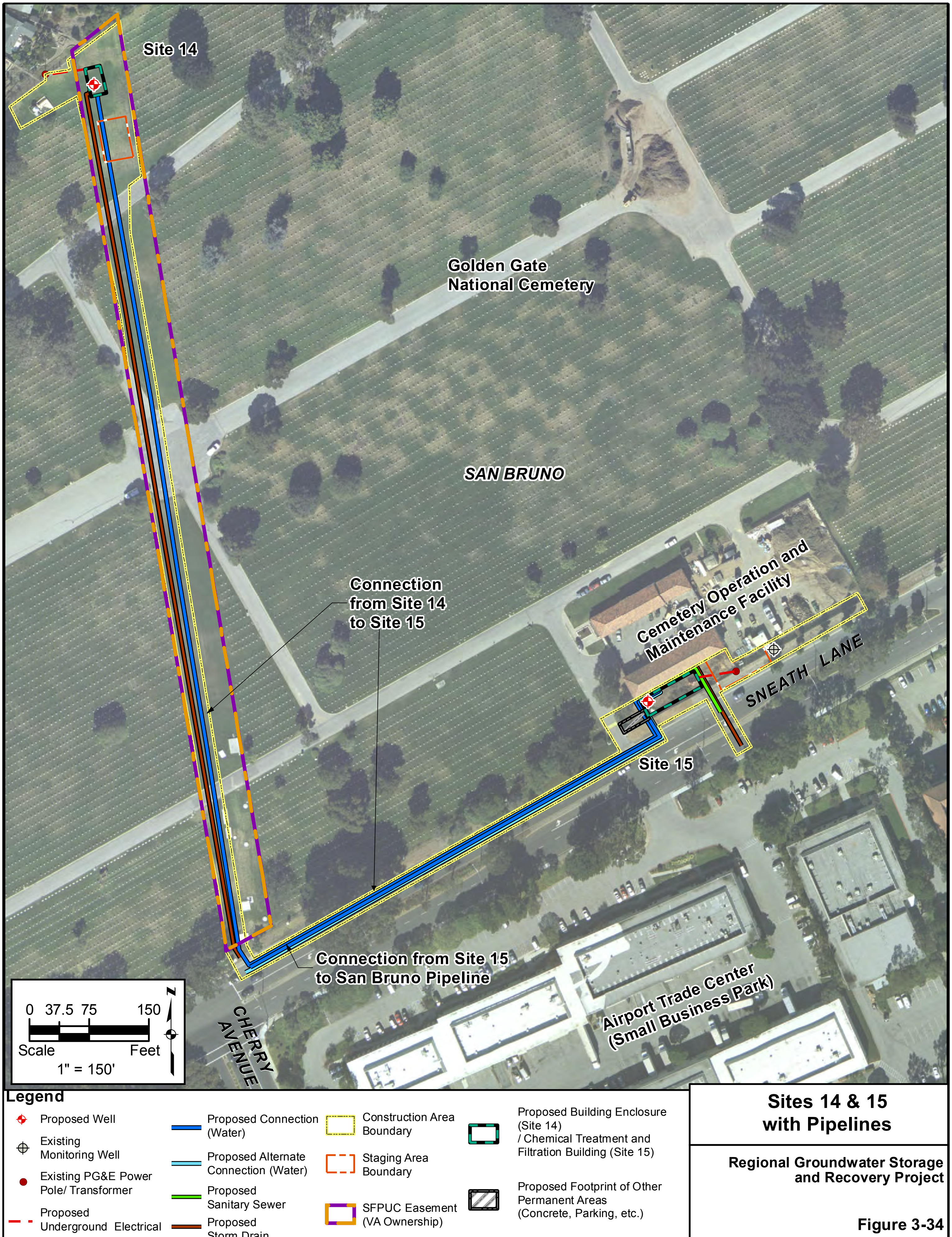
The SFPUC is working with the VA on the design and location of facilities within GGNC. The enclosure for Site 14 could be a building or a wall. The building would be 700 square feet with dimensions of 34 feet long, 21 feet wide, and six to eight feet high. The wall enclosure would be one foot thick and the footprint would be similar in size to the building (34 feet long, 21 feet wide and six to eight feet high).

The analysis in this EIR was conducted on the building design, which is larger and can be considered a worst case scenario.

---

[6] Following preliminary discussions with the VA, the SFPUC is including in the project description and analyses in this Draft EIR the demolition of the pump station, tank, and well. However, this work would only proceed with approval from the VA and only in connection with implementation of a well facility at Site 14.

[7] Grass pavers are permeable pavers made of plastic or concrete grids. While providing sufficient support for maintenance vehicles, grass pavers also allow grass to grow in the gaps to provide the appearance of a turf surface.



Sites 14 & 15 with Pipelines

Regional Groundwater Storage and Recovery Project

Figure 3-34

Source: SFPUC and Kennedy/Jenks

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Site 14
Golden Gate National Cemetery

Legend

- Proposed Well
- Existing PG&E Power Pole
- Proposed Underground Electrical
- Proposed Connection (Water)
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Easement (VA Ownership)
- Proposed Well with Building Enclosure

0 10 20 40
Scale Feet
1" = 40'

Regional Groundwater Storage and Recovery Project

Figure 3-35

Source: SFPUC and Kennedy/Jenks

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Site 15: Golden Gate National Cemetery

Layout Type	Well plus chemical treatment and filtration facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	San Bruno
Pipeline Length	670 feet
Alternate Water Connection	SFPUC
Pipeline Length	680 feet
Sanitary Sewer & Storm Drains	255 feet
Pavement Size	455 square feet
Building Size	2,095 square feet

Site 15 would also be located north of Sneath Lane in the GGNC in San Bruno on property owned by the VA. Site 15 is situated immediately adjacent to the GGNC maintenance building along Sneath Lane. The proposed Project at Site 15 includes a new production well and continued use of an existing water quality monitoring well. The layout at Site 15 is shown on Figure 3-36.

The VA manages the cemetery through its National Cemetery Administration and construction of new structures at the GGNC would need approval from the VA (see Section 3.9 [Required Permits and Approvals]). Treatment processes at Site 15 would include disinfection, pH adjustment (if needed), fluoridation, and iron and/or manganese removal.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 55 feet to the east.

The building and fencing would be designed to integrate visually with the surrounding structures and landscape.

Temporary construction access and permanent access would be via Sneath Lane and an existing cemetery driveway. A new on-site driveway would be constructed from the cemetery driveway to the well facility.

The SFPUC is working with the VA on the design and location of facilities within GGNC. The design and location of facilities at Site 15 has some flexibility. The facilities include an approximately 2,095 square foot well facility, a chemical treatment and filtration building, and a driveway. A range of designs and locations are being considered by the SFPUC and the VA. The building enclosure for Site 15 could range in size from 90 feet long, 20 feet wide, and 20 feet high located on the eastern side of the site to 36 feet long, 20 feet wide, and 18 feet high located closer to the western side of the site. The smaller western building would also include a fenced enclosure 20 feet long by 72 feet wide. The analysis in this EIR was conducted on the larger building design located on the eastern side of the site. This can be considered a worst case scenario because the facilities are larger and located closer to potential historic resources.

Site 16: Millbrae Corporation Yard

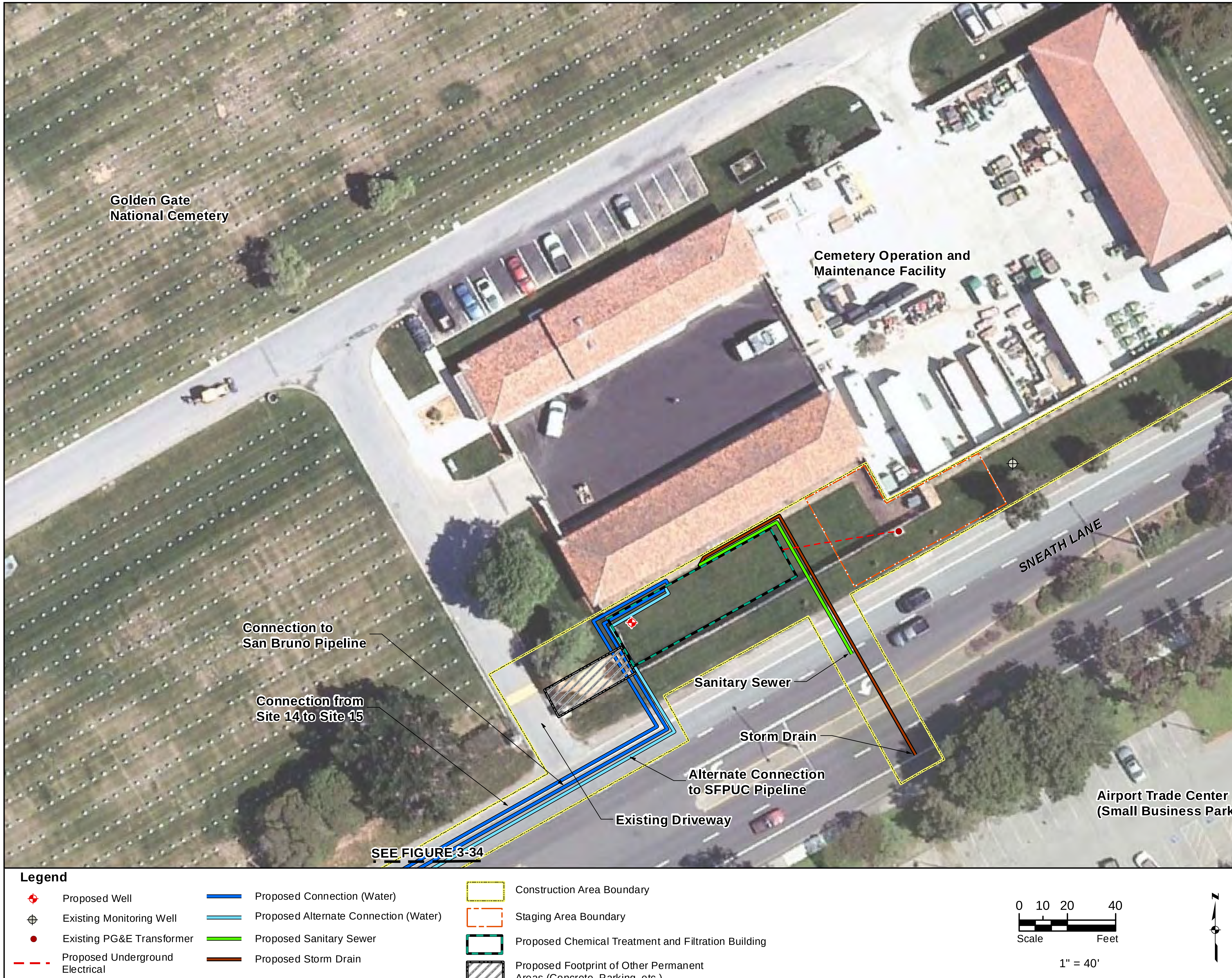
Layout Type	Well plus chemical treatment facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	40 feet
Alternate Water Connection	Other SFPUC
Pipeline Length	700 feet
Sanitary Sewer & Storm Drains	395 feet
Pavement Size	1,585 square feet
Building Size	1,480 square feet

Site 16 would be located east of El Camino Real in Millbrae on SFPUC property on portion of which is leased to Orchard Supply Hardware. The proposed site layout is illustrated in Figure 3-37. The well facility would be located adjacent to a storage area and parking lot for Orchard Supply Hardware. The site would be situated near the Millbrae Manor Apartments to the south and the

Caltrain right-of-way on the east. The proposed Project at Site 16 would include a new production well and the continued use of an existing water quality monitoring well. Treatment processes would include disinfection, pH adjustment, and fluoridation.

Electrical power would be provided to the site through a new underground connection to an existing PG&E power pole located approximately 55 feet to the north.

Temporary construction access and permanent access would be either from Hemlock Avenue and an existing access driveway or from El Camino Real through the Orchard Supply Hardware parking lot. The existing access driveway would be improved from Hemlock Avenue to the well facility. The SFPUC would work with Orchard Supply Hardware, its tenant, to ensure that deliveries could continue by providing a means of delivering materials during construction and operation of the Project. Several options would be available to modify access within the site leased to Orchard Supply Hardware during construction including providing a temporary means of delivering materials through a redesigned access approach to the delivery area or through an alternate delivery access point or by development of a delivery schedule that is compatible with construction activities. Delivery access during Project operation would be developed through delivery access modifications within the site leased by Orchard Supply Hardware. Modifications could include reorientation of the loading area and reconfiguration of the area to allow truck access.



Site 15
Golden Gate National Cemetery

Regional Groundwater Storage and Recovery Project

Figure 3-36

Source: SFPUC and Kennedy/Jenks

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Site 16
Millbrae Corporation Yard

Regional Groundwater Storage and Recovery Project

Figure 3-37

Source: SFPUC and Kennedy/Jenks

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Site 17 (Alternate): Standard Plumbing Supply

Layout Type	Well plus chemical treatment facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	Cal Water
Pipeline Length	105 feet
Alternate Water Connection	SFPUC
Pipeline Length	20 feet
Sanitary Sewer & Storm Drains	145 feet
Pavement Size	735 square feet
Building Size	1,495 square feet

Site 17 (Alternate) would be located along Collins Avenue west of El Camino Real in Colma on land, a portion of which is owned by Standard Plumbing Supply and the remainder of which is SFPUC property. The site layout is shown on Figure 3-38. The well facility would be located south of Collins Avenue, partially within the Standard Plumbing Supply parking lot; the construction staging would be located on the north side of Collins Avenue. The site would be adjacent to commercial uses and behind the Cypress Lawn Memorial Park. The proposed Project at Site 17 (Alternate) includes a new production well. The treatment processes at the site would include disinfection and pH adjustment (if needed), and fluoridation.

Electrical power would be provided to the site through a new underground connection to an existing buried line in Collins Avenue.

Temporary construction access and permanent access would be from Collins Avenue. An existing temporary access driveway to the proposed construction staging area would be improved.

A new permanent access driveway would be constructed from Collins Avenue to the well facility, with a permanent loss of two on-street parking spaces on the south side of Collins Avenue to accommodate the new driveway.

Site 18 (Alternate): Alta Loma Drive

Layout Type	Well plus chemical treatment facility
Pump Type	Aboveground vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	130 feet
Alternate Water Connection	Cal Water
Pipeline Length	120 feet
Sanitary Sewer & Storm Drains	295 feet
Pavement Size	795 square feet
Building Size	1,495 square feet

Site 18 (Alternate) would be located south of Alta Loma Drive within a single-family residential area on a parcel of land owned by the City of South San Francisco. The site layout is shown on Figure 3-39. The proposed Project at Site 18 (Alternate) includes a new production well. The treatment processes at the site would include disinfection, pH adjustment (if needed), and fluoridation.

Electrical power would be provided to the site through a new underground connection to an existing PG&E buried power line in Alta Loma Drive, approximately 55 feet north of the well facility.

Temporary construction access and permanent access would be provided from Alta Loma Drive.

A new permanent access driveway would be constructed from Alta Loma Drive to the well facility, and a new temporary driveway would be constructed from Alta Loma Drive to the staging area. There would be a temporary loss of four on-street parking spaces and a permanent loss of two on-street parking spaces on the south side of Alta Loma Drive to accommodate the driveways.

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Site 17 (Alternate)
Standard Plumbing Supply

Legend

- Proposed Well
- Proposed Underground Electrical
- Proposed Connection (Water)
- Proposed Alternate Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)
- ProposedTemporary Access Driveway

0 10 20 40
Scale Feet
1" = 40'

N

Regional Groundwater Storage and Recovery Project

Figure 3-38

Source: SFPUC and Kennedy/Jenks

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Legend

- Proposed Well
- Existing PG&E Power Pole
- Proposed Underground Electrical
- Proposed Connection (Water)
- Proposed Alternate Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)

0 10 20 40
Scale Feet
1" = 40'

N

Site 18 (Alternate)
Alta Loma Drive

Regional Groundwater Storage and Recovery Project

Figure 3-39

Source: SFPUC and Kennedy/Jenks

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Site 19 (Alternate): Garden Chapel Funeral Home

Layout Type	Well with fenced enclosure
Pump Type	Submersible vertical turbine
Proposed Water Connection	SFPUC
Pipeline Length	1450 feet
Alternate Water Connection	Other SFPUC
Pipeline Length	150 feet
Storm Drains	190 feet
Pavement Size	1,920 square feet
Building Size	700 square feet

Site 19 (Alternate) would be located west of El Camino Real and north of Southwood Drive in South San Francisco on SFPUC property. The layout is shown on Figure 3-40. The site would be adjacent to Our Redeemer's Lutheran Church and single-family residences. The proposed Project at Site 19 (Alternate) includes a new production well.

Water from Site 19 (Alternate) would be conveyed to Site 12 for treatment. Treatment processes at Site 12 would include disinfection and pH adjustment. If Site 19 (Alternate) is constructed and the well facility at Site 12 is found to be infeasible, a treatment facility would still be constructed at Site 12 to treat water from Site 19 (Alternate).

Temporary construction access and permanent access would be from Southwood Drive. A new access driveway would be constructed from Southwood Drive to the well facility. There would be a permanent loss of two on-street parking spaces on the north side of Southwood Drive to accommodate the new driveway.

3.4.4 Partner Agencies' Wells

The Partner Agencies would continue to operate their existing wells, but would operate them consistent with the Operating Agreement. The Operating Agreement is described in detail in Section 3.8.1 of this Chapter.

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Site 19 (Alternate)
Garden Chapel Funeral Home

Regional Groundwater Storage and Recovery Project

Figure 3-40

Source: SFPUC and Kennedy/Jenks

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3.5 PROJECT CONSTRUCTION

As explained above in Section 3.4.2 (Production Wells and Associated Facilities), the Project consists of the operation of 16 new groundwater well facilities. This EIR evaluates 19 potential well facility sites; however, a maximum of 16 well facilities would ultimately be operated as part of the Project. The SFPUC has selected the 16 well facility sites it proposes to develop; three alternate sites are also evaluated and would be developed in the event that one to three of the 16 preferred sites cannot be successfully implemented and operated for currently unforeseen reasons.

Each well site would include either installation of a new production well or the conversion of an existing test well to a production well. Construction varies at each site, but in general construction would include installation of a well, well pumps and electrical panels, construction of a well facility building, treatment facilities as needed, and water distribution pipelines and other utilities.

This section describes the following:

- Construction Sequencing and Schedule,
- Construction Methods for Production Wells and Well Facilities,
- Pipeline and Power line Excavation,
- Construction Access,
- Construction Staging,
- Construction Equipment, and
- Project Workforce.

3.5.1 Construction Sequencing and Schedule

The SFPUC proposes to construct the Project starting approximately in June 2014 with completion targeted for February 2016. Construction would occur in clusters of approximately four well facilities grouped together as shown in Table 3-7 (Facility Construction Clusters and Construction Sequencing). Well facility construction would begin with production well drilling for those sites without an existing test well. Up to four wells would be drilled within each construction cluster during the first month of the overall 21-month construction schedule. At completion of drilling, well facility construction would begin at the four sites in each cluster and continue for approximately 16 months for sites with buildings and approximately three months for sites with no building, with some exceptions as noted below.

TABLE 3-7
Facility Construction Clusters and Construction Sequencing

Facility Sites	Well Drilling		Well Facilities	
	Estimated Construction Start date	Estimated Construction Finish date	Estimated Construction Start date	Estimated Construction Finish date
Construction Cluster A				
Sites 1, 3, 4, 7	June 2014	July 2014	July 2014	October 2015
Construction Cluster B				
Sites 12, 14, 15, 16, 19 (Alternate)	August 2014	September 2014	September 2014	December 2015
Construction Cluster C				
Sites 9, 11, 18 (Alternate)	October 2014	November 2014	November 2014	February 2016
Sites 10, 13	No well drilling needed	No well drilling needed	November 2014	February 2016
Construction Cluster D				
Sites 2, 5, 6, 8, Westlake Pump Station	No well drilling needed	No well drilling needed	June 2014	September 2015
Site 17 (Alternate)	July 2014	August 2014	August 2014	November 2015

Following is a list of the activities and estimated duration associated with construction of the well facilities and pipelines.

- **Well Drilling** - Production well drilling would require four to six weeks to complete each new well.
- **Well Facility Construction** – Construction timeframes varies between a well with fenced enclosure and a well building:
  - *Wells with Fenced Enclosure.* Sites with fenced enclosures would require a three-month construction period, which would include about one week of site preparation requiring heavy equipment. During the remainder of the construction period heavy equipment would only be operated one or two hours per day. It should be noted that two well sites with fenced enclosures have slightly different proposed construction schedules: 1) Site 2 has a proposed one month construction schedule (SFPUC 2012a) and 2) Site 3 would be constructed over two summers, when the neighboring schools are not in session. During the intervening school year the site would be restored for school use.
  - *Well Facility Building.* Sites with a well facility building would require a 14-month construction period, including the following proposed construction timeframes:
    - Clearing, grubbing, and other site preparation activity: One month
    - Foundation and utility connections: Two months
    - Building and equipment: Nine months

- Start-up and testing: Two months

- **Pipeline Construction –** Pipeline installation would generally proceed at a rate of 300 to 600 feet per week. Installation of pipelines would overlap with construction of the well facility including excavation, disconnection of affected utilities, pipeline replacement, utility reconnection, and backfill of construction trenches.

- **Total Construction Time –** Sites with a well and a well facility building would require approximately 16 months for construction (including conversion to a production well at those sites with an existing test well). Sites with a well and fenced enclosure would require an approximately six-month construction period.

In addition, for construction within or near cemeteries, the SFPUC would temporarily stop construction to accommodate graveside services if requested by the cemetery, and would coordinate with the cemeteries to accomplish this.

3.5.1.1 Construction Methods for Production Wells

To install a production well on a site with no existing test well, the site would first be cleared of vegetation, if present, which would be temporarily stockpiled on-site. Then an area would be graded (as needed) and covered with gravel base rock, to create a level pad for supporting the drill rig and other equipment. A 30-inch steel conductor casing would be installed to a depth of 50 feet and cemented in place. A minimum 22-inch diameter production borehole would be drilled to a depth of approximately 500 to 750 feet, the approximate depth of the aquifer that is proposed for production. Drilling and other drilling related activities (e.g., equipment and material delivery to support drilling) would extend for about a week both during the day and night. The completed borehole would be logged to confirm the hydrogeologic conditions and the proposed well design. The well casing, consisting of a 12-inch diameter stainless steel well casing and well screen would be installed in the borehole. A two-inch diameter steel pipe would be welded to the well casing and installed to a depth of approximately 350 to 400 feet. The pipe would serve as a sounding tube for measuring water levels in the well. This pipe would extend approximately two feet above the ground surface. Finally, an impervious seal consisting of sand/cement grout would be placed in the well annular space above the filter pack[8].

Development of the well would begin after the annular seal has set for a minimum of 24 hours. Initial development of the well would be performed using airlift pumping and swabbing of the well screen. Final development of the well would be performed by surging and pumping using a temporary test pump.

[8] A filter pack places filter medium between the screen and the well casing to prevent unwanted materials from entering the well.

Various well pumping tests would be performed after final well development. These tests would include: (a) pumping for durations of two hours each at different discharge rates ("step-drawdown test"); and (b) continuous pumping for 12 to 48 hours at the final design capacity of the well ("constant-discharge aquifer test"). Groundwater samples would be collected during the pumping tests to verify the water quality produced.

When the pumping tests have been completed and the test pump removed, final activities would include video and alignment surveys, as well as disinfection of the completed well. After disinfection, a steel cover plate would be welded on top of the well casing, which would extend approximately two feet above the ground surface. For protection, steel guard posts would be set into the ground around the well casing. The well site would be cleaned, the baserock used for the drilling pad would be removed, and wood chips (mulch) would be spread over the site to prevent soil erosion. Equipment used for well construction would include a truck-mounted drill rig, shaker, support trucks, portable storage tanks, forklift, and loader/backhoe.

Up to three million gallons of groundwater would be produced from a well during the final well development and pumping tests, which would be discharged to the local storm drain and/or the sanitary sewer. The peak discharge rate during well development (lasting for a few hours) would be approximately 800 gpm, although the typical discharge rate would be closer to 500 gpm. The development and testing would occur over the course of approximately 150 hours for each well resulting in an average discharge of 0.5 mgd. Water from the well development and testing would be discharged to the nearest local storm drain and/or sanitary sewer system. The SFPUC would notify the stormwater and wastewater agencies in advance of the well testing discharge to determine the appropriate discharge method and the appropriate discharge rate for the various stormwater and wastewater agencies.

The capacity of the sanitary sewer systems is variable, but if necessary, the groundwater discharge would be pumped to portable storage tanks and then released to the sanitary sewer such that the discharge rate would not exceed the capacity of the individual sanitary sewer system. No discharges from well development, pumping tests, and flushing are expected from Sites 2, 5, 6, 8, 10, and 13, because at these sites there are existing test wells that would be converted to production wells.

The well testing for quantity described above is intended to verify whether the pumping capacity would meet the Project's objectives. Samples would be tested to verify whether the water quality would meet the Project's objectives (with treatment). If the results of the well testing are favorable and the wells are confirmed as permanent production well sites, then further site development would occur, including construction of appropriate enclosures, chemical treatment and filtration facilities, and pipelines, as described in Section 3.5.1.2 (Construction Methods for Well Facilities). If a well is not selected as a permanent well site, it would be decommissioned and sealed, with one of the alternate sites being selected instead. The decommissioned well would be abandoned in accordance with the requirements of the California Water Code (Water Code Division 7 Article 4 §13800), the San Mateo County well ordinance requirements in chapter 4.68 of the San Mateo County Ordinance Code, and to the extent applicable, Title 13, Chapter 13.20 of the Daly City Municipal Code. After construction is complete, well sites would be restored to their general pre-construction conditions, although in accordance with the SFPUC's Vegetation Management Policy, they may be revegetated with alternate plantings (SFPUC

2007a). When construction is complete, all disturbed areas would be hydroseeded and receive erosion control measures as necessary. Equipment and workers needed as well as the construction schedule for each well facility are discussed in Table 3-8 (Estimated Daily Worker and Construction Equipment Trips for Wells and Well Facilities Construction). Diesel generators with self-contained fuel tanks may be used during construction.

TABLE 3-8

Estimated Daily Worker and Construction Equipment Trips for Wells and Well Facilities Construction[a]

Project Components and Construction Activities	Construction Vehicles and Equipment	Construction Duration	Daily Construction Worker Trips (round trip)		Daily Construction Equipment Trips per Site (round trips)	
			Typical	Min to Max	Typical[b]	Min to Max
Production Well (Sites 1, 3, 4, 7, 9, 11, 12, 14, 15, 16, 17 [Alternate], and 18 [Alternate])						
- Site preparation - Pilot hole drilling - Bore hole drilling - Testing	Grader, mounted drill rig on a support truck, cement truck, pump truck, trailers, pickup trucks, air compressor, submersible diesel pump during well testing.	Well construction, development and testing would require approximately four to six weeks.	3-4	2-5	0	0-4
Fenced Enclosure Construction (Sites 2, 3, 4, 5 [Consolidated Treatment at Site 6], 7 [Consolidated Treatment at Site 6], and 19 [Alternate])						
- Site preparation and grading - On-site pipeline installation - Install pumps - Landscaping and site restoration	Front end loader, backhoe, excavator, fork lift, telescopic crane, cement mixer, concrete pump truck, compactor, hauling trucks, pump-setting rig, arc welder. Diesel generators with self-contained fuel tanks may be used during construction.	Each site would require approximately four months; if test well has already been drilled (Site 2), then duration is one month	3-4	0-12	1-3	0-5

TABLE 3-8

Estimated Daily Worker and Construction Equipment Trips for Wells and Well Facilities Construction[(a)]

Project Components and Construction Activities	Construction Vehicles and Equipment	Construction Duration	Daily Construction Worker Trips (round trip)		Daily Construction Equipment Trips per Site (round trips)	
			Typical	Min to Max	Typical[(b)]	Min to Max
Well Facility Building Construction (Sites 1, 5 [On-site Treatment], 6, 7 [On-site Treatment], 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], and 18 [Alternate])						
- Site preparation and grading - On-site pipeline installation - Building foundation - Building construction - Install wells and pumps - Landscaping and site restoration	Front end loader, backhoe, excavator, fork lift, telescopic crane, cement mixer, concrete pump truck, asphalt truck, compactor, hauling trucks, pump-setting rig, arc welder. Diesel generators with self-contained fuel tanks may be used during construction.	Each site would require approx. 14 months	3-4	0-12	1-3	0-5
Utility Pipelines (All Sites, except for the Westlake Pump Station)						
- Vegetation removal and grading or pavement cutting depending on the location. - Trench excavation and shoring to stabilize the sides of the trench, if necessary. - Pipeline installation - Trench backfilling and compacting - Surface restoration	Excavator, front-end loader, hauling trucks, compactor, asphalt trucks, arc welder. Diesel generators with self-contained fuel tanks may be used during construction.	300 to 600 feet per week	3	2-4	1	0-2

TABLE 3-8

Estimated Daily Worker and Construction Equipment Trips for Wells and Well Facilities Construction[(a)]

Project Components and Construction Activities	Construction Vehicles and Equipment	Construction Duration	Daily Construction Worker Trips (round trip)		Daily Construction Equipment Trips per Site (round trips)	
			Typical	Min to Max	Typical[(b)]	Min to Max
Westlake Pump Station						
- Install pumps and upgrade treatment systems	Fork lift, telescopic crane, cement mixer, pump-setting rig, arc welder. Diesel generators with self-contained fuel tanks may be used during construction.	Approx. four months	3-4	0-12	1-3	0-5

Notes:

(a) Haul truck trips associated with cut and fill material are presented in Table 3-10 (Construction Soil Material Haul Amounts and Anticipated Haul Truck Trips) and are not included in the vehicle trip numbers presented in this table.

(b) A typical construction day would not include movement of construction vehicles on and off the construction site. Construction equipment would be moved on-site as needed, and the equipment would remain on site until it is no longer needed at which point it would be removed from the site. Therefore, a typical construction day would have no construction vehicle trips.

3.5.1.2 Construction Methods for Well Facilities

For sites where test wells already exist (Sites 2, 5, 6, 8, 10, and 13), the test well would be converted to a production well under the proposed Project. Work would include installation of pumps and other equipment, connection to existing power supplies, and installation of transformers and other electrical equipment to facilitate provision of power to the pump station and treatment facilities to operate the well facilities.

For new wells, well facility construction would begin approximately six weeks after the beginning of well drilling. Construction of facilities at the well sites may require additional site clearing and grubbing beyond that conducted for the production well drilling. Site excavation and grading would be minor, with excavation extending to a maximum depth of five feet for the building foundation (if the well facility is intended to have a building) and utilities underneath the building. After the foundation and utilities connections are constructed, the remainder of the building would be constructed and the well pump and other equipment installed, as needed. Construction equipment is expected to include: a front end loader, backhoe, excavator, fork lift, telescopic crane, cement mixer, concrete pump truck, compactor, hauling trucks, pump-setting rig, and arc welder. Equipment and workers needed as well as the construction schedule are discussed in Table 3-8 (Estimated Daily Worker and Construction Equipment Trips for Well Facilities Construction) for each well facility. Diesel generators with self-contained fuel tanks may be used during construction.

3.5.1.3 *Construction Methods for Water Distribution and Utility Pipeline Installation*

The Project includes installation of pipelines to connect the new wells to the regional water system or to Partner Agency water systems, to connect wells to neighboring well facilities for water treatment and disinfection, and to connect well facilities to the local storm drain system and/or the sanitary sewer system. The Project would also provide underground or overhead electricity lines to the well facility from existing nearby power lines.

New pipelines would be installed below ground using standard open-trench construction methods. Open-trench construction involves the following steps:

1) vegetation removal and grading or pavement cutting depending on the location,
2) trench excavation and shoring to stabilize the sides of the trench if necessary,
3) pipeline installation,
4) trench backfilling and compacting, and
5) surface restoration.

The width of pipeline construction zones generally would be 20 feet, although the width would be narrower for the underground electrical conduit construction zone. In general, the pipeline trench would be excavated to a depth of up to six feet and would be approximately 10 feet wide and would accommodate multiple pipelines. Shoring for trenches would be installed in accordance with SFPUC Health and Safety, and California Occupational Safety and Health Administration, requirements.

After trenching, the pipe would be placed in the trench. The trench would then be backfilled with native soil excavated from the trench, to the extent feasible and appropriate, and then compacted to meet applicable compaction requirements. However, depending on the soil conditions of the excavated materials, imported backfill could be necessary for compatibility and stability. Once the trenches are backfilled, disturbed areas would be graded to restore to approximate pre-construction conditions and repaved or revegetated with native plant seed mix or turf as appropriate for the site. During installation, open trenches within roadways would be covered at the end of each workday with steel plates or trench backfilling to accommodate vehicle access during non-work hours.

Construction equipment is expected to include an excavator, front-end loader, hauling trucks, compactor, asphalt trucks, and arc welder. Diesel generators with self-contained fuel tanks may be used during construction of these facilities.

Temporary lane closures would be required during construction along some of the pipeline routes as described below, in Section 3.5.2 (Construction Area, Site Preparation, Excavation and Spoil Handling) and Table 3-9 (Construction Area Size and Characteristics), for each site. At least one lane of traffic would be open along all roadways during construction; therefore, no road closures would be required.

3.5.1.4 *Dewatering and Other Potential Discharges*

Although not expected to be needed during construction, a dewatering system could be required to provide a dry work area if groundwater is encountered during pipeline installation or other excavation activities. Any groundwater encountered during pipeline work would be held in a Baker tank or a similar water storage system and disposed of off-site or added to the existing stormwater facilities in conformance with San Francisco Bay Regional Water Quality Control Board (RWQCB) and applicable local discharge requirements.

Before being placed into service, the new pipelines at all sites and the new treatment facilities at sites with chemical and filtration facilities must be flushed and disinfected to meet water quality regulations. All water used for flushing would come from the new wells and be either dechlorinated and sent to the storm drain or, if not dechlorinated, sent via the nearest sanitary sewer to local wastewater treatment plants for processing.

3.5.1.5 *Temporary Lighting*

Temporary lighting would be required for nighttime well drilling. Prior to construction, the SFPUC or contractor would prepare a construction lighting plan that specifies locations and methods for minimizing light spillover to adjacent residential areas, such as directing lights downward and inward. The lighting plan would also include specifications for temporary lighting structures and total brightness of the lighting as well as glare control methods. Additional elements of the lighting plan would include suggested corrective actions in the event lighting problems are reported by the public during well drilling operations.

3.5.1.6 *Demolition*

Demolition of some existing structures would occur at two well facility sites. At Site 1, the restroom at the Lake Merced Golf Club would be demolished. At Site 14, the Project may include demolition of an existing pump station, tank, and well. If the VA, the land owner at Site 14, finds the demolition acceptable, demolition would include closure and abandonment of the well per California regulations and removal of the pump enclosure, small tank, and any exposed piping to below the current grade.

3.5.2 Construction Area, Site Preparation, Excavation and Spoil Handling

Construction of the proposed Project would be accomplished within the construction area delineated for each well facility site. The size of the proposed construction areas varies by site, depending on individual site characteristics and the size and location of proposed facilities on the site. Grading and vegetation removal, including tree removal and tree trimming, would be required at most sites. Table 3-9 (Construction Area Size and Characteristics) includes construction characteristics for each well facility site, including the size of the construction area, the need for temporary construction driveway access, tree removal and trimming, and potential soils hauling and fill requirements.

Construction at the sites would involve excavation and grading, as well as spoil management and handling. Before construction mobilization, the contractor would clear and grade the site of vegetation and debris, as necessary, to provide a relatively level surface for the movement of construction equipment. Workers would clear the site in stages as construction progresses to limit exposure of soil to stormwater runoff and erosion.

Each well facility site layout includes a temporary construction staging area located within the construction area boundary. Staging areas would range in size between 1,725 and 2,205 square feet and would be fenced. The construction staging areas would be used at each site for the entire construction period. The location of the staging area for each well facility site is shown on its site plan (see Figures 3-11 through 3-40).

TABLE 3-9
Construction Area Size and Characteristics

Project Site	Construction Area (square feet)	New Temporary Access Driveway (Yes/No)	Trees in the Construction Area[(a)]	Streets with Temporary Lane Closures and/or Loss of On-Street Parking
Construction Cluster A				
Site 1	16,730	No	1	None
Site 3	65,125	Yes	0	Park Plaza Drive
Site 4[(b)]	58,723	Yes	24	Park Plaza Drive
Site 7 [(b)]	150,395	No	53	Colma Boulevard
Construction Cluster B				
Site 12	57,040	No	35	Southwood Drive, El Camino Real
Site 14[(b)]	68,155	No	0	Sneath Lane
Site 15[(b)]	68,155	No	1	Sneath Lane
Site 16	35,925	No	0	Hemlock Avenue
Site 19 (Alternate)	34,530	No	18	Southwood Drive, El Camino Real
Construction Cluster C				
Site 9	18,690	No	1	None
Site 10	29,415	No	0	Camaritas Avenue
Site 11	35,070	No	8	None
Site 13	69,830	No	0	South Spruce Avenue, Huntington Avenue
Site 18 (Alternate)	23,175	No	3 trees plus willows	Alta Loma Drive
Construction Cluster D				
Site 2[(b)]	58,723	No	0	Park Plaza Drive
Site 5[(b)]	150,395	No	0	B St, D St, Hill St
Site 6 [(b)]	150,395	No	0	D St, Hill St
Site 8	28,670	No	0	None
Westlake Pump Station	36,530	No	0	None
Site 17 (Alternate)	24,035	Yes	0	Collins Avenue

Notes:

(a) Trees reported here include trees inside the construction area boundary which may be removed during construction.

(b) Some construction area boundaries include two or more sites; this is usually because of connecting pipelines. Combined construction areas include: Sites 2 and 4; Consolidated Treatment for Sites 5, 6, and 7; and Sites 14 and 15.

Soil would be excavated for installation of well facilities and pipelines needed to connect the wells to sanitary sewers, storm drains, and electrical facilities. Soil excavated during well facility construction and pipeline installation may be used as backfill around the facilities, but a large portion of the material would be hauled off-site for recycling or disposal, as presented in Table 3-10 (Construction Soil Material Haul Amounts and Anticipated Haul Truck Trips). It is estimated that fill material may be imported to some well facility sites, since there may be insufficient or inappropriate soil for backfill. The estimated amount of material to be hauled off-site and the amount of fill material to be hauled to the sites are also presented in Table 3-10.

Soils to be disposed of would be tested for hazardous materials prior to disposal. Excavated materials and construction debris found to contain unacceptable levels of hazardous materials would be hauled to a licensed disposal site. Potential hazardous material disposal sites include Waste Management's Kettleman Hills Disposal Site in Kettleman City, California, (for Resource Conservation Recovery Act hazardous [RCRA hazardous] and non-RCRA hazardous waste) and ECDC Environmental in East Carbon, Utah (for non-RCRA hazardous waste, only). Non-hazardous materials would be taken to an approved local disposal area.

Currently, the SFPUC has identified the Ox Mountain Sanitary Landfill in Half Moon Bay, California, as the Project spoil disposal site. The Guadalupe Sanitary Landfill Site in Santa Clara and the Waste Management Altamont Landfill in Livermore are other potential disposal sites. Although some of the excavated soil may be used for backfill at the well facility sites, most would be taken to the appropriate disposal areas listed above, where the material would be reused as alternate daily cover at the landfills.

Vegetation removal would be required at most sites; tree removal and/or trimming would be required at some sites. Tree removal would be required for construction at sites with trees within the construction area boundary or along pipeline routes. Vegetation would be removed and disposed of at an appropriate facility. Vegetation may be stockpiled at staging areas prior to disposal.

Table 3-10 (Construction Soil Material Haul Amounts and Anticipated Haul Truck Trips) lists the estimated cubic yards of soil that would be hauled from each well facility site during well drilling, pipeline construction, and well facility construction. The table also includes the number of haul truck trips required to remove the excavated materials from the site. Excess soil would be reused on-site (for engineering fill) or disposed of at a Class III non-hazardous waste disposal site.

Table 3-10
Construction Soil Material Haul Amounts and Anticipated Haul Truck Trips[a]

Project Site	Material Export for Well Drilling (Cut Material in Cubic Yards)	Material Export for Pipeline Construction (Cut Material in Cubic Yards)	Material Import for Facility Site Construction (Fill Material in Cubic Yards)	Material Export for Facility Site Construction (Cut Material in Cubic Yards)	Haul Truck Trips (20-Cubic Yard Vehicle, Roundtrips)
Construction Cluster A					
Site 1	100	30	40	0	9
Site 3	110	70	0	0	10
Site 4	110	100	315	0	27
Site 7[b]	110	200	0	20	17
Total	**430**	**400**	**355**	**20**	**63**
Construction Cluster B					
Site 12	100	145	25	0	15
Site 14	100	360	0	35	25
Site 15	100	60	0	0	8
Site 16	75	80	0	0	8
Site 19 (Alternate)	110	85	80	0	15
Total	**485**	**730**	**105**	**35**	**71**
Construction Cluster C					
Site 9	90	55	0	0	8
Site 10	No well drilling	50	0	75	7
Site 11	110	60	0	0	9
Site 13	No well drilling	270	0	0	14
Site 18 (Alternate)	110	25	25	0	10
Total	**310**	**460**	**25**	**75**	**48**
Construction Cluster D					
Site 2	No well drilling	20	20	0	2
Site 5[b]	No well drilling	130	0	0	7
Site 6[b]	No well drilling	25	45	0	4
Site 8	No well drilling	50	0	55	5
Site 17 (Alternate)	110	30	30	0	10
Westlake Pump Station	No well drilling	0	0	0	0
Total	**110**	**255**	**95**	**55**	**28**

Table 3-10
Construction Soil Material Haul Amounts and Anticipated Haul Truck Trips[(a)]

Project Site	Material Export for Well Drilling (Cut Material in Cubic Yards)	Material Export for Pipeline Construction (Cut Material in Cubic Yards)	Material Import for Facility Site Construction (Fill Material in Cubic Yards)	Material Export for Facility Site Construction (Cut Material in Cubic Yards)	Haul Truck Trips (20-Cubic Yard Vehicle, Roundtrips)
Total Export and Import for All Sites	**1,335**	**1,845**	**580**	**185**	**210**

Notes:

(a) An expansion factor of 20 percent has been added to the volume of well cuttings, spoil from pipelines, and export material for well facility construction.

(b) The soil excavation volumes for Sites 5, 6, and 7 under the consolidated treatment at Site 6 option are slightly greater than the soil excavation volumes for Sites 5, 6, and 7 under the on-site treatment option, therefore only the volumes for the consolidated treatment option are reported.

3.5.3 Construction Hours, Construction Workforce, and Construction Truck Trips

3.5.3.1 Construction Hours

Typical daily construction hours would be between 7:00 a.m. and 7:00 p.m. Monday through Friday, except for construction of production wells. If necessary, construction work may occasionally occur on Saturdays between the hours of 7:00 a.m. and 5:00 p.m. The nature of production well installation requires continuous operation of the drilling equipment until the desired depth is achieved and the well is constructed because when drilling in unconsolidated sediments such as those present in the Westside Groundwater Basin, there is a risk that the borehole walls could cave sufficiently to require re-drilling of the well. To reduce the risk of caving, the proposed well drilling method is the Reverse Circulation Rotary Method, which uses "what can best be described as muddy water rather than drilling fluids…although a low concentration of polymetric drilling fluid additive may also be used" (Driscoll 1986). Other drilling methods use drilling muds to support and stabilize the bore hole. The Reverse Circulation Rotary Method is proposed for the Project because the absence of drilling mud provides for a potentially higher well capacity and well efficiency (SFPUC 2012b). Therefore, well installation would require nighttime and weekend activity during drilling and other drilling-related activities (for up to seven consecutive days and nights) and during pump testing (for one continuous 48-hour period).

3.5.3.2 Construction Workforce and Delivery Truck Trips

The estimated equipment and workforce required for each phase of construction, as well as daily truck trips, is presented in Table 3-8 (Estimated Daily Worker and Construction Equipment Trips for Well Facilities Construction). The table includes the anticipated workers to complete the construction phases on a daily, minimum, and maximum basis. The table also includes the daily truck trips associated with construction by phase. The maximum number of workers at a site at any time is estimated to be 16.

Primary regional access to the well facility sites during construction would be from I-280. Some sites may be accessed from U.S. Highway 101. Construction truck traffic, deliveries, and most vehicles would enter and exit work sites along local roadways, as noted for each site in Section 3.4.3 (Facility Sites).

3.6 SFPUC STANDARD CONSTRUCTION MEASURES

The SFPUC has established Standard Construction Measures for all WSIP projects (SFPUC 2007b). The main objective of these measures is to reduce impacts on existing resources to the extent feasible. The measures include activities such as early identification of sensitive environmental resources in the WSIP project area and notifying businesses, owners, and residents of adjacent areas potentially affected by the WSIP projects about the nature, extent, and duration of construction activities. The SFPUC project manager, environmental project manager, and contract manager would ensure that the proposed Project contains uniform provisions to address these issues.

3.7 GREENHOUSE GAS REDUCTION ACTIONS

In addition to the above-listed standard construction measures, the SFPUC is committed to the following greenhouse gas (GHG) reduction actions as part of the WSIP program. The SFPUC will include the following measures in all WSIP contractor specifications, which in addition to having other environmental benefits, would also help reduce GHG emissions.

- The SFPUC will require that all contractors maintain tire inflation to the manufacturers' inflation specifications.
- The SFPUC will implement a construction worker education program for all WSIP projects.
- WSIP projects that include construction of new buildings will consult with the SFPUC Power Enterprise's Energy Efficiency Group to incorporate all applicable energy efficiency measures into the project design. Projects with building components will attempt to maximize energy efficiency by exceeding Title 24 minimum requirements by at least 20 percent. Projects with building components will attempt to meet or exceed LEED Silver certification as required by the City and County of San Francisco's (CCSF's) Green Building Ordinance.

3.8 OPERATIONS AND MAINTENANCE

As explained more fully in Section 3.4.1 (Groundwater Storage and Recovery), operation of the GSR Project is designed to provide up to 60,500 af of increased groundwater storage in the South Westside Groundwater Basin, which would be recovered by the SFPUC and Partner Agencies for use during dry years. Operation of the Project by the SFPUC and the Partner Agencies would be governed by an Operating Agreement, which is described below.

3.8.1 Operating Agreement[9]

Under a proposed agreement between the SFPUC and the Partner Agencies for operation of groundwater pumping by these entities from the South Westside Groundwater Basin, the SFPUC would "store" water in the South Westside Groundwater Basin through the mechanism of in-lieu or natural recharge by providing surface water as a substitute for groundwater pumping by the Partner Agencies. As part of its annual April 15 estimate of water supply available to the regional water system, the SFPUC would determine, and give notice to the Partner Agencies of, the availability, anticipated quantities, and timing of the in-lieu water deliveries, thereby requiring the Partner Agencies to accept delivery of surface water in lieu of pumping groundwater from their existing wells (generally during wet and normal water years). This determination would take into consideration the amount of groundwater that the Partner Agencies must continue to pump due to water quality blending or other treatment, distribution system constraints, well maintenance, and other requirements.

During normal and wet years, when water would be stored in the groundwater basin (Put Periods)[10], the SFPUC could require the Partner Agencies to accept delivery of up to 5.52 mgd of regional water system water in lieu of pumping a like amount of groundwater from their existing facilities. As a result of the in-lieu deliveries, up to 60,500 af of groundwater storage or Put credits could accrue to the SFPUC Storage Account, which is described below. During shortages of SFPUC system water due to drought, emergencies, or scheduled maintenance, the Partner Agencies would return to pumping from their existing wells. In addition, the SFPUC and the Partner Agencies would extract groundwater from the SFPUC Storage Account using the new wells installed by the SFPUC as part of the proposed Project (Take Periods)[11], at a maximum annual volume of 8,100 af withdrawn at an average rate of 7.2 mgd. The SFPUC would not direct pumping during these Take Periods unless a positive balance exists in the SFPUC Storage Account as described below.

The SFPUC would maintain an accounting of the storage volumes in the SFPUC Storage Account. The SFPUC would track the amount of water that has been stored during normal and wet years (Put Periods), and the amount of water pumped from the SFPUC Storage Account (Take Periods). Accruals in the SFPUC Storage Account would be recorded based on metered, in-lieu surface water deliveries and corresponding metered decreases in groundwater pumping. An Operating Committee would be formed for purposes of Basin management to monitor and track the SFPUC Storage Account, including any losses from the Basin resulting from the Project, and establish annual pumping schedules for Project wells. As discussed in Section 3.3 (Existing Groundwater Use in the Westside Groundwater Basin), the Partner Agencies would continue to maintain and operate their existing wells and associated

[9] The SFPUC also refers to this agreement in other Project-related documents as the Conjunctive Use Agreement.
[10] Put Periods may also be referred to as "Storage Periods" in the Operating Agreement and other documentation concerning the Project.
[11] Take Periods may also be referred to as "Recovery Periods" in the Operating Agreement and other documentation concerning the Project.

infrastructure, and install new or replacement wells in the future, if necessary[12]. The Partner Agencies would agree to limit pumping from their existing wells and any new wells to the designated quantities totaling 6.9 mgd over a five-year averaging period. The proposed initial apportionment among the Partner Agencies is as follows:

- Daly City: 3.43 mgd/ 3,840 af per year (Daly City 2011),
- Cal Water: 1.37 mgd/ 1,534 af per year (Cal Water 2011), and
- San Bruno: 2.1 mgd/ 2,350 af per year (San Bruno 2011).

When the SFPUC Storage Account is full, defined as 60,500 af, but there is no shortage requiring the SFPUC to pump groundwater from Project wells (Hold Periods), pumping could not exceed 7.6 mgd in any year of the five-year averaging period under the terms of the proposed Operating Agreement. This 10 percent increase over 6.9 mgd could occur as a result of transfer of designated quantities between Partner Agencies. Such transfers would be permitted under the Operating Agreement (SFPUC 2012c) provided the adjustments receive unanimous approval of the Operating Committee. If a Partner Agency engages in over-production, then that agency would be required to:

- take steps to pump less during future years to bring pumping back within the 6.9 mgd aggregate designated quantity,
- provide a source of water that has the effect of replacing water lost from the Basin due to the over-production, or
- take other actions that may be recommended by the Operating Committee[13].

During normal and wet years, Project wells would be operated by the SFPUC or the Partner Agencies only periodically to exercise the wells for maintenance purposes. Maintenance pumping of the Project wells would be at a rate of approximately 0.04 mgd. The Partner Agencies would pump their existing wells at a rate of approximately 1.38 mgd to 1.9 mgd for maintenance purposes. In circumstances where the SFPUC determines that delivery of in-lieu water cannot be made due to a dry year, emergencies, system rehabilitation, scheduled maintenance, or malfunctioning of the water system, or upon recommendation of the Operating Committee, the SFPUC may direct the Partner Agencies to extract groundwater from the SFPUC Storage Account using Project wells, in addition to continued pumping from the Partner Agencies' existing wells to meet the remainder of their water supply needs. Pumping from the SFPUC Storage Account by the Partner Agencies and the SFPUC would only occur if a positive balance exists in the SFPUC Storage Account as a result of previous in-lieu recharge.

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[12] Future plans for installation of new or replacement wells by the Partner Agencies would be subject to environmental review under CEQA to the extent required.
[13] The Operating Committee would respond to issues as they arise. Additional CEQA review may be required.

During dry years, the SFPUC would deliver water to the Partner Agencies from two sources: reduced surface water deliveries from the regional water system and groundwater from the proposed Project wells. The Partner Agencies could also pump groundwater from their existing wells up to an amount that would not exceed the annual average rates consistent with the pumping limits expressed in the Operating Agreement. The specific volumes to be pumped during a drought, as shown in Figure 3-2 (Source of Proposed Water Supply for Partner Agencies), are based on proposed Project operations, but actual volumes in any given year could vary depending on factors including:

1) the final location and capacity of the Project well facilities;
2) the volume of water in the SFPUC Storage Account; and
3) direction from the Operating Committee regarding which wells should be used, based on the need to avoid well interference (see Section 5.16, Hydrology and Water Quality) and other basin management considerations[14].

The SFPUC and the Partner Agencies would operate and maintain Project wells connected to their respective water systems. The Partner Agencies may be allowed to use Project facilities for non-Project purposes,[15] but only under certain specified conditions where necessary, with approval of the Operating Committee, and only for periods not to exceed 30-days duration. Pumping by the Partner Agencies from Project wells for non-Project purposes would not result in a debit to the SFPUC Storage Account. In the event of a sudden, non-drought event such as an earthquake or other catastrophic event, the Operating Committee may allow Partner Agency use of Project facilities for the duration of the emergency.

3.8.2 Project Operation

The primary purpose of the Project is to provide a dry-year water supply during a multiple-year drought. As described above, the Project would use vacated storage space in the South Westside Groundwater Basin filled through in-lieu or natural recharge during normal and wet years. Neither Project wells nor Partner Agency wells would be pumped in these Put Periods, apart from volumes needed to periodically exercise the wells. Water would accrue in the SFPUC Storage Account based on the metered reduction in each Partner Agency's designated quantity, as described in Section 3.8.1 (Operating Agreement).

When the SFPUC Storage Account is full, defined as 60,500 af, but there is no shortage requiring the SFPUC to pump groundwater from Project wells (Hold Periods), the Project wells installed by the SFPUC would remain inactive apart from occasional well exercising. Existing Partner Agency wells would be pumped at rates not to exceed an annual amount of 6.9 mgd over the five-year averaging period, with a ceiling of up to 7.6 mgd in any year of the five-year averaging periods, as described in Section 3.8.1 (Operating Agreement). The Partner Agencies would continue to be able to take delivery of their

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[14] The Operating Committee would respond to issues as they arise. Additional CEQA review may be required.
[15] For example, wells could be used as a back-up well during normal operation, but not for more than 30 days.

entitlements to surface water from the SFPUC during these Hold Periods, as the SFPUC Storage Account would remain full.

Proposed Project wells would be operated during a Take Period under the following circumstances:

- Beginning in the second dry year of a multiple-year drought;
- During emergencies;
- During system rehabilitation, scheduled maintenance or malfunctioning of the water system; or
- Upon recommendation of the Operating Committee established by the Operating Agreement for purposes of Basin management[16].

In these circumstances, proposed Project wells could be operated continuously or for shorter intervals, depending on the need for water. During these Take Periods, when groundwater is pumped to provide a dry-year supply, pumping would reduce the balance of water in the SFPUC Storage Account. Project wells would be operated by the Partner Agencies and the SFPUC, depending on whether the water is sent to the Partner Agencies' retail water distribution systems or to the regional water system. Project wells would only be pumped in Take Periods if there is a positive balance in the SFPUC Storage Account, and that pumping may not exceed 8,100 af per "supply year," defined as the period from July 1 to June 30 of the following year, pumped at an average rate of 7.2 mgd. Existing Partner Agency wells would be pumped at up to the rates indicated above during Hold Periods and as described in Section 3.8.1 (Operating Agreement).

3.8.3 Maintenance

Project wells would require exercising to ensure that the facilities remain operational during normal and wet years. Well exercising would occur either weekly or monthly. Wells would be exercised for one hour per week or for a single, four-hour period monthly. Flow rates for exercising are anticipated to be between 300 to 600 gpm. Operators may fine-tune the exercise schedule according to the characteristics of individual wells. A possible maintenance issue is bio-fouling,[17] which may require periodic disinfection as part of the exercise program. Groundwater pumped during exercising would be discharged to a local storm drain. In the event there is still chlorine residual in the groundwater, the water would be discharged to a sanitary sewer or dechlorinated prior to discharging to a storm drain. Partner Agencies would continue pumping their existing wells during Put Years as needed to maintain operability.

[16] The Operating Committee would respond to issues as they arise. Additional CEQA review may be required.

[17] Bio-fouling is the undesirable accumulation of microorganisms in the well. Well screen fouling can occur due to microorganisms which clog the pores of the screen, which in turn reduce flow from the well.

All well stations would be unmanned. Each well station would be visited daily when wells are operating for routine equipment checks, lasting approximately 30 minutes each. During normal and wet years (i.e., Put Years), the wells normally would be turned off, but regular exercising would be conducted as described above. At these times, the wells would be visited on a weekly basis or at a frequency determined by on-site conditions. During dry years (i.e., Take Years), the wells would be operational and in production. Longer term maintenance could include removal and repair or replacement of pumps, valves, and other equipment.

Production wells may require redevelopment and/or rehabilitation on an infrequent basis. The life of production wells is estimated to be at least 50 years, although pumps may need to be replaced every 15 to 20 years.

3.9 REQUIRED PERMITS AND APPROVALS

Well facility construction and operation would be conducted to meet all applicable regulations, including local, State, and federal drinking water standards and the amended California Department of Public Health water supply permits for each Partner Agency. Project operations would be conducted in accordance with the proposed Operating Agreement between the SFPUC and the Partner Agencies (see Subsection 3.8.1 [Operating Agreement]), if approved by the SFPUC and Partner Agencies following certification of this EIR by the San Francisco Planning Commission. Table 3-11 (Regulatory/Permitting Agencies/Utility) lists the federal, State, local, and regional regulatory/permitting agencies that may have permitting or approval authority over certain aspects of the Project.

TABLE 3-11
Regulatory/Permitting Agencies/Utility

Regulatory/Permitting Agency/Utility	Potential Permit/Approval
Federal Regulatory/Permitting Agencies	
U.S. Department of Veterans Affairs (VA)	Agreement for installation and maintenance of well facilities at Site 14 and Site 15; approval to demolish building located adjacent to SFPUC right-of-way on Site 14 and decommissioning pipelines; completion of environmental review under the National Environmental Policy Act (NEPA). Section 106 consultation for review and evaluation of Project impacts on cultural resources under the National Historic Preservation Act.
State Regulatory/Permitting Agencies	
California Department of Public Health	Water supply permit amendments for each Partner Agency and the SFPUC. Approval of well construction and operation.
California Department of Toxics Substances Control	Contaminated Soil Treatment Work Plan (required only if contaminated soil is encountered during construction).
California Re+gional Water Quality Control Board, San Francisco Bay Region (RWQCB)	Discharge permits, if required, for emergency and/or maintenance water discharges, and for "overboard" pumping of wells to waters of the State.
California Department of Transportation (Caltrans)	Encroachment permits for access along, and to construct or operate facilities in, a State roadway and interstate highway right-of-way.
State Water Resources Control Board	Stormwater General Permit and Stormwater Pollution Prevention Plan.
State Historic Preservation Officer	Compliance with Section 106 of the National Historic Preservation Act at Sites 14 and 15.
Local and Regional Regulatory/Permitting Agencies	
Bay Area Air Quality Management District (BAAQMD)	Permit required for stationary equipment that may generate air pollutants.
San Francisco Board of Supervisors	Adoption of CEQA findings, and approval of funding appropriation and property rights acquisition.
San Francisco Public Utilities Commission	Project approval. Adoption of CEQA findings and mitigation monitoring and reporting program. Award of construction contracts. Approval of Operating Agreement, and approval of property rights acquisitions.

TABLE 3-11
Regulatory/Permitting Agencies/Utility

Regulatory/Permitting Agency/Utility	Potential Permit/Approval
San Francisco Planning Commission	Certification of Final EIR.
Local City Councils and/or San Mateo County Board of Supervisors	Easement and/or land sale approval.
San Francisco Historic Preservation Commission	Review of a Memorandum of Understanding pursuant to the federal Section 106 process under the National Historic Preservation Act.
Local School Districts	Approval for construction and use of property under its jurisdiction.
San Francisco Arts Commission	Approval of exterior design of proposed facilities on SFPUC property or right-of-way.
Local Department(s) of Public Health	Approval of Certified Unified Program Agencies (CUPA)/Hazardous Materials Business Plan (for Project operations).
San Mateo County Environmental Health Division	Approval of well construction and well abandonment/destruction in accordance with the California Department of Water Resources standards.
Local Departments of Public Works or Engineering	Approval of excavation permits in local streets, encroachment permits, and temporary occupancy permits for street space.
City of Daly City, Water and Wastewater Department	Permit for well construction or well abandonment/deconstruction.
City of Daly City	Approval of Operating Agreement Approval to access, use and construct improvements at the Westlake Pump Station.
Bay Area Rapid Transit (BART)	Encroachment permits to cross BART property.
City of San Bruno	Approval of Operating Agreement.
California Water Service Company (Cal Water)	Approval of Operating Agreement.
San Mateo County Transit (SamTrans)	Approval to temporarily relocate bus stop.

3.10 PROPERTY RIGHTS ACQUISITION

Several types of property rights would be needed for Project construction and operation, as shown in Table 3-12 (Property Rights Proposed for Acquisition). The process for acquiring right-of-way may involve the preparation of a deed and appraisal map, an appraisal of fair market value, negotiations with property owners, and condemnation (if necessary).

TABLE 3-12
Property Rights Proposed for Acquisition

Property Acquisition Type	Rights
Access Easement	Temporary or permanent rights to enter or cross another property.
Pipeline Easement	Rights to install and maintain a pipeline over or across another property.
Construction Easement	Temporary rights to use another property during construction.
Fee Acquisition	Purchase of all the property rights, land, improvements (if any), etc.
Permanent Easement	Rights to permanent right to operate a well facility on another property.
Encroachment Permit	Rights to encroach across a publicly-owned road or transit rights-of-way for pipeline or other purposes.

Of the 19 potential well sites, 12 sites are on SFPUC property or within SFPUC right-of-way. The other seven well sites are on other public and private parcels, which would require an acquisition of easements and access permits, or other rights, for the construction and maintenance of well facilities, connecting pipelines, and/or access. Lastly, several sites have lengthy connecting pipeline requirements that would most likely be constructed on a combination of public and private parcels.

Table 3-13 (Anticipated Property Rights Requirements) provides information on the various parcels that would be needed for the proposed Project. Permanent and temporary right-of-way acquisition requirements could change as the detailed design progresses. No acquisition of property rights is needed for the Westlake Pump Station.

TABLE 3-13

Anticipated Property Rights Requirements[a]

Site	Site Name	Well Site Owner	Access Easement/ Temporary Construction Easement	Permanent Well Site Easement	Permanent Pipeline Easement	Encroachment Permit	Notes
Site 1	Lake Merced Golf Club	Lake Merced Golf Club	Yes	Yes	Yes	No	Existing agreement with the SFPUC for one well, but may require additional or modified agreement for proposed site location.
Site 2	Park Plaza Meter	SFPUC[18]	No	No	No	Yes	Proposed pipeline along Park Plaza Drive would need an encroachment permit from the City of Daly City.
Site 3	Ben Franklin Intermediate School	Jefferson School District	Yes	Yes	Yes	No	Would require agreement with the school district to construct and operate well facility. Also includes new pipeline.
Site 4	Garden Village Elementary School	County of San Mateo	No	Yes	Yes	Yes	Would require encroachment permit and permanent easement from the County of San Mateo. Also includes new pipeline adjacent to Park Plaza Drive.

[18] Property owned by the CCSF and managed by the SFPUC.

TABLE 3-13

Anticipated Property Rights Requirements[(a)]

Site	Site Name	Well Site Owner	Access Easement/ Temporary Construction Easement	Permanent Well Site Easement	Permanent Pipeline Easement	Encroachment Permit	Notes
Site 5	Right-of-Way at Serra Bowl	SFPUC	No	No	No	Yes	An encroachment permit would be needed for the pipeline route and utility from the City of Daly City. An encroachment permit may be needed for utility installations (e.g., PG&E and AT&T).
Site 6	Right-of-Way at Colma BART	SFPUC	No	No	No	Yes	The SFPUC would need an encroachment permit from the City of Daly City to access the SFPUC parcel and for utility installation.
Site 7	Right-of-Way at Colma Boulevard	SFPUC	No	No	No	Yes	The facility would be constructed entirely on SFPUC land, with access from Colma Boulevard. Would need an encroachment permit from the Town of Colma for utility installation.
Site 8	Right-of-Way at Serramonte Boulevard	SFPUC	Yes	No	Yes	No	Would need access easement to the facility through parking lot of adjacent business (Kohl's).
Site 9	Treasure Island Trailer Court	SFPUC	Yes	No	Yes	No	Access easement would be needed from BART and San Mateo County. May need rights from adjacent property owner to connect to SFPUC Pipeline.

TABLE 3-13

Anticipated Property Rights Requirements[(a)]

Site	Site Name	Well Site Owner	Access Easement/ Temporary Construction Easement	Permanent Well Site Easement	Permanent Pipeline Easement	Encroachment Permit	Notes
Site 10	Right-of-Way at Hickey Boulevard	SFPUC	No	No	No	Yes	Access to the facility would be through property owned by City of South San Francisco. May need an encroachment permit from City of South San Francisco for utilities. Set-back area would need to be verified by City.
Site 11	South San Francisco Main Area	SFPUC	Yes	No	Yes	No	May require access agreement from BART and City of South San Francisco between Chestnut Boulevard and well facility. May need agreement from adjacent property owner to connect to the Cal Water distribution system.
Site 12	Garden Chapel Funeral Home	SFPUC	No	Yes	Yes	Yes	Site is SFPUC property, but operations and access would be coordinated with current lessee. Connection to SFPUC pipeline would be in the sidewalk at El Camino Real. Pipeline easement or encroachment permit would be from the City of South San Francisco/Caltrans for the street area.
Site 13	South San Francisco Linear Park	SFPUC	Yes	No	If pipes cross private property	Yes	Existing agreement (negotiated in land sale) with City of South San Francisco. Lengthy pipeline from site to connection in San Bruno.

TABLE 3-13

Anticipated Property Rights Requirements[(a)]

Site	Site Name	Well Site Owner	Access Easement/ Temporary Construction Easement	Permanent Well Site Easement	Permanent Pipeline Easement	Encroachment Permit	Notes
Site 14/15	Golden Gate National Cemetery	U.S. Dept. of Veterans Affairs. Site 14 would be located in the SFPUC right-of-way, including pipelines. Site 15 would be on U.S. Dept. of Veterans Affairs property	Yes	Yes	Yes	Yes	Agreement with the VA to construct and maintain well facilities, within the cemetery and potential demolition of existing building at Site 14. Connection to City of San Bruno system is in Sneath Lane.
Site 16	Millbrae	SFPUC	No	No	No	No	Access to the facility would be through parking lot of Orchard Supply Hardware. Existing lease would need to be amended.
Site 17 (Alternate)	Standard Plumbing Supply	Standard Plumbing Supply	Yes	Yes	Yes	Yes	Would require easement from the property owner. An encroachment permit from the Town of Colma would be required.
Site 18 (Alternate)	Alta Loma Drive	City of South San Francisco	Yes	Yes	Yes	Yes	Would require encroachment permit from the City of South San Francisco.
Site 19 (Alternate)	Garden Chapel Funeral Home	SFPUC	No	No	Yes	No	Site is SFPUC land, but access would be coordinated with current lessee.

Note:

(a) Construction may require acquisition of temporary construction easements at each proposed well facility site.

3.11 REFERENCES

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4 PLANS AND POLICIES

Sections
4.1 Overview
4.2 Plans and Policies Relevant to the Groundwater Storage and Recovery Project
4.3 Inconsistency Evaluation
4.4 References

4.1 OVERVIEW

Pursuant to California Environmental Quality Act (CEQA) Guidelines Section 15125(d), this chapter describes land use plans and policies relevant to the siting, construction, and operation of the proposed Project, and then discusses the Project's potential for inconsistency with the applicable plans and policies. Whether a project is consistent with particular plans for which a consistency determination is required will be decided at the time of Project approval, by the agency charged with that determination. Land use plans typically contain numerous policies emphasizing differing legislative goals; an interpretation of consistency requires balancing of all relevant policies.

The plans and policies addressed in this section include:

U.S. Department of Veterans Affairs (VA), National Cemetery Administration. Facilities Design Guide.

City and County of San Francisco (CCSF). Extraterritorial Lands, San Francisco General Plan, Western Shoreline Area Plan (the coastal plan for San Francisco's western shoreline within the coastal zone), Accountable Planning Initiative, Sustainability Plan, and Municipal Green Building Program.

San Francisco Public Utilities Commission (SFPUC). Water Enterprise Environmental Stewardship Policy, Right of Way Integrated Vegetation Management Policy, and Strategic Sustainability Plan.

Other Local Jurisdictions. General Plans of Daly City, South San Francisco, San Bruno, Millbrae, Colma and San Mateo County. Other Local Jurisdiction Management Plans: South Westside Basin Groundwater Management Plan, Bay Area Rapid Transit (BART) Station Area Specific Plan and the San Mateo County Airport Use Plan.

To the extent the land use plans and policies discussed in this section contain objectives and policies that avoid or mitigate environmental effects, the consistency of the Project with such plans and policies is examined in each relevant Chapter 5 analysis section. For example, Sections 5.2 through 5.19 of this EIR describe the Project's consistency with pertinent resource-specific plans and policies (e.g., Section 5.8, Air Quality discusses air quality management plans; Section 5.14, Biological Resources discusses consistency with local tree ordinances).

4.2 PLANS AND POLICIES RELEVANT TO THE GROUNDWATER STORAGE AND RECOVERY PROJECT

4.2.1 Federal Plans and Policies

The U.S. Department of Veterans Affairs (VA) land use plans and policies are applicable to projects within the jurisdictional boundaries of VA facilities, including VA cemeteries. Well facility Sites 14 and 15 would be located within the Golden Gate National Cemetery (GGNC), which is under the jurisdiction of the VA.

4.2.1.1 U.S. Department of Veterans Affairs, National Cemetery Administration – Facilities Design Guide

Two VA agencies have plans and policies that govern construction at VA cemeteries – the National Cemetery Administration (NCA) and the Office of Construction and Facility Management. These agencies have jointly issued the NCA Facilities Design Guide (Design Guide) (VA 1999; VA 2010), which consolidates applicable VA standards and criteria for construction and design of VA cemeteries. The relevant policies in the Design Guide pertain to siting maintenance activities and facilities in areas that are not readily visible to the public and away from the Public Information Center and gravesites; accessing wells and pump houses from service roads; and routing utility lines between gravesite areas to avoid obstruction of individual gravesites, and burying utility lines underground. The policies for grading, drainage and planting activities are to:

- Retain the site in as natural a state as possible.
- Keep grading to a minimum, while meeting the functional requirements of the cemetery.
- Leave undisturbed such features as natural drainage ways, valuable trees or tree groups, shrubs, ground covers, rock out-croppings and streams.
- Use construction practices that minimize adverse effects on the natural habitat.

4.2.1.2 Coastal Zone Management Act

The authority to evaluate projects conducted, funded or permitted by the federal government is granted to coastal states through the federal Coastal Zone Management Act (CZMA) of 1972, as amended (16 U.S.C. Section 1451 et seq.). The CZMA is implemented in California through the California Coastal Commission (CCC), a State agency, with the exception of San Francisco Bay which is subject to the jurisdiction of the Bay Conservation and Development Commission (BCDC). The key component of California's Coastal Management Program is the California Coastal Act (Public Resources Code, Division 20, Section 30000 et seq.). The CCC has approved the City and County of San Francisco's (CCSF's) local coastal program pursuant to the Coastal Act. The San Francisco local coastal program includes the *Western Shoreline Area Plan*, which is the City's coastal plan.

In evaluating whether a federal permitting action is consistent with the State's coastal management program, the CCC would look to policies contained in Chapter 3 of the California Coastal Act which include policies related to coastal access, protection of water-oriented activities and recreational boating, protection of the marine environment, protection of environmentally sensitive habitat areas, agricultural lands, and archaeological and paleontological resources. These policies are embodied in the *Western Shoreline Area Plan*, which includes policies, among others, specific to Lake Merced. The *Western Shoreline Area Plan* is discussed below in Section 4.2.2.2 (San Francisco General Plan).

4.2.2 City and County of San Francisco Plans and Policies

The CCSF land use plans and policies are primarily applicable to projects within the jurisdictional boundaries of San Francisco, although in some cases their underlying goals may apply to projects outside of San Francisco (see Section 4.2.2.1 [Extraterritorial Lands]). Although the proposed facility sites are all located outside of San Francisco, the underlying goals of the following plans are applicable to the proposed Project: the San Francisco General Plan; the Accountable Planning Initiative; the San Francisco Municipal Green Building Program; and the San Francisco Sustainability Plan. In addition, the SFPUC has adopted various plans and policies that further direct its activities, such as the *Water Enterprise Environmental Stewardship Policy* and the *Right of Way Integrated Vegetation Management Policy*, which are discussed below in Section 4.2.3 (SFPUC Plans and Policies).

4.2.2.1 Extraterritorial Lands

Under the San Francisco City Charter (SFCC)[1], the SFPUC has authority over the management, use and control of certain extraterritorial lands; that is, properties outside of the City that the CCSF owns or leases or over which it holds easements that are within the jurisdiction of the SFPUC (SFCC Section 4.112). These lands owned by the CCSF outside of the City are subject to the SFPUC's exclusive charge of the construction, management, use, and control of the City water supplies and utilities (SFCC Section 8B.121). Accordingly, the CCSF considers its own plans and policies on its extraterritorial lands, to the extent applicable.

California Government Code Section 53090, et seq., provides that the SFPUC receives intergovernmental immunity from the zoning and building ordinances of other cities and counties on extraterritorial CCSF lands. The SFPUC, however, seeks to work cooperatively with local jurisdictions where CCSF-owned facilities are sited outside of San Francisco to avoid conflicts with local land use plans and building and zoning codes. Also, the SFPUC is required under Government Code Section 65402(b) to inform local

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[1] Section 8B.121 of the City Charter provides that ". . . the Public Utilities Commission shall have exclusive charge of the construction, management, supervision, maintenance, extension, expansion, operation, use, and control of all water, clean water, and energy supplies and utilities of the City as well as the real, personal, and financial assets, that are under the Commission's jurisdiction or assigned to the Commission under Section 4.132."

governments of its plans to construct buildings or structures or to acquire or dispose of real property. The local governments have a 40-day review period to determine project consistency with their general plans. Under this requirement, the cities' or counties' determinations of consistency are advisory to the SFPUC rather than binding.

4.2.2.2 San Francisco General Plan

California planning law (Government Code Sections 65302–65303) requires each city and county within the State to develop and adopt a general plan. General plans are long-range policy documents to guide the use and future development of private and public lands within the boundaries of a city or county. General plans represent a jurisdiction's official position on issues, such as development and resource management.

The San Francisco General Plan sets forth the comprehensive, long-term land use policy for San Francisco. One of the basic goals of the general plan is "coordination of the growth and development of the city with the growth and development of adjoining cities and counties and of the San Francisco Bay Region." The general plan consists of 10 issue-oriented plan elements. The plan elements that may be relevant to the Project are described below:

- *Air Quality Element.* This element aims to improve air quality and comply with State and federal air quality standards for the Bay Area.
- *Commerce and Industry.* This element sets objectives and policies for economic activities, with a goal of balancing environmental quality and development objectives.
- *Community Safety.* This element aims to minimize death and injuries, property loss, environmental damage, and social and economic disruption from manmade and natural disasters, including protection from geologic and seismic hazards.
- *Environmental Protection.* This element addresses the protection of water resources, biological resources, other natural resources, and addresses construction-related noise.
- *Urban Design***.** This element sets objectives and policies for the physical character and order of the city, including the protection of historic and visual resources.

The San Francisco General Plan also contains area plans that cover specific geographic areas within the City. One of the area plans, the *Western Shoreline Area Plan*, is the local coastal plan and is part of the City's Local Coastal Program. The Plan sets objectives and policies for preserving the recreational and natural habitat of Lake Merced and maintaining the water quality of the lake as a standby reservoir for emergency use. These policies call for preserving the recreational facilities, passive activities, playgrounds and vistas of Lake Merced (Objective 5, Policy 5.1), maintaining a recreational pathway around the lake for multiple use (Objective 5, Policy 5.2) and allowing only those activities in the lake which will not threaten its quality for use as a standby emergency reservoir (Objective 5, Policy 5.3).

4.2.2.3 *Golden Gate Park Master Plan*

The *Golden Gate Park Master Plan* (adopted by the San Francisco Recreation and Park Commission in October 1998) is intended to "provide a framework and guidelines to ensure responsible and enlightened stewardship of the park" (SFRPD 1998). The goal of this plan is to "manage the current and future park and recreation demands while preserving the historic significance of the park." The plan identifies objectives and policies for park landscape, circulation, recreation, visitor facilities, buildings and monuments, utilities and infrastructure, maintenance and operations areas, park management, park funding, and special area plans. Policies and objectives relevant to the GSR Project include: preserving naturalistic parkland, including lakes; preserving the design integrity of Golden Gate Park lakes and water features; and maintaining lake water quality and levels, wildlife habitat, and recreational values.

4.2.2.4 *Accountable Planning Initiative*

In November 1986, the voters of San Francisco approved Proposition M, the Accountable Planning Initiative, which added Section 101.1 to the City Planning Code (San Francisco Planning Department 2006) to establish eight Priority Policies. The Priority Policies serve as the basis upon which inconsistencies in the General Plan are resolved. Of the eight Priority Policies, Policies 6, 7, and 8 are relevant to the proposed Project.

1. Existing neighborhood-serving retail uses shall be preserved and enhanced and future opportunities for resident employment in and ownership of such businesses enhanced.
2. Existing housing and neighborhood character shall be conserved and protected in order to preserve the cultural and economic diversity of our neighborhoods.
3. The City's supply of affordable housing shall be preserved and enhanced.
4. Commuter traffic shall not impede San Francisco Municipal Railway (MUNI) transit service or overburden our streets or neighborhood parking.
5. A diverse economic base shall be maintained by protecting our industrial and service sectors from displacement due to commercial office development, and future opportunities for resident employment and ownership in these sectors shall be enhanced.
6. The City shall achieve the greatest possible preparedness to protect against injury and loss of life in an earthquake.
7. Landmarks and historic buildings shall be preserved.
8. Parks and open space and their access to sunlight and vistas shall be protected from development.

In accordance with the Accountable Planning Initiative, prior to issuing a permit for any project, or adopting legislation that requires an initial study under CEQA, or adopting any zoning ordinance or development agreement, and before taking any action that requires a finding of consistency with the general plan, the CCSF is required to find that the project is consistent with the Priority Policies established by Proposition M.

4.2.2.5 San Francisco Sustainability Plan

The San Francisco Board of Supervisors endorsed the *Sustainability Plan for the City of San Francisco* in 1997, although the Board has not committed the CCSF to perform the actions addressed in the plan. The plan serves as a blueprint for sustainability, with many of its individual proposals requiring further development and public comment. The underlying goals of the plan are to maintain the physical resources and systems that support life in San Francisco and to create a social structure that will allow such maintenance. The plan is divided into 15 topic areas, 10 that address specific environmental issues (air quality; biodiversity; energy, climate change and ozone depletion; food and agriculture; hazardous materials; human health; parks, open spaces and streetscapes; solid waste; transportation; and water and wastewater) and five that are broader in scope and cover many issues (economy and economic development, environmental justice, municipal expenditures, public information and education, and risk management). Under the topic "water," there are goals addressing water reuse, water quality, water supply, groundwater supply and infrastructure. Each topic area in the plan contains a set of indicators to be used over time in determining whether San Francisco is moving in a sustainable direction in that particular area (San Francisco 1997).

4.2.2.6 San Francisco Municipal Green Building Program

San Francisco's Green Building Program was established in 1999 when the CCSF adopted the Resource Efficient Building Ordinance, which established green building standards for municipal buildings to increase energy efficiency, conserve CCSF finances, reduce the environmental impacts of demolition, construction and operation of buildings, and create safe workplaces for CCSF employees and visitors. In 2004, amendments to Chapter 7 of the Environment Code set Leadership in Energy and Environmental Design (LEED) (U.S. Building Council Leadership in Energy and Environmental Design) Silver Certification as the minimum environmental performance requirement for all municipal projects that would involve buildings with areas of over 5,000 square feet. The Resource Efficient Building (REB) Task Force assists City departments in complying with the LEED Silver Certification requirement and helps to determine which projects are subject to LEED standards. For all municipal construction projects, including those projects that do not involve buildings and are not required to obtain LEED Silver Certification, the REB Task Force provides recommended best practices and sample specifications for building materials such as recycled steel and concrete (San Francisco Department of the Environment 2007).

4.2.2.7 Significant Natural Resource Areas Management Plan

The San Francisco Recreation and Park Department is currently completing a Significant Natural Resource Areas Management Plan (SNRAMP) for designated significant natural areas in San Francisco. The purpose of the management plan is to establish a maintenance and preservation program related to the protection and enhancement of natural resource values. While the SNRAMP itself has not been finalized and adopted and thus is not yet in effect, the Recreation and Park Department's Natural Areas Program was developed to protect and restore the City's natural areas. In 1995, the Recreation and Park Commission adopted a staff report on the SNRAMP (SFRPD 1995). The staff report set forth general objectives, policies, and management actions to guide development of the SNRAMP. General policies and management actions in the staff report are relevant to recreational and biological resources at Pine Lake and Lake Merced, including general policies to maintain/promote indigenous plant species and control/remove invasive species, monitor wildlife populations, etc. These policies and management actions are discussed in Sections 5.11, Recreation, and 5.14, Biological Resources.

4.2.3 SFPUC Plans and Policies

The following SFPUC plans and policies are applicable to the proposed Project.

4.2.3.1 Water Enterprise Environmental Stewardship Policy

Adopted in 2006, the *SFPUC Water Enterprise Environmental Stewardship Policy* established the long-term management direction for CCSF-owned lands and natural resources affected by operation of the regional water system within the Tuolumne River, Alameda Creek, and Peninsula watersheds (SFPUC 2006). It also addresses rights-of-way and properties in urban areas under SFPUC management. The policy includes the following:

- The SFPUC will proactively manage the watersheds under its responsibility in a manner that maintains the integrity of the natural resources, restores habitats for native species, and enhances ecosystem function.
- To the maximum extent practicable, the SFPUC will ensure that all operations of the regional water system (including water diversion, storage, and transport), construction and maintenance of infrastructure, land management policies and practices, purchase and sale of watershed lands, and lease agreements for watershed lands to protect and restore native species and the ecosystems that support them.
- Rights-of-way and properties in urban areas under SFPUC management will be managed in a manner that protects and restores habitat value where available, as well as encouraging community participation in decisions that significantly interrupt or alter current land use in these parcels.

The Environmental Stewardship Policy calls for integration of this policy into the Water System Improvement Program (WSIP) and WSIP facility improvement projects (such as the proposed Project).

4.2.3.2 Right of Way Integrated Vegetation Management Policy

In 2007, the SFPUC adopted a *Right of Way Integrated Vegetation Management Policy* to manage vegetation that poses a threat or hazard to the system's operation, maintenance, and infrastructure throughout its water distribution and collection systems (SFPUC 2007). The roots of large woody vegetation can damage transmission pipelines by causing corrosion of the outer casements. Trees and other vegetation directly adjacent to pipelines can also make emergency and annual maintenance difficult, hazardous, and expensive, and can increase concerns for public safety. Fire danger within the SFPUC rights-of-way is also a concern. The SFPUC is required to comply with local fire ordinances, which require that existing vegetation be identified, reduced, and managed to prevent potential disruption to fire protection services.

One of the other objectives of this policy is to reduce and eliminate as much as practicable the use of herbicides on vegetation within the right-of-way. Specific elements of the SFPUC Vegetation Management Policy address the management and removal of vegetation, annual grasses, and weeds within the SFPUC right-of-way and the management and removal of vegetation and trees on land leased or permitted by the SFPUC.

4.2.3.3 Strategic Sustainability Plan

In 2008, the SFPUC released its *Sustainability Plan and Program*, which focused on long-term sustainability goals for the organization (SFPUC 2008). Later that year, the SFPUC started a strategic planning effort with a 12- to 18-month forward tracking of performance used to manage the SFPUC's priority fiscal year activities. Since then, the SFPUC has integrated the two, resulting in the SFPUC's *Strategic Sustainability Plan* released in March 2011 (SFPUC 2011). It is actively in use for purposes of strategic sustainability planning and management that takes into account the long-term economic, environmental, and social impacts of the SFPUC business. The *Strategic Sustainability Plan* contains goals, objectives, and performance indicators to implement the SFPUC's vision and values. The five goals are as follows: provide high quality services; plan for the future; promote a green and sustainable City; engage the SFPUC's public; and invest in its communities. Using performance indicators provided in the plan, the SFPUC will measure the progress it makes each year in improving its performance relative to reaching its objectives and goals.

4.2.4 Land Use Plans and Policies of Other Local Jurisdictions

4.2.4.1 General Plans

Project facilities are proposed in the cities of Daly City, South San Francisco, and Millbrae; the Town of Colma; unincorporated San Mateo County; and in the city of San Bruno within the Golden Gate National Cemetery (see Figures 3-3, 3-4, and 3-5 in Chapter 3, Project Description). The intent of the general plans of these entities is to preserve and improve the quality of life for their citizens and to consider growth in a manner that appropriately reflects community values. The general plans of these entities set forth plans, policies, and objectives for future development.

The following factors affect the application of the above jurisdictions' general plans to the Project:

- *Local Jurisdiction Approvals*. Specific well facility sites may require encroachment permits from local jurisdictions. Of the 19 potential sites, 11 sites may require encroachment permits for connecting pipelines and/or for site access.
- *Building and Zoning Ordinances*. Building and zoning ordinances represent the most specific expressions of general plan goals, objectives, and policies. State law and judicial interpretation of State law mutually exempt cities and counties from complying with each other's building and zoning ordinances. As noted above in Section 4.2.2.1 (Extraterritorial Lands), the SFPUC, which is part of the CCSF, is therefore exempt from complying with the building and zoning ordinances of other cities and counties.

- *Local Government Notification and Consistency Determination Requirements*. As noted above in Section 4.2.2.1 (Extraterritorial Lands), California Government Code Section 65402(b) requires that the SFPUC inform cities and counties of its plans to construct projects or acquire or dispose of extraterritorial property. The local governments have 40 days to determine project consistency with their general plans; these consistency determinations are advisory to the SFPUC rather than binding. Implementation of WSIP facility improvement projects (such as the proposed Project) would trigger the requirements of Section 65402(b). The SFPUC would notify local governments of the Project as required pursuant to California Government Code Section 65402(b).

Notwithstanding the above, where facilities are proposed to be sited outside of San Francisco, the SFPUC seeks to work cooperatively with local jurisdictions to avoid conflicts with local land use plans and building and zoning codes.

City of Daly City General Plan

Sites 1, 2, 5, and 6 would be located in Daly City.

The most recent Daly City General Plan was adopted in November of 1987, with an update to the Housing Element in September 2009 (Daly City 1987; 2009). The General Plan goals, objectives and policies are aimed at providing opportunities for growth and expansion; providing open space and commercial service in nearby convenient locations for each neighborhood; and preserving and improving the quality of residential neighborhoods. The only land use goal is to create a balanced mixture of land uses that ensures equal opportunities for employment, housing, open space, and services which adequately serve both personal needs of the citizens and economic needs of the community.

Specific policies relevant to the proposed Project are found in the Land Use, Circulation, Noise, and Resource Management elements of the General Plan. These policies include avoiding locating critical facilities in areas containing geologic hazards (e.g., steep slopes, land slide potential, seismically induced ground shaking); and avoiding or mitigating significant disruption of the natural or urban environment, including such aspects as scenic corridors and other visual resources, roadway levels of service, air quality, noise, and historic resources. Resource Management Policy 1.1 is to continue to purchase water from San Francisco and blend this water with Daly City well water to maintain good water quality. Resource Management Policy 3.3 is to protect areas such as cemeteries, golf courses, and other large open space areas, which contribute to the recharge of the Daly City Aquifer. Site 1 would be located on the Lake Merced Golf Club.

Town of Colma General Plan

Sites 7, 8, and 17 (Alternate) would be located in the Town of Colma.

The most recent Colma General Plan was adopted in 1999, with an update to the Housing Element in 2012 (Colma 1999, 2012). The General Plan concept is to strengthen the Town's identity by placing emphasis on the greenbelt theme of Colma, on enhancing its residential environment and on promoting its status as a regional center for cemeteries and commerce. The policies related to the General Plan goals and objectives that are relevant to the proposed Project are presented in the Land Use, Circulation, Open Space/Conservation, Noise, Safety, and Historic Preservation elements of the General Plan. Section 5.02.161.4 of the General Plan identifies the SFPUC as maintaining lands, easements, and rights-of-way for water projects and water transmission through Colma and recognizes that the SFPUC rights-of-way contribute to open space due to "the fact that the subsurface waterlines prevent structures from being built."

Land Use Element policies relevant to the Project include: siting, constructing, and operating facilities to be compatible with the tranquil atmosphere required for the Town's memorial parks; incorporating street trees in projects involving public street frontage, in accordance with an adopted tree planting plan, or if no plan exists, installing trees a minimum spacing of one tree each 25 feet parallel to the public roadway; incorporating a Spanish/Mediterranean architectural theme into facility designs; placing utility lines underground; siting and designing maintenance buildings and other buildings so they do not detract from the greenbelt theme; and consistency with the Cemetery (G) or Executive/Administrative (E) land use categories for developments on parcels located on El Camino Real between F Street and Mission Road. Site 7 would be located along this corridor.

Circulation Element policies relevant to the Project include: working with the SFPUC to see if landscaping and pedestrian improvements are possible on the right-of-way between Serramonte Boulevard and Collins Avenue; and providing sufficient off-street parking for new construction. Site 8 would be located within the SFPUC right-of-way between Serramonte Boulevard and Collins Avenue.

Open Space/Conservation Element policies relevant to the Project include: using seasonal flowers and shrubbery in conjunction with public improvement projects; identifying and preserving selected tree masses, landscape features and other scenic elements important to Colma's visual setting; and recognizing tree masses[2] and other vegetative cover indicated on the Open Space Map as natural resources to be managed and preserved and replacing vegetation removed as part of a development project at a 1:1 replacement ratio. Site 7 would be located in an area mapped as having a designated tree mass.

Other policies relevant to the Project include considering the noise generation impacts of new development to ensure that the tranquil atmosphere for the town's memorial parks is maintained (Noise Element); and including the potential for seismic and geologic hazards as part of the review process for new development (Safety Element).

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[2] The Town of Colma's General Plan identifies specific tree masses throughout the Town. The General Plan and Tree Ordinance use several terms to when discussing tree masses, including "major" tree masses, "significant" tree mass, and "designated" tree mass. These terms are used interchangeably throughout these Town policy documents. For consistency, this EIR uses the more general terms "tree mass" or "designated" tree mass.

City of South San Francisco General Plan

Sites 9, 10, 11, 12, 13, 18 (Alternate), and 19 (Alternate) would be located in South San Francisco.

The most recent South San Francisco General Plan was adopted in 1999, with an update to the Housing Element in 2010 (South San Francisco 1999, 2010). The General Plan goal is to balance regional growth objectives with conservation of residential and industrial neighborhoods. The General Plan goals and policies that are relevant to the proposed Project are contained in the Land Use, Parks and Recreation, Open Space and Conservation, Water Quality, Air Quality, Historic and Cultural Resources, Health and Safety, and Noise elements.

Relevant Land Use goals and policies include development of a streetscape plan for the El Camino Real SubArea, where Sites 9, 11, 12, and 19 (Alternate) would be located. The streetscape plan specifies a consistent row of trees on either side of El Camino Real for the six-lane stretch that starts at the Kaiser Medical Center garage and parking lot area and runs south (Sites 11, 12, and 19 [Alternate] would be located along this route). Land use policies also encourage the development of the Treasure Island Trailer Court as Medium Density Residential development. Site 9 would be located adjacent to this trailer court.

Maintenance of the residential character of the Winston-Serra area is included in the General Plan (Sites 10 and 18 [Alternate] would be located within this area). Also included in the Land Use Element is a policy to retain steep hillside areas in excess of 30 percent grade in their natural state and keep grading to a minimum when developing hillside sites; and not permitting the industrial uses on the south side of Railroad Avenue to expand or substantially change, unless the properties are upgraded through added parking, landscaping, improved signage, and exterior building remodeling. Site 13 would be located in this area.

Relevant Parks and Recreation policies are to work with the SFPUC to lease and develop linear parks on existing public utility rights-of-way. Site 13 would be located adjacent to Centennial Way Trail. A relevant Open Space and Conservation goal is to protect special-status species and supporting habitats. A water quality goal is to comply with the San Francisco Bay Regional Water Quality Control Board (RWQCB) regulations and standards to maintain and improve the quality of surface and ground water resources.

Relevant Air Quality policies are to use the City's development review process and the CEQA regulations to evaluate and mitigate the local and cumulative effects of new development on air quality and adopt the standard construction dust abatement measures included in the Bay Area Air Quality Management District's (BAAQMD's) CEQA Guidelines.

Relevant Historic and Cultural Resources policies are to conserve historic, cultural, and archaeological resources, to ensure the protection of known archaeological resources by requiring a records review for any development proposed within an area of known resources, and to require the preparation of a resource mitigation plan and monitoring program by a qualified archaeologist in the event that archaeological resources are uncovered.

Relevant Health and Safety policies are to minimize risk to life and property from geologic and seismic hazards; prevent stormwater pollution by working with the RWQCB in implementing the San Mateo Countywide Stormwater Pollution Prevention Program; reduce the generation of solid waste; and minimize the risk to life and property from generation, storage, and transportation of hazardous materials and waste by complying with all applicable federal, State, and local regulations.

Relevant Noise policies are to control noise levels from new development through site and building design, landscaping, hours of operation, and other techniques.

City of San Bruno General Plan

Sites 14 and 15 would be located in San Bruno.

The most recent San Bruno General Plan was adopted in 2009 (San Bruno 2009). The General Plan promotes balanced development, outlines strategies for conserving established neighborhoods and revitalizing downtown and other aging commercial and industrial areas, and fosters development of transit-supportive uses adjacent to the new BART and Caltrain station. The General Plan also outlines strategies for improved bicycle and pedestrian connections between residences, activity centers, and transit stations, as well as seeks to conserve existing natural resources and minimize hazards.

Six of the eight General Plan elements contain policies that are relevant to the proposed Project. The Land Use and Urban Design policies are to ensure that new development is sensitive to existing uses and is of the highest quality design and construction; to assure that new development mitigates impacts on existing public services, including water, sewer and storm drainage systems; and to require buildings 100 feet or longer to use non-reflective materials to minimize glare. Relevant Transportation policies are to maintain acceptable levels of service for vehicular movement along the city's streets; to limit widening, modification or realignment of the city's scenic corridor and to preserve trees and maintain wide setbacks; and to recognize and protect Sneath Lane as a local scenic corridor. Site 15 would be located along Sneath Lane.

Open Space and Recreation policies include protection of mature trees, as feasible, during new construction. Environmental resources and conservation policies include protection of the natural environment, including wildlife, from destruction during new construction; preservation and enhancement of historic, archaeological, and cultural resources; ensuring that new development adjacent to historic structures is compatible with the character of the structures and the surrounding neighborhood; protection of significant paleontological resources; and preservation of mature trees and vegetation along the city's scenic roadways.

Sites 14 and 15 would be located within the GGNC. The GGNC is owned and operated by the VA (see Section 4.2.1 [Federal Plans and Policies]). However, portions of the proposed Project's water, sanitary sewer, and storm drain pipelines would extend into Sneath Lane, which is within the city's jurisdiction. Trenching for placement of pipelines in Sneath Lane would require an encroachment permit from the City.

City of Millbrae General Plan

Site 16 would be located in Millbrae.

The most recent Millbrae General Plan was adopted in 1998, with an update to the Housing Element in 2006 (Millbrae 1998, 2006). Most of the land in Millbrae is developed with urban uses, with a land use pattern that is already well established. General Plan concerns therefore focus on issues such as the preservation of community character; upgrading older areas; strengthening the city's economic base; use of undeveloped and reusable lands; and providing for the community's housing, social, economic development, and safety needs.

Land Use policies relevant to the Project pertain to promoting proper site planning, architectural design, property maintenance, and landscape design for all new development, renovation or remodeling in keeping with Millbrae's suburban character; assuring that noise, traffic, and other conflicts between residential and non-residential land uses are eliminated to the greatest extent possible; assuring that design and scale of a project is appropriate in relation to the neighborhood it is located in; assuring the appropriateness of design for industrial projects including screening unsightly uses; and providing safe, reliable and adequate utility infrastructure, including water supply.

San Mateo County General Plan

Sites 3 and 4 would be located in the Broadmoor neighborhood of unincorporated San Mateo County.

Site 3 would be located on Ben Franklin Intermediate School property and Site 4 would be located on San Mateo County property near the Garden Village Elementary School.

The most recent San Mateo County General Plan was adopted in 1986, with an update to the Housing Element in 2010 (San Mateo County 1986a, 1986b, 2010). The stated General Plan goal is to provide overall policy to assure orderly, balanced utilization, and conservation of all County resources. A goal related to community development is to promote the provision and maintenance of public and private services and facilities that are basic to human habitation, including water supplies, wastewater management, transportation systems, and solid waste management. The Water Supply Element of the General Plan describes water supply sources and water quality and provides policies to guide the actions of decision-makers concerning water supply management. The element states that one possible option to address the problem of emergency water service interruptions could involve the use of water wells. Under this option, local wells could be constructed, carefully sited to reduce risk of contamination, and held in reserve in anticipation of future emergencies.

4.2.4.2 Other Plans and Policies

Local Coastal Program

Pursuant to the California Coastal Act, the CCSF adopted the Local Coastal Program (LCP) for San Francisco, which was certified by the California Coastal Commission in 1984. The policies and objectives of the LCP have been incorporated into the *Western Shoreline Area Plan (*San Francisco 1988b) as an element of the San Francisco General Plan (San Francisco 1988a). Refer to Section 4.2.2.2 (San Francisco General Plan) above, for a discussion of the objectives and policies of the Western Shoreline Plan relevant to Lake Merced.

South Westside Basin Groundwater Management Plan

The *South Westside Basin Groundwater Management Plan* (GWMP) was developed by the City of San Bruno in cooperation with California Water Service Company, Daly City, and the SFPUC, and completed in 2012 (San Bruno et al. 2012). The goal of the GWMP is to ensure a sustainable, high-quality, reliable water supply at a fair price for beneficial uses achieved through local groundwater management. One element of the plan to help meet the GWMP objectives is the Facilitation of Conjunctive Use Operations in the form of in-lieu recharge, in which other supply sources may replace groundwater, thus offsetting future groundwater pumping during times of reduced imported water supplies. Two related actions in support of the goal and objectives of the GWMP are as follows:

> *H1*. Consider the development, implementation, and maintenance of programs and projects to recharge aquifers. Programs may be local and regional in scope. These may use imported water, recycled water and other waters to offset existing and future groundwater pumping, except in the following situations:
>
> - Groundwater quality would be reduced, unless lower water quality provides maximum benefit;
> - Available groundwater aquifers are full; or
> - Rising water tables threaten the stability of existing structures.
>
> *H2*. Support regional groundwater banking operations that are beneficial to the South Westside Basin and the region and support the goals of the GWMP.

Vista Grande Watershed Study and Vista Grande Drainage Basin Alternatives Analysis Report

The *Vista Grande Watershed Study* was prepared for the City of Daly City in conjunction with the City of San Francisco in 2006 to identify planning solutions to meet the goal of resolving flooding at the Vista Grande Drainage Canal, adjacent to Lake Merced (Daly City 2006). The Vista Grande Drainage Basin Alternatives Analysis Report was prepared for the City of Daly City in 2011 to evaluate four alternative solutions (Daly City 2011a).

The Vista Grande Drainage Canal serves as the conveyance for stormwater from a 2.5-square mile watershed area in Daly City, unincorporated San Mateo County and San Francisco to the Pacific Ocean. Historically, wet weather flows in excess of the capacity of the canal and the downstream tunnel to the ocean resulted in local flooding and overflows into Lake Merced. Because of the concern over Lake Merced lake levels, the Watershed Study evaluated several lake level augmentation alternatives, including the potential use of Vista Grande Drainage Canal stormwater flows. The Vista Grande Drainage Basin Alternatives Analysis Report evaluated four alternative solutions relative to constructability, operability, public benefit, environmental compliance and cost criteria and recommends implementation of the Lake Merced Alternative. The City of Daly City selected the Lake Merced Alternative to address the flooding issues and enhance Lake Merced at their May 23, 2011 City Council Meeting (Daly City 2011b). In February 2013, the City of Daly City released a Notice of Preparation (NOP)/Notice of Intent (NOI) to prepare a joint EIR/Environmental Impact Statement (EIS) for the Vista Grande Drainage Improvement Project (Daly City 2013).

The Vista Grande Drainage Improvement Project would construct facilities needed to screen storm water; divert flows to the existing Vista Grande Drainage Canal, Lake Merced, or both; improve storm water and authorized non-storm water quality through a surface flow wetland; control the Lake's water surface; and reduce the potential for localized flooding in the watershed. Diverting a portion of the watershed's storm water and non-storm water (after processing through constructed surface wetlands system) into Lake Merced would increase the lake's water volume and increase the lake level management flexibility (Daly City 2011a).

San Francisco International Airport Land Use Plan

The San Francisco International Airport Land Use Plan is a part of the *San Mateo County Comprehensive Airport Land Use Plan* (C/CAG 1996) and applies to the geographic areas in incorporated cities and unincorporated areas in the vicinity of San Francisco International Airport that are impacted by aircraft noise, restrictions on the height of structure and/or objects near the airport and airport/aircraft safety guidelines. The San Francisco Airport Land Use Plan includes policies, standards, and criteria to address each of these issues. Airport/land use compatibility is determined by comparing a proposed land use policy action with the Aircraft Noise/Land Use Compatibility Standards, the relevant height restriction and safety criteria contained in the San Francisco Airport Land Use Plan.

Airport noise contours are the principal tool for analyzing airport/land use compatibility in the vicinity of airports. According to the San Francisco Airport Land Use Plan, industrial uses, including utilities, that are located within a CNEL[3] contour of less than 75 dBA[4], are considered compatible with little or no noise impact and requiring no special noise insulation requirements for new construction. All of the proposed facility sites are located within the CNEL contours of 60, 65, and 70 dBA. The San Francisco Airport Land Use Plan also provides guidelines to determine if an object is an obstruction to air navigation. Any proposed new construction or expansion of existing structures that would penetrate any of the Federal Aviation Regulations (FAR Part 77) imaginary surfaces for obstruction evaluation is deemed to be an incompatible land use unless either the Federal Aviation Administration has determined that the structure does not constitute a hazard or the State Aeronautics Program has issued a permit to allow construction.

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[3] CNEL is the Community Noise Equivalent level metric. It is a measure of the overall noise experienced during an entire day.

[4] The dBA, or A-weighted decibel, refers to a scale of noise measurement that approximates the range of sensitivity of the human ear to sounds of different frequencies.

In addition, certain types of land uses are recognized as hazards to air navigation in the vicinity of San Francisco International Airport. This includes any use that would direct a steady or flashing light toward an aircraft engaged in take-off or landing or that would cause sunlight to be reflected toward an aircraft engaged in take-off or landing. It also includes any use that would generate smoke or rising columns of air, or that would attract large concentration of birds within approach-climb-out (i.e., take-off) areas, or that would generate electrical interference that may interfere with aircraft communications or aircraft instrumentation.

BART Station Area Specific Plan

Sites 5 and 6 would be within the area covered by the BART Station Area Specific Plan (San Mateo et al. 1993), in unincorporated San Mateo County and Daly City.

This plan addresses the status and condition of a 110-acre area partially within Daly City and partially within an unincorporated portion of San Mateo County, within which was planned construction of a new Colma BART station (San Mateo et al. 1993). As the lead agency for the BART Station Area, San Mateo County adopted the plan in 1993, and the plan provisions were incorporated into the Daly City and San Mateo County general plans. The plan recommends a process and physical development plan for gradual transition to urban uses that support the area's intended transportation/transit role and complements the character of the adjacent neighborhoods and business districts. It shows the preferred location, intensity and character of all land uses, capital improvements and transportation systems that would implement the Colma Area Plan and Daly City policies and that would be consistent with both Daly City's and San Mateo County's long-range goals. An emphasis was placed on making new and existing uses accessible by foot, bike, transit, or auto. New development located directly adjacent to BART would be linked to the station via a network of public spaces, such as stairways, paths, plazas and new streets.

Sites 5 and 6 would be located in Daly City, within the 110-acre area addressed by the Plan, in a swath identified in the Plan as the Hetch Hetchy right-of-way. The Plan recommends taking advantage of the undevelopable area of the right-of-way around Site 5 when determining building placement, plaza locations, and parking lot access points. At Site 6 the right-of-way is described as a deep swale, unsuitable for use as a parking lot or other public access area, but protection of the right-of-way south of D Street, as permanent landscaped easement is recommended. The Plan states that while underground water pipes prevent trees or buildings in this area, grass and small shrubs should be planted as a gateway symbol. (San Mateo et al. 1993)

4.3 INCONSISTENCY EVALUATION

4.3.1 Approach to Analysis

The evaluation of a project's inconsistency with plans and policies is based on the application of relevant land use plans and policies to the siting, construction and operation of the proposed Project. Because the policy language found in a land use plan can be interpreted in various ways, it is often difficult to determine whether a proposed project is consistent or inconsistent with such policies. Moreover, because land use plans often contain numerous policies emphasizing differing legislative goals, a proposed project may be consistent with a general plan taken as a whole, even though it may appear to be arguably inconsistent with specific policies within the plan. The board or commission that enacted the plan or policy generally determines the meaning of such policies; these interpretations prevail if they are "reasonable," even though other reasonable interpretations are also possible. In light of these considerations, the inconsistency evaluation in this EIR represents the best attempt to advise the decision-makers as to whether the proposed Project is inconsistent with applicable land use plans and policies.

Direct and indirect physical impacts resulting from potential conflicts with applicable plans and policies are addressed in Sections 5.2 through 5.19 of the EIR to the extent that they are relevant to the specific significance criteria under CEQA that require an analysis of the incompatibility of the proposed Project with certain aspects of local land use plans and policies. The particular significance criteria that directly relate to inconsistency with plans and policies are listed below, along with the location in this document where the reader can find the relevant impact evaluation. For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on Plans and Policies if it were to:

- Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, or local coastal program) adopted for the purpose of avoiding or mitigating an environmental effect is addressed in Section 5.2, Land Use and Section 5.3, Aesthetics.
- Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., conflict with policies promoting bus turnouts and bicycle racks) or causing a substantial increase in transit demand that cannot be accommodated by existing or proposed transit capacity or alternative travel modes is addressed in Section 5.6, Transportation and Circulation.
- Expose people to or generate noise levels in excess of standards established in a local general plan or noise ordinance, or applicable standards of other agencies is addressed in Section 5.7, Noise and Vibration.
- Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance, is addressed in Section 5.14, Biological Resources.
- The significance criteria for conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or State habitat conservation plan are not applicable to the Project, as no such plans have been adopted in the areas that would be affected by the Project.

4.3.2 Federal Plans, Policies, and Guidelines

The VA Facilities Design Guide provides policies and objectives for siting and design of facilities located within the GGNC. Any conflicts between the proposed Project and policies that relate to physical environmental issues are discussed in Sections 5.2 through 5.19 of this EIR. The policies that do not relate to physical environmental issues are as follows: accessing wells and pump houses from service roads; and routing utility lines between gravesite areas to avoid obstruction of individual gravesites, and burying utility lines underground. Implementation of mitigation measures identified in Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, would ensure that the proposed Project is constructed and operated in a manner that is consistent with the VA design requirements. By implementing mitigation measures in Section 5.3, Aesthetics, and Section 5.5, Cultural and Paleontological Resources, which describe the design elements and design characteristics needed to be consistent with the Facilities Design Guide within the VA cemetery, the Project would preserve the visual and cultural qualities of the cemetery. Overall, there are no apparent inconsistencies between the VA Design Guide and the proposed Project.

The California Coastal Act, an integral element of California's Coastal Management Program developed pursuant to the federal CZMA, includes policies for protection of coastal resources, including recreational facilities and boating, water quality and protection of environmentally sensitive habitat areas (see Section 4.2.1 [Federal Plans and Policies]). These policies for the San Francisco coastal zone are embodied in the *Western Shoreline Area Plan*, the City's local coastal plan. The evaluation of the Project as it relates to these policies is discussed below.

4.3.3 San Francisco Plans and Policies

4.3.3.1 San Francisco General Plan

The San Francisco General Plan provides policies and objectives to guide land use decisions. Any conflicts between the proposed Project and policies that relate to physical environmental issues are discussed in Sections 5.2 through 5.19 of this EIR. The compatibility of the proposed Project with San Francisco General Plan policies that do not relate to physical environmental issues will be considered by the SFPUC as part of its decision to approve or disapprove the proposed Project.

Implementation of mitigation measures identified in Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, would ensure that the proposed Project is constructed and operated in a manner consistent with the five relevant elements of the San Francisco General Plan, as well as policies pertaining to Lake Merced in the General Plan's *Western Shoreline Area Plan* (San Francisco 1988b). The Project would further goals in the Community Safety Element by constructing facilities to current seismic standards, thereby improving the seismic reliability and water delivery reliability of the system. The Project would also support regional water system reliability goals of the Environmental Protection Element by providing an increased level of regional operational flexibility to respond to and restore water service during unplanned outages and/or a loss of a water source. By implementing mitigation measures in Section 5.3, Aesthetics, which includes measures to ensure design consistency with surrounding areas, as well as landscaping plans to maintain existing community character and preserve visual resources, the Project would also be consistent with the Urban Design Element. Also, mitigation measures in Section 5.16, Hydrology and Water Quality would implement lake level management measures for Lake Merced (M-HY-9 [Lake Level Management for Lake Merced], which would avoid significant impacts on Lake Merced beneficial uses, recreation, and scenic resources and would meet the Lake Merced water quality objectives of the *Western Shoreline Area Plan* (San Francisco 1988b) for the preservation of recreational and natural habitat of Lake Merced. Overall, there are no apparent inconsistencies between the San Francisco General Plan, including the Western Shoreline Plan, and the proposed Project.

4.3.3.2 Golden Gate Park Master Plan

The GSR Project would not conflict with the *Golden Gate Park Master Plan*. As discussed in Section 5.16, Hydrology and Water Quality, because the park lakes do not intersect the groundwater and are not hydraulically connected with the North Westside Groundwater Basin aquifer, no impacts to the lakes would occur. Subsequently, the Project would not interfere with objectives and policies to maintain lake levels, water quality, habitat, or recreation opportunities.

4.3.3.3 Accountable Planning Initiative Priority Policies

Of the eight priority policies contained in the Accountable Planning Initiative, three are relevant to the proposed Project. Policy 6 stipulates that the City achieve the greatest possible preparedness to protect against injury and loss of life in an earthquake. Policy 7 states that landmarks and historic buildings shall be preserved and Policy 8 states that parks and open space, and their access to sunlight and vistas, shall be protected from development.

In general, Chapter 5 of this EIR discusses the consistency of the proposed Project with the environmental topics associated with the priority policies. More specifically, with respect to Policy 6, the primary purpose of the proposed Project is to provide a reliable water supply to protect the City and region from emergencies. Not only would Project facilities be designed to seismic safety standards, but they also would provide an increased level of regional operational flexibility to respond to and restore water service during unplanned outages and/or a loss of a water source, including during a seismic event. The Project's consistency with Policy 7, which states that landmarks and historic buildings shall be preserved, is discussed in Section 5.5, Cultural and Paleontological Resources, which concludes that historic resources would be protected from damage during construction of Sites 14 and 15 through implementation of physical and administrative mitigation measures. The Project's consistency with Policy 8, which requires that parks and open space and their access to sunlight and vistas shall be protected from development, is discussed in Section 5.3, Aesthetics and Section 5.10, Wind and Shadow, which conclude that the Project would not alter vistas or views at parks in the area or have an adverse impact on the visual character of the site or surrounding area or eliminate access to sunlight.

Overall, there are no apparent inconsistencies between the Accountable Planning Initiative and the proposed Project.

4.3.3.4 San Francisco Sustainability Plan

The San Francisco Sustainability Plan was developed for the purpose of addressing San Francisco's long-term environmental and economic sustainability (San Francisco Department of the Environment 1997). The proposed Project would be consistent with the goals of the Sustainability Plan. It would make a beneficial contribution to long-term environmental and economic stability by providing a dry-year water supply, by increasing water delivery reliability, by meeting customer water supply needs, and by improving management of the South Westside groundwater basin. Overall, there are no apparent inconsistencies between the San Francisco Sustainability Plan and the proposed Project.

4.3.3.5 San Francisco Municipal Green Building Program

As explained above in Section 4.2.2.6 (San Francisco Municipal Green Building Program), the City's Program was established in 1999 when the CCSF adopted the Resource Efficient Building Ordinance, which established green building standards for municipal buildings. The 2004 amendments to Environment Code Chapter 7 set LEED Silver Certification as the minimum environmental performance requirement for all municipal projects that would involve buildings with areas of over 5,000 square feet. For all municipal construction projects, the REB Task Force provides recommended best practices and sample specifications for building materials.

As discussed in Chapter 3, Project Description, Section 3.7 (Greenhouse Gas Reduction Actions), the SFPUC is committed to GHG reduction actions, including use of green building materials, as part of all WSIP projects, including the proposed Project. Overall, there are no apparent inconsistencies between the San Francisco Municipal Green Building Program and the proposed Project.

4.3.3.6 Significant Natural Resource Areas Management Plan

Of the 30 candidate natural areas identified in the San Francisco Recreation and Park Department's SNRAMP staff report, only two are relevant to the proposed Project: Pine Lake and Lake Merced. The proposed Project would not conflict with the general policies and management actions proposed in the 1995 SNRAMP staff report. As mentioned in Section 4.2.2.7 (Significant Natural Resource Area Management Plan), that report is intended to establish a maintenance and preservation program to protect and enhance natural resource values. Although the SNRAMP staff report does not contain policies and management actions specific to Lake Merced or Pine Lake, the policies or management actions in the staff report related to Lake Merced include: maintaining/promoting indigenous plant species and controlling/removing invasive species; monitoring wildlife populations; and maintaining/improving water quality, etc. Mitigation measures described in Sections 5.14, Biological Resources and 5.16, Hydrology and Water Quality, would be implemented to mitigate potential impacts to the beneficial uses of Lake Merced, including management of lake levels to avoid impacts to wetlands and other habitats around the lake. As discussed in Section 5.16, Hydrology and Water Quality, the proposed Project would have little or no effect on groundwater levels near Pine Lake and therefore would not significantly impact wetland or other sensitive habitat at Pine Lake. Overall, there are no apparent inconsistencies between the SNRAMP staff report and the proposed Project.

4.3.4 SFPUC Policies and Plans

4.3.4.1 Water Enterprise Environmental Stewardship Policy

The proposed Project would not conflict with the underlying goals of the *Water Enterprise Environmental Stewardship Policy*. Under the proposed Project, the SFPUC would continue to responsibly manage the rights-of-way and properties in urban areas in a manner that protects and restores habitat value where available and would continue to encourage community participation in decisions that significantly interrupt or alter current land uses as a result of the Project. Overall, there are no apparent inconsistencies between the *Water Enterprise Environmental Stewardship Policy* and the proposed Project.

4.3.4.2 *Right of Way Integrated Vegetation Management Policy*

Removal of trees and other vegetation would be required at some of the proposed well facility sites to allow for Project construction and operation (see Section 5.14, Biological Resources and Section 5.3, Aesthetics). All vegetation removal within the SFPUC right-of-way would be in accordance with the Vegetation Management Policy. Specifically, vegetation would be removed as needed to protect system components from damage and to provide for ease of facility maintenance. All vegetation removal work would be reviewed and supervised by a SFPUC qualified professional; the required City and public notification process for planned vegetation removal would be followed. Therefore, the proposed Project would be implemented consistent with the Vegetation Management Policy. Overall, there are no apparent inconsistencies between the *Right-of-Way Integrated Vegetation Management Policy* and the proposed Project.

4.3.4.3 *Strategic Sustainability Plan*

The proposed Project would assist the SFPUC in attaining the following goals and objectives presented in its *Strategic Sustainability Plan*:

Goal: Provide High Quality Services.

Objective B. Enhance partnerships with City Departments, Agencies, and Raker Act entities.

Objective C. Provide high quality service to all customers, including customers who are most vulnerable to service interruptions.

Goal: Plan for the Future

Objective N. Optimize planning to meet water, wastewater, and power demand.

Goal: Environment and Natural Resources

Objective T. Diversify high quality water sources and advance water efficiency, conservation and reuse.

Overall, there are no apparent inconsistencies between the *Strategic Sustainability Plan* and the proposed Project.

4.3.5 Land Use Plans and Policies of Other Local Jurisdictions

4.3.5.1 *General Plans*

As described above in Section 4.2.2.1 (Extraterritorial Lands), the SFPUC is not legally bound by the land use plans of other local jurisdictions (e.g., the Daly City General Plan, Colma General Plan, South San Francisco General Plan, San Bruno General Plan, Millbrae General Plan, and the San Mateo County General Plan). Determinations of Project consistency with local general plans would be made by the pertinent land use jurisdictions following circulation of the environmental documentation for this Project under CEQA and notification by the SFPUC pursuant to State law (Government Code Section 65402).

The local jurisdictions in which the proposed Project would be located are primarily built out, established communities. Current general plans of these jurisdictions generally seek to preserve the existing community character, protect natural resources and unique physical features, protect the health and safety of residents, and support appropriate levels of economic growth and community services.

The intent of general plans is to preserve and improve the quality of life for citizens and to consider growth in a manner that appropriately reflects the community's values. An adequate and reliable water supply is a fundamental public service requirement to accomplish these goals. San Mateo County and each of the cities, in which the proposed Project would be located, receive all or part of their water supply from the SFPUC. Local jurisdictions would also consider whether construction and operation of the Project would be consistent with general plan goals.

Most of the general plans contain land use goals that recognize the need for an adequate and dependable water supply, including the need for easements to allow siting of facilities for water supply development and transmission. The Project would directly respond to these goals. The proposed Project would provide enhanced regional water system reliability for Partner Agencies while simultaneously improving the sustainability and management of groundwater resources in the South Westside Groundwater Basin through groundwater recharge during normal and wet water years.

As described previously in Section 4.2.4 (Land Use Plans and Policies of Other Local Jurisdictions), the general plans of each jurisdiction generally include policies that address facility design and environmental resources, including design of facilities in character with the surrounding areas, locating utilities to avoid or minimize damage from seismic and geologic hazards; protecting sensitive wildlife habitats and plants; locating utility lines underground to minimize visual impacts; conserving and protecting archaeological and historic resources; implementing noise and traffic controls; appropriate design of new development; and tree preservation and planting. In addition, several general plans include policies specifically related to the protection of the SFPUC water supply and call for coordination with the SFPUC to ensure a reliable source of water. All of these policies are addressed where relevant in the substantive analysis of the project's environmental impacts in Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, as well as in Chapter 6, Other CEQA Issues, Section 6.1 (Growth Inducement).

The proposed Project would minimize or avoid inconsistencies with the objectives and policies of local land use plans through implementation of mitigation measures included in Section 5.3, Aesthetics; Section 5.5, Cultural and Paleontological Resources; Section 5.7, Noise and Vibration; Section 5.8, Air Quality; Section 5.9, Greenhouse Gas Emissions; Section 5.11, Recreation; Section 5.14, Biological Resources; Section 5.15, Geology and Soils; Section 5.16, Hydrology and Water Quality; and Section 5.17, Hazards and Hazardous Materials. Regardless, some impacts would remain. However, on the whole, with implementation of these mitigation measures, the proposed Project would mitigate impacts to the extent feasible and would be consistent with the environmental protection policies included in the local land use plans. Overall, for San Mateo County customers who receive all or part of their water from the SFPUC, the proposed Project would seem to conform to the broader goals of their respective general plans to maintain and improve the quality of life of the local population through maintaining high-quality water supply, reducing vulnerability of the regional water system to earthquakes, increasing water supply reliability and meeting water supply needs.

4.3.5.2 Other Plans and Policies

Local Coastal Program

The evaluation of whether the Project is inconsistent with the *Western Shoreline Area Plan* relating to objectives and policies for Lake Merced is discussed above under Section 4.3.3.1 (San Francisco General Plan).

South Westside Basin Groundwater Management Plan

The Project is consistent with the GWMP, because it provides a conjunctive use project that would increase the volume of groundwater in storage through a reduction in groundwater pumping by the Partner Agencies made possible by increased surface water deliveries from the regional water system (City of San Bruno, et al. 2012). This "conjunctive," or cooperative, use of the basin would allow the naturally stored water to be pumped during dry years. The Project would help meet a goal of the GWMP to ensure a sustainable, high-quality, reliable water supply.

Vista Grande Watershed Study and Vista Grande Drainage Basin Alternatives Analysis Report

The component of the *Vista Grande Watershed Study* relevant to the proposed Project is the Lake Merced Alternative. The proposed Project would not conflict with the overall objectives of the potential Vista Grande Drainage Basin Improvement Project. As discussed in Section 5.16, Hydrology and Water Quality, measures would be implemented to mitigate the GSR Project's impacts on Lake Merced water levels and other beneficial uses. Therefore, the GSR Project would be complementary to the Lake Merced Alternative. Overall, there are no apparent inconsistencies between the goal and objectives for the Vista Grande Lake Merced Alternative and the proposed Project.

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5 ENVIRONMENTAL SETTING, IMPACTS, AND MITIGATION MEASURES

5.1 OVERVIEW

This chapter provides a project-level analysis of the physical environmental effects of implementing the Regional Groundwater Storage and Recovery (GSR) Project. This chapter describes the environmental setting, assesses impacts, and identifies mitigation measures for significant impacts.

5.1.1 Scope of Analysis

This Draft Environmental Impact Report (EIR) analyzes the potential effects of the proposed GSR Project (proposed Project or Project) on the environment under the applicable environmental resource topics listed in the California Environmental Quality Act (CEQA) Initial Study Checklist used by the Environmental Planning (EP) Division of the San Francisco Planning Department. The EP CEQA Initial Study Checklist is based on the CEQA Guidelines Appendix G with some modifications. The checklist includes the environmental resource topics identified below:

- Land Use (see Section 5.2)
- Aesthetics (see Section 5.3)
- Population and Housing (see Section 5.4)
- Cultural and Paleontological Resources (see Section 5.5)
- Transportation and Circulation (see Section 5.6)
- Noise and Vibration (see Section 5.7)
- Air Quality (see Section 5.8)
- Greenhouse Gas Emissions (see Section 5.9)
- Wind and Shadow (see Section 5.10)
- Recreation (see Section 5.11)
- Utilities and Service Systems (see Section 5.12)
- Public Services (see Section 5.13)
- Biological Resources (see Section 5.14)
- Geology and Soils (see Section 5.15)
- Hydrology and Water Quality (see Section 5.16)
- Hazards and Hazardous Materials (see Section 5.17)
- Mineral and Energy Resources (see Section 5.18)
- Agriculture and Forest Resources (see Section 5.19)

Each environmental resource section includes a discussion of the environmental setting, applicable regulations pertaining to the resource area, impact assessment, and mitigation measures where applicable. Each section of Chapter 5 contains the following elements:

Setting. This subsection presents a description of the existing physical environmental conditions in the vicinity of the Project with respect to each resource area at an appropriate level of detail to understand the impact analysis. It describes existing conditions and provides a baseline by which to compare the potential impacts of the proposed Project.

Regulatory Framework. This subsection provides a brief discussion of federal, State, and local regulations and policies that are relevant to the resource.

Impacts and Mitigation Measures. This subsection evaluates the potential for the Project to adversely affect the physical environment described in the setting. Significance criteria for evaluation of environmental impacts are defined in the beginning of the impact analysis section, including an explanation of how the significance criteria are used in the evaluation of impacts for the Project. The subsection includes a discussion of the approach to the analysis, including identification of the significance criteria that are not applicable to the proposed Project. Potential impacts are identified and characterized. Where applicable and feasible, mitigation measures are identified to avoid or reduce the impact to a less-than-significant level.

The Impacts and Mitigation Measures Section in each resource chapter includes an impact statement followed by the evaluation of the impact for each of the facility sites. Each impact statement includes a significance determination at the end of the statement in parentheses. This significance determination reflects the most severe or significant impact level for any of the sites included in the evaluation. For instance, even if some of the sites evaluated under a particular impact statement were deemed to have a less-than significant or no impact and one site was determined to have a significant impact that could be reduced with mitigation, the significance determination shown in parentheses in the impact statement would be less than significant with mitigation, to reflect the one site that has a significant impact. Mitigation is included in the evaluation and applied to sites where the significant impact would occur.

Because of the multiple well facility sites associated with the proposed Project, overlapping impacts may occur from construction and/or operation of well facilities that are in geographic proximity to each other and/or have concurrent construction periods. During construction, combined impacts from groups of individual well facilities could occur based on geographic proximity and concurrent construction periods presented in Table 3-7 (Facility Construction Clusters and Construction Sequencing) in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule). During operation, combined impacts from groups of individual well facilities could occur based on geographic proximity and the concurrent operational activities, as described in Chapter 3, Project Description, Section 3.8 (Operations and Maintenance). These combined impacts from groups of individual well facilities are evaluated only in those cases, and only for those resources, where construction and/or operational impacts from multiple facility sites would overlap to create greater impacts than would have been created by an individual site alone. Where this would be the case, it is identified in the Approach to Analysis section in the resource chapter. In all other cases, the impacts of the Project would only occur at individual well facility sites and are evaluated accordingly.

Cumulative Impacts and Mitigation Measures. Cumulative impacts are discussed in each environmental resource section following the description of the Project-specific impacts and identified mitigation measures. The cumulative impact analysis considers the effects of the Project together with other past, present, or reasonably foreseeable future projects proposed by the San Francisco Public Utilities Commission (SFPUC) or other entities. The cumulative impact analysis is based on the same setting, regulatory framework, and significance criteria presented in each resource topic section. Additional mitigation measures are identified if the analysis determines that the Project's contribution to an adverse cumulative impact would be cumulatively considerable and, therefore, significant.

5.1.2 Significance Determinations

The impact significance criteria used in this Draft EIR are based on the EP Initial Study Checklist. The significance criteria used for each environmental resource topic are presented in each section of Chapter 5 following the setting and before the discussion of impacts. For the impact analyses, the following categories are used to determine impact significance:

No Impact (NI). This determination is made if a resource is absent or if a resource exists within the Project area or area of potential effect, but there is no potential that the proposed Project could affect the resource.

Less than Significant (LS). This determination applies if there is a potential for some limited impact on a resource, but the impact is not significant under the significance criterion.

Less than Significant with Mitigation (LSM). This determination applies if there is the potential for a substantial adverse effect in accordance with the significance criterion, but mitigation is available to reduce the impact to a less-than-significant level.

Significant and Unavoidable with Mitigation (SUM). This determination applies if it is certain that the Project would result in an adverse effect that meets the significance criteria and there is some mitigation available to lessen the impact, but the residual effect after implementation of the measure would remain significant.

Significant Unavoidable (SU). This determination applies to impacts that are significant, but for which there appears to be no feasible mitigation available to reduce the impact to a less-than-significant level.

Within each section in this chapter, a summary table is included at the beginning of the impact discussion to summarize the potential impacts at each individual facility site. This table also indicates the level of impact significance before and after mitigation. Environmental impacts are numbered throughout this EIR, using the section name (abbreviated) followed by sequentially numbered impacts. Mitigation measures are numbered to correspond to the impact numbers; for example, Mitigation Measure M-LU-1 addresses Land Use Impact LU-1.

5.1.3 Relationship to the WSIP PEIR

As discussed in Chapter 2, Introduction and Background, the proposed Project is one of the facility improvement projects included in the SFPUC's Water System Improvement Program (WSIP). The Program EIR (PEIR), which was certified by the San Francisco Planning Commission on October 30, 2008, addresses the potential environmental impacts of the WSIP and evaluates regional water supply alternatives (San Francisco Planning Department 2008). Because the proposed Project is a component of the WSIP, the Project would also contribute to the WSIP's water supply and system operations impacts.

The PEIR analyzed potential water supply and system operations impacts (separate from environmental impacts associated with the facility improvements) within the following geographic regions: the Tuolumne River, Alameda Creek and Peninsula watersheds, and the Westside Groundwater Basin. The PEIR identified the cumulative effects of implementing the WSIP and system operations in combination with other past, present, and reasonably foreseeable future projects within each of these watersheds. It also discussed the potential effects of climate change and global warming on the regional water system.

The PEIR concluded that the WSIP would result in changes in reservoir levels and associated changes in downstream flows in rivers and creeks in the three affected watersheds, potentially resulting in impacts on groundwater, water quality, fisheries, and terrestrial biological resources. In the event that deliveries to customers exceed an average annual 265 million gallons per day (mgd), streamflow changes in the Tuolumne River watershed could affect fisheries and terrestrial biological resources. In the Alameda Creek and Peninsula watersheds, the WSIP, which includes restoring the historical storage capacities of Calaveras and Lower Crystal Springs reservoirs, could affect reservoir levels, downstream flows, fisheries, and terrestrial biological resources. In addition, the WSIP includes projects, such as the proposed GSR Project (which includes development of groundwater supplies in the Westside Groundwater Basin), which could result in basin overdraft, seawater intrusion, and changes in the water levels of surface water bodies.

As stated above, the proposed Project is a component of the WSIP and, therefore, would contribute to the water supply impacts identified in the PEIR. Tables D-1a through D-1e in Appendix D, WSIP PEIR Water Supply Impact and Mitigation and Consistency Analysis, summarize the WSIP water supply impacts and mitigation measures for each geographic region analyzed in the PEIR. The reader is referred to the complete WSIP PEIR for a detailed explanation of the summary tables. In addition to water supply impacts and mitigation measures, the PEIR provides a program-level analysis of the impacts associated with WSIP facility improvement projects, including construction and operation impacts. This EIR addresses the same issues as the PEIR for the proposed Project at a project level of detail. That is, this EIR provides more project-specific and site-specific descriptions and analysis of Project effects based on a much more detailed Project description and more information about the Project area. Appendix D presents a comparison between the programmatic mitigation measures identified for the Project in the PEIR and the mitigation measures identified for the Project in this EIR.

This project-level EIR tiers from the PEIR, and the analyses relevant to this proposed Project are incorporated by reference into this EIR. CEQA permits tiering from a program EIR to allow agencies to broadly consider the environmental effects of a series of actions and/or policies and then to provide a more detailed examination of project-specific impacts in project-level EIRs. The PEIR is available for public review at the San Francisco Planning Department, 1650 Mission Street, San Francisco, CA 94103, and is on the Planning Department's website at http://www.sf-planning.org/index.aspx?page=1829. The State Clearinghouse Number for the PEIR is 2005092026.

5.1.4 Evaluation of Well Facility Sites and Alternates

This Draft EIR evaluates construction of up to 19 proposed well facilities. The SFPUC has identified 16 preferred well facility sites, three alternate well facility sites, and upgrades at the Westlake Pump Station as the Project evaluated in this EIR. The proposed sites and the alternate sites are both evaluated in the same manner and at the same level of detail in Chapter 5. Any of the alternate well facility sites could replace any of the preferred well facility sites. The conditions under which the alternate sites would be developed instead of the preferred sites are discussed in Chapter 3, Project Description, Section 3.4.2, (Production Wells and Associated Facilities).

This EIR also evaluates pipeline connections to the water distribution system for the 16 preferred and three alternate well facility sites. In addition, alternate connections to water distribution systems at 14 of the well facility sites are evaluated in the EIR. The conditions under which the alternate connection at any of the sites would be developed instead of the proposed connection are discussed in Chapter 3, Project Description, Section 3.4.2 (Production Wells and Associated Facilities).

This Draft EIR also evaluates two different optional designs at Sites 5, 6, and 7. The SFPUC prefers to provide "consolidated treatment" at Site 6, meaning water from Sites 5 and 7 would be conveyed to a centralized treatment facility at Site 6. However, the SFPUC has also identified an option to construct individual, on-site treatment facilities at Sites 5, 6, and 7. This option is also evaluated in this EIR in the instance the SFPUC determines that consolidated treatment at Site 6 is infeasible due to unforeseen circumstances, as further described in Chapter 3, Project Description. These two options are identified as "Consolidated Treatment at Site 6" and "On-site Treatment" (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]).

5.1.5 Well Facility Sites that are Dependent on Other Sites for Treatment

Some of the well facility sites would not have water treatment systems at the site and would need to rely on treatment systems located at a nearby facility site. Table 5.1-1 (Location of Treatment for Well Facilities without Treatment Systems) lists the well facility sites that would be dependent upon treatment at a nearby facility. The impacts of constructing and operating the well facilities at Sites 2, 3, 4, 5 (Consolidated Treatment at Site 6), 7 (Consolidated Treatment at Site 6), 14, and 19 (Alternate) are therefore a combination of the impacts identified at the location of the well and at the location of the water treatment facility.

TABLE 5.1-1
Location of Treatment for Well Facilities without Treatment Systems

Site	Proposed Location of Water Treatment
Sites 2, 3, and 4	Westlake Pump Station
Site 5 (Consolidated Treatment at Site 6)	Site 6
Site 7 (Consolidated Treatment at Site 6)	Site 6
Site 14	Site 15
Site 19 (Alternate)	Site 12

5.1.6 Groundwater Modeling Overview

Because the Project evaluated in this EIR is a groundwater storage and recovery project, a key component of the impact analysis is the use of groundwater modeling to evaluate existing conditions and conditions that would occur in the groundwater basin in the future with operation of the project, as well as under cumulative conditions (i.e., with operation of the proposed Project along with other existing and reasonably foreseeable projects). Groundwater models are mathematical computer models of groundwater flow systems and are a standard analytical tool used in the development and evaluation of groundwater projects. The volume of groundwater and the depths of groundwater levels vary from year to year depending on meteorological conditions, pumping by well owners, and historic conditions in the groundwater basin. The relationships among these parameters are complex. Therefore, the groundwater models are utilized by the SFPUC and the Partner Agencies to conduct groundwater supply planning and to evaluate the impacts of proposed groundwater projects. This section provides an overview of the groundwater modeling used for the GSR Project, including basic assumptions and definitions of key terms used in the analysis.

Two groundwater models have been developed and used for the analysis in this EIR: 1) Westside Basin Groundwater Model (for evaluating conditions in the basin as a whole); and 2) Lake-Level Model (for evaluating conditions at Lake Merced). These are described below.

5.1.6.1 Westside Basin Groundwater Model

The Westside Basin Groundwater Model is a regional basin-wide groundwater model of the Westside Groundwater Basin, which is located in western San Francisco and San Mateo County. The model was developed using MODFLOW 2000 (a numerical modeling software developed by the United States Geological Survey) and was developed over a period of several years by the City of Daly City, with assistance from the City of San Bruno, the California Water Service Company (Cal Water), and the SFPUC. Each entity contributed and ultimately agreed upon information to be used in the model relative to hydrologic and groundwater pumping conditions in the Westside Groundwater Basin.

Because many aspects of groundwater systems are unknown, most basin-specific groundwater models are calibrated prior to being used for predictions. Calibration is performed using statistical methods and is important in order to have confidence in the model's predictions. The Westside Basin Groundwater Model Version 3.1, which was used for the analysis in this EIR, was calibrated to observed groundwater conditions within the Basin for a period of 51 years, from October 1958 through September 2009 (HydroFocus 2011). The calibration used available records of historical hydrologic and pumping data, including more than 2,000 observed monthly water levels in 125 wells representing a broad range of locations, depths, and hydrologic conditions. The hydrology used in the calibration relied on actual, measured monthly rainfall and temperature data from various climate stations throughout the Westside Groundwater Basin and included conditions ranging from wet periods to droughts of different magnitude and duration.

The adequacy of the model calibration was assessed by calculating the average difference between modeled and observed groundwater levels. The calibrated groundwater levels were on average (throughout the entire modeled area) within 19 feet of the observed water levels, which is approximately four percent of the total range in observed groundwater levels across the modeled area. Typically, calibration is considered adequate when this difference is less than 15 percent (Kennedy/Jenks 2012a). Based on these results, the Westside Basin Groundwater Model is considered reasonably well calibrated and a tool that may be used for basin-scale analyses and comparison of water resources management alternatives.

Modeled Scenarios and Pumping Assumptions

Consistent with CEQA Guidelines Section 15125(e), the baseline year for the hydrologic parameters used in the groundwater modeling for the GSR Project is 2009, which is the year that the Project's Notice of Preparation of an Environmental Impact Report (NOP) was issued (see Appendix A, Notice of Preparation). Using the calibrated model, the Westside Basin Groundwater Model was used to project groundwater levels and other parameters for three scenarios: modeled existing conditions, conditions with the proposed GSR Project, and the cumulative conditions. For each scenario, groundwater conditions were modeled for a 47-year hydrologic sequence derived from hydrologic parameters measured from 1958 to 2005 and using the pumping assumptions listed in Table 5.1-2 (Model Input - Pumping Assumptions for Modeling Scenarios). This 47-year period includes many different types and sequences of actual hydrological events, including years of drought and above-average rainfall of varying magnitude and duration. Because natural groundwater systems are dynamic and vary from year to year, it is a necessary and standard industry practice to use a long-term historical record to represent the range of hydrological conditions that can be expected in the future. The long-term 47-year historical record is used in the model to represent the range of hydrologic conditions that could occur in the future and to assess what types of impacts the Project might have under a range of conditions.

The Westside Basin Groundwater Model considers a Put, Take, Hold sequence to simulate in-lieu groundwater recharge during wet and normal rainfall years and groundwater extraction during dry years. This sequence is defined as follows:

- A Put Period is a period when the SFPUC would provide supplemental surface water to the Partner Agencies. The surface water would be used by the Partner Agencies in lieu of groundwater, allowing them to reduce their groundwater pumping rates. During a Put Period, the reduced pumping would effectively increase the amount of groundwater in storage. The SFPUC would maintain an accounting of the supplemental surface water deliveries to the Partner Agencies, known as the SFPUC Storage Account (see Chapter 3, Project Description, Section 3.8.1 [Operating Agreement]), for a discussion of the SFPUC Storage Account). During a Put Period, Project wells would be operated by the SFPUC or the Partner Agencies periodically to exercise the wells for maintenance purposes.
- A Take Period is a dry period when water shortages could occur and the SFPUC would not provide supplemental surface water to the Partner Agencies. During a Take Period, the volume of water pumped by the Project wells would be limited to the total amount of groundwater included in the SFPUC Storage Account and the Partner Agencies would also pump their municipal wells at their typical rate for municipal supply.
- A Hold Period is a period when the SFPUC Storage Account is full and there would be no supplemental surface water deliveries by the SFPUC. The SFPUC Storage Account is full when 60,500 acre-feet (af) have been stored after accounting for Project-related losses from the Account. During a Hold Period, the Partner Agencies could pump their municipal wells at their typical rate for municipal supply, but Project wells would be operated by the SFPUC or the Partner Agencies periodically to exercise the wells for maintenance purposes.

The pumping assumptions for each scenario are identified in Table 5.1-2 (Model Input - Pumping Assumptions for Modeling Scenarios). The modeled scenarios are described following the table.

TABLE 5.1-2
Model Input – Pumping Assumptions for Modeling Scenarios

Pumped Wells		Pumping Rate for Modeling Scenarios Million Gallons per Day (mgd) Existing Conditions	GSR Project	Cumulative Conditions
Municipal Pumping				
Partner Agencies (PA)[(a)]				
	Take Periods	6.84	6.90	6.90
	Put Periods	6.84	1.38	1.38
	Hold Periods	6.84	6.90	6.90
GSR Project				
	Take Periods	0.0	7.23	7.23
	Put Periods	0.0	0.04	0.04
	Hold Periods	0.0	0.04	0.04
San Francisco Groundwater Supply Project (SFGW Project, a cumulative project)				
	Year-round Pumping	0.0	0.0	4.0
Total Municipal Pumping (PA and GSR and SFGW Projects)				
	Take Periods	***6.84***	***14.13***	***18.13***
	Put Periods	***6.84***	***1.42***	***5.42***
	Hold Periods	***6.84***	***6.94***	***10.94***
Irrigation and Other Non-Potable Pumping				
Golden Gate Park	Elk Glen	0.081	0.081	0.0
	South Windmill	0.498	0.498	0.0
	North Lake	0.563	0.563	0.0
	Subtotal	**1.142**	**1.142**	**0.0**
Golf Clubs	Burlingame Golf Club	0.150	0.150	0.150
	California Golf Club No. 02	0.192	0.192	0.192
	Green Hills No. 05	0.099	0.099	0.099
	Lake Merced Golf Club No. 01	0.004	0.004	0.004
	Lake Merced Golf Club No. 02	0.004	0.004	0.004

TABLE 5.1-2
Model Input – Pumping Assumptions for Modeling Scenarios

Pumped Wells		Pumping Rate for Modeling Scenarios Million Gallons per Day (mgd)		
		Existing Conditions	**GSR Project**	**Cumulative Conditions**
	Lake Merced Golf Club No. 03	0.010	0.010	0.010
	Olympic Golf Club[(b)]	0.002	0.002	0.002
	San Francisco Golf Club West	0.035	0.035	0.035
	Subtotal	**0.495**	**0.495**	**0.495**
Cemeteries	Cypress Lawn Cemetery No. 02	0.020	0.020	0.020
Cemeteries	Cypress Lawn Cemetery No. 03	0.144	0.144	0.144
Cemeteries	Eternal Home Cemetery	0.013	0.013	0.013
Cemeteries	Hills of Eternity Cemetery No. 02	0.020	0.020	0.020
Cemeteries	Holy Cross Cemetery No. 03	0.190	0.190	0.230
Cemeteries	Home of Peace Cemetery No. 02	0.039	0.039	0.039
Cemeteries	Italian Cemetery	0.033	0.033	0.033
Cemeteries	Olivet Memorial Park	0.098	0.098	0.098
Cemeteries	Woodlawn Memorial Park No. 02	0.085	0.085	0.085
	Subtotal	**0.641**	**0.641**	**0.681**
Other	Hillsborough Residents 1-12	0.291	0.291	0.291
Other	Edgewood Development Center	0.009	0.009	0.009
Other	Zoo No. 05	0.321	0.321	0.321
Other	Stern Grove	0.004	0.004	0.013
	Subtotal	**0.626**	**0.626**	**0.635**
	Total Irrigation and Other Non-potable Pumping	***2.90***	***2.90***	***1.81***

Source: Kennedy/Jenks 2012a

Notes:

(a) Total pumping by Partner Agencies was derived from the median values of individual agency pumping over the historical period from 1959 to 2009 (Kennedy/Jenks 2012a).

(b) Olympic Golf Club No. 9 values include pumping for both Olympic Club Wells.

- **Modeled Existing Conditions**. The purpose of this scenario is to project the results of historical and existing pumping over the wide range of meteorological and hydrologic conditions incorporated into the model. In this way, the modeled existing conditions scenario estimates groundwater levels that would occur, for example, during a drought if historical and existing pumping patterns were maintained. Under this scenario, all historical and existing pumping would continue at its current rate for the entire simulation, as indicated in Table 5.1-2 (Model Input - Pumping Assumptions for Modeling Scenarios), which shows the rate of pumping by each pumper. In this scenario, it is assumed that municipal pumping by the Partner Agencies in the South Westside Groundwater Basin would continue to be 6.84 mgd combined, which would occur year round.

  Irrigation pumping from the South Westside Groundwater Basin is estimated to be 0.46 mgd by the golf clubs and 0.641 mgd by the cemeteries. However, it should be noted that these rates represent annual averages. During the summer season actual pumping rates would be higher, and during the winter season they would be lower. The rates would be even higher during dry years when the irrigation and municipal demand would be at its greatest; however, the rates would be lower during wet years when the irrigation demand would be at its lowest. The only other pumping in the South Westside Groundwater Basin under the modeled existing conditions scenario would be 0.29 mgd to account for irrigation wells at residences in Hillsborough. Under the modeled existing conditions, the total pumping from the South Westside Groundwater Basin would be 8.23 mgd.

  In the North Westside Groundwater Basin, the existing pumping includes 1.186 mgd of irrigation pumping, 0.321 mgd of pumping at the San Francisco Zoo (Zoo), and 0.004 mgd of pumping at Stern Grove to maintain Pine Lake water levels. As for the irrigation pumping described above, these pumping volumes represent annual averages; actual pumping rates during the irrigation season would be higher, and pumping during the non-irrigation season would be lower. Under the modeled existing conditions, the total pumping from the North Westside Groundwater Basin would be 1.51 mgd.

- **GSR Project.** Under the Project scenario, the SFPUC and the Partner Agencies would operate 16 wells to recover groundwater stored during Put Periods. Pumping would vary according to the Put, Take, Hold sequence described above, as indicated in Table 5.1-2 (Model Input - Pumping Assumptions for Modeling Scenarios), which shows the volume of pumping for each Put, Take, and Hold Period.

  Under the terms of the proposed Operating Agreement between the SFPUC and the Partner Agencies (described in Chapter 3, Project Description, Section 3.8.1 [Operating Agreement]), municipal pumping by the Partner Agencies during Take and Hold Periods under this scenario would average 6.9 mgd, compared to 6.84 mgd under modeled existing conditions. During Put Periods, total municipal pumping by the Partner Agencies could be reduced to a minimum of 1.38 mgd because of supplemental surface water deliveries by the SFPUC.

  Municipal pumping by the Partner Agencies as input into the Westside Basin Groundwater Model would be consistent with the Urban Water Management Plans (UWMPs) adopted by the Partner Agencies. During Take and Hold Periods, municipal pumping would be 3.43 mgd for Daly City, 1.37 mgd for Cal Water, and 2.1 mgd for San Bruno, as follows:

- The adopted Daly City 2010 UWMP states: "The modeling study identified that Daly City's sustainable [pumping] yield is 3.43 mgd." The document lists the volume of groundwater projected to be pumped in 2035 as 3,842 acre-feet per year (afy), which is equivalent to 3.43 mgd (Daly City 2011b).
- The adopted 2010 Cal Water UWMP states: "Cal Water, Daly City, and San Bruno will coordinate their respective pumping such that the 6.9 mgd value is not exceeded on an annual basis (or other mutually agreed upon averaging period). Cal Water has from the beginning of discussions regarding the GSR Project offered to limit its planned production of groundwater from the Westside Groundwater Basin to 1.37 mgd, which at 1,535 afy is in line with the current pumping capacity and historical production from the basin" (Cal Water 2011b).
- The adopted 2010 San Bruno UWMP lists the volume of groundwater production as part of the projected future water supply in 2035 to be 2.10 mgd (San Bruno 2011).

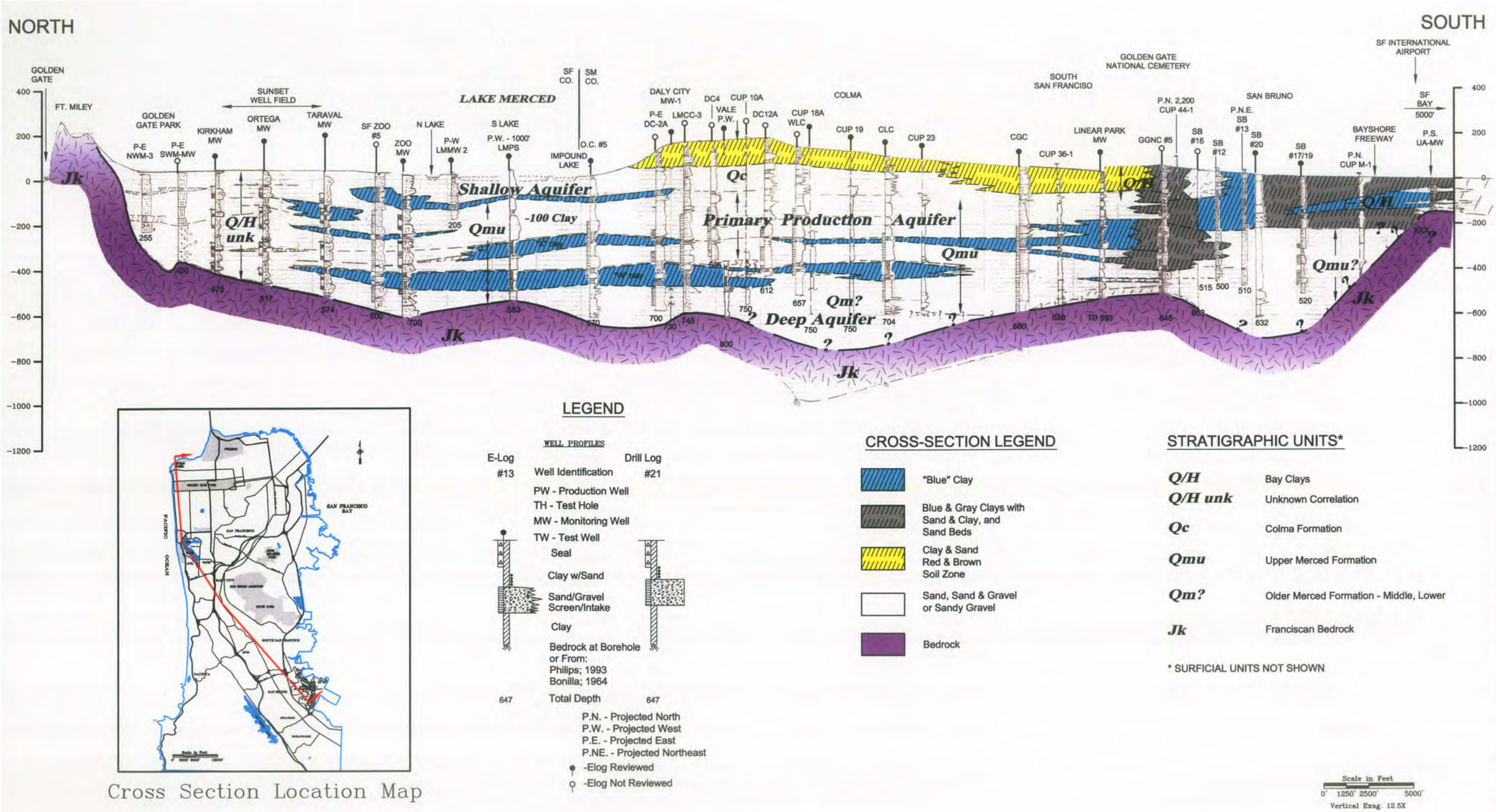
The Westside Basin Groundwater Model simulates groundwater conditions in five layers, shown on Figure 5.1-1 (North South Geologic Cross Section, Westside Groundwater Basin). Layer 1 approximates the Shallow Aquifer (or shallow water-bearing zone); Layers 2, 3, and 4 approximate the Primary Production Aquifer; and Layer 5 approximates the Deep Aquifer. These aquifers are those that could be affected by the proposed Project; therefore, the discussion of the modeling results focuses on these layers.

Figure 5.1-2 (Effects of Project and Cumulative Conditions relative to Modeled Existing Conditions on Groundwater Storage Volumes and the Westside Groundwater Basin) shows how total groundwater storage increases during Put Periods and decreases during Take Periods.

Project pumping during Take Periods by the SFPUC and the Partner Agencies would be up to 7.2 mgd of water from the 16 wells installed under the proposed Project. During Put and Hold Periods, Project pumping would be reduced to 0.04 mgd for well maintenance. Irrigation pumping under this scenario would be the same as under modeled existing conditions.

During Put Periods when the SFPUC Storage Account is being replenished, total pumping from the South Westside Groundwater Basin would be 2.85 mgd, and the SFPUC would deliver up to a total of 5.52 mgd of supplemental water deliveries for in-lieu recharge of the Basin. During Hold Periods, when the SFPUC Storage Account is full, the total pumping would be 8.33 mgd. During Take Periods, the total pumping would be 15.52 mgd.

As shown in Figure 5.1-2 (Effects of Project and Cumulative Conditions relative to Modeled Existing Conditions on Groundwater Storage Volumes and the Westside Groundwater Basin), groundwater storage volumes in the Westside Groundwater Basin as a whole would



North South Geologic Cross Section, Westside Groundwater Basin

Regional Groundwater Storage and Recovery Project

Figure 5.1-1

Source: LSCE 2010

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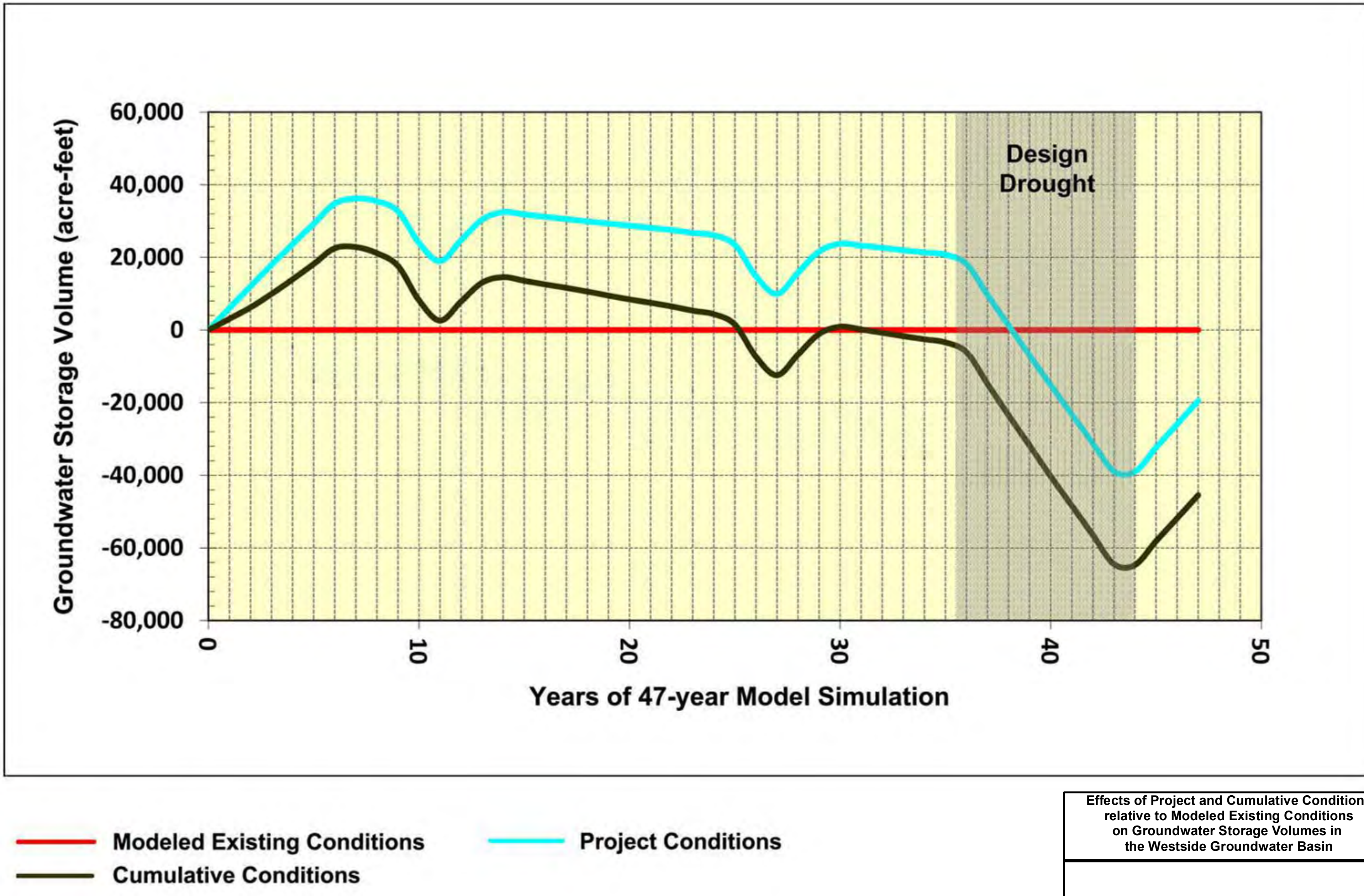

Effects of Project and Cumulative Conditions relative to Modeled Existing Conditions on Groundwater Storage Volumes in the Westside Groundwater Basin

Regional Groundwater Storage and Recovery Project

Figure 5.1-2

Source: Kennedy/Jenks 2012b

be higher under the Project for 70 to 80 percent of the 47-year simulation than under modeled existing conditions. Groundwater storage volumes would be lower under the Project than under modeled existing conditions for approximately 20 to 30 percent of the simulation.

No Project pumping would occur in the northern portion of the Westside Groundwater Basin and the municipal and private pumping in the northern portion of the Westside Groundwater Basin would be the same as under modeled existing conditions. The model does not account for GSR pumping in response to emergencies (which would be allowed under the proposed Operating Agreement as described in Section 3.8.1 of the Project Description), because such pumping would be unpredictable and temporary.

- **Cumulative Conditions.** The cumulative conditions scenario combines the existing pumping in the Basin (modeled existing conditions) plus the Project pumping described above (GSR Project), with pumping associated with other reasonably foreseeable projects that may affect the Westside Groundwater Basin; the pumping assumptions for these projects are described below. Each of these reasonably foreseeable, or cumulative, projects is described in Table 5.1-3 (Projects Considered for Cumulative Impacts).
  - **San Francisco Groundwater Project (SFGW Project) (cumulative project A-1 through A-6).** Under this scenario, the SFGW Project would pump 4.0 mgd from six wells. Existing irrigation pumping in Golden Gate Park would no longer occur (replaced by the use of recycled water for irrigation), while pumping at the Zoo and at the Edgewood Development Center would be the same as under the existing conditions. For Pine Lake, the pumping at the Stern Grove well would be increased from 0.004 mgd to 0.013 mgd to allow for an increase in the volume of water needed to maintain water levels in Pine Lake. Total pumping from the North Westside Groundwater Basin would be 4.38 mgd. This cumulative project would not change the pumping in the South Westside Groundwater Basin. Table 5.1-2 (Model Input - Pumping Assumptions for Modeling Scenarios) shows the SFGW project pumping under the cumulative conditions column.
  - **Holy Cross Cemetery Expansion (cumulative project E).** For the Holy Cross Cemetery, the groundwater model assumes that groundwater pumping would be increased from 0.190 mgd to 0.230 mgd because of the potential for buildout of the cemetery. Table 5.1-2 (Model Input - Pumping Assumptions for Modeling Scenarios) shows the additional pumping for this cumulative project under the cumulative conditions column.
  - **Vista Grande Drainage Basin Improvement Project (cumulative project B).** For the Vista Grande Drainage Basin Improvements Project, the groundwater modeling assumes that the Lake Merced Alternative, as recommended and described in Daly City's Vista Grande Drainage Basin Alternatives Analysis Report, is a reasonably foreseeable project (Daly City 2011c). The Lake Merced Alternative would divert an average 429 afy of stormwater flow to Lake Merced and lower the Lake Merced

spillway from an elevation of 13 to 9.5 feet City Datum to assist in managing lake levels (Daly City 2011a, 2011c, 2011d). This cumulative project would not change pumping in the Westside Groundwater Basin, so it is not listed in Table 5.1-2 (Model Input - Pumping Assumptions for Modeling Scenarios); however, the groundwater modeling does include model inputs for the Vista Grande Drainage Basin Improvement Project in the modeling for the cumulative scenario.

Other Westside Groundwater Basin Model Assumptions

The modeled hydrologic sequence uses temperature and rainfall data from each year of the 47-year hydrologic record. The sequence of hydrologic data from the historic period of 1958 through 2005 has been altered to include the same 8.5-year "design drought" used in the WSIP water supply modeling, but has been rearranged to allow for filling of the SFPUC Storage Account to occur during Put Years prior to pumping groundwater during a Take Period (Kennedy/Jenks 2012a). A design drought is a planning and operations tool used by water agencies to define a reasonable worst-case drought scenario in order to establish design and operating parameters for the water system.

In addition, the modeled design drought is a more severe drought than any that occurred during the 1958 to 2005 historic period. The modeled design drought is simulated by rearranging the hydrologic sequence such that the actual drought that occurred from December 1975 through December 1977 is repeated and placed after the dry hydrologic conditions of July 1987 to November 1992, for a combined total of an 8.5-year design drought sequence. In the simulations, the design drought is followed by a period of three Put Years to evaluate the rate of recovery after the design drought. Westside Basin Groundwater Model Strengths and Limitations

The Westside Basin Groundwater Model was developed to assist basin-wide data interpretation and system understanding and is considered a reliable data analysis tool for various purposes. The model provides a means to synthesize data and integrate processes that potentially influence groundwater conditions. The Model simulates changes in groundwater levels and storage over time. The strongest predictive ability of the model is estimating relative changes over a broad area, rather than providing absolute predictions of groundwater elevations at local areas or at a single well (Kennedy/Jenks 2012a). As such, the effects estimated under the Project-specific and cumulative conditions scenarios are compared to the effects estimated under the modeled existing conditions scenario (which estimates baseline hydrology under a wide range of rainfall conditions based upon historical hydrologic conditions and absent operation of the proposed Project and the cumulative projects) to determine if the predicted effects are related specifically to the Project. Such relative changes in groundwater parameters are also useful for assessing changes in surface water levels, groundwater storage, water quality, and the potential for seawater intrusion and land subsidence in response to pumping. These related effects are assessed based on the modeling results as supplemented by various analytical approaches, as summarized in the impact analyses in Section 5.16, Hydrology and Water Quality.

While the Westside Basin Groundwater Model provides useful information to inform basin management decisions and impact analyses, there are some specific areas of weakness and/or limitations in the model and model calibration (Kennedy/Jenks 2012a). One weakness is in the Colma and San Bruno subareas of the modeled area where there was the greatest difference between the modeled and historic groundwater elevations during the model calibration. These differences are likely due to limitations in available historic groundwater level data, model scaling, and the uncertainty in certain aquifer parameters in these subareas. Because of the higher level of differences in these subareas compared to the other subareas, there is a higher degree of uncertainty regarding the model results in the Colma and San Bruno subareas.

Similarly, the Westside Basin Groundwater Model does not allow an input for the maximum elevation of Lake Merced and, during each of the model scenarios, there are instances when the lake levels are predicted to exceed the existing spillway elevation of 13 feet City Datum (which is not possible due to the presence of the outlet in the spillway). This discrepancy results in an artificial filling of the lake above levels that are physically possible (due to the existing elevation of the spillway) and could have an effect on simulated groundwater levels in the Shallow Aquifer, which is in direct hydraulic connection with Lake Merced. To address this limitation, the scenarios were run iteratively to remove excess water from the lake as the lake spills, until the level of the lake remained below the spillway elevation.

Further, while the modeled Lake Merced water levels are generally accurate to within approximately two to three feet of the observed historic water levels during years 1 through 14 and 39 through 47 of the historic simulation, some of the differences during other periods are as great as seven feet. Therefore, the modeled lake levels should be considered representative of relative changes in lake levels in response to groundwater pumping, but are not suitable for estimating absolute changes in lake levels. To address this limitation, the spreadsheet-based Lake-Level Model described below was used for the estimation of water level changes in Lake Merced.

Another limitation is related to the areas where the Westside Groundwater Basin interacts with the Pacific Ocean and San Francisco Bay. The model does not account for the density difference between seawater and freshwater, or the wedge-shape of possible seawater intrusion. To address this limitation, additional analytical tools were used to assess the potential for seawater intrusion as discussed in Section 5.16, Hydrology and Water Quality.

In the Golden Gate Park area, the model may overestimate the drawdown in the well facilities for the cumulative conditions scenario, especially for the future proposed wells associated with the SFGW Project.

The Westside Basin Groundwater Model does not explicitly include changes in hydrologic parameters in response to climate change, because the effect of climate change on the groundwater basin is uncertain. However, if climate change were to cause more frequent drought conditions than observed historically, then such conditions would be included in the Model results through the use of the design drought – a drought that is more severe than any observed during the 47 years of historic records used in creating the Model. In addition, it is possible that climate change might have occurred during the period of the observed rainfall and temperature record. If so, then the observed rainfall and temperature data would include the effects of climate change as part of the overall data record. Since the observed rainfall and temperature data are used as inputs to the Westside Basin Groundwater Model then the possible effects of climate change upon the 47 years of historical record would be included implicitly in the simulations.

Finally, for evaluating the potential effects of pumping that would occur during operation of the Project, the model assumes that the hydrology used in the 47-year historical simulation would be repeated (although the hydrologic sequence has been altered to include the design drought and has been re-sequenced, as described above). Inclusion of the design drought (which is more severe than any drought in the hydrologic record) allows the SFPUC to plan for a drought more severe than has historically occurred. However, the hydrology that may occur over time as the Project is implemented, including parameters such as temperature and rainfall, would not occur exactly as it has in the past; rather, the actual response to pumping could vary from the modeled scenarios in any given year. Although there is inherent uncertainty regarding whether the historical hydrology will be repeated in the future, the use of historical data over the 47-year period provides a wide range of annual variations in hydrology that could be experienced in the future.

Even though the Westside Basin Groundwater Model is not intended to predict precise basin or surface water levels in a given year, over the course of the 47-year model period, the model does portray a reasonable range of anticipated basin and surface water levels such that, for EIR purposes, impacts that would be affected by changes in basin and surface water levels (e.g., biology, hydrology, water quality, etc.) can be conservatively evaluated.

5.1.6.2 Lake Merced Lake-level Model

To provide a more accurate estimate of Lake Merced surface water levels in response to changes in groundwater levels, results from the Westside Basin Groundwater Model were used as input to the Lake-level Model, a spreadsheet-based mass balance model that has been calibrated to 70 years of actual, measured historic water levels in Lake Merced (Kennedy/Jenks 2012a).

Use of the Lake-level Model allows for changes in the surface area of Lake Merced as a function of lake level, a dynamic simulation of changes in lake volume, a more complete evaluation of stormwater runoff, and evaluation of occasional flooding events resulting from overflows of the Vista Grande Drainage Canal. The hydrology used for each scenario in the Lake-level Model was the same as that used for the Westside Basin Groundwater Model, and the measured water level of 5.7 feet City Datum in Lake Merced in June 2009 was used as the initial lake level for the Lake-level Model.

5.1.7 Cumulative Impacts

Cumulative impacts are defined as "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts" (CEQA Guidelines Section 15355). Cumulative impacts can result from individually minor, but collectively significant, actions when added to those of other closely related past, present, or reasonably foreseeable future projects. Guidance for cumulative impact analysis is provided in Section 15130 of the CEQA Guidelines:

- An EIR shall discuss cumulative impacts of a project when the project's incremental effect is "cumulatively considerable" (i.e., the incremental effects of an individual project are considerable when viewed in connection with the effects of past, current, and probable future projects, including those outside the control of the agency, if necessary).

- An EIR should not discuss impacts that do not result in part from the project evaluated in the EIR.
- A project's contribution is less than cumulatively considerable, and thus not significant, if the project is required to implement or fund its fair share of a mitigation measure or measures designed to alleviate the cumulative impact.
- The discussion of impact severity and likelihood of occurrence need not be as detailed as for effects attributable to the project alone.
- The focus of analysis should be on the cumulative impact to which the identified other projects contribute, rather than on attributes of the other projects that do not contribute to the cumulative impact.

The cumulative impact analysis for each environmental resource topic is described in the appropriate subsections of this Chapter, following the description of direct project impacts and identified mitigation measures. A summary of all cumulative impacts is provided in Chapter 6, Other CEQA Issues, Section 6.2 (Summary of Cumulative Impacts).

5.1.7.1 Approach to Cumulative Impact Analysis

Two approaches to a cumulative impact analysis are discussed in CEQA Guidelines Section 15130(b). The first approach is a list of past, present, and reasonably foreseeable future projects producing related or cumulative impacts. The second approach is a summary of projections contained in an adopted local, regional, or statewide plan, such as a general plan or related planning document, or in an adopted or certified environmental document, which describes or evaluates conditions contributing to cumulative effects. For this EIR, other projects that may cause cumulative impacts have been identified using the list approach.

Three criteria were used to determine an appropriate list of relevant past, present, and future projects to be considered in this cumulative analysis: similar environmental impacts, geographic scope and location, and timing and duration of implementation. A relevant future project is defined as one that is "reasonably foreseeable," such as a proposed project that has approved funding or for which an application has been filed with the approving agency.

Similar Environmental Impacts

Projects that are relevant to the cumulative analysis include projects that could contribute incremental environmental effects on the same resources as, and would have similar impacts to, those discussed in this EIR. Cumulative impacts that could occur when the impacts of the Project are considered in combination with the impacts of other relevant projects are discussed in Sections 5.2 through 5.19 of this EIR.

Geographic Scope

Projects that are relevant to the cumulative analysis include those that are within the defined geographic scope for the cumulative effect. The defined geographic scope is dependent on the environmental resource affected. Generally, the geographic scope includes the area within and adjacent to the well facility sites. However, for certain environmental resource topics the geographic scope extends further, such as the regional roadway network, regional air basin, or the Westside Groundwater Basin.

Timing and Duration of Implementation

Projects that are relevant to the cumulative analysis also include projects that could contribute impacts that coincide with Project impacts during construction and demolition (short-term) or operation (long-term). Construction of the Project would last approximately 21 months (for all of the well facility sites), occurring between approximately June 2014 and February 2016 (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). For temporal impacts such as noise and traffic, cumulative effects could overlap with those of the Project, or could occur immediately prior to or immediately after construction of the Project, and would affect the same environmental resources.

5.1.7.2 List of Relevant Projects

Table 5.1-3 (Projects Considered for Cumulative Impacts) provides a list of the past, present, and reasonably foreseeable projects within and near the Project area, including a brief description of the projects and their anticipated construction schedules. Table 5.1-3 also identifies the potential cumulative effects associated with each of the listed projects. Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis) shows the location of the cumulative projects. The cumulative impact analysis is presented in each resource topic in the subsections that follow this Chapter. A summary of all the cumulative impacts is provided in Chapter 6, Other CEQA Issues, Section 6.2 (Summary of Cumulative Impacts).

The Bay Area Water Supply and Conservation Agency (BAWSCA) is creating a new groundwater model to evaluate the feasibility of potential brackish groundwater desalination projects. The groundwater model is intended to support planning level, brackish groundwater project feasibility assessments. The model is intended to assist BAWSCA in estimating the yield from brackish aquifers and identify potential locations and regional impacts from brackish groundwater extraction. The model is currently being developed and calibrated. No specific projects are identified at this time. (SFPUC 2013)

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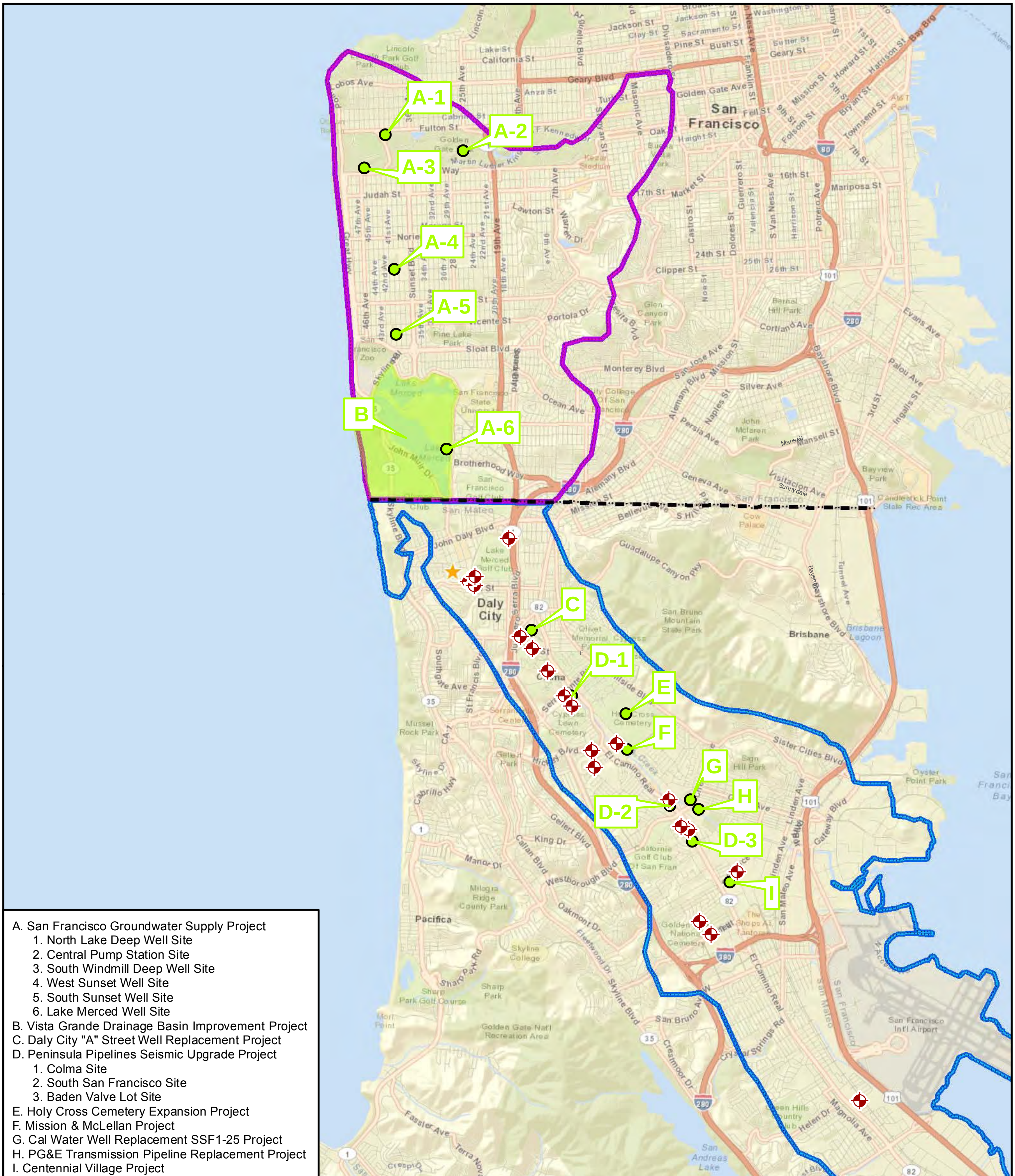

Legend

- Proposed Project Well Facility Sites
- Westlake Pump Station
- Cumulative Project Locations
- Cumulative Project Area
- County Boundary
- North Westside[1] Groundwater Basin
- South Westside[1] Groundwater Basin

0 0.75 1.5

Scale Miles

1" = 1.5 miles

Location of Projects Considered in the Cumulative Analysis

Regional Groundwater Storage and Recovery Project

Figure 5.1-3

[1] The Westside Groundwater Basin has been administratively divided at the San Francisco-San Mateo County line.

TABLE 5.1-3
Projects Considered for Cumulative Impacts

Cumulative Project No.	Project Name (Jurisdiction)	Project Description	Potential Cumulative Impact Topics	Potentially Affected Project Components/ Areas of Overlap	Estimated Construction Schedule	Approximate Distance to GSR Project
A-1 to A-6	San Francisco Groundwater Supply Project (SFPUC)	The SFPUC would construct and operate up to six potable groundwater production well facilities. Four would be new well facilities (phase 1) and two would be converted from existing irrigation well facilities (phase 2). Each well facility would include a groundwater production well and a pump station (San Francisco Planning Department 2013a).	Operation: land use, noise, recreation, biological resources, hydrology and water quality, hazards and hazardous materials, energy resources	The southernmost well site (Lake Merced Site) would be located approximately 1.3 miles (6,800 feet) north of GSR Site 1. The San Francisco Groundwater Supply Project would draw groundwater from the Westside Groundwater Basin, the same as the GSR Project.	fall 2014 through spring 2016	Between 1.3 and 5.0 miles north of GSR Site 1
B	Vista Grande Drainage Basin Improvement Project (Daly City)	The project purpose is to address storm-related flooding in the Vista Grande Watershed Drainage Basin, and to provide other environmental benefits, including restoration and management of water levels within Lake Merced, and improving the existing ocean outfall. The project would reconnect a significant portion of Lake Merced's historic watershed. The project includes: • Partial replacement of the existing Vista Grande Drainage Canal to incorporate a debris screening device, a treatment wetland, and diversion and outfall structures to route some stormwater (and authorized non-stormwater) flows from the Vista Grande Drainage	Construction: traffic, air quality, utilities and service systems, biological resources, hydrology and water quality, hazards and hazardous materials, energy resources, Operation: recreation, utilities and service systems, biological resources, hazards and hazardous materials, hydrology and water quality, energy resources	Project located north of the northernmost well (Site 1 Lake Merced Golf Club)	Approximately 2014 through 2016	Between 0.58 and 0.89 miles west of GSR Site 1, 0.58 miles northwest of GSR Sites 2 and 3, between 0.44 and 1 mile north of Westlake Pump Station

TABLE 5.1-3
Projects Considered for Cumulative Impacts

Cumulative Project No.	Project Name (Jurisdiction)	Project Description	Potential Cumulative Impact Topics	Potentially Affected Project Components/ Areas of Overlap	Estimated Construction Schedule	Approximate Distance to GSR Project
B Continued		Canal to Lake Merced; • Replacement of the existing Vista Grande Tunnel to increase its peak capacity and extend its operating life; and • Replacement of the existing ocean outfall structure at Fort Funston. (Daly City 2013). • Additionally, operational components of the project would include management of water elevations in Lake Merced and a Lake Management Plan that would implement water quality best management practices.				
C	"A" Street Well Replacement (Daly City)	Replace/upgrade existing well so that it continues to be able to pump up to 0.63 mgd (Daly City 2010).	Construction: cultural and paleontological resources, traffic, noise, air quality, utilities and service systems, biological resources, hydrology and water quality, hazards and hazardous materials, energy resources Operation: land use, noise, utilities and service systems, hazards and hazardous materials, energy resources	Timing of construction could overlap. The well would pump from the Westside Groundwater Basin, the same as the GSR Project.	Funded as part of the FY 13-14 Capital Improvement Program	Estimated between 0.1 mile and 0.5 mile northeast of GSR Site 5, between 0.2 and 0.4 miles northeast of GSR Site 6, and 0.5 mile northeast of GSR Site 7

TABLE 5.1-3
Projects Considered for Cumulative Impacts

Cumulative Project No.	Project Name (Jurisdiction)	Project Description	Potential Cumulative Impact Topics	Potentially Affected Project Components/ Areas of Overlap	Estimated Construction Schedule	Approximate Distance to GSR Project
D-1 Colma Site D-2 South San Francisco Site D-3 Baden Valve Lot Site	Peninsula Pipelines Seismic Upgrade Project (SFPUC)	The Peninsula Pipelines Seismic Upgrade (PPSU) project would include seismic upgrades to the SFPUC San Andreas Pipeline No. 2 (SAPL2), San Andreas Pipeline No. 3 (SAPL3), and Sunset Supply Branch Pipeline (SSBPL) that deliver water from the Harry Tracy Water Treatment Plant to the SFPUC's regional water system. The PPSU project would include five separate sites and a staging area: • The Colma Site covers 2.24 acres of urbanized land between Serramonte Boulevard and Collins Avenue. The project proposes the installation of approximately 700 feet of new 54-inch-diameter steel pipeline to replace an existing pipeline segment of the SAPL2. The construction area includes 0.77 acre for staging and spoils and a 1.47 acre construction zone. • The South San Francisco Site covers the area between Arroyo Drive and West Orange Avenue. The project in this area covers approximately 1.34 acres. The project proposes installation of approximately 720 feet of new 54-inch diameter steel pipeline to replace an existing pipeline segment of SAPL2. The construction area includes 0.05	Construction: land use, aesthetics, cultural and paleontological resources, traffic, noise, air quality, utilities and service systems, biological resources, geology and soils, hydrology and water quality, hazards and hazardous materials, energy resources Operation: utilities and service systems, biological resources, geology and soils, hazards and hazardous materials, energy resources	The PPSU project would replace portions of the San Andreas Pipeline No. 2, the San Andreas Pipeline No. 3, and Sunset Supply Branch Pipeline. Some pipeline replacement construction activities and staging would occur in locations where the GSR Project, if approved, would construct well facilities and pipelines. • The Colma Site would include construction within GSR Sites 8 and 17 (Alternate). In addition to intersecting geographically, including the overlapping construction sites and potential overlapping staging areas, the timing of construction activities could overlap.	2014 to 2015	0 miles, overlaps GSR Sites 8 and 17 (Alternate)

TABLE 5.1-3
Projects Considered for Cumulative Impacts

Cumulative Project No.	Project Name (Jurisdiction)	Project Description	Potential Cumulative Impact Topics	Potentially Affected Project Components/ Areas of Overlap	Estimated Construction Schedule	Approximate Distance to GSR Project
D Continued		acre for staging and spoils and a 1.29 acre construction zone. • The Baden Valve Lot is an approximately 2-acre triangular-shaped site within the SFPUC right-of-way at the corner of El Camino Real and West Orange Ave. A 0.32 acre portion of the lot would be used for staging. • The San Bruno North Site is bounded on the north by San Bruno Avenue West by Interstate 280 (I-280) off-ramps on the west and south, and by a residential neighborhood on the east. The project proposes the stabilization of approximately 140 feet of SAPL2 within a tunnel from San Bruno Avenue West to just before the San Bruno Avenue West northbound exit from I-280 through which SAPL2 currently extends. The construction area includes 0.14 acre for staging and spoil areas and a 0.76-acre construction zone. • The San Bruno South Site is west of I-280 in a residential area immediately to the west and south of Shelter Creek Condominiums and north of the Peninsula High School parking lot. The project proposes the installation of		• The South San Francisco Site would be located approximately 550 feet north of GSR Sites 12 and 19 (Alternate). The timing of construction activities could overlap in close geographic areas. • PPSU construction staging would occur at the Baden Valve Lot site. GSR Project construction staging would also occur in an approximately 0.32 acre portion of the Baden Valve Lot site. • The San Bruno North Site would be located approximately 2.2 miles northwest of GSR Site 16. • The San Bruno South Site would be		

TABLE 5.1-3
Projects Considered for Cumulative Impacts

Cumulative Project No.	Project Name (Jurisdiction)	Project Description	Potential Cumulative Impact Topics	Potentially Affected Project Components/ Areas of Overlap	Estimated Construction Schedule	Approximate Distance to GSR Project
D Continued		approximately 1,170 feet of new 54-inch diameter pipeline to replace an existing pipeline segment of SAPL2 and installation of 1,050 feet of 66-inch pipeline to replace an existing pipeline segment of SAPL3. The construction area includes 2.31 acres for staging and spoils areas and a 1.59 acre construction zone. • The Millbrae Site extends through a residential neighborhood, City of Millbrae open space and a golf club. The site generally extends east from the intersection of Banbury Lane and Ridgewood Drive, through two residential side yards, and through a portion of the Green Hills Country Club golf club. The site is accessible from I-280 via the Larkspur Drive and Hillcrest Boulevard exits. The project proposes the installation of a new 60-inch diameter steel pipeline to replace an existing 900-foot segment of the SSBPL. The construction area includes 2.03 acres for staging and spoil and a 1.07-acre construction zone. (San Francisco Planning Department 2013b)		located approximately 2 miles west of GSR Site 16. • The Millbrae Site would be located approximately 1 mile northeast of GSR Site 16.		

TABLE 5.1-3
Projects Considered for Cumulative Impacts

Cumulative Project No.	Project Name (Jurisdiction)	Project Description	Potential Cumulative Impact Topics	Potentially Affected Project Components/ Areas of Overlap	Estimated Construction Schedule	Approximate Distance to GSR Project
E	Holy Cross Cemetery Expansion (Colma)	Holy Cross Cemetery buildout would include an expansion of the cemetery and may require an additional 0.04 mgd to be pumped from the existing wells at the cemetery (Kennedy/Jenks 2012b).	Construction: cultural resources, traffic, noise, air quality, utilities and service systems, biological resources, hydrology and water quality, hazards and hazardous materials, energy resources Operation: utilities and service systems, hydrology and water quality, hazards and hazardous materials, energy resources	Expansion could potentially occur near GSR Site 9. It is unknown whether the timing of expansion of the cemetery would overlap with GSR project construction. The increased pumping would be from the Westside Groundwater Basin, the same as the GSR Project.	No current plans; however, buildout is projected to occur at approximately 1.5 acres per year from 2010 to 2030 (a total of 30 acres over 20 years).	Cemetery is 300 feet east of GSR Site 9, 0.3 miles east of GSR Site 10 and 0.4 mile east of Site 18 (Alternate) Expansion area is assumed to be 0.65 miles east of GSR Site 9 and 1 mile east of GSR Site 18 (Alternate)
F	Mission & McLellan (South San Francisco)	The Mission & McLellan Project is located at 1309 Mission Road and includes 20 condominium units with approximately 6,000 square feet of commercial space on a 1.41-acre site (South San Francisco 2011).	Construction: land use, aesthetics, traffic, noise, air quality, utilities and service systems, biological resources, hydrology and water quality, hazards and hazardous materials, energy resources Operation: land use, aesthetics, traffic, noise, recreation, utilities and service systems, hazards and hazardous materials, energy resources	Potentially overlapping geographically with GSR Site 9. It is unknown whether the timing of construction would overlap.	Approved March 2011 Construction schedule unknown	760 feet southeast of GSR Site 9, 0.4 miles east of GSR Sites 10 and 18 (Alternate)

TABLE 5.1-3
Projects Considered for Cumulative Impacts

Cumulative Project No.	Project Name (Jurisdiction)	Project Description	Potential Cumulative Impact Topics	Potentially Affected Project Components/ Areas of Overlap	Estimated Construction Schedule	Approximate Distance to GSR Project
G	Well Replacement SSF1-25 (Cal Water)	Well replacement (SSF1-25) to be located near South San Francisco, near Mission Road and Chestnut Avenue (Cal Water 2011a).	Construction: construction-related impacts to land use, aesthetics, cultural and paleontological resources, traffic, noise, air quality, utilities and service systems, biological resources, hydrology and water quality, hazards and hazardous materials, energy resources Operation: land use, noise, utilities and service systems, hazards and hazardous materials, energy resources	Timing of construction could overlap. The well would pump from the Westside Groundwater Basin, the same as the GSR Project.	CEQA Approval April 2014. Construction starts in Oct 2014. In-service in July 2015.	630 feet southeast of GSR Site 11 pipelines and 0.2 miles southeast of GSR Site 11. 0.2 miles northeast of GSR Sites 12 and 19 (Alternate).
H	PG&E Transmission Pipeline Replacement (PG&E Project in South San Francisco)	PG&E intends to replace a portion of a gas transmission line. The pipeline route extends from Evergreen Drive to Mission Road, to Chestnut Avenue, to Antoinette Lane then crossing over to El Camino Real between Chestnut Avenue and 1st Street, then continuing along El Camino Real to West Orange Avenue (PG&E 2012).	Construction: land use, aesthetics, cultural and paleontological resources, traffic, noise, air quality, recreation, utilities and service systems, biological resources, hydrology and water quality, hazards and hazardous materials, energy resources Operation: utilities and service systems, hazards and hazardous materials, energy resources	Potentially overlapping geographically with GSR Site 12 and adjacent to Sites 11 and Site 19 (Alternate). Potentially overlapping geographically with construction access route for GSR Sites 11, 12, and Site 19 (Alternate). It is unknown whether the timing of construction would overlap.	Not available	0.3 miles southeast of GSR Site 9, 200 feet southwest of GSR Site 11 pipelines and 0.2 miles southwest of GSR Site 11. 0 miles from GSR Site 12, 0.6 miles northwest of GSR Site 13, 0.6 miles southeast of GSR Site 18 (Alternate), 150 feet east of GSR Site 19 (Alternate) utility lines and 400 feet from GSR Site 19 (Alternate).

TABLE 5.1-3
Projects Considered for Cumulative Impacts

Cumulative Project No.	Project Name (Jurisdiction)	Project Description	Potential Cumulative Impact Topics	Potentially Affected Project Components/ Areas of Overlap	Estimated Construction Schedule	Approximate Distance to GSR Project
I	Centennial Village (South San Francisco)	The Centennial Village project is located at 180 El Camino Real in South San Francisco. The project includes the demolition of the existing Brentwood Shopping Center. The project also includes construction of a new, mixed-use 165,000-square foot shopping center anchored by Safeway Food, CVS Drugstore, and Wells Fargo Bank with 132 apartment units on a 14.5-acre site. As of December 2011, the project is under review by the City of South San Francisco (South San Francisco 2011).	Construction: aesthetics, traffic, noise, air quality, recreation, utilities and service systems, biological resources, hydrology and water quality, hazards and hazardous materials, energy resources Operation: aesthetics, land use, traffic, noise, recreation, utilities and service systems, hazards and hazardous materials, energy resources	Potentially overlapping geographically with GSR Site 13. It is unknown whether the timing of construction would overlap.	Currently under review by the City of South San Francisco	Adjacent to GSR Site 13 pipelines and 400 feet southwest of GSR Site 13 facility.

5.1.8 References

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5.2 LAND USE

This section describes the existing land uses within the vicinity of the proposed facility sites and evaluates the potential land use impacts of the proposed Project. It describes the existing land use setting and regulations that address land use planning in the study area. Potential land use impacts from Project construction and operation are evaluated and mitigation measures that would avoid or reduce significant impacts are identified. Impacts on recreational activities are evaluated in Section 5.11, Recreation. Impacts on irrigated land uses (i.e., golf clubs, cemeteries) due to changes in the pumping of groundwater are evaluated in Section 5.16, Hydrology and Water Quality.

5.2.1 Setting

The study area for land use includes the area within and surrounding the construction area for the facility sites, including sensitive land uses such as schools, residences, parks, and cemeteries that could be affected by construction and operation of the Project.

5.2.1.1 Existing Land Use

Existing land uses were identified and characterized based on field visits, aerial photographs, computer-aided street view tours, and review of planning documents. Proposed facility sites would be located in San Mateo County between Daly City in the north and Millbrae in the south along the urbanized spine of the northern San Francisco Peninsula. Urban land uses in the study area are mixed single- and multi-family residential, commercial, industrial, and public/quasi-public uses. Open spaces in the study area include golf clubs, cemeteries and urban parks. The facility sites would be located within the jurisdictions of unincorporated San Mateo County (Broadmoor), the Town of Colma, and the cities of Daly City, South San Francisco, San Bruno, and Millbrae.

Table 5.2-1 (Land Uses in the Vicinity of Facility Sites) provides the jurisdiction, on-site land uses, surrounding land uses, and duration of construction for the proposed facility sites. Following the table is a description of existing land uses at and surrounding each of the facility sites, organized by jurisdiction. Figures referenced are located in Chapter 3, Project Description; not all surrounding land uses are visible on the figures because of the scale of the drawings.

TABLE 5.2-1
Land Uses in the Vicinity of Facility Sites

Site	Juris-diction	On SFPUC Land?	Land Use within the Construction Area	Land Uses in the Vicinity of the Construction Area (including Pipelines)	Minimum Distance from Construction Area to Land Use [(a)]	Approximate Construction Duration[(b)]
Site 1	Daly City	No, owned by Golf Club	Golf club maintenance area, restroom and maintenance road	Lake Merced Golf Club	Adjacent	Well and Treatment Facility: 16 months Pipeline: 1 week
				Multi-family residential (Westlake Village Apartments)	Adjacent	
				Interstate 280 (I-280)	40 feet	
Site 2	Daly City	Yes, owned by City and County of San Francisco and managed by the SFPUC	Utility right-of-way and vacant land	Multi-family residential (Westlake Village Apartments)	40 feet	Well Facility: 1 month Pipeline: 2 to 3 weeks
				Lake Merced Golf Club	55 feet	
				Intermediate school (Ben Franklin Intermediate School)	60 feet	
				Elementary school (Garden Village Elementary School)	30 feet	
				Single-family residential	430 feet	
Site 3	San Mateo County	No, owned by Jefferson School District	School playing field and parking lot	Intermediate school (Ben Franklin Intermediate School)	Adjacent	Well and Well Facility: 6 months over two summers Pipeline: 2 to 3 weeks
				Single-family residential	20 feet	
				Multi-family residential (Westlake Village Apartments)	65 feet	
				Lake Merced Golf Club	130 feet	
				Elementary school (Garden Village Elementary School)	330 feet	

TABLE 5.2-1
Land Uses in the Vicinity of Facility Sites

Site	Juris-diction	On SFPUC Land?	Land Use within the Construction Area	Land Uses in the Vicinity of the Construction Area (including Pipelines)	Minimum Distance from Construction Area to Land Use [(a)]	Approximate Construction Duration[(b)]
Site 4	San Mateo County	No, owned by County	County road right-of-way, school playing field, and roadway	Elementary school (Garden Village Elementary School)	Adjacent	Well and Well Facility: 5 months Pipeline: 2 to 4 weeks
				Single-family residential	Adjacent	
				Lake Merced Golf Club	55 feet	
				Intermediate school (Ben Franklin Intermediate School)	100 feet	
West- lake Pump Station	Daly City, San Mateo County	No, owned by City of Daly City	Municipal pump station and corporation yard	Single-family residential	Adjacent	Pump Station Upgrades: 4 months
				Multi-family residential (Westlake Village Apartments)	Adjacent	
				Intermediate school (Ben Franklin Intermediate School)	Adjacent	
Site 5	Daly City	Yes, SFPUC right-of-way	*Consolidated Treatment at Site 6:* Utility right-of-way and roadway *On-site Treatment:* Utility right-of-way, roadway, and parking lot	Commercial (Former Serra Bowl and insurance office)	Adjacent	*Consolidated Treatment at Site 6:* Well Facility: 3 months Pipeline: 3 to 5 weeks *On-site Treatment:* Treatment Facility: 14 months Pipelines: 2 to 3 weeks
				Single-family residential	Adjacent	
				Commercial (Car dealership)	Adjacent	
				SFPUC Valve Lot	50 feet	
				SamTrans Park and Ride parking lot	100 feet	
				Bay Area Regional Transit (BART) Colma Station	250 feet	

TABLE 5.2-1
Land Uses in the Vicinity of Facility Sites

Site	Juris-diction	On SFPUC Land?	Land Use within the Construction Area	Land Uses in the Vicinity of the Construction Area (including Pipelines)	Minimum Distance from Construction Area to Land Use [(a)]	Approximate Construction Duration[(b)]
				Elementary school (Holy Angels Elementary School)	475 feet	
Site 6	Daly City	Yes, SFPUC right-of-way	Utility right-of-way, roadway, and vacant	SamTrans Park and Ride parking lot	Adjacent	Treatment Facility: 14 months Pipeline: 2 to 3 weeks
				BART Colma Station	Adjacent	
				Cemetery (Woodlawn Memorial Park)	90 feet	
				Commercial (Former Serra Bowl)	200 feet	
				Multi-family residential	470 feet	
Site 7	Colma	Yes, SFPUC right-of-way	*Consolidated Treatment at Site 6:* Utility right-of-way and roadway *On-site Treatment:* Utility right-of-way, roadway, and cemetery	Cemetery (Woodlawn, Greenlawn, and Greek Orthodox Memorial Parks)	Adjacent	*Consolidated Treatment at Site 6:* Well and Well Facility: 5 months Pipeline: 3 to 6 weeks *On-site Treatment:* Well and Treatment Facility: 16 months Pipelines: 1 to 2 weeks
				Commercial (Shopping Center, including Home Depot Pro)	120 feet	
Site 8	Colma	Yes, SFPUC right-of-way	Utility right-of-way and parking lot	Commercial (Kohl's Department Store)	Adjacent	Treatment Facility: 14 months Pipeline: 1 to 2 weeks
				Commercial (Car dealerships)	Adjacent	
				Enterprise Car Rental and Collision Center	200 feet	
				Residential (Senior Care Facility)	440 feet	

TABLE 5.2-1
Land Uses in the Vicinity of Facility Sites

Site	Juris-diction	On SFPUC Land?	Land Use within the Construction Area	Land Uses in the Vicinity of the Construction Area (including Pipelines)	Minimum Distance from Construction Area to Land Use [(a)]	Approximate Construction Duration[(b)]
Site 9	South San Francisco	Yes, SFPUC fee owned-lands	Utility right-of-way and vacant land	Residential (Treasure Island Trailer Court)	Adjacent	Well and Treatment Facility: 16 months Pipeline: 1 to 2 weeks
				Single-family residential	65 feet	
				Commercial (Costco and services along Mission Road)	50 feet	
				Light Industrial	70 feet	
				Multi-family residential (Verano Condominiums)	200 feet	
				Cemetery (Holy Cross Cemetery)	280 feet	
Site 10	South San Francisco	Yes, SFPUC right-of-way	Utility right-of-way, vacant land, and private roadway	Commercial (Chevy's Restaurant and Winston Manor Shopping Center)	25 feet	Treatment Facility: 14 months Pipeline: 1 to 2 weeks
				Single-family residential	165 feet	
				Commercial (Hotel/motel)	225 feet	
Site 11	South San Francisco	Yes, SFPUC fee owned-lands	Utility right-of-way and vacant land	Public/Institutional (BART Ventilation Structure)	Adjacent	Well and Treatment Facility: 16 months Pipeline: 3 to 5 weeks
				Public/Institutional (Kaiser Medical Center garage and parking lot)	100 feet	
				Public/Institutional (Kaiser Medical Center)	725 feet	
				Open Space (South San Francisco Centennial Way Trail)	75 to 230 feet	

TABLE 5.2-1
Land Uses in the Vicinity of Facility Sites

Site	Juris-diction	On SFPUC Land?	Land Use within the Construction Area	Land Uses in the Vicinity of the Construction Area (including Pipelines)	Minimum Distance from Construction Area to Land Use [(a)]	Approximate Construction Duration[(b)]
				Commercial (neighborhood shopping center)	275 feet	
				Single-family residential	400 feet	
Site 12	South San Francisco	Yes, SFPUC right-of-way	Utility right-of-way, parking lot, vacant, and roadway	Commercial (Garden Chapel Funeral Home)	Adjacent	Well and Treatment Facility: 16 months Pipeline: 3 to 6 weeks
				Single-family residential	Adjacent	
				Public/Institutional (Our Redeemer's Lutheran Church and R.W. Drake Pre-School Center)	30 feet	
				Commercial (Restaurants, motel, small businesses)	125 feet	
				Multi-family residential (Clubview Apartment Homes)	480 feet	
Site 13	South San Francisco	Yes, SFPUC fee owned-lands	Utility right-of-way and roadway	Commercial (Credit union, carwash, residence motel)	Adjacent	Treatment Facility: 14 months Pipeline: 5 to 9 weeks
				Open Space (Francisco Terrace Playlot, South San Francisco Centennial Way Trail)	50 to 70 feet	
				Public/Institutional (San Mateo County offices and U.S. Post Office)	Adjacent	
				Single-family residential	70 feet	
				Industrial (Freeman Warehouse)	90 feet	

TABLE 5.2-1
Land Uses in the Vicinity of Facility Sites

Site	Juris-diction	On SFPUC Land?	Land Use within the Construction Area	Land Uses in the Vicinity of the Construction Area (including Pipelines)	Minimum Distance from Construction Area to Land Use [(a)]	Approximate Construction Duration[(b)]
Site 14	San Bruno	Yes, SFPUC Right-of-Way	Cemetery and roadway	Cemetery (Golden Gate National Cemetery)	Adjacent	Well and Treatment Facility: 16 months Pipeline: 5 to 10 weeks
				Single-family residential	Adjacent	
				Light Industrial (Airport Trade Center)	75 feet	
				Multi-family residential	225 Feet	
Site 15	San Bruno	No, owned by U.S, Department of Veterans Affairs	Cemetery and roadway	Cemetery (Golden Gate National Cemetery)	Adjacent	Well and Treatment Facility: 16 months Pipeline: 2 to 4 weeks
				Light Industrial (Airport Trade Center)	75 feet	
				Multi-family residential	110 feet	
				Public/Institutional (Veterans Administration Clinic)	90 feet	
Site 16	Millbrae	Yes, SFPUC right-of-way	Utility right-of-way, parking lot and roadway	Multi-family residential (Millbrae Manor)	Adjacent	Well and Treatment Facility: 16 months Pipeline: 2 to 4 weeks
				Commercial (Orchard Supply Hardware, A&W/KFC)	Adjacent	
				Public/Institutional (Convalescent hospital)	120 feet	
				Public/Institutional (SFPUC administrative offices)	Adjacent	
				Commercial (Businesses along El Camino Real)	100 feet	
				Single-family residential	250 feet	

TABLE 5.2-1
Land Uses in the Vicinity of Facility Sites

Site	Juris-diction	On SFPUC Land?	Land Use within the Construction Area	Land Uses in the Vicinity of the Construction Area (including Pipelines)	Minimum Distance from Construction Area to Land Use [(a)]	Approximate Construction Duration[(b)]
				Public/Institutional (Millbrae Racquet Club, undeveloped park land, and PG&E substation)	90, 180, and 150 feet respectively	
Site 17 (Alternate)	Colma	Staging area would be on SFPUC Right-of-way; well facility would be located on private property	Utility right-of-way, roadway, vacant land, and parking lot	Commercial (Standard Plumbing Supply)	Adjacent	Well and Treatment Facility: 16 months Pipeline: 1 week
				Cemetery (Cypress Lawn Memorial Park)	Adjacent	
				Commercial (Enterprise Car Rental and Collision Center)	25 feet	
				Commercial (Car dealership)	165 feet	
				Residential (Senior Care Facility)	390 feet	
Site 18 (Alternate)	South San Francisco	No, owned by City of South San Francisco	Utility right-of-way, vacant, and roadway	Single-family residential	Adjacent	Well and Treatment Facility: 16 months Pipeline: 1 to 2 weeks
				Intermediate school (Alta Loma Middle School)	170 feet	
				Pre-school (Little Hugs Preschool)	300 feet	

TABLE 5.2-1
Land Uses in the Vicinity of Facility Sites

Site	Juris-diction	On SFPUC Land?	Land Use within the Construction Area	Land Uses in the Vicinity of the Construction Area (including Pipelines)	Minimum Distance from Construction Area to Land Use [(a)]	Approximate Construction Duration[(b)]
Site 19 (Alternate)	South San Francisco	Yes, SFPUC Right-of-way	Utility right-of-way, parking lot, roadway, and vacant	Public/Institutional (Our Redeemer's Lutheran Church and R.W. Drake Preschool)	Adjacent	Well and Well Facility: 5 months Pipeline: 3 to 6 weeks
				Commercial Garden Chapel Funeral Home	Adjacent	
				Single-family residential	Adjacent	
				Multi-family residential (Clubview Apartment Homes)	70 feet	
				Commercial (Fairway Plaza)	600 feet	

Notes:

(a) Measurements are taken from the closest boundary of the construction zone to the closest edge of the land use, including parking areas for the land use.
(b) Approximate construction duration developed using well facility and pipeline installation timeframes provided in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule). Duration of pipeline installation is not necessarily the same as the duration of lane closures, because lane closures involve connection to existing utilities that may require extra time. The duration of lane closures is discussed below under Impact LU-1; refer to Section 5.6, Transportation and Circulation, for additional information.

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The following provides a brief description of the land uses at the facility sites, along the pipeline routes, including alternate pipeline routes, and within the surrounding area. The specific land uses are included in Table 5.2-1, which also lists distances from the proposed construction area to the nearby land use and the duration of construction at the site. A description of land uses along potential routes for construction traffic follows the description of land uses near the facility sites.

Daly City

Site 1

Site 1 would be located on the Lake Merced Golf Club property and within Poncetta Drive, as shown on Figure 3-11. The facility site would be located west of Interstate Highway 280 (I-280) and south of the Westlake Village apartment complex. Surrounding land uses include I-280, multi-family residential uses, and the golf club.

Site 2

Site 2 would be located within the SFPUC utility right-of-way, as shown on Figure 3-12. The surrounding land uses include multi-family residential uses to the north of the site and the Lake Merced Golf Club immediately east of the site. Garden Village Elementary School is located south of the site and Ben Franklin Intermediate School is located to the west across Park Plaza Drive.

Site 5

Site 5 would be located within the SFPUC utility right-of-way and within B Street, as shown on Figures 3-15 and 3-19. The well facility would be constructed adjacent to a single-family residence and commercial businesses including a State Farm Insurance office and the former Serra Bowl bowling alley. A car dealership is located across B Street from the facility site. The SamTrans Park and Ride lot and the Colma Bay Area Rapid Transit (BART) Station are both located southeast of the proposed facility site. Site 5 includes two possible treatment options. The preferred consolidated treatment option includes installation of pipelines to convey water from the well facility at Site 5 to the well facility at Site 6 for treatment. The pipeline route between Sites 5 and 6 would pass through commercial land uses, the SamTrans Park and Ride lot and the Colma BART Station property. Alternately, if it is not feasible to consolidate treatment at Site 6, water may be treated on site at Site 5 with a water system connection within B Street.

Site 6

Site 6 would be located within the SFPUC utility right-of-way and within D Street, as shown on Figures 3-16 and 3-20. The well facility and pipelines would be constructed immediately adjacent to the Colma BART Station and the SamTrans Park and Ride lot. Other land uses near the site include commercial uses to the northwest. The Woodlawn Memorial Park is located approximately 90 feet south of the southern edge of the Site 6 construction area. The size and location of Site 6 would be the same for either the consolidated treatment option at this location for Sites 5 and 7 or the on-site treatment option for Sites 5 and 7.

Westlake Pump Station

The Westlake Pump Station upgrades would be located within the existing pump station property, which also serves as a corporation yard for the City of Daly City. Surrounding land uses include playing fields for the Ben Franklin Intermediate School and single- and multi-family residential uses as shown in Figure 3-13.

Unincorporated San Mateo County

Site 3

Site 3 would be located within the athletic field of Ben Franklin Intermediate School and within the school parking lot as shown on Figure 3-12. Surrounding land uses include single-family residential uses immediately south and west of the well facility and multi-family residential uses north of the access road to the well facility. The Lake Merced Golf Club is located east of the proposed facility site across Park Plaza Drive.

Site 4

Site 4 would be located on San Mateo County road right-of-way and within the playing field at Garden Valley Elementary School, as shown on Figure 3-12. Pipelines would be installed within Park Plaza Drive and 87th Street. Other land uses surrounding the facility site include single-family residences. Lake Merced Golf Club is located adjacent to pipelines that would be installed north of the proposed well facility to connect to the Daly City water distribution system.

Colma

Site 7

Site 7 would be located within the SFPUC utility right-of-way, as shown on Figure 3-17 and 3-21. The well facility would be constructed adjacent to the Woodlawn and Greenlawn Memorial Parks and across Colma Boulevard from the Greek Orthodox Memorial Park. The site would also be located near commercial uses to the southwest, including the Home Depot Pro store, which is part of a larger shopping center. Site 7 includes two possible treatment options. The preferred consolidated treatment option includes installation of a pipeline to convey water from the well at Site 7 to the water treatment facility at Site 6 for treatment. The pipeline between Sites 7 and Site 6 would pass through the Woodlawn Memorial Park as shown on Figure 3-17. Alternatively, if it is not feasible to consolidate treatment at Site 6, water may be treated on-site at Site 7 with a water system connection extending into Colma Boulevard, as shown in Figure 3-21.

Site 8

Site 8 would be located within the SFPUC utility right-of-way and within the parking lot for an adjacent commercial use, Kohl’s Department Store, as shown on Figure 3-22. The site is surrounded by commercial land uses (i.e., automobile dealerships). A residential senior care facility is located approximately 440 feet to the southeast of the site.

Site 17 (Alternate)

Site 17 (Alternate) would be located partially within the SFPUC utility right-of-way, but also within the side yard and parking lot of an adjacent commercial use, Standard Plumbing Supply, as shown in Figure 3-38. Pipelines would extend into Collins Avenue. A portion of the construction area would be located within the SFPUC right-of-way across Collins Avenue. Surrounding land uses include commercial uses, a residential care facility to the east across Collins Avenue, and Cypress Lawn Memorial Park to the south and west.

South San Francisco

Site 9

Site 9 would be located on vacant land owned by the SFPUC, as shown on Figures 3-23 and 3-24. Surrounding land uses include multi-family residential to the northwest (Treasure Island Trailer Court), single-family residential to the east, and commercial and light industrial to the east and southeast. The San Mateo County Flood Control Channel and the Costco parking lot are located to the southwest. Holy Cross Cemetery is located approximately 280 feet east of the proposed site, across Mission Road.

Site 10

Site 10 would be located within the SFPUC utility right-of-way, as shown on Figure 3-25. Pipelines would extend into Camaritas Avenue. Surrounding land uses include commercial uses east of the proposed facility site (Chevy's Restaurant and Winston Manor Shopping Center). Single-family residences are located to the west and south of the proposed facility site, and additional commercial land uses are located across Hickey Boulevard north of this site.

Site 11

Site 11 would be located on vacant land owned by the SFPUC, as shown on Figures 3-26 and 3-27. Nearby land uses include a BART ventilation structure and a Kaiser Permanente Medical Center garage and parking lot; the Medical Center is approximately 725 feet north of the proposed well facility site. Surrounding land uses are commercial and single- and multi-family residential uses. The South San Francisco Centennial Way Trail is located within 75 to 230 feet as it passes to the north and east. There are public and commercial land uses near the access driveway leading to Antoinette Lane. The South San Francisco City Hall and commercial businesses are located uphill and across El Camino Real from the proposed well facility site.

Site 12

Site 12 would be located within the SFPUC utility right-of-way, a portion of which is currently occupied by the Garden Chapel Funeral Home parking lot and side yard, as shown on Figures 3-28 and 3-29. Pipelines would extend into Southwood Drive. Surrounding land uses include the Our Redeemer's Lutheran Church and R.W. Drake Pre-School Center northwest of the site and a single-family residential area to the south and west of the site. Several commercial businesses are located northeast of the site and across El Camino Real. Site 12 also includes a pipeline route along the western edge of El Camino Real from the well facility site to West Orange Avenue as shown on Figure 3-29. Land uses in the vicinity of the proposed pipeline route include the SFPUC Baden Valve Lot, single-family residences, and numerous commercial uses.

Site 13

Site 13 would be located on vacant land owned by the SFPUC, as shown on Figures 3-31 and 3-32. Surrounding uses are commercial, residential, and open space/recreation. The South San Francisco Centennial Way Trail and Francisco Terrace Playlot are located northeast and northwest of the well facility site, respectively. A large warehouse is located northeast of the site. Single-family residences are located northwest of the facility site across South Spruce Avenue. Land uses north of the site include commercial and light industrial uses. Construction at the site would include installation of a pipeline along South Spruce Avenue to Huntington Avenue then south along Huntington Avenue to Noor Avenue. Land uses along the proposed pipeline route include governmental uses (San Mateo County offices and a U.S. Post Office) and commercial uses, including a movie theater and an extended stay motel.

Site 18 (Alternate)

Site 18 (Alternate) would be located on a vacant parcel of land owned by the City of South San Francisco, in a single-family residential area, as shown on Figure 3-39. Pipelines would extend into Alta Loma Drive. The SFPUC right-of-way, Alta Loma Middle School, and the Little Hugs Pre-school are located south of the proposed well facility site.

Site 19 (Alternate)

Site 19 (Alternate) would be located within the SFPUC utility right-of-way, as shown on Figure 3-40. The Our Redeemer's Lutheran Church and R.W. Drake Pre-School Center are located adjacent to the well facility site. Surrounding land uses include single-family residences to the southwest, multi-family residences to the west, and commercial uses to the north and east. Water pumped from the well at Site 19 (Alternate) would be conveyed to the facility at Site 12 for treatment. The pipeline to convey water from Site 19 (Alternate) to Site 12 would be installed across Southwood Drive and along the SFPUC right-of-way through the Garden Chapel Funeral Home parking lot.

San Bruno

Site 14

Site 14 would be located within the Golden Gate National Cemetery (GGNC) on land owned by the U.S Department of Veterans Affairs (VA), as shown on Figure 3-35. The construction area at Site 14 would be located on or adjacent to an existing SFPUC easement near the northern boundary of the cemetery, in proximity to gravesites. Surrounding land uses include the cemetery and single-family residential uses to the north. Water pumped from the well at Site 14 would be conveyed to Site 15 for treatment[1]. The pipeline would be installed within the SFPUC easement through the cemetery to Sneath Lane, as shown in Figure 3-33. Land uses along the proposed pipeline in Sneath Lane include light industrial uses at the Airport Trade Center and multi-family residences.

Site 15

Site 15 would be located at the Golden Gate National Cemetery adjacent to a cemetery operations and maintenance facility along Sneath Lane, as shown on Figure 3-36. Surrounding land uses include the cemetery and commercial uses to the south, across Sneath Lane. A VA Medical Clinic is also located across Sneath Lane to the southeast of the site. A pipeline would extend along Sneath Lane to connect to the San Bruno water distribution system. Multi-family residential uses and light industrial uses occur south of the pipeline route.

Millbrae

Site 16

Site 16 would be located on SFPUC-owned land that is currently occupied by Orchard Supply Hardware and within Hemlock Avenue, as shown on Figure 3-37. The site would be located within the parking lot and a portion of a storage yard associated with the hardware store. Surrounding land uses include the Caltrain rail line, commercial and industrial uses, single- and multi-family residences and a convalescent hospital. To the north of the Caltrans tracks are a tennis club, an undeveloped park, and a PG&E substation.

Construction Traffic Routes

The construction traffic routes would extend from the individual sites to the nearest freeway: I-280, U.S. 101, I-380, and State Route 82 (El Camino Real) and are listed in detail in Section 5.6, Transportation and Circulation. The land uses along the construction traffic routes are similar to the lands uses immediately surrounding the individual facility sites, as the study area is fairly homogeneous: single-and multi-family residential, commercial, public/institutional, golf clubs, and cemeteries. Most of the routes are on collector roads and arterials that have relatively high traffic volumes (see Table 5.6-3 [Local Roadway Existing Level of Service Conditions] in Section 5.6, Transportation and Circulation, for specific volumes). Where the proposed facility sites are located away from arterials within residential neighborhoods, the portion of the route closest to the site would also be lined with residences.

[1] If Site 14 is constructed and the well facility at Site 15 is found to be infeasible, a treatment facility would still be constructed at Site 15 to treat water from Site 14; see discussion in Chapter 3 Project Description, Section 3.4.3 (Facility Sites).

5.2.2 Regulatory Framework

5.2.2.1 Federal and State Regulations

No federal or State land use regulations apply to the proposed Project, except at Sites 14 and 15, which would be located on federal land. Please see Chapter 4, Plans and Policies, for a discussion of the regulatory setting related to federal lands.

5.2.2.2 Local Regulations

Under California Government Code Section 53090, et seq., the SFPUC receives intergovernmental immunity from city and county zoning and building ordinances. Please see Chapter 4, Plans and Policies, for a discussion of the regulatory setting related to land use plans and policies and more detailed information regarding intergovernmental immunity.

5.2.3 Impacts and Mitigation Measures

5.2.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on land use if it were to:

- Physically divide an established community.
- Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect.
- Have a substantial impact upon the existing character of the vicinity.
- Substantially disrupt or displace existing land uses or land use activities.

5.2.3.2 Approach to Analysis

This analysis evaluates the potential for land use impacts, including short-term impacts on existing land uses that could result from temporary construction activities and long-term impacts that could result from the siting, operation, and maintenance of proposed facilities. The significance criteria identified above were used to determine the level of significance of potential impacts.

Two of the four significance criteria will not be discussed further in this EIR for the following reasons:

Physically divide an established community. This criterion is not applicable to the Project because of the Project's nature and scale. None of the proposed facilities or construction activities would physically divide an established community. During construction, neighborhoods, commercial areas, schools and parks could be temporarily disrupted by pipeline construction and lane closures or detours. These short-term activities and associated impacts pertain more to disrupting the land use character of a community and are, therefore, discussed below under Impact LU-1. After construction, the largest footprint of above-ground Project facilities at any one site (including structures, paving, and parking) would measure approximately 70 feet by 140 feet. Pipelines to connect the well facilities to existing off-site water lines, sanitary sewer lines, and storm drains would be below ground. Proposed power lines would also be below ground at all the sites except at Site 9, where power lines would be above ground to avoid the need to tunnel beneath the Colma Creek Diversion Channel.

Conflicts with applicable land use plans, policies, or regulations of an agency with jurisdiction over the project. This criterion is evaluated in Chapter 4, Plans and Policies.

In addition to the two criteria listed above, potential land use disruptions associated with construction noise, dust, and access impacts at cemeteries during funeral services is not discussed further in the land use analysis below for the following reason. The SFPUC proposes to coordinate with cemetery managers to gain information about the dates and times of upcoming funeral services that would coincide with pipeline construction through their properties. The SFPUC also proposes that pipeline construction activities would cease during funeral services, as discussed in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule), which would thereby avoid potential land use disruptions associated with noise dust, and access.

The remaining significance criteria are discussed in the impact analysis. The analysis considers short- and long-term impacts on land uses in the vicinity of the Project which would: (1) substantially affect the existing character of the vicinity by introducing land uses that would be incompatible or conflict with established land uses or (2) substantially disrupt or displace existing land uses or land use activity.

The approach to analysis considers whether temporary adverse impacts on land use would occur due to substantial disruption or displacement of existing land uses or substantial interference with access to land uses during construction, thereby affecting the existing land use character of the area. The analysis also evaluates whether temporary land use disturbance adjacent to Project construction activities would result from a combination of effects, including noise, dust, traffic delays, and/or access disruption. Each of these potential construction effects is evaluated separately in Section 5.6, Transportation and Circulation; Section 5.7, Noise and Vibration; 5.8, Air Quality; and Section 5.11, Recreation; however, the intensity or potential combination of these construction effects is considered in this section as a potential land use disruption issue. Land use displacement would occur if implementation of the Project required temporary relocation of existing land uses to accommodate construction or temporary restrictions on land use activities. Mitigation for construction noise and traffic impacts is referenced throughout this section, as these measures are required to reduce the effects of the temporary land use disturbance associated with Project construction. The complete description of these measures is not repeated in this section, but references to the location of mitigation measures are included in the text.

Air Quality Impacts Affecting Land Use

For example, well facility construction could generate construction-related dust. Although this short-term construction-related air quality impact would not be generated by changes in land use, it would be attributable to well facility construction activities and could, therefore, disturb land uses in the vicinity of the construction area boundary. Such an impact is analyzed in detail in Section 5.8, Air Quality, and its relationship to potential impacts on existing land use character is explained below. The analysis takes into account the fact that construction-related land use impacts would be temporary and short-term. That is, these impacts would not be continuous over the total construction period and would not extend beyond the estimated construction duration for each site (see Table 5.2-1 [Land Uses in the Vicinity of Facility Sites] for the construction duration at each site). Although construction-related air quality impacts have the potential to temporarily affect land use, for almost all sites, mitigation measures are available that would reduce the severity of the impact sufficiently that land use would not be disturbed, as noted below.

Construction-period Dust Impacts at All Sites

Construction at each of the facility sites would generate construction-related fugitive dust emissions, which would substantially disrupt neighboring land uses, and result in a significant impact. However, as described in Section 5.8, Air Quality, Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures), would be included in all construction contracts to reduce impacts from fugitive dust to less-than-significant levels. Since the resulting fugitive dust levels would be temporary and less than significant, they would not substantially alter the existing character of the vicinity or disrupt the land use. As a result, this impact would be *less than significant*.

Construction-period Diesel Particulate Matter Impacts at All Sites

Project construction activities would require the use of heavy-duty diesel vehicles and equipment that emit diesel particulate matter (DPM) as $PM_{2.5}$, that can pose cancer risk and non-cancer hazards. As described in Section 5.8, Air Quality, Impact AQ-3, to address such potential health risk impacts, estimated emissions data from the proposed construction activities were input to a dispersion model that computes DPM/$PM_{2.5}$ and organic compound concentrations at receptor locations. The dispersion model computed that Project cancer risks, non-cancer hazard indices and $PM_{2.5}$ concentrations would be below regulatory threshold limits at all facility sites except at Site 5 (with On-Site Treatment). Impacts at 18 of the 19 well facility sites, therefore, would be less than significant. As described in Section 5.8, Air Quality, Mitigation Measure M-AQ-3 (Construction Health Risk Mitigation) would reduce the impact at Site 5 (with On-site Treatment) to less than significant with mitigation. Because the residual impacts would be less than significant, they would not substantially alter the existing character of the vicinity or disrupt land uses. As a result, this impact would be *less than significant*.

Operational Emissions All Sites

Facility operations at each of the 19 well facility sites would generate pollutant emissions from groundwater pump operations due to the infrequent use of portable generators in the event of a power failure and vehicle trips for well facility maintenance. As described in Section, 5.8 Air Quality, under Impacts AQ-5 and AQ-6, pollutant emissions from these sources would be quite small, and are therefore not anticipated to cause localized emissions that would lead to significant excess cancer risk, significant acute or chronic hazards, or annual $PM_{2.5}$ concentrations. Therefore, potential air quality impacts attributable to the Project operations would be less than significant. Since air quality impacts would be less than significant, they would not substantially alter the existing character of the vicinity or disrupt the land use. As a result, this impact would be *less than significant*.

Other Indirect Effects on Land Use

The approach to analysis also evaluates whether permanent impacts on land use that could result from siting and operation of the Project would change the physical environment surrounding the facility site to such an extent that the character of the vicinity would be changed or nearby land uses would be substantially disrupted or displaced. For example, well facility operations could produce a new noise source that could conflict with residential land uses located nearby. Construction-period noise impacts are considered to have the potential to affect land use if nighttime construction is proposed. Daytime noise impacts are not considered to result in a significant disruption in land use.

In a departure from the general organization of this EIR's other analysis sections, any applicable mitigation measures are presented at the end of the impact analysis for each group of sites, rather than following the discussion of each facility site to reduce redundancy. Most of the mitigation measures apply to many of the facility sites. Therefore, it is more efficient to present and discuss the measure once, rather than with each site and referring the reader back to the measure's original discussion in the section. Mitigation measures specific to an individual site are shown under the site analysis.

5.2.3.3 Summary of Impacts

Table 5.2-2 (Summary of Impacts – Land Use) provides a summary of potential land use impacts.

TABLE 5.2-2
Summary of Impacts – Land Use

Sites	Impact LU-1: Project construction would have a substantial impact on the existing character of the vicinity and could substantially disrupt or displace existing land uses or land use activities.	Impact LU-2: Project operations would result in substantial long-term or permanent impacts on the existing character or disrupt or displace land uses.	Impact C-LU-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to land use.
Site 1	SUM	LSM	LS
Site 2	LS	LS	LS
Site 3	SUM	LS	LS
Site 4	SUM	LS	LS
Westlake Pump Station	NI	LSM	LS
Site 5 (Consolidated Treatment at Site 6)	LSM	LS	LS
Site 6 (Consolidated Treatment at Site 6)	LS	LS	LS

TABLE 5.2-2
Summary of Impacts – Land Use

Sites	Impact LU-1: Project construction would have a substantial impact on the existing character of the vicinity and could substantially disrupt or displace existing land uses or land use activities.	Impact LU-2: Project operations would result in substantial long-term or permanent impacts on the existing character or disrupt or displace land uses.	Impact C-LU-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to land use.
Site 7 (Consolidated Treatment at Site 6)	LSM	LS	LS
Site 5 (On-site Treatment)	SUM	LSM	LS
Site 6 (On-site Treatment)	LS	LS	LS
Site 7 (On-site Treatment)	LS	LS	LS
Site 8	LS	LS	LS
Site 9	SUM	LSM	SUM
Site 10	LSM	LS	LS
Site 11	LSM	LS	LS
Site 12	SUM	LS	SUM
Site 13	LSM	LS	LS
Site 14	SUM	LS	LS
Site 15	LSM	LS	LS
Site 16	SUM	LS	LS
Site 17 (Alternate)	LSM	LS	LS
Site 18 (Alternate)	SUM	LSM	LS
Site 19 (Alternate)	SUM	LS	SUM

Notes:

NI = No Impact

LS = Less than Significant

LSM= Less than Significant with Mitigation

SUM= Significant and Unavoidable with Mitigation

5.2.3.4 Construction Impacts and Mitigation Measures

Impact LU-1: Project construction would have a substantial impact on the existing character of the vicinity and could substantially disrupt or displace existing land uses or land use activities. (Significant and Unavoidable with Mitigation)

As indicated in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule), Project construction activities would take place over an approximate three-month period for construction of the well-only facilities[2] and associated pipelines and up to 16 months for construction of wells plus treatment and filtration buildings and the associated pipelines. Construction activities involve site preparation work, well drilling, foundation laying, utility connections, and building or enclosure construction (see Chapter 3, Project Description, Section 3.5 [Project Construction]). Construction activities may temporarily remove or damage existing recreational resources on or adjacent to facility sites. Project construction activities would result in construction vehicles traveling to and from facility sites along urban roadways. Construction vehicle traffic could result in increased traffic congestion and traffic safety hazards for automobiles, bicyclists, and pedestrians traveling along the construction access routes, as well as temporary traffic delays associated with construction vehicles.

The following evaluation of impacts discusses sites with no impacts first, followed by sites with less-than-significant impacts, and then sites with significant impacts.

<u>Westlake Pump Station</u>

Westlake Pump Station upgrades would occur within the fenced and paved pump station property, which is bordered by single- and multi-family residential uses and playing fields at the Ben Franklin Intermediate School. The proposed upgrades, including new pipelines, would be inside the existing buildings at the pump station site. *No impact* would occur to neighboring land uses, because construction would occur on the existing Westlake Pump Station site, construction would occur within existing buildings, and no road closures would be needed. As a result, construction activities would not substantially change the character of the vicinity or substantially disrupt or displace adjacent land uses.

Impact Conclusion: No Impact

<u>Sites 2, 6, 7 (On-site Treatment), and 8</u>

Site 2

Construction at Site 2 would occur near the Lake Merced Golf Club, multi-family residences, and the Garden Village Elementary School. Pipeline installation would occur along Park Plaza Drive, as shown in Figure 3-12. Construction at Site 2 would not displace these land uses, and would not disrupt the recreational experience at the Lake Merced Golf Club. The golf playing surface is about 20 feet higher in

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[2] Exceptions to the three-month construction duration for the well-only facilities include Site 3, where construction would occur over two three-month summers and Site 2, where construction would require only about one month.

elevation than the proposed well facility site. The area between the well facility site and the fairway includes a large number of trees and shrubs that provide substantial screening between the well facility site and the fairway. Therefore, construction would not substantially displace the land use at the golf club nor adversely impact its existing land use character, because it would be brief (one month), and golfers would be separated from the construction site by both elevation and vegetative screening.

During the estimated one-month construction period, recreationists using the Garden Village Elementary School athletic fields; nearby residents, including residents of the Westlake Village Apartments; and users of the adjacent playing surface at the golf club would experience noise impacts. However, since the resulting noise levels would be temporary and less than significant, they would not substantially alter the existing character of the vicinity or disrupt the land use. As a result, this impact would be *less than significant*.

Site 6

Site 6 would be located on the SFPUC utility right-of-way between the Colma BART Station and the SamTrans Park and Ride lot. Pipeline construction, including the alternate water connection, would occur underneath the existing pedestrian bridge from the Park and Ride lot to the BART station. Impacts from noise from construction would have little impact on BART customers, because customers would continue to have access to the Park and Ride lot and the BART station as they do now and would experience construction-related effects for only a brief time as they cross the pedestrian bridge (see Section 5.6, Transportation and Traffic, and Section 5.7, Noise and Vibration). Similarly, Woodlawn Memorial Park would experience only minor land use impacts, because the closest gravesites are over 100 feet away from the proposed construction area, screened by mature vegetation, and at a higher elevation than the site. Land use impacts would be the same for both the Consolidated Treatment at Site 6 and for the On-site Treatment options at Sites 5 and 7, and would also be the same for the proposed and alternate water connection pipelines. Therefore, construction activities would not substantially change the character of the vicinity and would not substantially disrupt or displace adjacent land uses. The impact would therefore be *less than significant*.

Site 7 (On-site Treatment)

Site 7 (On-site Treatment) would be located on the SFPUC utility right-of-way near Woodlawn, Greenlawn and Greek Orthodox Memorial Parks, and adjacent to the back of a Home Depot Pro store, as shown in Figure 3-17.

Visitors would experience minor delays on Colma Boulevard due to temporary lane closures when storm drain and sanitary sewer pipelines and electricity conduit are extended into the street. Lane closure would last approximately one week. The proposed water connection pipeline would stay entirely within the SFPUC utility right-of-way, but the alternate water connection pipeline would connect to the California Water Service Company (Cal Water) distribution system within Colma Boulevard, which would also require a temporary lane closure. However, these temporary effects would not substantially change the character of the vicinity or cause a substantial disruption or displacement of the adjacent cemetery land uses.

During daytime construction of the well facility and pipelines, lasting approximately 16 months, visitors to the cemeteries would be exposed to increased noise, (nighttime construction would not affect the cemetery land uses). However, impacts would be temporary (approximately 16 months) and would only briefly affect individuals who may occasionally visit the cemeteries. The resulting impact on the character of the vicinity would therefore be *less than significant* and the land use would not be substantially disrupted or displaced.

Site 8

Site 8 would be located on the SFPUC utility right-of-way, between the back of a Kohl's Department Store and the Serramonte Volkswagen car dealership located immediately southwest and at a higher elevation than the site, beyond an approximately 25-foot high retaining wall, as shown in Figure 3-22. For purposes of this analysis, it is assumed that construction would temporarily delay access to the back of the Kohl's store during installation of the electrical conduit for up to two days, based upon the length of the pipeline, which is approximately 120 feet and the SFPUC's proposed rate of pipeline construction of 300 to 600 feet per week (see Chapter 3 Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). An approximately 50 foot segment of sanitary sewer pipeline would be installed in the parking lot behind the Kohl's store and may require one day to install. Construction noise would not substantially disrupt surrounding land uses because of distance and the presence of intervening structures between the construction site and surrounding land uses. Noise from construction activities would have minimal impact on the neighboring land uses, because Kohl's customers and deliveries would continue to have access to the store, and the few customers of Kohl's, and of the car dealership, who approach the construction area would be only briefly exposed to the construction effects (see Section 5.6, Transportation and Traffic and Section 5.7, Noise and Vibration,). Land use impacts would be the same for both the proposed and alternate water connection pipelines. As a result, construction activities would not substantially change the character of the vicinity or substantially disrupt or displace adjacent land uses. The impact would therefore be *less than significant.*

Impact Conclusion: Less than Significant

<u>Sites 5 (Consolidated Treatment at Site 6), 7 (Consolidated Treatment at Site 6), 10, 11, 13, 15, and 17 (Alternate)</u>

Site 5 (Consolidated Treatment at Site 6)

Construction at Site 5 (with treatment consolidated at Site 6) would occur adjacent to a single-family residence within a mostly commercial area. No nighttime construction would be necessary, because a test well already exists at the site. During daytime construction of the well facility and pipelines (including the proposed water connection pipeline to Site 6, a storm drain and an electrical line), which would occur over approximately three months, noise levels would be elevated. Although these impacts would be temporary (three months), construction of the fenced enclosure would occasionally result in significant noise impacts. Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which are described in Section 5.7, Noise and Vibration, would reduce this temporary impact on the adjacent residence to less-than-significant levels. The proposed water connection pipeline from Site 5 to Site 6 would be constructed across Hill Street and D Street and under the pedestrian bridge from the

SamTrans Park and Ride lot to the BART station. Impacts from noise from construction would have little impact on BART customers, because customers would continue to have access to the Park and Ride lot and the BART station as they do now and would experience construction-related effects for only a brief time as they cross the pedestrian bridge (see Section 5.6, Transportation and Traffic, and Section 5.7, Noise and Vibration). Therefore, impacts on the existing character of the vicinity would be *less than significant with mitigation*, and no land uses would be substantially disrupted or displaced.

Site 7 (Consolidated Treatment at Site 6)

Site 7 (Consolidated Treatment at Site 6) would be located on the SFPUC utility right-of-way near Woodlawn, Greenlawn and Greek Orthodox Memorial Parks, and adjacent to the back of a Home Depot Pro store, as shown in Figure 3-17.

Visitors would experience minor delays on Colma Boulevard due to temporary lane closures when a storm drain pipeline and electrical conduit are extended into the street. Pipeline installation in Colma Boulevard would last approximately one week. The proposed water pipeline connection to Site 6 would stay entirely within the SFPUC utility right-of-way. These temporary effects would not substantially change the character of the vicinity nor cause a substantial disruption or displacement of the cemetery land uses.

During daytime construction of the well facility (which would be a fenced enclosure with no building), lasting approximately three months, visitors to the cemeteries would be exposed to increased noise, dust and equipment exhaust (however, nighttime construction would not affect the cemetery land use). These noise levels would be intermittent and temporary, and the impact on the character of the vicinity would be *less than significant* and the adjacent land uses would not be substantially disrupted or displaced.

In addition, construction would include installation of approximately 1,780 feet of pipeline across the Woodlawn Memorial Park, to convey water to Site 6 for treatment. Noise from the pipeline construction would occur during the estimated five-week construction period for the pipeline crossing Woodlawn Memorial Park. Cemetery visitors would experience construction noise during pipeline installation; however, increased noise levels would be intermittent during the temporary construction. Construction noise would not interrupt funeral services because, as noted in Chapter 3 Project Description, Section 3.5.1 (Construction Sequencing and Schedule), the SFPUC would coordinate with the cemetery and halt construction activities during funeral services. Construction noise affecting individuals who may occasionally visit the Woodlawn Cemetery would be intermittent and temporary, lasting for up to five weeks, and construction would cease during funeral services; therefore, the impact would be *less than significant*.

Pipeline installation across Woodlawn Memorial Park would cross several internal cemetery access roads, which could result in temporary access impediments to portions of the cemetery. This could have a substantial disruption of the cemetery land use and, in which case, would be a *significant* impact. However, Mitigation Measure M-LU-1 (Maintain Internal Cemetery Access) would reduce the land use impact to *less than significant* by providing access to all portions of the cemetery within a reasonable time period for both visitors and maintenance.

Mitigation Measure M-LU-1: Maintain Internal Cemetery Access (Site 7 [Consolidated Treatment at Site 6] and Site 14)

Prior to commencing construction at either Site 7 (where treatment for Site 7 is consolidated at Site 6) or at Site 14, the SFPUC or its construction contractor shall develop an access plan to be implemented during construction to ensure that access is available for visitors to all portions of the Woodlawn Memorial Park and Golden Gate National Cemetery within a reasonable period of time upon their arrival at the cemetery. The access plan shall include, for example, trench plating and alternative routing for visitors. The plan shall also address measures to maintain access for cemetery operations and maintenance. A copy of the access plan shall be submitted to the owner or operator of the Woodlawn Memorial Park and the Golden Gate National Cemetery prior to commencing construction, and they also shall be provided with the name of, and contact information for, a person identified to act as a liaison during construction at these sites.

Site 10

Site 10 would be located on the SFPUC utility right-of-way between single-family residential land uses to the west and commercial land uses to the east, as shown in Figure 3-25.

Installation of the proposed sanitary sewer pipeline at Site 10 would require the partial closure of Camaritas Avenue during pipeline installation, affecting an egress/ingress to the Winston Manor Shopping Center from Camaritas Avenue for approximately one week. However, the shopping center has alternative access points, and temporary delays on Camaritas Avenue would not substantially affect the character of the vicinity or substantially disrupt or displace nearby commercial uses. Land use impacts of the proposed and alternate water connection pipelines would be the same.

No nighttime construction is required at Site 10, because a test well already exists on the site. During daytime construction of the well facility and pipelines, which would occur over approximately 14 months, noise levels would be significant (see Section 5.7, Noise and Vibration). These noise levels could potentially disrupt the adjacent land uses, which would be a *significant* impact. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce potential noise impacts to less-than-significant levels. The resulting noise levels would, therefore, be less than significant during the daytime. As a result, the impact on the character of the vicinity would be *less than significant with mitigation* and the land use would not be substantially disrupted or displaced.

Site 11

Site 11 would be located in an area of public and institutional land uses between El Camino Real and the Colma Creek Flood Control Channel, as shown in Figures 3-27 and 3-28. Neighboring land uses include an adjacent BART ventilation structure, the Kaiser Permanente Medical Center garage and parking lot, and an area used by the City of South San Francisco Public Works Department. The construction area would range from approximately 75 to 230 feet away from the South San Francisco Centennial Way Trail (which is a linear pedestrian and bicycle pathway) as it passes northeast of the site and would be approximately 400 feet from the closest residential uses located to the southwest across El Camino Real and at a higher elevation.

Project construction would not limit access to the trail or require closure of any portion of the trail. Construction would not limit access to the BART ventilation structure or the Kaiser Permanente Medical Center garage and parking lot. Therefore, there would be no land use impacts related to loss of access.

During daytime construction of the well facility and pipelines, which would occur over approximately 16 months, noise levels would not be significant (see Section 5.7, Noise and Vibration) and would not disrupt adjacent land uses. During nighttime construction associated with well drilling, residents would experience significant noise impacts, and therefore construction during this time would substantially disrupt the nearby residential land uses, which would be a *significant* impact. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce nighttime noise impacts to less-than-significant levels at the residences. Since the resulting noise levels would be temporary and less than significant and they would not substantially alter the existing character of the vicinity or disrupt the land use. As a result, this impact would be *less than significant with mitigation*.

Site 13

Site 13 would be located on SFPUC-owned land adjacent to commercial and single-family residential land uses. Approximately 60 feet east of the construction zone boundary is the South San Francisco Centennial Way Trail, which is a linear pedestrian and bicycle pathway. Construction activities would not require closure of the trail, and it would remain available to recreational users during construction.

Construction at Site 13 would require temporary alternating lane closures on segments of South Spruce Avenue and Huntington Avenue. Access to the businesses and offices along Huntington Avenue could be temporarily impacted during construction as installation of the pipeline may limit driveway access. In addition, access to a bank adjacent to Site 13, which only has one driveway off South Spruce Avenue, would also be temporarily blocked for approximately one day during pipeline installation associated with this site. Temporary loss of access to adjacent properties would substantially disrupt these land uses. The land use impact would be *significant*. However, as described in Section 5.6, Transportation and Circulation, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact of blocked access to the businesses and offices along Huntington Avenue and South Spruce Avenue to a less-than-significant level by limiting lane closures and maintaining access to driveways. Therefore, the impact on transportation access (including emergency access) following mitigation would not disrupt land use. As a result, this impact would be *less than significant with mitigation*.

No nighttime construction would be required at Site 13, because a test well already exists on the site. During daytime construction of the well facility and pipelines, which would occur over approximately 14 months, noise levels would be significant (see Section 5.7, Noise and Vibration). These noise levels could potentially disrupt the adjacent land uses, which would be a *significant* impact. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels to less-than-significant levels. Since the resulting noise levels would be temporary and less than significant, they would not substantially alter the existing character of the vicinity or disrupt the land use. As a result, the land use impact would be *less than significant with mitigation*.

Site 15

Site 15 would be located at the GGNC along Sneath Lane adjacent to the cemetery's operations and maintenance building and across the street from commercial uses. The pipeline installation associated with Site 15, which would extend along Sneath Lane to Cherry Avenue, would be adjacent to the GGNC, commercial land uses, and near multi-family residential land uses, as shown in Figure 3-36.

The pipeline to connect to the storm drain would require the temporary closure of both westbound and eastbound lanes of Sneath Lane and the temporary closure of the southern entrance to the GGNC. Although construction would affect the southern access to the GGNC, the main access to the cemetery, which is approximately 0.4 mile west of the construction area, would not be blocked, and visitors could continue to access the site via that entrance. As a result, access to the GGNC would be altered, but not eliminated. Land use impacts would be the same for both the proposed and alternate water connection pipelines. As a result, construction activities would not substantially change the character of the vicinity or substantially disrupt or displace adjacent land uses, and the impact would therefore be *less than significant*.

Daytime construction activities would result in temporary noise increases at nearby gravesites located as close as 30 feet away from the construction area. Visitors to the cemetery would also be exposed to construction-related noise.

During daytime construction of the well facility and pipelines, which would occur over approximately 16 months, noise levels would not be significant at the multi-family residences on Cherry Lane, which would therefore not substantially disrupt the land use (see Section 5.7, Noise and Vibration). However, during nighttime construction associated with well drilling, residents would experience significant noise impacts, which would therefore substantially disrupt the nearby residential land uses, which would be a *significant* impact. Nevertheless, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels to less-than-significant levels at the residences during the nighttime. Since the resulting noise levels would be less than significant, they would not substantially alter the existing character of the vicinity or disrupt the land use. As a result, this impact would be *less than significant with mitigation*.

Site 17 (Alternate)

Site 17 (Alternate) would be located within the SFPUC utility right-of-way and a portion of the Standard Plumbing Supply Company parking lot, as shown in Figure 3-38. The closest gravesites at Cypress Lawn Memorial Park would be approximately 150 feet from the construction area and separated from the facility site by mature vegetation and an elevation difference of approximately 25 feet. There is a senior care facility located about 400 feet northeast of the site. Visitors to Cypress Lawn would experience elevated levels of noise during the 16 months of construction at Site 17 (Alternate), but the cemetery is shielded from the proposed construction area by a change in elevation and mature landscaping (see Section 5.7, Noise and Vibration). Nighttime construction, which would be required during well drilling, would not disturb or disrupt the cemetery or commercial land uses in the area, since these are not open overnight. During nighttime construction residents at the senior care facility would experience *significant* noise impacts, which would disrupt this residential use. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce nighttime noise impacts to a less-than-significant level. As a result, this land use impact would be *less than significant with mitigation*. Pipeline installation (proposed water connection, sanitary sewer, storm drain, and electrical) for the site would extend halfway into Collins Avenue, which would require a temporary closure of the eastbound lane during construction, which is assumed for this analysis to last for approximately one week. Land use impacts for the proposed and alternate water connection pipelines would be the same. Standard Plumbing Supply would remain accessible, given that construction would not completely obstruct the driveway at this location. Access to other surrounding land uses, including the Serramonte Volkswagen car dealership and Cypress Lawn Memorial Park, would not be impeded. Although during construction, a portion of the Standard Plumbing Supply parking lot would be inaccessible, the majority of parking spaces would not be affected.

The Project would not substantially change the character of the vicinity or displace or disrupt adjacent commercial or cemetery land uses, which would be able to continue normal operations throughout construction. Nighttime noise impacts at the senior care center would be mitigated to ensure that this land use is not disrupted, and the impact would therefore be *less than significant with mitigation.*

Temporary land use disruption impacts would be reduced to a *less-than-significant* level through implementation of the mitigation measures identified below, as discussed for each well facility site in the preceding analyses.

Impact Conclusion: Less than Significant with Mitigation

<u>Sites 1, 3, 4, 5 (On-site Treatment) 9, 12, 14, 16, 18 (Alternate), and 19 (Alternate)</u>

Site 1

Land uses surrounding Site 1 include multi-family residential (Westlake Village Apartments), the Lake Merced Golf Club, and I-280 as shown on Figure 3-11. Construction of the alternate water connection pipeline (to Daly City) for Site 1 would require temporary closure of end of Poncetta Drive, whereas construction of the proposed water connection pipeline (to SFPUC) would not. The portion of Poncetta Drive that would be temporarily closed would be at the end of the roadway and would not affect access to residences or the apartments' garbage area.

Site 1 would be located within approximately 50 feet of Hole #4 and within 1,000 feet of six other playing holes used by golfers. During construction, Lake Merced Golf Club golfers would experience significant noise levels (see Section 5.7, Noise and Vibration) as they pass by the construction area. Section 5.11, Recreation analyzes the temporary impacts on golfing during construction. Because noise impacts from well drilling and construction of the well facility building would be significant and last over 16 months, the character of the recreational experience would deteriorate within approximately 340 feet of the well facility and the impact on recreation would therefore be *significant*. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would require a Noise Control Plan that would identify the best available noise control practices for the site and implementation of noise barriers such that noise levels would be reduced to less-than-significant levels. Construction of pipelines and the well facility building would therefore not substantially alter the existing character of the vicinity and, as a result, would not cause disruption or displacement of the land use, reducing impacts to *less-than-significant* levels.

During well drilling (which would occur over approximately seven days) residents in the Westlake Apartments closest to the proposed facility site would be exposed to high noise levels both during the day (within approximately 340 feet of the well facility) and night (within approximately 1,900 feet of the well facility). Noise levels during the day would be *significant* (see Section 5.7, Noise and Vibration). During nighttime construction associated with well drilling, residents would experience significant noise impacts, which would therefore substantially disrupt the nearby residential land use (apartment building), which would be a *significant* land use impact. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would require a Noise Control Plan that would identify the best available noise control practices for the site and require the implementation of noise barriers such that noise levels would be reduced at the apartment building. However, the resulting noise levels would still, at times, result in significant daytime impacts (within approximately 110 feet of the well facility for up to 16 months) and would continue to be significant at night (within approximately 190 feet of the well facility for up to seven days). This adjacent residential land use could therefore be disrupted during the nighttime construction. This would be a *significant and unavoidable* land use impact with mitigation, given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to an acceptable nighttime level and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]).

Site 3

Construction at Site 3 would occur near single-family residences and within the Ben Franklin Elementary School athletic fields. Construction would occur during two summer seasons when the school is not in session.

During daytime construction of the well facility (which includes a fenced enclosure without a building), which would occur over approximately six months, noise levels would be elevated. However, these impacts would be temporary and would not be significant at the neighboring land uses (see Section 5.7, Noise and Vibration). The Ben Franklin Intermediate School athletic field would be closed and inaccessible for recreation during the two summer seasons when construction would occur. These impacts on the recreational land use at the school would be temporary and recreational activities could be relocated to nearby recreational resources; see Section 5.11, Recreation for further information. Impacts on the existing character of the vicinity during daytime construction would therefore be *less than significant*, and no land uses would be substantially disrupted or displaced.

During nighttime construction associated with well drilling, residents located adjacent to Site 3 would experience significant noise impacts. During nighttime construction associated with well drilling, residents located up to 1,900 feet away would experience significant noise impacts, which would therefore substantially disrupt the nearby residential land uses, resulting in a *significant* land use impact. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels to less-than-significant levels. Although the resulting noise levels would be less than significant during the daytime, they would remain loud enough to disturb the sleep of the nearby residents (within approximately 190 feet of the well facility),which could therefore disrupt the adjacent residential land uses during the period of construction (approximately seven days for well drilling). Nighttime construction would have a *significant and unavoidable* land use impact with mitigation given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to an acceptable nighttime level and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]).

Site 4

Construction at Site 4 would occur near single-family residences and within and adjacent to the Garden Village Elementary School playing fields. Installation of the proposed water connection pipeline would occur along Park Plaza Drive within the school athletic field, as shown in Figure 3-12. Installation of the storm drain and electrical conduit would require temporary lane closures in Park Plaza Drive and in the intersection of Park Plaza Drive and 87th Avenue. Lane closures in Park Plaza Drive would occur for approximately one week, and the intersection would require controlled traffic for an additional week. School facilities are sensitive to construction-related noise, and can be more vulnerable to safety hazards, such as increased truck traffic, proximity to construction sites (e.g., open trenches), and construction equipment.

For purposes of this analysis, it is assumed that the Project would temporarily close or alter pedestrian access to the Garden Village Elementary School from Park Plaza Drive for up to two days, but that an alternate access would remain available from Garden Lane and Village Lane.

During daytime construction of the well facility (including only a fenced enclosure without a building), which would occur over approximately three months, noise levels would also be elevated (see Section 5.7, Noise and Vibration). These impacts would be *significant* at the neighboring land uses. However, impacts on the existing character of the vicinity would be *less than significant with mitigation* (M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), and no land uses would be substantially disrupted or displaced.

During nighttime construction associated with well drilling, residents located up to approximately 1,900 feet away from the well facility would experience significant noise impacts, which could therefore substantially disrupt the nearby residential land uses, resulting in a *significant* land use impact. Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce daytime noise impacts to less-than-significant levels; but residents within approximately 190 feet of the well facility would still experience significant nighttime noise impacts. Although the resulting noise levels would be less than significant during the daytime, they would remain loud enough to disturb the sleep of the nearby residents and could therefore disrupt these residential land uses during the period of construction (approximately seven days for well drilling). This would be a *significant and unavoidable* land use impact with mitigation, given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to an acceptable nighttime level and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]). Because the school is closed at night, it would not experience significant impacts during nighttime construction. The Garden Village Elementary School classrooms are sufficiently far away from the well site such that noise levels from well drilling during the daytime would not be *significant*, and therefore would not disrupt or displace the land use.

Site 5 (On-site Treatment)

Construction at Site 5 would occur adjacent to a single-family residence within a mostly commercial area. No nighttime construction would be necessary, because a test well already exists at the site. Pipeline installation, including storm drain, proposed and alternate water connections, sanitary sewer, and electrical line, would occur in B Street. Pipeline installation would require lane closures in B Street for approximately three weeks. Land use impacts of the proposed and alternate water connection pipelines would be the same. During daytime construction of the well facility and pipelines, which would occur over approximately 14 months, noise levels would be significant (for residents within approximately 340 feet of the well facility) (see Section 5.7, Noise and Vibration, for an explanation of terms and an evaluation of impacts). These noise levels could temporarily interfere with speech, which could significantly disrupt the adjacent residential land use due to their duration. Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels during the daytime; however noise impacts would still be significant for residents within approximately 110 feet of the well facility, resulting in a *significant and unavoidable* land use impact. The SFPUC would prefer to develop the GSR Project with consolidated treatment at Site 6 (refer to the Description of Sites 5, 6, and 7 in Section 3.4.3 of the Project Description), which would have the effect of avoiding the noise and related land use impact. If consolidated treatment at Site 6 is not possible, the noise (and therefore, land use) impact resulting from development of Site 5 with on-site treatment would be *significant and unavoidable* (see Section 5.7, Noise and Vibration).

Site 9

Site 9 would be located on the SFPUC-owned land adjacent to the Treasure Island Trailer Court, as shown in Figure 3-23. A Costco store and commercial uses along El Camino Real lie across the San Mateo County Flood Control Channel to the south; single- and multi-family residences and commercial uses lie across the Colma Creek Diversion Channel to the north.

Access to the proposed facility site would be along an existing San Mateo County Flood Control District (SMCFCD) access road that runs along the Colma Creek Diversion Channel adjacent to the trailers. Construction at the site could result in temporary impacts on the Treasure Island Trailer Court due to increased levels of noise, as described and analyzed under Impacts NO-1 and NO-2 in Section 5.7, Noise and Vibration. The closest trailers at the Treasure Island Trailer Court are located approximately 10 feet from proposed construction activities. At this distance, construction noise levels would be *significant*.

During daytime construction of the well facility and pipelines, which would occur over approximately 16 months, noise impacts would be significant (see Section 5.7, Noise and Vibration). Residences within approximately 340 feet of the well facility would experience significant daytime noise impacts. During nighttime construction associated with well drilling, residences located within approximately 1,900 feet of the well facility would experience significant noise impacts, which could substantially disrupt the nearby residential land use, resulting in a *significant* land use impact. Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels. Nevertheless, even with mitigation, residences within approximately 110 feet of the well facility would experience significant daytime noise impacts at times over the course of the 16-month construction period, and residences within approximately 190 feet of the well facility would experience significant noise impacts over the seven-day well drilling period. This would be a *significant and unavoidable* land use impact with mitigation, given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to a less-than-significant daytime or nighttime level and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]).

Site 12

Site 12 would be located west of El Camino Real on the SFPUC utility right-of-way, as shown in Figures 3-29 and 3-30. Site 12 would be located adjacent to single-family residences and adjacent to the Golden Chapel funeral home. The site would be across Southwood Drive from the Our Redeemer's Lutheran church, which also operates a daycare center. The pipeline route from Site 12 would parallel El Camino Real south along the SFPUC's Baden Valve Lot until reaching West Orange Avenue.

At Site 12, the installation of sanitary sewer, storm drain, and the proposed water connection line (to SFPUC) would require a temporary closure of portions of Southwood Drive, a portion of sidewalk along El Camino Real and portions of the funeral home parking lot. However, the remaining portions of the parking lot would remain available to business patrons during construction. Travel lane closures on Southwood Drive would have a significant impact related to safety hazards for vehicles sharing the road with construction vehicles. As described in Section 5.6, Transportation and Circulation, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the potential impact to a less-than-significant level. A SamTrans bus stop on southbound El Camino Real near West Orange Avenue would be located within the construction area boundary of the proposed water connection pipeline for Site 12 (Alternate) (see Figure 3-29). If the alternate water connection line (to a different SFPUC transmission pipeline) were installed instead, impacts on El Camino Real and the SamTrans bus stop would be avoided. However, if the proposed water connection were constructed, the impact on the performance and safety of public transit at this location would be significant, and therefore substantially disrupt this land use, which would be a *significant* impact. However, as described in Section 5.6, Traffic and Circulation, Mitigation Measure M-TR-1 would reduce the impact of construction on the performance and safety of the southbound bus stop on El Camino Real near West Orange Avenue by requiring coordination with SamTrans and the City of South San Francisco to arrange the temporary relocation of the bus stop, as necessary. Since the resulting impact would be less than significant, it would not substantially disrupt this land use. As a result this land use impact would be *less than significant*.

During daytime construction of the well facility and pipelines, which would occur over approximately 16 months, noise levels would be significant (see Section 5.7, Noise and Vibration). The funeral home would also be exposed to significant noise impacts during the daytime. During nighttime construction associated with well drilling residents located up to 190 feet away would experience significant noise impacts, which could substantially disrupt the nearby residential land use (apartment building), resulting in a *significant* land use impact. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels to less-than-significant levels at the funeral home and adjacent residences during daytime, but would remain significant at the adjacent residences during the nighttime (within 190 feet of the well) for the period of construction (approximately seven days for well drilling). This would be a *significant and unavoidable* land use impact with mitigation, given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to a less-than-significant nighttime level and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]).

Site 14

Site 14 would be located within the GGNC and near single-family residences, as shown in Figure 3-35 and Figure 3-35.

Well facility construction and pipeline installation at Site 14 would affect the land use at the GGNC due to increased levels of noise and reduced access to some gravesites during construction activities. Construction activities at Site 14 include installation of approximately 1,130 feet of pipeline through the cemetery within the SFPUC easement to convey water from the well at Site 14 to Sneath Lane (and then to the Site 15 treatment facility along Sneath Lane). The pipeline would cross three internal cemetery access roads, which could affect the circulation of visitors, as well as cemetery maintenance operations, through the cemetery grounds. This could be a substantial disruption of the GGNC's land use and if so, would be a *significant* land use impact. Land use impacts of the proposed water connection pipeline (to San Bruno) and the alternate water connection pipeline (to SFPUC) would be the same. However, Mitigation Measure M-LU-1 (Maintain Internal Cemetery Access) (as described above under Site 7) would reduce the land use impact relative to the existing character of the vicinity and disruption or displacement of the land use to *less than significant* by providing access to all portions of the cemetery within a reasonable time period for both visitors and maintenance.

During daytime construction of the well facility and pipelines, which would occur over approximately 16 months, noise impacts would be significant at the closest single-family residences, in that homes within 340 feet would at times experience significant noise impacts (see Section 5.7, Noise and Vibration). During nighttime construction associated with well drilling, residents located up to 1,900 feet away would experience significant noise impacts, which could substantially disrupt the nearby residential land use, resulting in a *significant* land use impact. However, Mitigation Measures M-NO-1 and M-NO-3 (Noise Control Plan and Expanded Noise Control Plan) would reduce noise impacts to during the daytime. However, residences located within approximately 110 feet of the well facility would still experience significant noise impacts over the 16-month construction period. Noise impacts experienced at residences during the nighttime would also be reduced. However, residences located within approximately 190 feet of the well facility would still experience significant nighttime noise levels during the seven-day well drilling period. The resulting noise levels would therefore remain loud enough to disrupt the residential land use. This would be a *significant and unavoidable* land use impact with mitigation, given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to less-than-significant levels either during the daytime or nighttime and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]).

Mitigation Measure M-LU-1: Maintain Internal Cemetery Access (Site 7 [Consolidated Treatment at Site 6] and Site 14)
(See above for description.)

Site 16

Site 16 would be located on the SFPUC-owned land currently occupied by Orchard Supply Hardware and used for parking, storage, and delivery truck turnaround. To the south, Site 16 is bordered by multi-family residential land uses and a convalescent hospital is located to the southwest, as shown in Figure 3-37. If the alternate water connection (between the proposed well and El Camino Real) is selected (see Figure 3-37), the pipeline would be installed through the Orchard Supply Hardware and A&W/KFC parking lot. Installation of this alternate pipeline connection would result in limited access to approximately one-third of the existing parking lot, which is assumed for the purposes of this analysis to occur over approximately 10 days. Customers of the hardware store and fast-food restaurant would be subject to increased noise and reduced parking during construction activities, but such effects would be temporary, and individual customers would be exposed for only brief periods of time as they walk to their cars or on the sidewalk along El Camino Real. Therefore, impacts on the existing character of the vicinity would be *less than significant*.

Delivery truck access during construction of the well facility at the site could be impaired because delivery trucks access the loading dock through an area immediately adjacent to the construction area boundary. Delivery trucks may have difficulty maneuvering within the reduced turning space available during construction at the site. As proposed, the SFPUC would work with Orchard Supply Hardware, its tenant, to ensure that deliveries could continue during construction by providing a temporary means of delivering materials either through a redesigned access approach, an alternate access point, or by development of a delivery schedule when access would be made available during Project construction (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). Therefore, impact on land use access during construction would be *less than significant*.

During daytime construction of the well facility and pipelines, which would occur over approximately 16 months, noise impacts would be significant at the multi-family residences (see Section 5.7, Noise and Vibration). During nighttime construction associated with well drilling, residents located up to approximately 1,900 feet away would experience significant daytime and nighttime noise impacts, which could substantially disrupt the nearby residential land use, which would be a *significant* land use impact. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels to less-than-significant levels during daytime but at residences located within approximately 190 feet of the well facility, noise levels would remain significant during the nighttime. Since the resulting noise levels would be less than significant during the daytime, they would not alter the existing character of the vicinity or disrupt or displace land uses. However, since noise levels at night would be significant within 190 feet of the well facility, they could disrupt the nearby residential land use during the period of nighttime construction (approximately seven days for well drilling). This would be a *significant and unavoidable* land use impact with mitigation, given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to a less-than-significant nighttime level and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]).

Site 18 (Alternate)

Site 18 (Alternate) would be located on a vacant parcel of land in a single-family residential area, as shown in Figure 3-39. An undeveloped portion of the Alta Loma Middle School grounds is located 170 feet to the southeast of the proposed Site 18 (Alternate) construction area; the nearest school structure would be approximately 415 feet away.

During daytime construction of the well facility and pipelines, which would occur over approximately 16 months, noise impacts would be significant at the adjacent single-family residences to the southwest (residences located within approximately 340 feet of the well facility would experience significant noise impacts at times with speech; see Section 5.7, Noise and Vibration).

Construction of the alternate water connection pipeline (to Cal Water) would require temporary closure of Alta Loma Drive for approximately two days, whereas the proposed water connection pipeline (to the SFPUC) would not result in lane closures. As described in Section 5.6, Transportation and Circulation, under Impacts TR-1 and TR-3, the travel lane closure on Alta Loma Drive would result in a temporary reduction in roadway capacity, but because the roadway would continue to operate satisfactorily during construction, the impact would be less than significant. Construction would also require a temporary closure (up to two days) of an approximately 25-foot stretch of sidewalk along the eastbound lane of Alta Loma Drive (see Figure 3-39). The potential impact would be less than significant, given that any such impact would be short-term and because the sidewalk along the westbound lane of Alta Loma Drive would remain open for pedestrian access around the construction zone. As described in Section 5.6, Transportation and Circulation, under Impact TR-2, the temporary closure also could result in increase in traffic safety hazards for vehicles sharing the road with construction vehicles. However, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Alta Loma Drive to a less-than-significant level. Because the impacts from the temporary closure of Alta Loma Drive would be less than significant with implementation of Mitigation Measure M-TR-1, the closure would not substantially disrupt adjacent land uses or affect the existing character of the vicinity. Therefore, this impact would be *less than significant*.

During nighttime construction associated with well drilling, residents located up to approximately 1,900 feet away would experience significant noise impacts, which could substantially disrupt the nearby residential land use, resulting in a *significant* land use impact. However, although Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels during the daytime, residences located within approximately 110 feet of the well facility would still experience significant daytime noise impacts at times over the course of the 16-month construction period, and during the nighttime, residences located within approximately 190 feet of the well facility would still experience significant nighttime noise impacts during the seven-day well drilling period. This would result in a *significant and unavoidable* land use impact with mitigation, given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to a less-than-significant daytime or nighttime level and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]).

Site 19 (Alternate)

Site 19 (Alternate) would be located west of El Camino Real on the SFPUC utility right-of-way, as shown in Figure 3-40. Site 19 (Alternate) would be located adjacent to single-family residences; a church, which also operates a daycare center; and across Southwood Drive from a funeral home.

At Site 19 (Alternate), the installation of storm drain and the alternate water connection line (to SFPUC) would require a temporary closure of Southwood Drive, whereas the proposed water connection pipeline (to a different SFPUC pipeline) would require temporary closure of portions of the funeral home parking lot. However, the remaining portions of the parking lot would remain available to business patrons during construction. Because construction-related access impacts would be temporary and because land uses would remain accessible during construction, the impacts on the existing character of the vicinity would be *less than significant*, and these land uses would not be displaced or significantly disrupted.

During daytime construction of the well facility (involving a fenced enclosure without a building) and pipelines, which would occur over approximately three months, noise impacts would be significant at the church and pre-school (see Section 5.7, Noise and Vibration). During nighttime construction associated with well drilling, residences located up to approximately 1,900 feet away would experience significant nighttime noise impacts, and the closest residences would experience significant daytime and nighttime noise impacts, which could substantially disrupt the nearby residential land use, resulting in a *significant* land use impact. However, Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce noise levels to less-than-significant levels at the church and pre-school during daytime. Nevertheless, at residences located within approximately 190 feet of the well facility, nighttime noise levels would remain significant during the approximately seven days required for well drilling. This would be a *significant and unavoidable* land use impact with mitigation, given that, although feasible mitigation is available that can reduce noise impacts (Mitigation Measures M-NO-1 [Noise Control Plan] and M-NO-3 [Expanded Noise Control Plan]), no feasible mitigation is available to reduce noise levels further to a less-than-significant nighttime level and well drilling must be continuous (see explanation in Chapter 3 Project Description, Section 3.5.3.1 [Construction Hours]).

Impact Conclusion: Significant and Unavoidable with Mitigation

5.2.3.5 Operation Impacts and Mitigation Measures

Impact LU-2: Project operations would result in substantial long-term or permanent impacts on the existing character or disrupt or displace land uses. (Less than Significant with Mitigation)

The following evaluation of impacts discusses sites with less-than-significant impacts first, followed by sites with significant impacts.

<u>Sites 2, 3, 4, 5 (Consolidated Treatment at Site 6), 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17 (Alternate), and 19 (Alternate)</u>

As described in Section 5.2.3.2 (Approach to Analysis), permanent displacement or long-term disruption of existing land uses would occur if the Project were to permanently displace existing land uses or permanently disrupt existing land uses or activities. The well facilities at Sites 2, 5 (Consolidated Treatment at Site 6), 6, 7, 8, 10, 12, and 19 (Alternate) would be located within the SFPUC's utility right-of-way. Well facilities at Sites 11 and 13 would be located on land owned by the SFPUC. Therefore, no existing land uses would be displaced or disrupted as a result of construction of the Project at these sites. In addition, operation and maintenance of groundwater well facilities at these locations would be consistent with the intended use of this land, given that these facilities would be located within the SFPUC's existing right-of-way or fee-owned lands, or within an existing public utility building. In addition, noise from operation of these well facilities would not be significant (see Section 5.7, Noise and Vibration, for further analysis). As a result, potential land use impacts on the existing character of the vicinity and/or displacement of existing land uses would be *less than significant*.

Operation and maintenance of the well facilities at Sites 3, 4, and 17 (Alternate) would be located within educational, undeveloped, and commercial land uses, respectively. Development of the well facilities would displace a small portion of these existing land uses. However, the well facilities at Sites 3 and 4 would be small[3] and would not be incompatible or conflict with established land uses, given that these facilities would be located within undeveloped or open landscaped areas and, because of their limited size and the passive unobtrusive nature of their operation, they would not require changes to the existing land uses. At Site 17 (Alternate), the existing commercial use's side yard (approximately 4,000 square feet), which appears to be used for storage, would be converted to a public facility use for the well facility building. This loss would reduce the size of the commercial land use in the area, but the parcel would continue to meet requirements for the Commercial zoning designation for setbacks, floor area ratio, and parking (Colma 2012). As a result, operation and maintenance of the well facilities at Sites 3, 4, and 17 (Alternate) would not have a substantial impact on the existing character of the Project vicinity. Residential, commercial, recreational, educational, and other existing land uses in the vicinity of these sites would continue without alteration or interference. Also, the buried pipelines associated with these sites would not interfere with ongoing use of the area, nor would they have a substantial impact on the existing character of the Project vicinity. In addition, noise from operation of these well facilities would not be significant (see Section 5.7 Noise and Vibration, for further analysis). Therefore, potential impacts on land use resulting from operation and maintenance of the well facilities at Sites 3, 4, and 17 (Alternate) would be *less than significant*.

Site 14 would be located at the northern boundary of the GGNC, approximately 80 feet from the cemetery boundary, within the SFPUC easement, which does not include grave sites. Existing roads and paths owned and maintained by GGNC would be used to access the site for operations and maintenance of the well. The well station would be visited daily, at times, during dry years for routine equipment inspections, lasting approximately 30 minutes each (see Chapter 3 Project Description, Section 3.8.3 [Maintenance]). An existing well house and tank facility adjacent to the site may be demolished, which, if so, could contribute to the existing land use character at this location in that additional open lawn area would be created as a result. Although the well facility building at Site 14 would be visible from surrounding gravesites, the overall character of the area would not change and the cemetery land use would, therefore, not be disrupted or displaced. In addition, noise from operation of the well facility would not be significant (see Section 5.7, Noise and Vibration, for further analysis). Therefore, the land use impact from operations at Site 14 would be *less than significant*.

Site 15 would be situated immediately adjacent to the GGNC maintenance building along Sneath Lane. Access roads for operations and maintenance of the well would be provided by existing roads and paths owned and maintained by GGNC. The well facility located adjacent to the GGNC maintenance building would not alter the use or change the character of the maintenance building because access to the maintenance building would remain unchanged, and the well facility design would be similar in character to the maintenance building as described in Chapter 3, Project Description. Also, noise from operation of the well facility would not be significant (see Section 5.7, Noise and Vibration, for further analysis). As a result, well facility siting, operation, and maintenance would not change the cemetery land use, surrounding land uses near Site 15, or the existing character of the Project vicinity, since access would not be impeded, and no cemetery components would be disrupted or displaced. Therefore, the land use impact from operations at Site 15 would be *less than significant*.

Site 16 would be located within the SFPUC's utility right-of-way. Therefore, no existing land uses would be displaced or disrupted as a result of construction of the Project at this site. In addition, operation and maintenance of groundwater well facilities at this location would be consistent with the intended use of this land, given that this facility would be located within the SFPUC's existing right-of-way. In addition, noise from operation of this well facility would not be significant (see Section 5.7, Noise and Vibration, for further analysis). As a result, potential land use impacts on the existing character of the vicinity would be *less than significant*.

The location of the well facility behind the loading dock of the adjacent commercial use would have the potential to impair delivery truck access during ongoing operation of the Project. Delivery trucks may have difficulty maneuvering within the reduced turning space available, and the limited turning space could affect deliveries for the Orchard Supply Hardware. However, the SFPUC would work with Orchard Supply Hardware, its tenant, to ensure that for deliveries would be maintained (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). Several options are available for modified access within the site leased by Orchard Supply Hardware, including reorientation of the loading area, reconfiguration of the area northwest of the well site to allow trucks to use this area for maneuvering, or temporarily roping off a portion of the parking lot as needed to provide delivery trucks with the space necessary to maneuver and deliver supplies. Therefore, the impact on land use access during operation would be *less than significant*.

Impact Conclusion: Less than Significant

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[3] Sites 3 and 4 would have fenced enclosures sized at 18 feet by 34 feet, or about 600 square feet.

Sites 1, 5 (On-site Treatment), 9, 18 (Alternate), and the Westlake Pump Station

The well facility at Site 5 (On-site Treatment) would be located within the SFPUC's utility right-of-way. The well facility at Site 9 would be located on land owned by the SFPUC. No existing land uses would be displaced or disrupted as a result of construction of the Project at these sites. In addition, operation and maintenance of groundwater well facilities at these locations would be consistent with the intended use of this land, given that these facilities would be located within the SFPUC's existing right-of-way or fee-owned lands.

Operation and maintenance of the well facilities at the Westlake Pump Station would not be incompatible or conflict with established land uses, given that these facilities would be sited within an existing municipal corporation yard. Also, the buried pipelines associated with these sites would not interfere with ongoing use of the area, nor would they have a substantial impact on the existing character of the Project vicinity.

Operation and maintenance of the well facilities at Site 1 would permanently remove a small portion of the golf club property from any future recreational use. Operation and maintenance of the well facilities at Site 18 (Alternate) would permanently remove a small portion of an undeveloped parcel of land from any future residential development. Although the well facilities at both of these sites would permanently displace a small area of an existing recreational use (Site 1) and a small area of land zoned for residential land use (Site 18), because of the limited size of the facilities, the loss of existing land uses and the land use character would be minimal. Existing recreational and residential uses in the vicinity of these sites would continue without substantial alteration. Therefore, the impact on land use from well facilities at Sites 1 and 18 (Alternate) would be *less than significant.*

Because the pipelines associated with the well facilities at all of these sites would be underground, they would not interfere with ongoing use of the areas, nor would they have a substantial impact on the existing character of the Project vicinity.

Operation of the well facilities at these sites would generate nighttime noise levels that could be significant at nearby residences (see Section 5.7, Noise and Vibration). In addition, up to three pumps would be added to the Westlake Pump Station; the size of these pumps is not known at this time and, therefore, this analysis assumes that nighttime operational noise could be significant. Long-term nighttime noise impacts would be a *significant* land use impact. However, Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce noise levels to less-than-significant levels. The resulting noise levels would not be significant, and, therefore, the impact on the character of the vicinity would be *less than significant*, and the land use would not be substantially disrupted or displaced.

Impact Conclusion: Less than Significant with Mitigation

5.2.4 Cumulative Impacts and Mitigation Measures

Impact C-LU-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to land use. (Significant and Unavoidable with Mitigation)

The geographic scope for the analysis of cumulative impacts on land use consists of each proposed GSR facility site and the immediate vicinity around each of these sites where adverse land use impacts could occur.

Alter the character of the vicinity or disrupt or displace a land use during construction

Construction of most of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would result in construction-related traffic safety hazards, noise, dust, and equipment exhaust in the vicinity of the proposed GSR Project sites. The cumulative projects identified in Table 5.1-3 are typical construction projects that can be assumed to occasionally occur within the cumulative study area on an ongoing basis; some are public works improvement projects, some are replacement of aging water and transportation infrastructure, and some are housing and commercial development projects. Potential cumulative impacts associated with construction period noise could occur at Sites 8, 12, 17 and 19, which overlap with the Peninsula Pipeline Seismic Upgrade Project; at Sites 11, 12, and 19, which overlap or are adjacent to the PG&E Transmission Pipeline Replacement Project (cumulative project H); at Site 11, which is close to the Cal Water Well Replacement SSF1-25 Project (cumulative project G); and at Site 9, which is close to the Mission & McLellan Project (cumulative project F). Land use disruption at Sites 9, 12, and 19 is considered a *significant and unavoidable impact* of the GSR Project because of nighttime construction noise. No nighttime construction is needed at Site 8 because the well has already been drilled at that location, and nighttime noise impacts are less than significant with mitigation at Sites 11 and 17.

Although construction of these projects could overlap with construction of the proposed GSR Project, cumulative impacts related to the existing character of the vicinity would be *less than significant*. Nighttime construction would occur in the same vicinity for both GSR Site 11 and the Cal Water Well Replacement SSF1-25 Project, but with mitigation the GSR Project's contribution to cumulative land use impacts would be *less than significant*. None of the other cumulative projects would require nighttime construction near a GSR Project facility site. Daytime construction noise is less than significant at Sites 8 and 17, and can be reduced to less than significant with mitigation at Sites 11 and 19. As with the proposed Project, the daytime construction activities associated with cumulative projects would be temporary and are not expected to rise to levels that would disrupt land use because the types of construction equipment and vehicles would be similar to those used for typical construction projects throughout the study area. Sites 9, 12, and 19 would result in significant disruptions to land use due to *unavoidable significant* impacts from daytime construction noise. Mitigation Measures M-NO-1 and M-NO-3 would reduce construction noise impacts, but the impact would remain significant at those sites. Combined with impacts of construction of cumulative projects at these sites, the GSR could result in cumulatively considerable contribution to a cumulative land use impact related to the existing character of the vicinity *(significant and unavoidable)*.

Alter the character of the vicinity or disrupt or displace a land use during operation

Most of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would be typical of the land uses in the cumulative study area and would have no long-term or permanent effect on the character of the vicinity given their nature. However, two of the cumulative projects, the Mission & McLellan Project (cumulative project F) and the Centennial Village Project (cumulative project I), are infill projects that would at least partially redevelop existing land dedicated to housing or commercial land uses; even so, these would not substantially change the character of the land uses in the vicinity because the two mixed-use projects would be located in an area of commercial and residential land uses.

After construction is complete, the proposed GSR Project would be a passive and unobtrusive land use located on appropriate sites for such public facilities. Therefore, cumulative impacts related to the existing character of the vicinity would be *less than significant*.

Operation of the proposed GSR facilities would also generate sufficient noise such that sleep may be significantly disrupted at nearby residences. These project-specific impacts would occur at GSR Sites 1, 5 (On-site Treatment), 9, 18 (Alternate), and the Westlake Pump Station. However, these impacts would be less-than-significant with implementation of Mitigation Measures M-NO-5 (Operational Noise Control Measures) (see Section 5.7, Noise and Vibration, for the full text of the mitigation measures and an explanation of their effectiveness). The cumulative projects that may also generate incremental additions to the noise environment from operations are: The San Francisco Groundwater Supply Project wells (cumulative projects A1 to A6), the Daly City "A" Street Well Replacement (cumulative project C), the Mission & McLellan Project (cumulative project F), the Cal Water Well Replacement SSF1-25 (cumulative project G), and the Centennial Village Project (cumulative project I). None of these cumulative projects is close enough to the GSR Project facility sites to create cumulative noise impacts. Therefore, cumulative impacts related to disturbance or disruption of land uses would be *less than significan*t.

5.2.5 References

Colma, Town of. 2012. *Colma Municipal Code Chapter Five: Planning, Zoning, Use, and Development of Land and Improvements, Subchapter 5.03: Zoning, Section 5.03.290: Restrictions Applicable to "C" Zone*. October.

5.3 AESTHETICS

This section addresses the potential aesthetic and visual quality impacts associated with implementation of the proposed Project. Aesthetic resources, also referred to as visual resources, are defined as the visible natural and built landscape features that surround a given area. This section describes the existing visual setting in the vicinity of each proposed facility site and evaluates the potential effects of the Project on visual resources.

5.3.1 Setting

The discussion below defines the terms used in the aesthetics evaluation. For the purpose of this aesthetics evaluation, the visual study area includes the Project construction areas and the surrounding vicinity from which views could be affected.

5.3.1.1 Concepts and Terminology

Visual or aesthetic resources are generally defined as both the natural and built features of the landscape that contribute to the public's experience and appreciation of the environment. Depending on the extent to which a project's presence would alter the visual character and quality of the environment, a visual or aesthetic impact may occur. Familiarity with the following terms and concepts will aid the reader in understanding the content of this chapter.

Visual character, visual quality and visual sensitivity are the terms used throughout the analysis, and are defined below.

Visual Character

Visual character is a general description of the visual attributes of a particular land use setting and the unique set of landscape features. The purpose of defining the visual character of an area is to provide the context within which the visual quality of a particular site or locale is most likely to be perceived by the viewing public. For urban areas, visual character is typically described on the neighborhood level or in terms of areas with common land use; intensity of development; socioeconomic conditions; and/or landscaping and urban design features. For natural and open space settings, visual character is most commonly described in terms of areas with common landscape attributes (such as landform, vegetation, water features).

Visual Quality

Visual quality is defined as the overall visual impression or attractiveness of a site or locale as determined by its aesthetic qualities (such as color, variety, vividness, coherence, uniqueness, harmony, and pattern). Natural and built features combine to form perspectives with varying degrees of visual quality, which is rated in this analysis as low, moderate, and high, as follows:

- **Low.** The location is lacking in natural or cultural visual resource amenities typical of the region. A site with low visual quality will have aesthetic elements that are relatively unappealing and perceptibly uncharacteristic of the surrounding area.
- **Moderate.** The location is typical or characteristic of the region's natural or cultural visual amenities. A site with moderate visual quality maintains the visual character of the surrounding area, with aesthetic elements that do not stand out as either contributing to or detracting from the visual character of an area.
- **High.** The location has visual resources that are unique or exemplary of the region's natural or cultural scenic amenities. A site with high visual quality is likely to stand out as particularly appealing and makes a notable positive contribution to the visual character of an area.

Affected Viewers and Exposure Conditions

Affected viewers and exposure conditions address the variables that affect viewers and their visual exposure to the well facility sites. The identification of *viewer types* and *volumes* describes the type and quantity of potentially affected viewers within the visual study area. Land uses that derive value from the quality of their settings are considered potentially sensitive to changes in visual conditions. S*ensitive viewers* are those who have a strong stake or interest in the quality of the landscape and have a greater level of concern towards changes that degrade or detract from the visual character of an area. Examples of viewers with elevated concern for visual quality include travelers on designated scenic routes, park visitors and other recreationists, bikers, pedestrians, and tourists. Cemetery visitors are included in this category for purposes of this study.

Viewer exposure considers some or all of the following factors: landscape visibility (the ability to see the landscape); viewing distance (the proximity of viewers to the facility sites); viewing angle (whether the facility sites would be viewed from a superior, inferior, or level line of sight); extent of visibility (whether the line of sight is open and panoramic to the facility sites or restricted by terrain, vegetation, and/or structures); and duration of view.

Visual Sensitivity

Visual sensitivity is the overall measure of a site's susceptibility to adverse visual changes. Visual sensitivity is rated as high, moderate, or low and is determined based on the combined factors of visual quality, viewer types and volumes, and visual exposure to the proposed Project as described above. A setting's overall visual sensitivity is the measure of its susceptibility to significant visual impacts as a result of project-caused visual change. Thus, significant adverse impacts are typically unlikely in a setting with low overall sensitivity.

Visual Study Area

The visual study area (viewshed)[1] for each facility site is that from which either well facilities or pipeline construction activities would be visible to the public. Because the proposed facility sites are located in both urban and heavily vegetated open space settings, trees, shrubs, and buildings quickly restrict or block views of facilities as viewers move away from facility sites; consequently, these elements limit the visual study area in most places to publicly accessible locations immediately surrounding proposed facility sites. In some locations, however, favorable topographic relationships or the lack of intervening features extends the distance from which a viewer would be able to observe features of the proposed sites. Further, proposed Project construction activities may remove existing visual screening, particularly trees and other vegetation, extending the area of potential visibility. Because the exact boundaries of the visual study area depend on site conditions (i.e., viewshed, structures, and vegetation), performing an assessment of the visual study area is important in identifying potentially affected viewers and describing the visual quality and character of relevant locations.

Field reconnaissance for the proposed Project was conducted in February 2010, April/May 2011 and March 2012. Observations of the proposed well facility sites and pipeline locations, including the proposed pipeline route and connection and the alternate connection, were performed to identify the visual study area and take representative photographs of existing visual conditions. Photographs are included in this section to document the existing visual conditions of the facility sites and adjacent areas at the time of the 2011 and 2012 field observations. Figures 5.3-1 through 5.3-10 depict views of facility sites and surrounding locations.

5.3.1.2 Visual Character of the Project Area

The proposed Project would be located in the northern portion of the San Francisco Peninsula. The 20 possible locations where Project facilities could be sited are located from Daly City to Millbrae, with the Coast Range foothills to the southwest, San Bruno Mountain to the north, and flat lands extending to San Francisco Bay to the east. Each of the proposed well facility sites would be situated within developed portions of the Peninsula, surrounded by man-made features. The Project area is characterized by developed urban/suburban areas, including portions of the urban cores of Daly City, Colma, South San Francisco, San Bruno, and Millbrae. The topography of the Project area is relatively flat, with a few moderate hills. Open spaces in the Project area are suburban in nature, including golf courses, cemeteries, and pedestrian pathways along channelized creeks. Vegetation is generally ornamental and non-native, with mature trees present in some areas.

The following provides a description of the areas where well facilities would be located, including a general description of the locations within the City of Daly City, Broadmoor Village in unincorporated

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[1] A viewshed is an area of land, water, or other urban or environmental element that is visible to the human eye from a fixed vantage point.

San Mateo County, the Town of Colma, the City of South San Francisco, the City of San Bruno, and the City of Millbrae.

City of Daly City

Sites 1, 2, and the Westlake Pump Station would be located in the Westlake Neighborhood. Westlake was developed in the late 1940s and early 1950s as a central shopping mall surrounded by single-family and multi-family residences on rolling topography. The single-family residences are primarily one or two stories with the primary living space over a single-car garage. Exterior construction materials and colors tend to be of masonry stucco and finished in pastel shades. This subdivision is one of the first master planned post-WWII suburbs and was known for its appearance of neat rows of homes along the residential streets in the area. The shopping mall forms the core of the neighborhood, with the Westlake Village Apartment complex adjacent to the south, east and west. Different parts of this large apartment complex are within sight of Sites 1, 2, and the Westlake Pump Station. Site 2 also borders on the Broadmoor Village neighborhood, discussed below.

Sites 5 and 6 would be located at the southern end of "Original Daly City" in an area known as the Bay Area Rapid Transit (BART) neighborhood or the Colma neighborhood. This area is mixed commercial, with Junipero Serra Boulevard providing a hard or defined visual boundary on the west. The BART tracks to the east and the cemeteries of Colma to the south also provide hard visual boundaries completing the triangular layout of this neighborhood. Approximately half of the area of this neighborhood is comprised of either parking lots or auto dealer show lot.

Broadmoor Village, Unincorporated San Mateo County

Sites 3 and 4 would be located in Broadmoor Village. The residential neighborhood of Broadmoor Village is within an unincorporated area of San Mateo County surrounded by the Daly City and adjacent to the south of the Westlake Neighborhood. Developed on sloped terrain, Broadmoor contains one-story bungalows with occasional larger two-story structures. Exterior construction materials and colors tend to be of masonry stucco and finished in pastel shades. While some stands of mature trees exist, generally the presence of vegetation is limited to lawns and other similar types of ornamental landscaping. The southern part of the Westlake Village Apartment complex forms a visual boundary between Broadmoor and the Westlake Neighborhood. The south-facing apartments are visible from Sites 3 and 4.

Town of Colma

Sites 7, 8, and 17 (Alternate) would be located within the Town of Colma. Colma is a community dominated by cemeteries surrounding a commercial core. San Bruno Mountain provides a natural visual backdrop to the town from the surrounding areas. Most of the land east of El Camino Real is committed to cemetery use or agricultural fields (e.g., flower growing plots, greenhouses). These uses lead up to the foot of San Bruno Mountain and impart a rural atmosphere. Land west of El Camino Real is oriented more towards commercial uses, although Colma's regionally oriented commercial core is bracketed on the north and south by cemeteries. The aesthetic component of the community's character is largely a function of the cemeteries and associated open space and landscaping. Wellgroomed lawns, rolling hills, manicured landscaping and natural vegetation, quiet scenic areas for meditation, and tranquil paths for strolling are common and essential features of Colma's memorial park uses.

City of South San Francisco

Sites 9, 10, 11, 12, 13, 18 (Alternate), and 19 (Alternate) would be located in South San Francisco. South San Francisco occupies a broad valley formed by San Bruno Mountain on the north and the Coast Range on the west. Most of the valley faces adjacent San Francisco Bay to the east and south, affording sweeping vistas from higher levels and a definite sense of identification with the Bay. The hills to the west shield the city from much of the fog that prevails in neighboring areas (South San Francisco 2012). The facility sites essentially parallel El Camino Real through the heart of the city. This corridor through the city is primarily commercial in appearance, with interspersed residences.

City of San Bruno

Sites 14 and 15 would be located in San Bruno within the Golden Gate National Cemetery (GGNC), a military cemetery bordered by single-family neighborhoods on the north, retail on the east and south and I-280 on the west. An auxiliary entrance to the cemetery is midway along its southern border off Sneath Lane where the cemetery's maintenance buildings are located. Site 14 would be located within the interior of the cemetery and Site 15 would be located adjacent to a GGNC maintenance building along Sneath Lane.

City of Millbrae

Site 16 is located in the east-central portion of Millbrae between El Camino Real and U.S. Highway 101 (U.S. 101) near San Francisco International Airport. The general area has a highway commercial appearance, with residential neighborhoods off of El Camino Real. In addition to El Camino Real, U.S. 101 and the Airport, this area is traversed by the Caltrain commuter rail line and Interstate 380 (I-380).

The visual characteristics and features of the facility locations are described below by jurisdiction and by facility site.

Overall Visual Sensitivity

The overall visual sensitivity of each facility site is described in terms of its visual quality, potentially affected viewers and exposure conditions. Table 5.3-1 (Summary of Visual Sensitivity Findings) summarizes these attributes, which are described in more detail in the remainder of this section. This section refers frequently to the site layout graphics included as Figures 3-11 through 3-40 in Chapter 3, Project Description.

TABLE 5.3-1
Summary of Visual Sensitivity Findings

Facility Site	Visual Quality	Affected Viewers and Exposure Conditions	Overall Visual Sensitivity
Site 1 Lake Merced Golf Club (see Figure 5.3-1) (see Figure 3-11)	Moderate	Partially visible to moderate numbers of golfers from golf links that would be roughly 50 feet away; not visible from I-280 due to tree line and speed of travel. Limited views from some neighboring residences. Site would be upslope from adjoining links; golfers would have an obstructed view of the site due to the angle of the slope and intervening vegetation (the site currently includes an existing restroom structure). Visual exposure is thus low. Viewer concern for visual quality would be moderate (golfers).	Moderately Low
Site 2 Park Plaza Meter (see Figure 5.3-1) (see Figure 3-12)	Moderate	Moderate exposure to numerous viewer groups, including relatively high numbers of motorists on Park Plaza Drive (brief), pedestrians, including students going to and from Garden Village and Ben Franklin schools, some residences, and athletic field users (periodic) who may be exposed for longer periods. Viewer concern of these affected groups would be moderate.	Moderate
Site 3 Ben Franklin Intermediate School (see Figure 5.3-4) (see Figure 3-12)	Moderate	Moderate exposure to Park Plaza Drive across an open athletic field. Exposed to athletic field users (periodic) at very close distance. Limited visual exposure to nearby residences. Viewer concern of these affected groups would be moderate.	Moderate

TABLE 5.3-1
Summary of Visual Sensitivity Findings

Facility Site	Visual Quality	Affected Viewers and Exposure Conditions	Overall Visual Sensitivity
Site 4 Garden Village Elementary School (Figure 5.3-4) (Figure 3-12)	Moderately High	Moderately high exposure to numerous viewer groups, including motorists along Park Plaza Drive (brief), pedestrians including students going to and from school, some nearby residences (limited), and playing field (periodic, distant) users who may be exposed for longer periods. Partial screening by existing trees, fencing. However, these trees would be removed during construction of the Project increasing exposure. Viewer concern of these affected groups would be moderately high.	Moderately High
Westlake Pump Station (Figure 5.3-2) (Figure 3-13)	Low	Minimal exposure. All Project components would be within the confines of the existing pump station.	Low
Site 5 Right-of-Way at Serra Bowl (Figure 5.3-2) (Figure 3-15, Figure 3-19)	Low	Moderately exposed to passing motorists on Junipero Serra Boulevard, B Street, and Hill Street (brief), pedestrians (brief), commercial service patrons (periodic), and to one residence. Viewer concern of these affected groups would be moderate.	Moderately Low
Site 6 Right-of-Way at Colma BART (Figure 5.3-3) (Figure 3-16, Figure 3-20)	Low	Highly exposed to passing motorists on D Street (brief), pedestrians (brief), and BART commuters (brief). Minimal exposure from Woodlawn Memorial Park because the cemetery is located beyond view of the proposed site. Viewer concern of these affected groups would be low.	Low

TABLE 5.3-1
Summary of Visual Sensitivity Findings

Facility Site	Visual Quality	Affected Viewers and Exposure Conditions	Overall Visual Sensitivity
Site 7 Right-of-Way at Colma Boulevard (Figure 5.3-3) (Figure 3-17, Figure 3-21)	Moderately Low	Facility Site: Moderate exposure to passing motorists (brief), pedestrians (brief), and Woodlawn and Greenlawn Memorial Park visitors (periodic). Cemetery visitors at Woodlawn Memorial Park, located north of the facility site, would have limited views of the facility site because topography partially limits views downslope to the site. Cemetery visitors at Greenlawn Memorial Park, located south of the facility site, would have unobstructed views of the facility site. Pipeline Route: highly exposed to Woodlawn Memorial Park visitors (brief and infrequent). Viewer concern would be moderately high (periodic cemetery visitors).	Moderately High
Site 8 Right-of-Way at Serramonte Boulevard (Figure 5.3-8) (Figure 3-22)	Moderately Low	Minimal exposure. Exposed only to motorists on Serramonte Blvd (brief), pedestrians (brief), and employees/patrons at surrounding businesses (periodic, random). Viewer concern of these affected groups would be low.	Low
Site 9 Treasure Island Trailer Court (Figure 5.3-5) (Figure 3-23, Figure 3-24)	Low	Minimal exposure. Isolated location. Exposed to bicyclists and pedestrians (brief) and upper floor residences located south of the facility site. Exposed to trailer court residences to the north. Viewer concern of these affected groups would be low.	Low
Site 10 Right-of-Way at Hickey Boulevard (Figure 5.3-6) (Figure 3-25)	Moderately Low	High exposure to motorists along Hickey Blvd and Camaritas Ave., pedestrians (few), and employees/patrons at neighboring businesses (periodic, random). Views from nearby residences (limited) mostly screened by existing vegetation. Moderate viewer sensitivity/concern.	Moderate

TABLE 5.3-1
Summary of Visual Sensitivity Findings

Facility Site	Visual Quality	Affected Viewers and Exposure Conditions	Overall Visual Sensitivity
Site 11 South San Francisco Main Area (Figure 5.3-6) (Figure 3-27, Figure 3-28)	Low	Facility site is minimally exposed to views from El Camino Real due to terrain and existing intervening trees and the BART structure. Moderately exposed to Centennial Way Trail users (brief) adjacent to a transit-service facility. Trees on El Camino are highly exposed to motorists and would be removed. Viewer concern of trail users and El Camino Real motorists is moderate.	Moderately Low
Site 12 Garden Chapel Funeral Home (Figure 5.3-7) (Figure 3-29, Figure 3-30)	Moderate	Highly exposed to high numbers of passing motorists along El Camino Real and Southwood Drive (brief); pedestrians (brief), and funeral home employees/visitors (periodic). Views from nearby residences highly filtered by existing backyard fences, landscaping. Overall exposure moderate (El Camino). Viewer concern is moderate.	Moderately High
Site 13 South San Francisco Linear Park (Figure 5.3-7) (Figure 3-31, Figure 3-32)	Moderate	Highly exposed to motorists on South Spruce Ave. (brief), pedestrians (brief), some residences, employees/patrons of adjacent businesses (periodic), and Centennial Way Trail users (periodic). Overall high exposure, due to adjacency of the trail. High viewer sensitivity/concern (trail users).	Moderately High
Site 14 Golden Gate National Cemetery (Figure 5.3-9) (Figure 3-34, Figure 3-35)	High	Highly exposed to GGNC cemetery visitors (brief and infrequent). Viewer concern high (GGNC).	High
Site 15 Golden Gate National Cemetery (Figure 5.3-9) (Figure 3-34, Figure 3-36)	Moderately High	Moderately high exposure to motorists along Sneath Lane (brief), pedestrians (brief), employees/patrons of adjacent businesses and V.A. Medical Clinic (periodic), and cemetery visitors (infrequent) users from limited vantage points. Viewer concern moderately high (GGNC).	Moderately High

TABLE 5.3-1
Summary of Visual Sensitivity Findings

Facility Site	Visual Quality	Affected Viewers and Exposure Conditions	Overall Visual Sensitivity
Site 16 Millbrae Corporation Yard (Figure 5.3-10) (Figure 3-37)	Low	Visually inaccessible to the public, except for brief views from adjacent portion of Monterey Street. Exposure is minimal due to the isolated location. Exposed only to employees/patrons of adjacent business (periodic) and a small number of adjacent upper floor residences. Viewer concern of these affected groups would be low.	Low
Site 17 (Alternate) Standard Plumbing Supply (Figure 5.3-10) (Figure 3-38)	Moderate	Moderate exposure to relatively low numbers of motorists on Collins Avenue (brief), few pedestrians (brief), and employees/patrons at Standard Plumbing Supply (periodic, random). Overall exposure is low. Viewer concern would be low (commercial/industrial area).	Low
Site 18 (Alternate) Alta Loma Drive (Figure 5.3-8) (Figure 3-39)	Moderate	Highly exposed to neighboring residential areas/streets and transit stops (brief, periodic). Minimally exposed from Alta Loma Middle School (distant, well-screened). Moderately high viewer sensitivity/concern (neighborhood).	Moderately High
Site 19 (Alternate) Garden Chapel Funeral Home (Figure 5.3-8) (Figure 3-40)	Moderate	Moderately exposed to passing motorists on Southwood Drive (brief) and funeral home employees/visitors (periodic). Views from nearby residences highly filtered by existing backyard fences, landscaping. Overall exposure moderate (El Camino Real). Viewer concern moderate.	Moderate

5.3.1.3 *Individual Project Well Facility Sites*

Daly City - Sites 1, 2, 5, 6, and the Westlake Pump Station

Site 1

Figure 5.3-1 (Views of Sites 1 and 2) shows the existing views of the site. Figure 3-11 (Site 1 Lake Merced Golf Club) in Chapter 3, Project Description shows the layout of the proposed facility site.

Visual Quality

Site 1, as well as its proposed and alternate water lines, storm drain, and sanitary sewer connections, would be located in the northeastern corner of the Lake Merced Golf Club, a privately owned and operated golf club. The site would be approximately 50 feet away from the fairways, not in direct line of view from these fairways, and lined by mature trees on the east, which partially obscure the view of I-280 to the east. The ground at this site is mostly bare. A restroom facility of concrete block construction is situated in the southern part of the site. At the time of the site visit, piles of vegetative waste were being stored on the site. While the visual quality of the site itself is low, visual quality of the setting for potentially sensitive viewers looking from within the golf club is moderate.

Affected Viewers and Exposure Conditions

Site 1 would be located such that the view from the fairways would be uphill toward I-280 and the Westlake Village Apartment complex. The apartment complex provides a developed backdrop for the site when viewed from the golf club. This site would also be visible to a limited number of residences on the upper floors of the apartment complex and potential views would be very limited in extent. There is sufficient existing vegetation to screen this site from travelers on I-280. Therefore, this site would have limited exposure from publicly accessible vantage points. Potentially affected high-sensitivity viewers would be limited to those on the golf club. Recreationists may be assumed to have high sensitivity to visual quality, although their overall number and, thus, viewer sensitivity in this case would be moderate. However, the site is upslope from adjoining links and, thus, largely screened from the links by intervening slope, partial screening by existing trees, and an existing restroom structure that is proposed for demolition by the Project. Overall exposure to golf club users is, thus, low.

Overall Visual Sensitivity

Site 1 would be located in the northeast corner of the Lake Merced Golf Club, which has limited publicly accessible viewing opportunities. The principal potentially sensitive viewers of Site 1 would be golfers who, as recreationists, would be considered to have high concern for visual quality. The site would be located above the golf links; golfers would have an obstructed view of the site due to the angle of the slope and intervening vegetation. The slope up to the site is landscaped and planted with acacia, which would likely eventually grow taller over time, continuing to effectively block the view of Site 1 from the fairways. Thus, viewer concern is potentially moderate and their exposure is low. Overall visual sensitivity at this site is considered moderately low, given the potential visual sensitivity of the particular viewer group and limited public views.

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Site 1: View looking southwest toward the facility site from the gate at Poncetta Drive. A restroom facility appears at left and the golf course is in the distance. The Westlake Village Apartments are behind the viewer.

Site 2: View looking southeast toward the facility site, with the Lake Merced Golf Course maintenance road and Park Plaza Drive in the foreground. The Ben Franklin playing fields are behind the viewer.

Legend

View Direction

Construction Area

Views of Sites 1 and 2

Regional Groundwater Storage and Recovery Project

Figure 5.3-1

Site 2

Figure 5.3-1 (Views of Sites 1 and 2) shows the existing views of Site 2 and Figure 3-12 (Site 2 Park Plaza Meter, Site 3, Ben Franklin Intermediate School, Site 4 Garden Village Elementary School) in Chapter 3, Project Description shows the layout of the facility site.

Visual Quality

Site 2 would be located just outside the southwest corner of the Lake Merced Golf Club and south of the golf club maintenance access road. Site 2's proposed connection to the Daly City pipeline and its storm drain connection would be in the same area. The site would not be visible from the fairways, which are located uphill from the site. This site is located immediately off the street at the edge of an extensive open space area comprised of playing fields of the Garden Village Elementary School and across Park Plaza Drive from the athletic fields at the Ben Franklin Intermediate School. The open space area is characterized by open grassy fields against a backdrop of mature trees to both the northeast and southwest. The large contiguous open space and prominent landscaping lends a park-like character to this segment of Park Plaza Drive. Site 2 is situated at the edge of this open space, demarcating a transition from residential apartments to the north. The site itself may have moderate visual quality, but it also occupies a prominent position within the more attractive and sensitive recreational open space. Visual quality of the open space setting is moderate.

Affected Viewers and Exposure Conditions

Motorists and pedestrians would temporarily see this well facility site traveling either direction on Park Plaza Drive. It would also be periodically visible to users and spectators at the athletic field if looking toward the site. This site would be visible from the south-facing apartments in a section of the Westlake Village Apartment complex. Because it occupies a prominent foreground position adjoining Park Plaza Drive and playfields of Ben Franklin and Garden Village schools, the site would be exposed to unobstructed views from both the street and open space area. Its exposure is considered moderate.

Affected viewer groups at this site include moderately high numbers of motorists, relatively high numbers of school children traveling to and from school, high numbers of students engaged mainly in active recreation on the adjoining playfields, and visitors entering Lake Merced Golf Club. Active recreationists may be considered to have lower levels of viewer concern than those engaged in recreational activity in which scenery is a primary focus. Viewer concern/sensitivity of all these groups is considered moderate.

Overall Visual Sensitivity

Site 2 would be visible from Park Plaza Drive and the athletic fields at the Benjamin Franklin Intermediate School. Recreationists involved in sports activities are assumed to be focused primarily on those activities and only secondarily on the visual setting. Sensitivity of these active recreational viewers is considered moderate. It would also be visible from portions of the Westlake Village Apartment complex. Residents may generally have high viewer sensitivity. However, visual exposure to the site from these homes is limited. Motorists on Park Plaza Drive would also have moderate sensitivity. Given the moderate visual quality of the vicinity, moderate visual exposure, and moderate viewer concern/sensitivity, overall visual sensitivity is considered moderate.

Westlake Pump Station

Figure 5.3-2 (Views of Westlake Pump Station and Site 5) shows the view of the Westlake Pump Station and Figure 3-13 (Westlake Pump Station Upgrades) in Chapter 3, Project Description illustrates the location of the existing pump station.

Visual Quality

The new facilities at the Westlake Pump Station would be housed inside the building. The pump station is situated within a fenced public works yard adjacent to the Westlake Village Apartments on the north, the Ben Franklin Intermediate School grounds to the south and east, and a single-family residential neighborhood to the west. As the new facilities would be installed within the confines of an existing building at a corporation yard, the visual quality here is considered low.

Affected Viewers and Exposure Conditions

The Westlake Pump Station is located at the northwest corner of the Ben Franklin Intermediate School and is located adjacent to the school's basketball courts and a playfield. Users of these facilities have a clear view of the pump station. This site would also be visible from the upper floors of the Westlake Village Apartment complex. However, proposed new facilities would be contained within the pump station structure, giving it minimal exposure from publicly accessible areas during construction.

Overall Visual Sensitivity

The existing Westlake Pump Station is located within a fenced public works yard adjacent to a section of the Westlake Village Apartment complex and the back side of the Benjamin Franklin Intermediate School. A cluster of mature eucalyptus and Monterey pine trees partially shield views of the pump station yard from residential areas to the west. This site is considered to have low visual sensitivity.

Site 5

Figure 5.3-2 (Views of Westlake Pump Station and Site 5) shows views of the proposed well facility site. The site layout is illustrated on Figure 3-15 (Site 5 [Consolidated Treatment at Site 6] Right-of-Way at Serra Bowl) and Figure 3-19 (Site 5 [On-Site Treatment] Right-of-Way at Serra Bowl) in Chapter 3, Project Description, which show the well facility with consolidated treatment at Site 6 and with the on-site treatment option, respectively.

Visual Quality

Site 5 would be located in a vacant paved lot between a State Farm Insurance Agency office and a single-family residence. The parking lot for the former Serra Bowl is adjacent to the south, with the Serra Bowl building beyond the parking lot. B Street creates the north border of the site; an automobile dealership is located across B Street from the site. Site 5's storm drain connection would be along B Street. There is no vegetation on this site to provide screening.

Site 5 includes two treatment options. The consolidated treatment option includes installation of pipelines to convey water from the well facility at Site 5 to the well facility at Site 6 for water treatment. The pipeline route would pass through the Serra Bowl parking lot, the SamTrans Park and Ride lot, and the Colma BART Station property. Alternately, if it is not feasible to consolidate treatment at Site 6, water may be treated on-site at Site 5 with a water system pipeline connection within B Street.

With the exception of the neighboring residence, Site 5 does not possess unique visual characteristics; therefore, the visual quality here is considered low.

Affected Viewers and Exposure Conditions

Site 5 would be visible to motorists and pedestrians on the surrounding streets, as well as from the Serra Bowl building, the insurance office, and the adjacent single-family residence. This site is on B Street, which is a side street with low levels of traffic. It is used mainly for parking and the area is dominated by the adjacent car dealership and other auto-related facilities. Construction of the pipeline between Sites 5 and 6 would be visible to motorists and pedestrians on D and Hill Streets. Given the neighboring streets and businesses, Site 5 is considered to have moderate exposure and the viewer concern is considered moderate.

Overall Visual Sensitivity

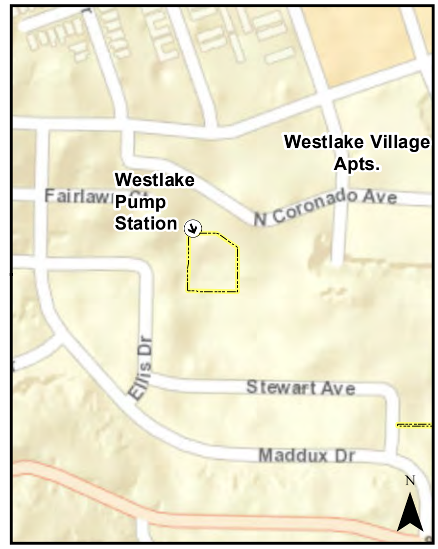
Site 5 would be located in a flat commercial area with no dominant visual features other than these urban land uses and a single residence. The pipeline route traverses an area of similar characteristics. With the predominance of commercial uses, the visual sensitivity of Site 5 is considered moderately low.

Site 6

Views of Site 6 are shown on Figure 5.3-3 (Views of Sites 6 and 7). Figure 3-16 (Site 6 [Consolidated Treatment at Site 6] Right-of-Way at Colma BART) in Chapter 3, Project Description shows the layout for the consolidated treatment option and Figure 3-20 (Site 6 [On-site Treatment] Right-of-Way at Colma BART) shows the on-site treatment option.

Visual Quality

Site 6 would be situated on a grassy area along the south side of D Street, across from the Colma BART Station, which dominates views of the area. Its proposed connection to the SFPUC pipeline, sanitary sewer, and storm drain would be within the immediate area of the site. The alternate connection to the California Water Service Company (Cal Water) pipeline would be in D Street north of the site, but within the SFPUC right-of-way. The SamTrans Park and Ride lot is located upslope from this site to the southwest, beyond a row of trees. The pedestrian bridge over D Street linking the parking lot to the station would have a clear view of this site. The Woodlawn Memorial Park is located to the south and upslope. The immediately adjacent portion of the cemetery is used for outdoor materials storage. As the visual elements of the area are not particularly notable, the visual quality at Site 6 is considered low.



Westlake Pump Station: View looking south toward the pump station from the end of North Coronado Avenue, with the Westlake Village Apartments behind the viewer. All project elements would be installed in the existing building.

Site 5: View looking south across B Street (foreground) toward the facility site, with the former Serra Bowl building in the background and a single-family residence to the left, and the SFPUC valve lot behind the viewer.

Legend

View Direction

Construction Area

Views of Westlake Pump Station and Site 5

Regional Groundwater Storage and Recovery Project

Figure 5.3-2

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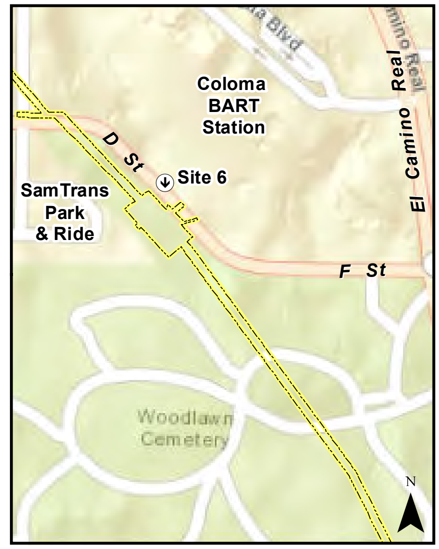
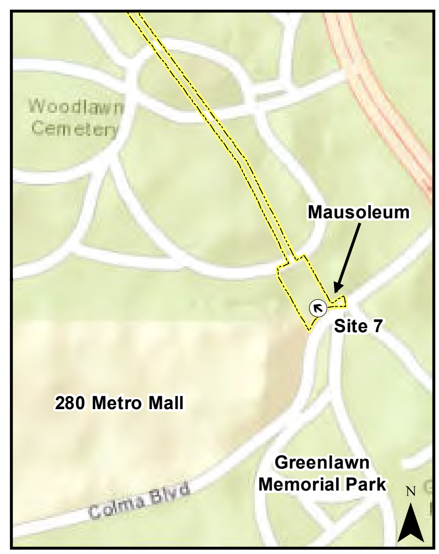


Site 6: View looking south from D Street (foreground) toward the facility site, with the Colma BART station behind the viewer and Woodlawn Memorial Park over the horizon.



Site 7: View looking northwest from Colma Boulevard toward the well facility site. Woodlawn Memorial Park is beyond the horizon with the Greenlawn Memorial Park to the right, and behind, the viewer.

Legend

View Direction

Construction Area

Views of Sites 6 and 7

Regional Groundwater Storage and Recovery Project

Figure 5.3-3

Affected Viewers and Exposure Conditions

Site 6 would be visible from D Street, the Colma BART station, and the station's pedestrian bridge linking it to a park and ride lot. This site is considered to have high, but temporary, exposure from these vantage points. Although adjacent to the grounds of the Woodlawn Memorial Park, Site 6 would not be visible from publicly accessible visitor areas. This site would have minimal exposure from Woodlawn Cemetery. Based on the above description, viewer concern is considered low.

Overall Visual Sensitivity

Site 6 would be visible from D Street and is located adjacent to the Colma BART station, rail track extension and storage yard on a grassy slope, with a row of trees visually separating the site from the adjacent park and ride lot. No high-sensitivity viewer groups are located in the vicinity of the site, giving Site 6 low visual sensitivity.

Unincorporated San Mateo County, Broadmoor - Sites 3 and 4

Views of Sites 3 and 4 are shown on Figure 5.3-4 (View of Sites 3 and 4). While these sites are located in an unincorporated portion of San Mateo County adjacent to Daly City, there is no clear visual transition between the two jurisdictions. Site layouts are shown on Figure 3-12 (Site 2 Park Plaza Meter, Site 3 Ben Franklin Intermediate School, Site 4 Garden Village Elementary School) in Chapter 3, Project Description.

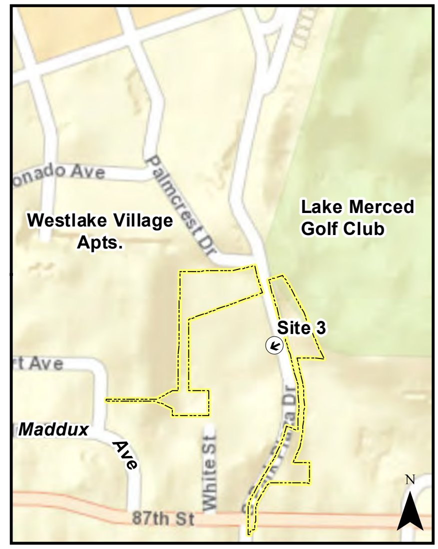
Site 3

Visual Quality

Site 3 would be located in the southwest corner of the athletic field at the Ben Franklin Intermediate School. Site 3's proposed pipeline connection to the Daly City pipeline and its storm drain connection would traverse the same athletic field. The site is covered in turf and located behind a baseball backstop on the field. It is at the foot of a slope, at the top of which single-family residences are located to the southwest; these residences front onto White Street and Maddux Drive. This puts the site low in the field of view from these residential areas. A small wooded area of tall eucalyptus trees directly adjoins the site to the east and southeast. Site 3's visual characteristics are typical of the large recreational open space described above under Site 2. Therefore, the visual quality of this site is moderate.

Affected Viewers and Exposure Conditions

Site 3 would be visible to users of the athletic field and in the distance to motorists and pedestrians on Park Plaza Drive. The view from Park Plaza Drive would be particularly clear in the southbound direction. The small wooded area intervenes somewhat between the site and Park Plaza Drive to the south. Site 3 is not visible from the buildings at Ben Franklin Intermediate School due to intervening topography. It is also not visible from publicly accessible points in the residential areas along White Street and Maddux Drive. Site 3 has moderate exposure to motorists and users of the playing fields, based on the temporary viewing opportunities. Both groups would also have moderate viewer concern/sensitivity.



Site 3: View looking southwest toward the facility site from Park Plaza Drive. Residences and Ben Franklin Intermediate School are in the distance upslope from the site, with Park Plaza Drive behind the viewer.

Site 4: View looking northeast along Park Plaza Drive toward the facility site from near the intersection with 87th Street. The grounds of the Garden Village Elementary School are beyond the trees, with the intersection of 87th Street & Park Plaza Drive behind the viewer.

Legend

View Direction

Construction Area

Views of Sites 3 and 4

Regional Groundwater Storage and Recovery Project

Figure 5.3-4

Overall Visual Sensitivity

Site 3 would be situated within prominent view of the Ben Franklin Intermediate School athletic fields, and from Park Plaza Drive, particularly in the southbound direction. Although single-family residences are in view to the south and southwest, Site 3 would not be visible from publicly accessible areas in the neighborhood. As discussed previously under Site 2, recreationists involved in sports activities near Site 3 are assumed to be focused primarily on those activities and only secondarily on the visual setting. Sensitivity of these active recreational viewers is considered moderate. Motorists on Park Plaza Drive would also have moderate sensitivity.

Site 4

Visual Quality

Site 4 would be located on a lot adjacent to Park Plaza Drive in the southwest corner of the Garden Village Elementary School grounds. The site is located atop a slope above the school's playing fields, and the slope is covered with grassy vegetation. Mature trees block the view of the site from the Ben Franklin Intermediate School, which is located across Park Plaza Drive. Construction of the well facility would require the removal of most existing trees on the site, and would be visible at foreground distance to the Garden Village Elementary School and Park Plaza Drive. Site 4 is adjacent to single-family residences that front onto 87th Street to the south and other single-family residences across Park Plaza Drive fronting onto White Street to the west. The visual quality of Site 4 is that of the large open space that it adjoins; therefore, the visual quality is considered moderately high.

Affected Viewers and Exposure Conditions

Construction at Site 4, the proposed connection to the Daly City pipeline, and its storm drain connection would be visible to motorists and pedestrians on Park Plaza Drive. There is also a partial view of the site from eastbound 87th Street at its intersection with Park Plaza Drive/Nimitz Drive. Trees currently on the site would block any views from the grounds of the Garden Village Elementary School. The site is in view over fences in the backyards of the residences on 87th Street and White Street, but not directly visible from most publicly accessible areas of the surrounding neighborhood. This site would be exposed to motorists, as well as to students traveling to and from school or using the adjoining playfields. The visual exposure and viewer concern is considered moderately high.

Overall Visual Sensitivity

Site 4 would be in full view of Park Plaza Drive and from most of the activity areas on the Garden Village Elementary School grounds. It would be seen from eastbound 87th Street at Park Plaza Drive/Nimitz Drive. Although visible from residences, it would not be visible from publicly accessible points at those residences. As for Site 3, motorists and students engaged in active recreation would have moderately high visual sensitivity.

Colma - Sites 7, 8, and 17 (Alternate)

Site 7

Figure 5.3-3 (Views of Sites 6 and 7) shows the existing view of Site 7. Figure 3-17 (Site 7 [Consolidated Treatment at Site 6] Right-of-Way at Colma Blvd.) in Chapter 3, Project Description illustrates the layout for Site 7 with the consolidated treatment at Site 6 option, while Figure 3-21 (Site 7 [On-site Treatment] Right-of-Way at Colma Blvd.) shows the layout for the on-site treatment option.

Visual Quality

Site 7 would be located in the foreground of Colma Boulevard in a segment dominated visually by adjoining Woodlawn Memorial Park to the north and Greenlawn Memorial Park to the south. Its storm drain connection would be at the site in Colma Boulevard. Views from the roadway in this segment are characterized by abundant foreground landscaping, long views over open lawn or toward San Bruno Mountain. It is a very intact landscape character dominated by mature tree canopy and natural features.

Site 7 would be located in an undeveloped grassy parcel. A mausoleum is located immediately to the east of the site on an adjacent property and a Greenlawn Memorial Park maintenance building is to the immediate west. The mausoleum is visually separated from the site by a mature stand of 58 trees, which is identified as a “tree mass” in the Town of Colma’s General Plan Figure OS-1 (Colma 1999). The utilitarian maintenance building is the only constructed element in an otherwise predominantly natural setting.

Site 7 includes two treatment options. The consolidated treatment option would include installation of a pipeline to convey water from the well facility at Site 7 to the well facility at Site 6 for treatment. The pipeline route would pass through the eastern portion of Woodlawn Memorial Park and close to the facility’s entrance during construction. Alternately, if it is not feasible to consolidate treatment at Site 6, water may be treated on-site at Site 7 with a water system connection within the SFPUC right-of-way and a sanitary sewer connection in Colma Boulevard. Considering the installation of the proposed connection pipeline from Site 7 to Site 6 under the consolidated treatment option, the visual quality of the setting is moderate as it would cover a more expansive area. However, if water would be treated at Site 7, the area of temporary and permanent disturbance would be entirely within the site’s construction area boundary, making the visual quality of the setting moderately low.

Affected Viewers and Exposure Conditions

Site 7 would be visible to motorists and pedestrians on Colma Boulevard, particularly in the eastbound direction, as well as to visitors to Greenlawn Memorial Park as they enter that site to the south across Colma Boulevard. Due to topography and trees, views of the well facility site from Woodlawn Memorial Park would be limited to a knoll immediately to the west. It would be more visible from Greenlawn Memorial Park to the south. The site would not be visible from the shopping center to the south due to intervening topography. Construction of the pipeline from Site 7 to Site 6, if this treatment option were to be implemented, would be visible from the Woodlawn Memorial Park entrance, office and chapel building (i.e., cemetery employees), and to anyone accessing any part of the cemetery. Given the moderate level of traffic and numbers of viewers who could see the well facility at Site 7, it would have a moderate exposure. The most sensitive viewer group at this site would be visitors to the adjacent cemeteries, who are assumed to have a moderately high level of concern for visual quality in this setting. However, these viewers would likely be the least frequent visitors during the construction period, and would likely be the least in number.

Overall Visual Sensitivity

Because of viewer expectations associated with the surrounding cemetery land uses and highly intact landscape setting, viewer sensitivity in the portion of Colma Boulevard adjoining Site 7 is considered moderately high.

Site 8

Figure 5.3-5 (Views of Sites 8 and 9) shows the existing view of Site 8, and Site 8 is shown on Figure 3-22 (Site 8, Right-of-Way at Serramonte Blvd.) in Chapter 3, Project Description.

Visual Quality

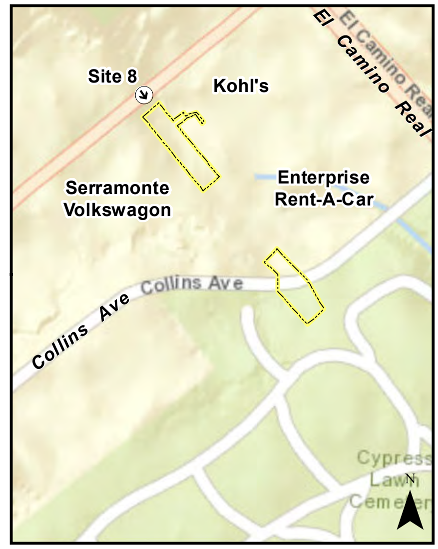
Site 8, the proposed water connection to the Cal Water system, the alternate connection to SFPUC pipelines, and the storm drain connections would all be located in a narrow grassy strip surrounded by various commercial establishments in a segment of Serramonte Boulevard lined car dealerships, Kohl's Department Store and its associated parking. The streetscape has a visual unity typical of the Central Colma Planning Area (Colma 1999). Site 8 would be shielded from view on all sides except the northeast due to depressed topography. Visual quality of the area is moderately low.

Affected Viewers and Exposure Conditions

Site 8 has quick, passing views for motorists and pedestrians on Serramonte Boulevard and Collins Avenue, due to its topography. For the same reason, it would not be visible from the commercial areas to the southwest due to topography. This site would be plainly visible to employees and patrons from the parking lots of surrounding businesses. With the limited vantage points, Site 8 would have limited visual exposure and low viewer concern.

Overall Visual Sensitivity

Given its location in a primarily commercial district, visual sensitivity of motorists on Serramonte Boulevard and at the businesses in the vicinity of Site 8 would be low. No high-sensitivity land uses (e.g., residential) or viewer groups (e.g., permanent residents) are located within view of the site, which is located in an area of low visual quality and viewer expectation.



Site 8: View looking southeast from Serramonte Boulevard toward the facility site in the level grassy area. Kohl's Department Store is to the left and the Serramonte Volkswagen car dealership is to the right beyond the retaining wall, with a vacant auto dealership behind the viewer.

Site 9: View looking northwest toward the facility site from a path connecting El Camino Real and Mission Road. The Treasure Island Trailer Court is beyond the site, the Colma Creek Diversion Channel and access road is to the right, and the access road continuing behind the viewer.

Legend

View Direction

Construction Area

Views of Sites 8 and 9

Regional Groundwater Storage and Recovery Project

Figure 5.3-5

Site 17 (Alternate)

Figure 5.3-10 (Views of Sites 16 and 17 [Alternate]) shows the existing view of Site 17 (Alternate), and it is shown on Figure 3-38 (Site 17 [Alternate], Standard Plumbing Supply) in Chapter 3, Project Description.

Visual Quality

Site 17 (Alternate) would be located in a flat, grassy area adjacent to the SFPUC right-of-way and next to Standard Plumbing Supply on a relatively lightly traveled section of Collins Avenue. Its connection to the nearest storm drain and the proposed connection to the Cal Water pipeline would stretch across this area to Collins Avenue. The alternate water pipeline would connect to an existing pipeline in the SFPUC right-of-way. The right-of-way, which is covered in grasses in this area, slopes up from Collins Avenue toward Cypress Lawn Memorial Park to the south, but is visually isolated from the cemetery by sloping terrain and tree cover. The Standard Plumbing Supply property, including this alternate well facility site, is surrounded by chain link fence with exposed parking and storage and poor visual quality typical of light industrial parcels. Visual quality of this segment of Collins Avenue is enhanced by substantial tree plantings and views of San Bruno Mountain, but the vicinity is typified by various commercial/light-industrial land uses. Overall visual quality is moderate.

Affected Viewers and Exposure Conditions

Site 17 (Alternate) would be in brief view of motorists and pedestrians on Collins Avenue, as well as periodically and randomly by patrons of Standard Plumbing Supply. Due to distance, topography, and intervening vegetation, this site would not be directly visible from active areas of Cypress Lawn Memorial Park. Because it would not be exposed to any high-sensitivity viewers, and would be visible to only moderate numbers of low sensitivity viewers, the visual concern and overall visual exposure is considered generally low.

Overall Visual Sensitivity

Because Site 17 (Alternate) would be visually isolated from all nearby high-sensitivity land uses (Cypress Lawn Memorial Park), there are no sensitive viewer groups in the site's viewshed. Visual sensitivity is low.

South San Francisco - Sites 9, 10, 11, 12, 13, 18 (Alternate), and 19 (Alternate)

All of these sites, with the exception of Site 18 (Alternate), would be within the SFPUC right-of-way and, as a result, are undeveloped.

Site 9

Figure 5.3-5 (Views of Sites 8 and 9) shows the existing view of Site 9, and Figures 3-23 (Site 9, Access Road Treasure Island Trailer Court) and 3-24 (Site 9, Treasure Island Trailer Court) in Chapter 3, Project Description illustrate the proposed site layout.

Visual Quality

Site 9, its water pipeline connection, and storm drain connection would be located on an existing undeveloped parcel between the concrete-lined Colma Creek Diversion and the San Mateo County Flood Control channels. The site, in a mixed commercial/residential area, is triangular in shape and covered with low-growing ruderal vegetation and has a lone tree at its center. Views to the south toward the Costco Wholesale Club are blocked by a fabric-covered chain link fence. Views to the northeast look on the rear areas of businesses and single-family residences fronting on Mission Road, including the Verano Condominiums. Views to the northwest look onto the Treasure Island Trailer Court. The site and surroundings are devoid of vivid or attractive visual features, and dominated by the adjacent concrete flood channels and the Costco parking lot. Visual quality is considered to be low.

Affected Viewers and Exposure Conditions

Site 9 would not be visible from any public roadways. An unnamed bicycle/pedestrian path linking El Camino Real to the west and Mission Road to the east provides fleeting views onto the site from the south and southeast. From El Camino Real, this path skirts the north side of the Costco parking lot along the County Flood Control Channel, crosses that channel, passes by the site access point, crosses the Colma Creek Diversion Channel, and proceeds through a landscaped area to Mission Road. Bicyclists and pedestrians would have full view of the site, but in the context of a scene lacking any visual cohesion, consisting of concrete lined flood channels, the Costco parking lot, and back lot fences of nearby residences and industrial parcels. The site would also be visible from the upper floors of the residences to the northeast, including the Verano Condominiums. It would also be partially visible over fencing along the Treasure Island Trailer Court. Given its relatively isolated location and limited opportunity as a public view, Site 9 is considered to have minimal visual exposure and viewer concern is low.

Overall Visual Sensitivity

Site 9 would be located in a mixed residential/commercial area. It would be plainly visible from the bicycle/pedestrian path and the upper floors of surrounding residences. The site would not be visible from Costco due to covered fencing or from the publicly accessible areas around the residences, the Verano Condominiums, and within the Treasure Island Trailer Court. Overall, Site 9 is considered to have low visual sensitivity.

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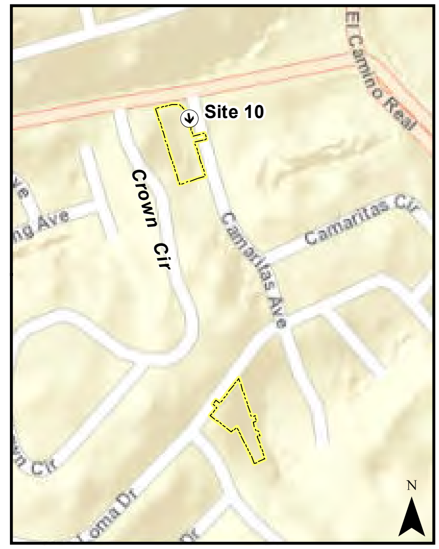

Site 10: View looking south along Camaritas Avenue from Hickey Boulevard toward the facility site in the level foreground area. A tree line screening the site from residences on Crown Circle is to the right, with the Hickey Boulevard and Camaritas Avenue intersection behind the viewer.

Site 11: View looking northeast toward the site from El Camino Real. The facility site would be located beyond the trees.

Legend

View Direction

Construction Area

Views of Sites 10 and 11

Regional Groundwater Storage and Recovery Project

Figure 5.3-6

Site 10

Figure 5.3-6 (Views of Sites 10 and 11) shows the existing view of Site 10, and the proposed site layout is illustrated on Figure 3-25 (Site 10, Right-of-Way at Hickey Blvd.) in Chapter 3, Project Description.

Visual Quality

Site 10 would be located on an undeveloped grassy lot on the southwest corner of Hickey Boulevard and Camaritas Avenue. The site's connection to either the Daly City (proposed water connection) or SFPUC (alternate water connection) pipelines, as well as its connection to the sanitary sewer in Camaritas Avenue, would be within this area of the SFPUC right-of-way. This site would be in an area that transitions from commercial activities on the east to residential areas in the other three directions. Trees line the west side of the lot, separating it from the single-family residences beyond Crown Circle to the west. The site slopes upward to the south and remains undeveloped, though single-family residences line Camaritas Avenue beyond stands of mature trees to the southeast. The Winston Manor Shopping Center is located to the east with a Chevy's Restaurant closest to the site across Camaritas Avenue. Immediately to the north across Hickey Boulevard, the topography slopes steeply upward providing partial views through mature trees of the fenced rear yards of single-family residences that front on Duval Drive. The site would be in an area transitioning from commercial strip development of low visual quality to a residential one marked by substantial large-scale tree canopies and grass slopes. Overall visual quality is thus considered moderately low.

Affected Viewers and Exposure Conditions

Site 10 would be prominently visible to high numbers of motorists and pedestrians on Hickey Boulevard and Camaritas Avenue. It would also be visible from the Winston Manor Shopping Center across Camaritas Avenue, though most of the public areas there (e.g., Chevy's outdoor seating) face away from it. The view from the Crown Circle residences is completely blocked by intervening mature trees. Likewise, views from residences on Duval Drive to the north and along Camaritas Avenue to the southeast are effectively blocked by intervening topography and mature stands of trees. Site 10 is considered to have high exposure; however, viewer concern is considered moderate.

Overall Visual Sensitivity

Site 10 would be situated in an area that transitions from commercial to residential areas. It would primarily be briefly visible to high numbers of motorists from Hickey Boulevard, as well as from Camaritas Avenue, and the Winston Manor Shopping Center to the east. The site would not be plainly visible from any publicly-accessible areas in the surrounding residential neighborhoods. Due to the transitory nature of this highly exposed view, visual sensitivity is considered moderate overall.

Site 11

Figure 5.3-6 (Views of Sites 10 and 11) shows the existing view of Site 11, and Figures 3-27 (Site 11, Pipeline and Access Road South San Francisco Main Area) and 3-28 (Site 11, South San Francisco Main Area) in Chapter 3, Project Description illustrate the proposed site layout and pipeline routes.

Visual Quality

Site 11 would be located next to a BART ventilation structure between El Camino Real and Mission Road northwest of Chestnut Avenue and Antoinette Lane. The site's connection to the waterlines and storm drain system would be to the west, with its sanitary sewer connection being in the BART access road. The site is covered in gravel with the adjacent slope covered in unmaintained grasses and mature trees. It would be located about 100 feet east of El Camino Real and at a lower elevation than the roadway. The topography and a row of trees along this portion of El Camino Real obstruct views of the site and the BART ventilation structure just beyond. The BART ventilation structure partially obstructs views of the site from the Centennial Way Trail to the east, which runs along the Colma Creek Diversion Channel, although the view would open up more as one travels north. To the north of the site is a five-story parking garage and surface parking lot for the Kaiser Permanente Medical Center. The remainder of the surrounding land is vacant or commercial without any visually notable features. Given the low visual unity of the highly disturbed setting, dominated by utilitarian features and uses, Site 11 is considered to have low visual quality.

Affected Viewers and Exposure Conditions

Site 11 would be relatively isolated visually. Being at the toe of slope, the site would not be visible to motorists or pedestrians on El Camino Real. It would not be visible from Mission Road due to its juxtaposition to the BART ventilation structure and intervening vegetation. However, a portion of a stand of prominent mature trees at the top of slope within the foreground of El Camino Real would be removed for construction of the well facility at this site. This stand of trees is a prominent feature within the El Camino Real viewshed as seen by high numbers of passing motorists. The principal viewpoint of Site 11 would be the Centennial Way Trail, particularly to bicyclists and pedestrians traveling southbound. These views would be partly screened by the BART ventilation structure and intervening trees. Given this limited view, Site 11 itself would have moderate visual exposure. Viewer concern of Centennial Way Trail users in the vicinity of Site 11 is considered moderate due to lowered scenic expectations as a result of the poor existing visual quality in the vicinity. Viewer concern of motorists on El Camino is also considered moderate.

Overall Visual Sensitivity

The primary sensitive viewer group of Site 11 would be bicyclists and pedestrians on the Centennial Way Trail. Although recreational viewers such as this may be assumed to have high visual sensitivity, this would be greatly moderated by the low visual quality of the vicinity and hence the visual expectations of viewers, as well as the limited duration and exposure to the site as described above. Therefore, the overall visual sensitivity is moderately low.

Site 12

Figure 5.3-7 (Views of Sites 12 and 13) shows the existing view of Site 12. The proposed site layout is shown on Figures 3-29 (Site 12 with Pipelines) and 3-30 (Site 12, Garden Chapel Funeral Home) in Chapter 3, Project Description.

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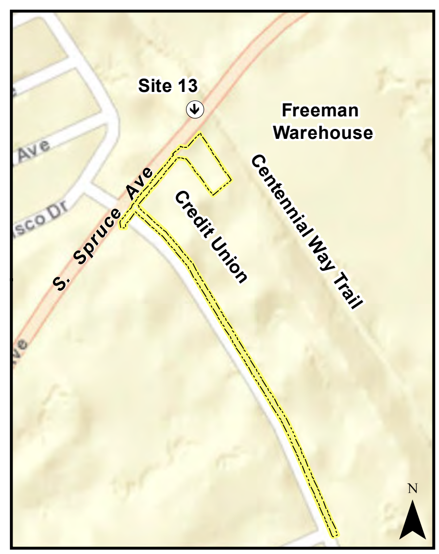
Site 12: View looking south toward the facility site along El Camino Real.



Site 13: View looking south toward the facility site from South Spruce Avenue, with Centennial Way Trail behind the viewer. The Centennial Way Trail pathway is also to the left in the view.

Legend

View Direction

Construction Area

Views of Sites 12 and 13

Regional Groundwater Storage and Recovery Project

Figure 5.3-7

Visual Quality

Site 12 would be located just west of El Camino Real in the easternmost portion of the Garden Chapel Funeral Home parking lot. The site is currently comprised of the parking lot, a grassy area with a dirt access for the SFPUC right-of-way, and a number of mature trees and shrubs. Its storm drain and sanitary sewer connections would traverse the parking lot and the proposed SFPUC pipeline connection would run to the southeast along El Camino Real to West Orange Avenue. The site would be at an elevation above El Camino Real and is currently substantially screened from view from that roadway by the mature trees including a dense row of Monterey pine, Monterey cypress, eucalyptus, and Aleppo pine. These trees are contributing resources in the City of South San Francisco's streetscape plan for El Camino Real, as noted in General Plan Implementing Policy 3.4-1-1. This policy calls for trees to line either side of this roadway to support Guiding Policy 3.4-G-1, which seeks to define El Camino Real as a boulevard (South San Francisco 1999). The view of the site from El Camino Real is currently obscured by these trees and the rise in elevation. Similarly, the site is partially screened by fences and vegetation from the single-family residences to the southwest fronting on Fairway Drive. Despite the predominance of the parking area paving, adjacent canopies of large Monterey pines and landscaping of the parking lot and funeral home grounds contribute elements of visual unity and vividness. The site is thus visually isolated from viewers other than visitors to the funeral home. From the perspective of visitors to the funeral home, who would represent the most sensitive and exposed viewer group, visual quality of the site is moderate.

Affected Viewers and Exposure Conditions

Site 12 would potentially be visible from El Camino Real, but is currently substantially screened from El Camino Real by large mature Monterey pine trees. Although the site may be seen from Southwood Drive through the funeral chapel parking lot, this view would be largely obscured by the parking lot in the foreground. It is visible in partially screened views over fences in the backyards of the residences fronting on Fairway Drive, although not from publicly accessible points in that neighborhood. The principal viewers of Site 12 would be visitors to the funeral home, who would view it while parking and entering the funeral home. Visibility would be high for this small, but sensitive, viewer group leading to moderate viewer concern overall. The construction of the water line connection would be plainly visible along El Camino Real. Overall exposure is thus considered moderate.

Overall Visual Sensitivity

Because of its visual isolation as described previously, the primary sensitive viewer group of Site 12 would be visitors to the funeral home as they park and enter or leave the facility, as well as motorists and pedestrians on El Camino Real. Both the owners and visitors to the funeral home would have an interest in maintaining the existing visual quality of that environment. Visual sensitivity is thus considered moderately high for this limited, but continuing, viewer group on-site and motorists on El Camino Real.

Site 13

Figure 5.3-7 (Views of Sites 12 and 13) shows the existing view of Site 13, and the proposed site layout is shown on Figures 3-31 (Site 13 with Pipelines) and 3-32 (Site 13, South San Francisco Linear Park) in Chapter 3, Project Description.

Visual Quality

Site 13 would be located on an undeveloped parcel on the southeast side of South Spruce Avenue covered with unmaintained grassy vegetation. It is bordered by a two-story retail/office building and parking lot on the west and a large beverage distribution warehouse on the east. Between the warehouse and the site is the Centennial Way Trail, with an interpretive panel with a trail map at the entrance on South Spruce Avenue. A fenced-in, buried utility vault is located between the site and the trail. The trail continues immediate across South Spruce Avenue with a large industrial bakery to the north and single-family residential neighborhood to the south. Visual quality of the South Spruce Avenue streetscape in this area is moderate, with substantial landscaping and views of hilltop ridgelines to both east and west. Principal vivid elements in the vicinity are stands of mature trees located within or along the pathway.

Site 13's sanitary sewer and storm drain connections would be in South Spruce Avenue. The proposed water connection to San Bruno would be installed in South Spruce and Huntington avenues. Huntington Avenue is lined with government and professional offices, commercial space, and a movie theater. Given the varied visual appearance of the area – considering the warehouses, commercial activities, office space, residential neighborhoods, and the Park pathway – visual quality is considered moderate.

Affected Viewers and Exposure Conditions

Site 13 would be plainly visible to motorists and pedestrians along South Spruce Avenue and patrons of the adjacent retail/office building. This site is also plainly visible to bicyclists and pedestrians using the Centennial Way Trail. It is visible in partially screened views over fences in the backyards of the residences fronting on Francisco Drive, although not from publicly accessible points in that neighborhood. This site has high visual exposure.

Overall Visual Sensitivity

Site 13 would be prominently visible from the adjacent Centennial Way Trail. Since such recreational destinations may be considered to have high visual sensitivity, Site 13 is considered to have moderately high sensitivity.

Site 18 (Alternate)

Figure 5.3-8 (Views of Sites 18 [Alternate] and 19 [Alternate]) shows the existing view of Site 18 (Alternate). The layout for the site is shown on Figure 3-39 (Site 18 [Alternate], Alta Loma Drive) in Chapter 3, Project Description.

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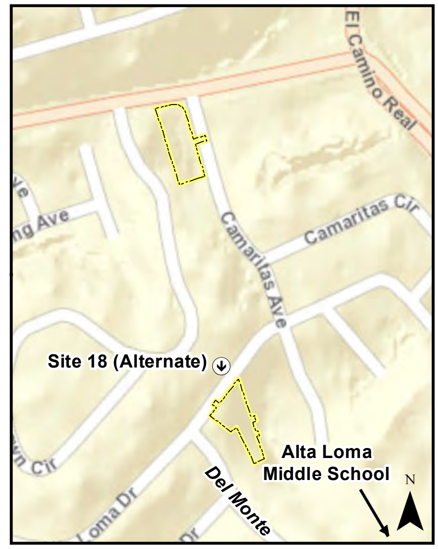
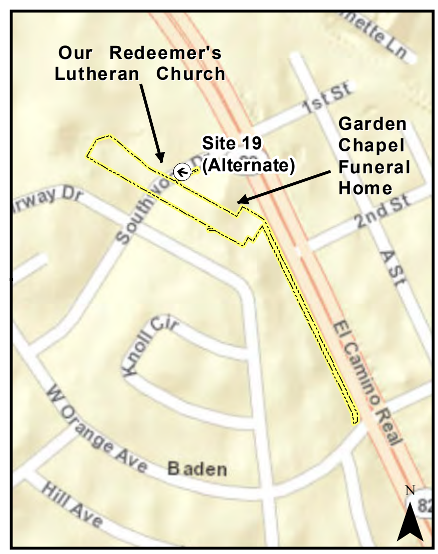


Site 18 (Alternate): **View looking south to the facility site from a SamTrans bus stop on Alta Loma Drive. Single-family residences are behind the viewer.**



Site 19 (Alternate): **View looking west from Southwood Drive toward the facility site, with the Garden Chapel Funeral Home behind the viewer. Our Redeemer's Lutheran Church is on the right and the multi-family housing is in the distance.**

Legend

View Direction

Construction Area

Views of Sites 18 (Alternate) and 19 (Alternate)

Regional Groundwater Storage and Recovery Project

Figure 5.3-8

Visual Quality

Site 18 (Alternate) would be located on an undeveloped parcel in a residential neighborhood along Alta Loma Drive on a knoll at street level overlooking a lower, moderately sloped grassy swale. The site's storm drain, sanitary sewer, and connection to the SFPUC pipeline would traverse this swale, which is in the SFPUC right-of-way. The site is densely vegetated with a small stand of willows that is about 15 feet high and covering approximately 3,400 square feet. It is adjacent to single family residences to the southwest fronting on Del Monte Avenue and others directly across Alta Loma Drive. Single-family residences also front on Camaritas Avenue to the east. Vivid elements in the vicinity include views to forested hillsides to the south and San Bruno Mountain to the north. Visual quality is considered moderate.

Affected Viewers and Exposure Conditions

Site 18 (Alternate) would be seen from the single-family residences along Alta Loma Drive and backyards of, and the publicly accessible areas around, the single-family residences fronting Camaritas Avenue on the far side of the swale, as well as the single-family residences fronting on Del Monte Avenue to the south. The site would be somewhat visible from Alta Loma Middle School, where the northern parking lot is about 400 feet away from the site. Site 18 (Alternate) would have high exposure and viewer concern would be moderately high.

Overall Visual Sensitivity

Given its elevated position on a knoll and close proximity to neighboring single-family residences, this site would be plainly visible from the surrounding neighborhood. Although residential viewers may be assumed to have high viewer sensitivity, because the visual quality is moderate and level of exposure is moderately high, this site would have moderately high visual sensitivity.

Site 19 (Alternate)

Figure 5.3-8 (Views of Site 18 [Alternate] and Site 19 [Alternate]) shows the existing view of Site 19 (Alternate). The proposed site layout is shown on Figure 3-40 (Site 19 [Alternate], Garden Chapel Funeral Home) in Chapter 3, Project Description.

Visual Quality

Site 19 (Alternate) would be across Southwood Drive from Site 12 and situated between the Our Redeemer's Lutheran Church and single-family residences fronting on Fairway Drive. The site, covered in mowed grassy vegetation, is partially screened by fences and vegetation from these single-family residences. Multi-family residential developments are also located to the north of this site and have limited views of the site through intervening landscape vegetation and trees. The SFPUC pipeline connection would cross Southwood Drive and traverse the Garden Chapel Funeral Home's parking lot to connect with the treatment facilities at Site 12. The storm drain connection would be in Southwood Drive. While Site 19 (Alternate) may be atypical when considered with its surroundings and provides a visual transition between the church and residences, it is not considered particularly unique in this urban setting. Its visual quality is considered moderate.

Affected Viewers and Exposure Conditions

Site 19 (Alternate) would be highly visible to a relatively large number of motorists from the immediate adjacent section of Southwood Drive and a portion of the church parking lot to the east. It would also be visible over a hedge separating the site from the R. W. Drake Preschool on the church's property. The eastern end of the site may be visible briefly while traveling north on El Camino Real at its intersection with Southwood Drive. It is also in view over fences in the backyards of the residences fronting on Fairway Drive, although not from publicly accessible points in that neighborhood. There are views of the site from the multi-family residential developments to the north, but these views are broken by intervening landscape vegetation and mature trees. Given this, Site 19 (Alternate) is considered to have moderate visual exposure and moderate viewer concern.

Overall Visual Sensitivity

Site 19 (Alternate) would be along Southwood Drive situated between Our Redeemer's Lutheran Church/R. W. Drake Preschool and single-family residences fronting on Fairway Drive. It would be plainly visible from the immediate section of Southwood Drive and the eastern portion of the church parking lot. Although the eastern end of the site may be visible briefly while traveling north on El Camino Real, it would be only in passing. Although adjacent to the single-family residences fronting on Fairway Drive, fences between these residences and the site partially block the view; it is not be visible from publicly accessible areas of this neighborhood. Site 19 (Alternate) would have moderate visual sensitivity.

San Bruno - Sites 14 and 15

Site 14

Figure 5.3-9 (Views of Sites 14 and 15) shows the existing view of Site 14 while Figures 3-34 (Sites 14 & 15 with Pipelines) and 3-35 (Site 14, Golden Gate National Cemetery) in Chapter 3, Project Description show the proposed site layout and pipeline routes.

Visual Quality

Site 14 would be located on the northern side of the GGNC about 1,600 feet east of a circular monument at the main entrance to the cemetery. The site would not be visible from the monument nor would it be visible from an auxiliary entrance from Sneath Lane at the cemetery's operations and maintenance yard, which is closer to the site. Site 14 would be located within the in a grassy area of the SFPUC right-of-way between the gravesites and close to an existing unused pump station, tank and well in the cemetery. It would be in proximity to the single-family neighborhood adjacent to the north along Greenwood and Rockwood drives, which are screened from the site by fences and mature trees. Site 14 would not be visible from the public roads surrounding the cemetery (i.e., Sneath Lane) due to distance, topography, and intervening trees, but is visible from internal roadways in this section of the cemetery.

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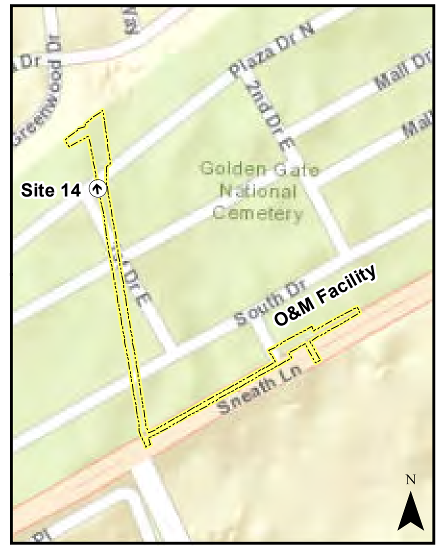
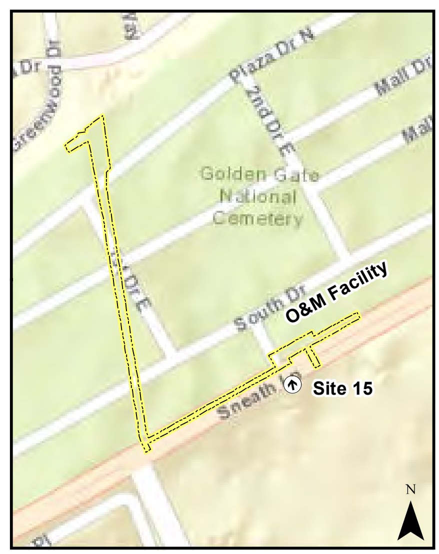


Site 14: View looking north toward the facility site along the SFPUC right-of-way between the internment areas, with internment areas and the SFPUC right-of-way continuing behind the viewer. An inactive well facility is seen to the left in the view.



Site 15: Mitigated View looking north across Sneath Lane (foreground) toward the operations and maintenance buildings on the GGNC, with the Airport Trade Center behind the viewer. A chain link fence borders the GGNC between the buildings and Sneath Lane.

Legend

View Direction

Construction Area

Views of Sites 14 and 15

Regional Groundwater Storage and Recovery Project

Figure 5.3-9

Water produced at Site 14 would be conveyed to Site 15 for treatment and connection to the SFPUC pipeline. This pipeline, and the site's storm drain, would be within the SFPUC right-of-way and traverse the cemetery to Sneath Lane. The setting of the GGNC is a highly ordered, well-landscaped open space area with high visual unity, intactness, and vivid elements including unobstructed views of ridge tops at the horizon, and old, overhanging tree canopies enclosing Sneath Lane. Visual quality of this setting is high.

Affected Viewers and Exposure Conditions

Site 14 would primarily be visible to people visiting and viewing gravesites in this section of the GGNC. It would not be clearly visible from the neighborhood backyards and publicly accessible areas immediately to the north along Greenwood and Rockwood drives. The pipeline construction at this site would be highly visible from Sneath Lane, although the view would be brief and random to passing traffic. Pipeline construction would not be highly visible from publicly accessible areas of the Peninsula Place apartment complex southwest of Sneath Lane and Cherry Avenue due to intervening vegetation. Given its location within the interment area, Site 14 is considered to have high visual exposure and viewer concern is high. Visits are infrequent and relatively brief; therefore, the number of affected viewers is low.

Overall Visual Sensitivity

Site 14 would be situated in plain view of the gravesites in this area of the GGNC. With the exception of pipeline construction, the site would not be visible from surrounding roadways or other publicly accessible areas. However, given its location within view of interment areas, Site 14 is considered to have high visual sensitivity.

Site 15

Figure 5.3-9 (View of Sites 14 and 15) shows the existing view of Site 15, and Figures 3-34 (Sites 14 & 15 with Pipelines) and 3-36 (Site 15, Golden Gate National Cemetery) in Chapter 3, Project Description illustrate the site layout and pipeline route.

Visual Quality

Site 15 would also be located within the GGNC, situated in a grassy area on the southern edge of the cemetery between Sneath Lane and the cemetery's operations and maintenance yard. The maintenance yard includes buildings designed to be sensitive to the surrounding portions of the cemetery. The connection to the proposed San Bruno pipeline would run from the site west to the SFPUC right-of-way near Cherry Avenue. The sanitary sewer and storm drain connection would primarily be within the site and connect in Sneath Lane at the site. This site would be located at an auxiliary entrance to the GGNC from Sneath Lane. A commercial/office park and a Veteran's Administration Medical Clinic are located to the south across Sneath Lane and are shielded from view somewhat by mature trees and landscaping. The site is located within the same immediate viewshed; however, the visual quality is considered moderately high at this location.

Affected Viewers and Exposure Conditions

Site 15 would be visible to a smaller portion of the cemetery, as the operations and maintenance building would screen it from view. However, it would still be visible from gravesites. Patrons and employees at the commercial/office park across Sneath Lane would have view of the site, although it would be broken by trees and landscaping lining Sneath Lane. Travelers on Sneath Lane would have a full view of the site through a chain link fence bounding the cemetery. Site 15 would not be highly visible from publicly accessible areas of the Peninsula Place apartment complex southwest of Sneath Lane and Cherry Avenue due to intervening vegetation. Given its location within view of interment areas and the alternate cemetery entrance, Site 15 is considered to have moderately high visual exposure and concern.

Overall Visual Sensitivity

Site 15 would be situated in plain view of a smaller number of gravesites in this area of the GGNC. It would be shielded from most neighboring portions of the cemetery by the operations and maintenance yard. The site would also be visible from motorists and pedestrians along Sneath Lane, as well as the commercial/office park and Veteran's Administration Medical Clinic across Sneath Lane. Given the site's highly prominent position on the street-facing front façade of the cemetery operations and maintenance buildings, the well facility would exert a strong visual impression on the many people visiting or passing the cemetery. The site thus would have moderately high visual sensitivity.

Millbrae

Site 16

Figure 5.3-10 (View of Site 16 and Site 17 [Alternate]) shows the existing view of Site 16 and Figure 3-37 (Site 16, Millbrae Corporation Yard) in Chapter 3, Project Description shows the proposed site layout.

Visual Quality

Site 16 would be located on SFPUC right-of-way behind the Orchard Supply Hardware store along El Camino Real. The site's connection to the SFPUC pipeline would be at the site, with the alternate connection traversing the store's parking lot and connecting into another SFPUC pipeline near El Camino Real. The sanitary sewer line would connect in Hemlock Avenue, with the storm drain directed toward existing drainage adjacent to the Caltrain commuter rail line. The paved site would be located in the truck delivery and outdoor storage areas at the rear of the parcel. To the east are the Caltrain line and a large electrical substation with tower. To the south is a three-story Millbrae Manor Apartments complex separated from the site by an alley, two fences, and a small storage yard. Site 16 is typical of a developed urban commercial environment and does not have any unique visual attributes. Therefore, this site is considered to be of low visual quality.

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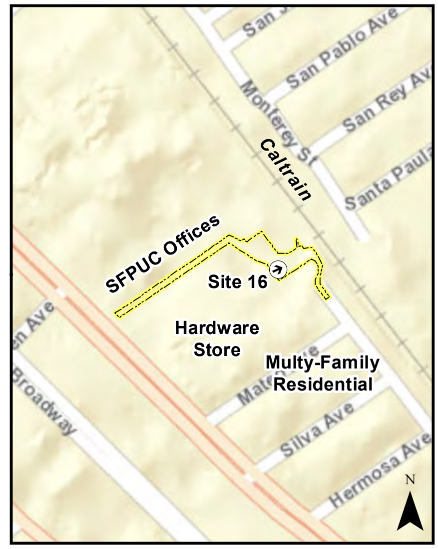
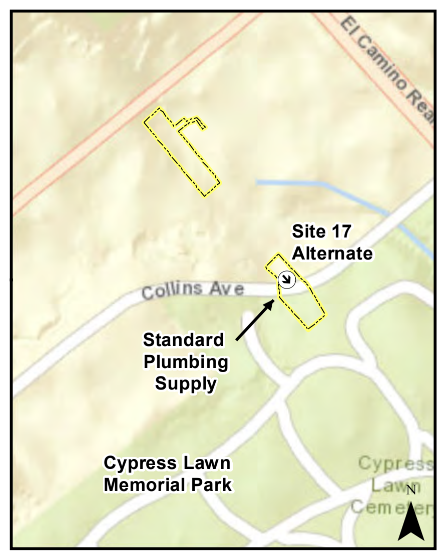


Site 16: View of the facility site looking east from the Orchard Supply Hardware store toward the site and the store's outdoor storage area, with the store and customer parking behind the viewer. Hemlock Avenue is to the right beyond the fence.



Site 17 (Alternate): View of the facility site looking southeast from Collins Avenue. The Standard Plumbing Supply building is to the right and the SFPUC right-of-way is to the left, with the Cypress Lawn Memorial Park out of view over the horizon. The SFPUC right-of-way contunues behind the viewer.

Legend

View Direction

Construction Area

Views of Sites 16 and 17 (Alternate)

Regional Groundwater Storage and Recovery Project

Figure 5.3-10

Affected Viewers and Exposure Conditions

Site 16 would be visible from the upper two stories of residential complex and the hardware store, as well as to patrons and employees in the hardware store parking lot, though it is generally inaccessible to the public. There would be limited views from Hemlock Avenue. Given these limited opportunities for view, this site is considered to have minimal exposure and viewer concern is low.

Overall Visual Sensitivity

Site 16 would be situated in plain view of the hardware parking lot, merchandise delivery, and outdoor storage area. The site would be visible from the upper two stories of the multi-family residence complex. Given the visual nature of the area (see Section 5.3.1.3 [Individual Project Well Facility Sites] above), this site would have low visual sensitivity.

5.3.2 Regulatory Framework

5.3.2.1 Federal

No federal regulations relative to scenic or visual resources would be applicable to the Project.

The U.S. Department of Veterans Affairs (VA), National Cemetery Administration, maintains a Facilities Design Guide that provides guidance for development within national cemeteries and related facilities. Section 5 of the Guide presents design criteria for structures within these facilities. There are no policies or criteria providing specific requirements for the design of facilities situated within the bounds of national cemetery facilities. Item 9.1 in Subsection 5.1 of the Guide states that topography, adjacent facilities, environmental impacts, and future development be considered to produce a design that is both functional and aesthetically successful (VA, National Cemetery Administration 1999, 2010).

5.3.2.2 *State*

California Scenic Highway Program

In 1963, the State of California established the Scenic Highway Program to develop a system of State roadways whose adjacent corridors contained scenic resources worthy of protection and enhancement[2].

Sections 260 through 263 of the State Streets and Highways Code establish the Scenic Highways Program and require local government agencies to take the following actions to protect the scenic appearance of the scenic corridor:

- Regulate land use and density of development,
- Provide detailed land and site planning,
- Prohibit off-site outdoor advertising and control on-site outdoor advertising,
- Pay careful attention to and control earthmoving and landscaping, and
- Scrutinize the design and appearance of structures and equipment.

See Table 5.3-2 (Designated State, County, and Local Scenic Roads in the Vicinity of Facility Sites) for a list of State-designated scenic highways in the Project vicinity.

5.3.2.3 *Local*

Scenic Roadways

Designation of local scenic routes is part of the local general plan process. For State routes and highways, this local designation also provides the basis for nominating and applying to the California Department of Transportation (Caltrans) for eligibility as a State scenic highway. Local scenic routes are considered notable roadways with scenic values that offer views of creeks, hillsides, open space features, water bodies, and unique visual resources. Development within or adjacent to scenic routes is typically subject to guidelines or restrictions (e.g., setbacks, screening, height limitations) that protect the scenic values of these routes. See Table 5.3-2 (Designated State, County, and Local Scenic Roads in the Vicinity of Facility Sites) for a list of State and local designations of scenic routes in the vicinity of the proposed well facility sites.

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[2] The state Scenic Highway Program lists highways that are either eligible for nomination as scenic highways or have been officially designated. Local governing bodies must nominate and apply to Caltrans in order for an eligible highway to be officially designated a Scenic Highway. Part of the application includes defining and identifying the scenic corridor of the highway, and adopting ordinances, zoning and/or planning policies to preserve the scenic quality of the corridor or documenting that such regulations already exist. These ordinances and policies constitute the Corridor Protection Plan.

TABLE 5.3-2
Designated State, County, and Local Scenic Roads in the Vicinity of Facility Sites

Designated Highway or Route	Description/Location	Potential View Exposure/Distance to Facility Sites[a]
State Designated Scenic Highway		
I-280 (Junipero Serra Freeway)[b] Designated	I-280 between the Santa Clara County line to the northern San Bruno city limit.	None
I-280 (Junipero Serra Freeway)[b] Eligible	I-280 between the northern San Bruno city limit and the San Francisco County line.	Site 1 (approximately 40 feet)
City of Daly City - No Designated Scenic Routes		
San Mateo County Designated Scenic Routes		
Junipero Serra Freeway[c]	I-280 from the Santa Clara County line to the City of Millbrae.	None
John Daly Boulevard	From I-280 to State Route 35	None
Town of Colma Designated Scenic Routes		
El Camino Real[d]	Segment that passes through Colma is designated as a scenic route. The Town has designated a 400-foot to 900-foot wide scenic corridor on both sides of El Camino Real. The intersection of El Camino Real and F Street is also designated as a Town gateway.	None
City of South San Francisco - No Designated Scenic Routes		
City of San Bruno Designated Scenic Routes		
Sneath Lane[e]	Segment of Sneath Lane west of El Camino Real is designated as a scenic corridor.	Pipeline construction for Site 14 (adjacent) Well Facility at Site 15 (approximately 25 feet)

Notes:

(a) Distances are measured from the construction area boundary.

(b) Caltrans 2012

(c) San Mateo 1986

(d) Colma 1999

(e) San Bruno 2009

Scenic Trees

Two of the local jurisdictions in the Project area have policies aimed at protecting trees specifically for their contribution to a scenic visual setting. While other Project area jurisdictions may have tree protection or preservation policies, the policies in the Town of Colma and the cities of San Bruno and South San Francisco incorporate the concept of the visual or aesthetic character in its policies.

Town of Colma

The Town of Colma considers its trees important to the community's identity and has developed goals, policies, and ordinances to protect and maintain this resource. This approach to tree protection looks at this resource from a biological and visual perspective. Section 5.14, Biological Resources discusses these goals, policies, and ordinances relative to potential Project impacts to biological resources, including an evaluation of tree preservation policies and ordinances. Tree protection ordinances are also discussed in Chapter 4, Plans and Policies.

The Town's General Plan Figure OS-1 identifies specific tree masses throughout the Town that contribute to the picturesque quality of the Town (Colma 1999)[3]. The majority of the trees were planted by cemetery owners as buffers or windbreaks and for aesthetic purposes. These tree masses have "grown" into Colma's physical environment and visual setting – becoming part of the Town's character. The General Plan includes Goal 5.04.034, which calls for the identification and preservation of selected tree masses (which are specifically identified in the Town of Colma General Plan), landscape features, and other scenic elements important to the Town's visual setting.

The Town has adopted a tree cutting and removal ordinance to protect both trees and views (Colma 2010). Under the Town's Municipal Code, Chapter 5, Subchapter 5.06, in connection with the issuance of tree permits, the Town may require the replacement of trees that are removed with new trees that will grow to a similar size and form. General Plan Policy 5.04.331 supports this ordinance by stating that tree removal should follow the guidelines of the tree ordinance (Colma 1999). Where appropriate, the Town seeks to have new trees planted that will achieve substantial height, and in groupings which will perpetuate the large massings associated with Colma's visual setting.

Sites 7 and 17 (Alternate) would be situated adjacent to, or within, identified tree masses in Colma. Therefore, Colma's local tree protection policies are discussed in evaluating the significance of aesthetic impacts that may result from implementation of the proposed Project at Sites 7 and 17 (Alternate).

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[3] The Town of Colma's General Plan identifies specific tree masses throughout the Town. The General Plan and Tree Ordinance use several terms to when discussing tree masses, including "major" tree masses, "significant" tree mass, and designated tree mass. These terms are used interchangeably throughout these Town policy documents. For consistency, this EIR uses the more general terms "tree mass" or "designated" tree mass.

City of San Bruno

The City of San Bruno's General Plan Open Space and Recreation Element includes Policy OSR-33 which calls for the balance of fire prevention goals with the preservation of the mature tree stands along the city's scenic corridors, including Sneath Lane, consistent with the Tree Preservation Ordinance. Policy OSR-34 also calls for the protection mature trees, as feasible, during new construction and redevelopment (San Bruno 2009).

Site 15 would be situated along Sneath Lane in San Bruno. Therefore, San Bruno's Heritage Tree ordinance (Municipal Code, Title 8, Chapter 8.25) is considered in evaluating the significance of aesthetic impacts that may result from implementation of the Project at Site 15 (San Bruno 2002). While Site 14 is situated in San Bruno, the city's tree ordinance does not apply to this site given its location within the GGNC and that no trees would be removed by the Project.

City of South San Francisco

Relevant Land Use goals and policies in the City of South San Francisco's General Plan include development of a streetscape plan for the El Camino Real SubArea, where Sites 11, 12, and 19 (Alternate) would be located along, and within sight of, El Camino Real. The streetscape plan specifies a consistent row of trees on either side of El Camino Real for the six-lane stretch that starts at the Kaiser Permanente Medical Center area and runs south. These trees are contributing resources in the city's streetscape plan, as noted in General Plan Implementing Policy 3.4-1-1. This policy calls for trees to line either side of this roadway to support Guiding Policy 3.4-G-1, which seeks to define El Camino Real as a boulevard (South San Francisco 1999). As noted in the discussion of Impact BR-4 in Section 5.14, Biological Resources, other city-defined heritage trees would be removed or trimmed due to the Project at Sites 9, 10, 13, and 18 (Alternate). However, impacts from removal of these trees are discussed in the context of the City of South San Francisco's tree preservation ordinance (South San Francisco n.d.) and discussed in Section 5.14, Biological Resources.

5.3.3 Impacts and Mitigation Measures

5.3.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on aesthetics if it were to:

- Have a substantial adverse effect on a scenic vista.
- Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and other features of the built or natural environment which contribute to a scenic public setting.
- Substantially degrade the existing visual character or quality of the site and its surroundings.
- Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area or which would substantially impact other people or properties.

5.3.3.2 *Approach to Analysis*

This section evaluates potential impacts on visual resources that could occur during Project construction and operations. For the purpose of this analysis, the visual setting is defined as the natural and built landscape features that can be seen from publicly accessible vantage points (viewshed).

Construction-related impacts on aesthetics could occur during well facility construction, use of construction staging areas, trenching for pipeline placement, and tree removal. Operational impacts on aesthetics could occur from the permanent placement of aboveground well facilities, or from not replacing trees that are removed during construction and not planned for replacement due to their location within the SFPUC right-of-way. See the subsection titled *Visual Quality* below for further discussion.

The visual impact analysis is based on field observations of the facility sites and surrounding viewsheds conducted in February 2010, April and May of 2011, and March 2012, site and aerial photographs, visual simulations, computer-aided street-view tours,[4] and review of relevant planning documents.

The following impact analysis addresses the short-term (construction-related) and long-term (siting, operations and maintenance-related) impacts on scenic resources, scenic vistas, and the visual quality and character of the facility sites and surroundings. For purposes of this analysis, scenic resources are defined as features of the built or natural environment that contribute to a scenic public setting, including but not limited to, trees and rock outcroppings. Scenic vistas are publicly accessible viewpoints that provide expansive views of a highly valued landscape.

The evaluation of temporary visual impacts during construction considers whether those activities would substantially degrade the existing visual character or quality of the site or surrounding area and the duration over which this change would occur. Being temporary in nature, construction-related effects on visual quality are generally considered to have a less-than-significant impact. However, construction activities that are highly visible to sensitive viewers in publicly-accessible areas – such as public areas in residential neighborhoods or buildings, passersby on public roadways and walkways, users of outdoor recreational facilities, and cemetery visitors – and that would be located at one site for a year or more may result in significant construction-related visual impacts depending on the overall visual context at each facility site.

Permanent visual impacts from facility siting and operation are assessed based on the Project's potential to have a substantial adverse effect on scenic vistas, substantially damage scenic resources, or substantially degrade the existing visual character or quality of the site and its surroundings.

The evaluation of permanent visual impacts of the operation and maintenance of the proposed Project relative to each site's overall visual sensitivity and visual contrast is presented. Table 5.3-3 (Visual Impact

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[4] Available on Google Maps™ and Google Earth™.

Scale) presents a three-point scale using the concepts and terminology discussed in Section 5.3.1 (Setting), for determining the level of impact for each of the above significance criteria for both construction-related and siting and operational impacts.

This table considers overall visual sensitivity of each site and its surroundings, as well as the visual change or contrast that would be caused by the Project. "Overall visual sensitivity" brings together the factors discussed in Section 5.3.1.1 (Concepts and Terminology) into a single consolidated measure: visual quality; affected viewers and exposure conditions; and visual sensitivity. "Visual change/contrast" refers to the transformation or modification of the appearance of the Project and/or its surroundings. As seen in the table, each of these measures are rated high, moderately high, moderate, moderately low, and low, with the significance dependent on how the potential Project impact would compare with both measures.

TABLE 5.3-3
Visual Impact Scale

		Overall Visual Sensitivity				
		High	**Moderately High**	**Moderate**	**Moderately Low**	**Low**
Visual Contrast/Change	**High**	Significant	Significant	Significant	Less than Significant	Less than Significant
	Moderately High	Significant	Significant	Significant	Less than Significant	Less than Significant
	Moderate	Significant	Significant	Less than Significant	Less than Significant	Less than Significant
	Moderately Low	Less than Significant	Less than Significant	Less than Significant	Less than Significant	Less than Significant
	Low	Less than Significant	Less than Significant	Less than Significant	Less than Significant	Less than Significant
	No Change/Effect	No Impact	No Impact	No Impact	No Impact	No Impact

The approach to evaluating the effect of the proposed Project under each CEQA significance criterion is briefly discussed below:

Scenic Vistas

This criterion is applicable only to projects that would be located on or disrupt access to a scenic vista, or result in significant visual changes within its viewshed. Scenic vistas may be officially recognized or designated (e.g., within local planning documents or the Caltrans scenic highway program), or they may be informal in nature (e.g., mountain peaks or expansive views). The Project's effect would be considered substantial if it were to appreciably damage or remove the visual qualities that make the view unique, unobstructed, and/or exemplary.

Scenic Resources

Damage to a scenic resource is substantial when it is substantially perceptible from affected publicly accessible views and when it appreciably degrades one or more of the aesthetic qualities that contributes to a scenic setting. The presence of and potential damage to scenic resources in this analysis is considered along with Project-related effects on the existing visual character and quality of a site or surroundings.

Visual Quality

This criterion is applicable to all locations where the Project would result in either temporary or permanent visual change. The Project is considered to "substantially degrade" the visual character or quality of a site if it would have a strongly negative influence on the public's experience and appreciation of the visual environment. As such, visual changes are always considered in the context of a site or locale's visual sensitivity (as described in the setting). Visual changes caused by the Project are evaluated in terms of their visual contrast with the area's predominant landscape elements and features, their dominance in views relative to other existing features, and the degree to which they could block or obscure views of aesthetically pleasing landscape elements. Visual changes are also evaluated in terms of potential damage to, or removal of, features of the natural or built environment that contribute to a scenic public setting. The magnitude of visual change that would result in a significant impact (i.e., substantial degradation) is also influenced by its degree of permanence. The significance of visual changes is also a function of the visual sensitivity of a site. Impacts to the visual quality of a site resulting from tree and vegetation removal during construction are addressed under construction-related impacts (Section 5.3.3.4 [Construction Impacts and Mitigation Measures] below). Impacts to the visual quality of a site resulting from long-term operation of Project facilities are addressed under operation-related impacts (Section 5.3.3.5 [Operation Impacts and Mitigation Measures] below), including the long-term visual impact from not replanting trees in the SFPUC right-of-way at some sites, which is guided and required by the SFPUC Integrated Vegetation Management Policy (SFPUC 2007).

Light and Glare

This criterion is applicable to projects that require substantial nighttime lighting (either during construction or operation) or that would include highly reflective surfaces that would create a new source of substantial glare from the sun.

Areas of No Project Impact

Due to the nature of the proposed Project, there would be no construction or operational impacts related specifically to glare; therefore, the issue of glare is not discussed further in this section for the following reasons:

Create a new source of substantial glare which would adversely affect day or nighttime views in the area either during construction or operation. Considering the nature of construction activities, equipment, and materials, there would be very little, if any, glare resulting from the Project. The only potential for Project-related glare would be from reflective surfaces (e.g., windshields) on construction equipment as they carry out construction activities. However, these instances of glare would be momentary and passing, depending on sky conditions. The permanent facilities would be constructed of board-formed concrete and metal panels in gray or earth tone with anti-graffiti coating, which would not be a highly reflective surface that would cause glare. Therefore, the Project would have no impact due to glare.

5.3.3.3 Summary of Impacts

Table 5.3-4 (Summary of Impact – Aesthetics) provides a summary of potential impacts to the aesthetic environment and significance determinations at each well facility site.

TABLE 5.3-4
Summary of Impacts – Aesthetics

	Construction		Operation		Cumulative
Sites	**Impact AE-1: Project construction would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.**	**Impact AE-2: Project construction would not create a new source of substantial light that would adversely affect day or nighttime views in the area.**	**Impact AE-3: Project operation would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.**	**Impact AE-4: Project operation would not create a new source of substantial light that would adversely affect day or nighttime views in the area.**	**Impact C-AE-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to scenic resources and visual character.**
Site 1	LS	LS	LS	LS	NI
Site 2	LS	NI	LS	LS	NI
Site 3	LS	LS	LS	LS	NI
Site 4	LSM	LS	LSM	LS	NI
Westlake Pump Station	NI	NI	NI	NI	NI
Site 5 (Consolidated Treatment)	LS	NI	NI	LS	NI
Site 5 (On-site Treatment Option)	LS	NI	LS	LS	NI
Site 6 (Consolidated Treatment and On-site options)	LS	NI	LS	NI	NI
Site 7 (Consolidated Treatment and On-site options)	SUM	NI	LSM	NI	NI
Site 8	LS	NI	LS	NI	LS
Site 9	LS	LS	LS	LS	LS
Site 10	LS	NI	LS	LS	NI
Site 11	LS	NI	LS	NI	LS
Site 12	LSM	LS	LS	LS	LSM
Site 13	LSM	NI	LS	LS	LSM
Site 14	LSM	LS	LSM	LS	NI

TABLE 5.3-4
Summary of Impacts – Aesthetics

Sites	Construction		Operation		Cumulative
	Impact AE-1: Project construction would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.	Impact AE-2: Project construction would not create a new source of substantial light that would adversely affect day or nighttime views in the area.	Impact AE-3: Project operation would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.	Impact AE-4: Project operation would not create a new source of substantial light that would adversely affect day or nighttime views in the area.	Impact C-AE-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to scenic resources and visual character.
Site 15	LSM	LS	LSM	LS	NI
Site 16	LS	LS	NI	LS	NI
Site 17 (Alternate)	LS	NI	LS	NI	LS
Site 18 (Alternate)	LSM	LS	LSM	LS	NI
Site 19 (Alternate)	LS	LS	LS	LS	LS

Notes:

NI = No Impact, LS = Less than Significant, LSM = Less than Significant with Mitigation, SUM = Significant and Unavoidable with Mitigation

5.3.3.4 Construction Impacts and Mitigation Measures

Impact AE-1: Project construction would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings. (Significant and Unavoidable with Mitigation)

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

The proposed Project could result in temporary construction-related impacts on the visual character of the facility sites and surrounding areas. Direct views of the facility sites, including views of construction work areas, are available from public roadways and public areas in residential neighborhoods, from outdoor recreational facilities, and from cemeteries in the area. Construction activities would occur over a 16-month period for facilities with chemical treatment facilities and would range from four weeks to six months for well with fenced enclosure facilities (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]).

The impact analysis for each well facility site references site layout figures found in Chapter 3, Project Description (Figures 3-6 through 3-8), in addition to the site photographs and simulations included this chapter.

<u>Westlake Pump Station</u>

The Westlake Pump Station is within a fenced public works yard adjacent to the Westlake Village Apartments on the north, the Ben Franklin Intermediate School grounds to the south and east, and a single-family residential neighborhood to the west (Figure 3-13). As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and low overall visual sensitivity.

Construction at the Westlake Pump Station would occur inside the existing buildings, with materials staging outside and within the existing fence that surrounds the property. Construction activities would have a temporary minor impact on the visual character of this area given that some materials would be staged outside the pump station building. However, the site has very limited exposure to potential viewers. The effect on overall visual sensitivity would be low with no change in visual contrast. In addition, the site would not be located within a scenic vista, nor along a designated scenic roadway. As a result, no scenic vistas, roadways, or resources would be affected. Therefore, there would be *no impact* on the visual character of the site and its surroundings, and there would be *no impact* on scenic roadways, resources, or vistas.

Impact Conclusion: No Impact

<u>Sites 1, 2, 3, 5, 6, 8, 9, 10, 11, 16, 17 (Alternate), and 19 (Alternate)</u>

Site 1

Site 1 would be located in the northeastern corner of the Lake Merced Golf Club, a privately owned and operated facility. This site is approximately 50 feet away from the fairways and lined by mature trees on the east, which partially obscure the view from I-280 to the east (Figure 3-11). The ground at this site is mostly bare, and a restroom facility of concrete block construction is situated in the southern part of the site. At the time of the site visit, piles of vegetative waste were being stored on the site. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has low visual exposure – though moderate visual sensitivity, moderate visual concern, and moderately low overall visual sensitivity.

Construction of the 1,480-square-foot well and chemical treatment facility at Site 1 (see Figure 3-11) would be visible from the end of Poncetta Drive, the Lake Merced Golf Club, and from a portion of the Westlake Village Apartments to the north. The facility would be approximately 40 feet west of I-280, which has been designated as eligible for the State Scenic Highway Program (see Table 5.3-2 [Designated State, County, and Local Scenic Roads in the Vicinity of Facility Sites], but would be partly screened by intervening vegetation along the eastern edge of the facility site. No scenic vistas or scenic roadways would be affected due to the existing screening between the highway and the site. Though it does not add to the visual quality of the site, the restroom facility currently on this site would be removed as part of the Project (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). Views of the site from residences would be seen only by a few individuals in a private setting and would not be visible from public areas within the multi-family residential area. The site would be located above the golf links and golfers would have a relatively unobstructed view of the construction site during the 16-month construction period if intervening vegetation is not of sufficient height to provide visual screening. However, the views from the golf links would not be publicly accessible and would be available only to the members and workers of this private golf club. Also, the apartments provide a developed backdrop when the site is viewed from the golf club. In this context, the visual quality of the area was rated as moderate because of scenic qualities of the golf club. Visual contrast at this site thus would be moderate. Therefore, the potential impact on the visual character of the site and its surroundings would be *less than significant*; whereas there would be *no impact* on scenic vistas or scenic roadways given that this site is, and would remain shielded from I-280 by existing trees.

Site 2

Site 2 would be located just outside the southwest corner of the Lake Merced Golf Club and south of the golf club maintenance access road (see Figure 3-12). This site is located immediately off the street at the edge of an extensive open space area comprised of playing fields of the Garden Village Elementary School and athletic fields at the Ben Franklin Intermediate School. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, visual quality, and overall visual sensitivity.

Activities associated with construction of a fenced enclosure and associated pipelines at Site 2 (see Figure 3-6) would be visible from Park Plaza Drive, the Ben Franklin Intermediate School's athletic field and portions of the main campus. A new well would not be drilled at this site, as the existing test well would be converted to a production well. Views along Park Plaza Drive would be temporary and fleeting as drivers pass the site. Several single-family residences are above the athletic field to the south at the Ben Franklin School and several multi-family residences are located to the northwest of the site. Views of construction activities would be substantially blocked from the Lake Merced Golf Club by trees and shrubs. No trees or other scenic resources would be affected. In addition, the location is not within a scenic vista, nor along a designated scenic roadway. As a result, no scenic vistas, resources, or roadways would be affected.

As discussed above in Section 5.3.1.3 (Individual Project Well Facility Sites) the site has moderate visual quality that is characteristic of the surrounding area and the overall visual sensitivity of this location is also considered moderate. Construction activities (i.e., fencing, connecting pipelines) would take approximately four weeks at the site (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]), and would be seen by a moderate number of viewer groups including motorists, students, and users of the school's athletic and playing fields. The relatively short construction duration would generate temporary, but moderate, visual change in the area. Coupled with the moderate overall visual sensitivity of the site and the moderate number of viewers at this site, the Project would result in a *less-than-significant* impact; whereas there would be *no impact* on scenic roadways, resources, or vistas at this site.

Site 3

Site 3 would be located in the southwest corner of the athletic field at the Ben Franklin Intermediate School (see Figure 3-12). The site is covered in turf and located behind a baseball backstop on the field. It would be located at the foot of a slope, at the top of which single-family residences are located to the southwest. This puts the site low in the field of view from these residential areas. A small wooded area of tall eucalyptus trees directly adjoins the site to the east and southeast. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, visual quality, and overall visual sensitivity.

Construction of the well with a fenced enclosure at Site 3 (see Figure 3-6) would be visible to a variety of viewer groups from Park Plaza Drive, the Ben Franklin Intermediate School athletic field, single-family residences located to the south and southwest on White Street and Maddux Drive, and the Westlake Village Apartments to the north. Pipeline construction in the athletic field, happening concurrently with the well facility construction, would also be visible from multi-family housing to the north. Construction at Site 3 would occur for a total of six months during two three-month construction periods and would occur during non-school months precluding its use for non-school activities (see Chapter 3, Project Description, Section 3.5.1[Construction Sequencing and Schedule]). Therefore, the potential number of viewers at the site would be reduced during construction.

Site 3 would not be located within a scenic vista, nor along a designated scenic roadway; the Project would not affect these resources. There would be *no impact* on scenic roadways, resources, or vistas at this site. The overall visual sensitivity is considered moderate. Although construction would temporarily degrade visual character during the two three-month construction periods, the duration and number of viewers would be limited in each case because construction would occur during non-school time, resulting in moderate visual change. Therefore, this would constitute a *less-than-significant* visual impact.

Site 5

Site 5 would be located in a vacant paved lot between a State Farm Insurance Agency office and a single-family residence (Figures 3-15 and 3-19). The parking lot for the former Serra Bowl is adjacent to the south, with the Serra Bowl building beyond the parking lot. B Street creates the north border of the site; an automobile dealership is located across B Street from the site. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, low visual quality, and moderately low overall visual sensitivity.

The facility at Site 5 would include a well with a fenced enclosure for the consolidated treatment at Site 6 option (see Figure 3-6 and Figure 3-14). The fenced enclosure and pipelines to deliver water to Site 6 for treatment would require approximately three months to construct (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). A 2,095-square-foot well and chemical treatment facility would be constructed for the on-site treatment option; construction of the well facility would take approximately 16 months to complete if treatment cannot occur at Site 6. The layout for on-site treatment is shown on Figures 3-18 and 3-19 in Chapter 3, Project Description.

Construction at Site 5 would be visible to surrounding commercial buildings, pedestrians along B Street, and the single-family residence east of the site. Construction of the pipeline from Site 5 to Site 6 would be visible to pedestrians and motorists along Hill Street, D Street, surrounding commercial buildings, and BART patrons using the Colma station. However, the location is not within a scenic vista, nor along a designated scenic roadway. As a result, no scenic vistas, resources, or roadways would be affected. Construction activities would have a temporary minor impact on the visual character of this largely developed commercial area, given that views of the construction activities from roadways would be temporary and fleeting and the overall visual quality is moderately low. The area is not seen by sensitive viewers and construction would generate only moderate visual contrast or change in the area. Therefore, the impact on the visual character of the site and its surroundings would be *less than significant*; whereas there would be *no impact* on scenic roadways, resources, or vistas at this site.

Site 6

Site 6 would be situated on a grassy area along the south side of D Street, across from the Colma BART station, which dominates views of the area (Figures 3-16 and 3-20). The SamTrans Park and Ride lot is located upslope from this site to the southwest, beyond a row of trees. The pedestrian bridge over D Street linking the parking lot to the station has a clear view of this site. The Woodlawn Memorial Park is located to the south and upslope. The immediately adjacent portion of the cemetery is used for outdoor materials storage. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure – but low viewer concern, low visual quality, and low overall visual sensitivity.

The proposed Project at Site 6 would include construction of a 2,990-square-foot, well, chemical treatment, and filtration facility for either the consolidated treatment at Site 6 option or a 2,095-square-foot facility for the on-site treatment option (see Figures 3-8, 3-16, and 3-20). Site 6 would be visible to travelers along D Street and to BART patrons. While El Camino Real is a Colma-designated scenic corridor and its intersection with F Street is designated as a Town gateway, this site would not be visible from either due to intervening vegetation and buildings. In addition, the location is not within a scenic vista. As a result, no scenic vistas, resources, or roadways would be affected.

Construction activities at Site 6 would not be visible from the publicly accessible portions of Woodlawn Memorial Park. The nearest portion of the memorial park from which the site could be visible would be an outdoor materials storage area, which is not open to the public. Also, intervening topography and vegetation (i.e., trees) further block views to Site 6 from this cemetery. Existing views from this portion of Woodlawn Memorial Park may include the Colma BART station and the SamTrans Park and Ride lot also adjacent to Site 6; however, this site would be out of view in these vistas as it would be below and out of the line of sight. The overall visual sensitivity of this site is considered low given its immediate surroundings and the fact that it is screened from potentially sensitive vistas. The change in visual contrast would also be considered low, given the visual environment at and around this site, as described here. Therefore, the impact on the visual character of the site and its surroundings would be *less than significant*; whereas, there would be *no impact* on scenic roadways, resources, or vistas at this site.

Site 8

Site 8 would be located in a narrow grassy strip surrounded by various large-scale commercial establishments in a segment of Serramonte Boulevard lined by car dealerships, Kohl's Department Store and its associated parking. The streetscape is thus dominated by unscreened parked automobiles, little landscaping and low visual unity. Site 8 would be shielded from view on all sides except the northeast due to depressed topography. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and low overall visual sensitivity.

Construction of the 2,095-square-foot well, chemical treatment, and filtration facility at Site 8 (see Figures 3-8 and 3-22) would be visible from Serramonte Boulevard, Kohl's Department Store rear parking lot, adjacent car dealerships, and distantly from Collins Avenue where it crosses the SFPUC's right-of-way (see Figure 3-22). However, the location is not within a scenic vista, nor along a designated scenic roadway. As a result, no scenic vistas, resources, or roadways would be affected. Construction activities would extend for more than one year, but no sensitive viewers would be affected given the temporary and random presence of potential viewers and the location of the site away from areas frequented by viewers. Construction at Site 8 would have a temporary minor impact on the visual character of this commercial area. However, the effect on overall visual sensitivity would be low, as would the change in visual contrast. Therefore, the impact on the visual character of the site and its surroundings would be *less than significant*; whereas there would be *no impact* on scenic roadways, resources, or vistas at this site.

Site 9

Site 9 would be located on an existing undeveloped parcel between the concrete-lined Colma Creek Diversion and San Mateo County Flood Control channels. The site, in a mixed commercial/residential area, is triangular in shape and covered with low-growing ruderal vegetation and has a lone tree at its center. The site and surroundings are devoid of vivid or attractive visual features, and dominated by the adjacent concrete flood channels and the neighboring Costco parking lot. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and low overall visual sensitivity.

Construction activities for a 2,095-square-foot well, chemical treatment, and filtration facility at Site 9 (see Figures 3-8, 3-23, and 3-24) would be visible from a portion of the Treasure Island Trailer Court, the Costco parking lot, a bicycle and pedestrian path, as well as the Verano Condominiums and other single-family residences on Mission Road to the southeast. However, the location is not within a scenic vista, nor would it be visible from any nearby designated scenic roadways. As a result, no scenic vistas, resources, or roadways would be affected by development of this site, including removal of the one Monterey pine. Therefore, there would be *no impact* on scenic roadways, resources, or vistas due to construction at this site.

Construction activities would have a temporary minor impact on the visual character of this largely developed commercial area for the duration of the 16-month construction period. Given the overall visual quality of the site, the visual contrast or change generated by the Project would be low. There are no sensitive viewers, except for residences; however, the views of the site from residences would be seen by only a few individuals in a private setting. As a result, the visual sensitivity of the site is low. Therefore, construction at the site would not degrade or detract from the visual character of the area, and the impact would be *less than significant*.

Site 10

Site 10 would be located on an undeveloped grassy lot on the southwest corner of Hickey Boulevard and Camaritas Avenue. Trees line the west side of the lot, separating it from the single-family residences beyond Crown Circle to the west. The site slopes upward to the south and remains undeveloped, though single-family residences line Camaritas Avenue beyond stands of mature trees to the southeast. The Winston Manor Shopping Center is located to the east with a Chevy's Restaurant closest to the site across Camaritas Avenue. Immediately to the north across Hickey Boulevard, the topography slopes steeply upward providing partial views through mature trees of the fenced rear yards of single-family residences that front on Duval Drive. The site is not visible from publicly accessible areas in the residential neighborhood. The site is in an area transitioning from commercial strip development of low visual quality to a residential one marked by substantial large-scale tree canopies and grass slopes. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure – though moderate visual sensitivity, moderately low visual quality, and moderate overall visual sensitivity.

Construction of a 2,095-square-foot well, chemical treatment, and filtration facility at Site 10 (see Figures 3-8, 3-25, and 3-26) would be visible from Hickey Boulevard, Camaritas Avenue, the Winston Manor Shopping Center, and from residences across Hickey Boulevard and on Camaritas Avenue (see Figure 3-25). The site would not be visible from the residential area to the west on Crown Circle, due to dense landscaping and topography. The overall visual sensitivity of this site is considered moderate and the change in visual contrast would also be considered moderate (see Section 5.3.1.3 [Individual Project Well Facility Sites]). Construction activities would occur over a 16-month period, with the presence of heavy construction equipment and materials that would temporarily change the visual character of the area. Given the visual environment at and around this site, the overall visual sensitivity and change in visual contrast of this site are considered moderate. Therefore, the Project would have a *less-than-significant* visual impact on the visual character of the site and its surroundings.

In addition, the location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, no scenic vistas resources, or roadways would be affected. Therefore, there would be *no impact* on scenic roadways resources, or vistas.

Site 11

Site 11 would be located next to a BART ventilation structure between El Camino Real and Mission Road northwest of Chestnut Avenue and Antoinette Lane (Figures 3-27 and 3-28). The site is covered in gravel with the adjacent slope covered in unmaintained grasses and mature trees. The topography and a row of trees along this portion of El Camino Real obstruct views of the site and the BART ventilation structure just beyond. The BART ventilation structure partially obstructs views of the site from the Centennial Way Trail to the east. To the north of the site is a five-story parking garage and surface parking lot for the Kaiser Permanente Medical Center. The remainder of the surrounding land is vacant or commercial without any visually notable features. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and moderately low overall visual sensitivity.

Construction of the 2,095-square-foot well, chemical treatment, and filtration facility structure at Site 11 (see Figures 3-8, 3-27, and 3-28) itself would not be visible from El Camino Real given intervening topography and vegetation. The visual sensitivity in the area of Site 11 is moderately low, as it would be located within a transit service corridor. The location is not within a scenic vista, nor along a designated scenic roadway. However, it would be viewed briefly by pedestrians and bicyclists on the Centennial Way Trail along the Colma Creek Diversion Channel, although this view is also partially blocked by an existing BART ventilation structure, giving it low visual quality. Trail users would have a temporary, fleeting, and partially obstructed view of Site 11, which would not significantly detract from their trail use experience. Water pipeline construction would be visible from El Camino Real and adjacent commercial areas, and sanitary sewer construction would be similarly visible from Antoinette Lane. Construction of Site 11 would remove up to seven Lombardy poplars and one Torrey pine tree. In addition, seven other trees adjacent to the construction zone may need to be trimmed. While construction would extend for approximately 16 months, the trees to be removed provide little value as visual buffers from area public vantage points. The Project would generate moderately low visual change. Motorists and pedestrians along El Camino Real would have a temporary and fleeting view of the construction area once the trees are removed. Therefore, the impact on the visual character of the site and its surroundings would be *less than significant*; whereas there would be *no impact* on scenic roadways resources, or vistas at this site.

Site 16

Site 16 would be located on SFPUC right-of-way behind the Orchard Supply Hardware store along El Camino Real (see Figure 3-37). To the east are the Caltrain line and a large electrical substation and tower. To the south is the three-story Millbrae Manor Apartments. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and low overall visual sensitivity.

Construction of a 1,480-square-foot well and chemical treatment facility at Site 16 (see Figure 3-7), including pipeline construction, would be visible from the Orchard Supply Hardware store parking lot, Caltrain, and the three-story Millbrae Manor Apartments to the south. The visual quality of the site is rated as low because of the commercial nature of the area and because the site has low visibility from public vantage points.

Although construction activities would occur over a 16-month period near residences, views from the multi-family residential areas would be seen by only a few individuals in a private setting. Construction at the site would not be visible from public viewing areas within the residential areas. In addition, the visual quality of the site is ranked as low and the number of affected viewers is low. The overall visual sensitivity is, therefore, considered low for the site. Given the existing appearance of the site, there would be minimal visual change during Project construction. Therefore, visual-related construction impacts would be *less than significant*. The location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, there would be *no impact* on scenic roadways, resources, or vistas at this site.

Site 17 (Alternate)

Site 17 (Alternate) would be located in a flat, grassy area adjacent to the SFPUC right-of-way and next to Standard Plumbing Supply on a relatively lightly traveled section of Collins Avenue (See Figure 3-38). The right-of-way, which is covered in grasses in this area, slopes up from Collins Avenue toward Cypress Lawn Memorial Park to the south, but is visually isolated from the cemetery by sloping terrain and tree cover. The Standard Plumbing Supply property is surrounded by chain link fence with exposed parking. The vicinity is typified by various commercial/light-industrial land uses. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure – though low visual sensitivity, moderate visual quality, and low overall visual sensitivity.

Construction of a 1,495-square-foot well and chemical treatment facility at Site 17 (Alternate) (see Figure 3-7 and 3-38) would be visible from Collins Avenue and the Standard Plumbing Supply store adjacent to the site to the west. The site would be located north of the Cypress Lawn Memorial Park, which is a representative example of picturesque cemetery design in Colma (see Figure 3-38). However, due to steep intervening topography, the store building and fencing, construction activities at the site would not be directly visible from publicly-accessible areas in Cypress Lawn. The site is not within a scenic vista nor would it be visible from any nearby scenic roadways, as a result no scenic vistas, resources, or roadways would be substantially affected. Construction would occur for approximately 16 months, but would not affect sensitive viewers given the temporary and random presence of potential viewers and the location of the site away from areas frequented by viewers. The effect on overall visual sensitivity would be low, as would the change in visual contrast. Therefore, the impact on the visual character of the site and its surroundings would be *less than significant*; whereas there would be *no impact* on scenic roadways, resources, or vistas at this site.

Site 19 (Alternate)

Site 19 (Alternate) would be across Southwood Drive from Site 12 and situated between the Our Redeemer's Lutheran Church and single-family residences fronting on Fairway Drive (see Figure 3-40). The site, covered in mowed grassy vegetation, is partially screened by fences and vegetation from these single-family residences. Multi-family residential developments are also located to the north of this site and have limited views of the site through intervening landscape vegetation and trees. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, visual quality, and overall visual sensitivity.

The construction zone for the fenced well facility site would be located behind the Our Redeemer's Lutheran Church, where it would be visible from the rear of the church and the R. W. Drake Preschool on church property. Construction of a fenced well facility at Site 19 (Alternate) (see Figure 3-6) would be visible from Southwood Drive, single-family residences to the west, multi-family residential uses to the north, and the Garden Chapel Funeral Home across Southwood Drive. The site is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result no scenic vistas, resources, or roadways would be substantially affected. Construction would occur for approximately three months, but would not affect sensitive viewers given the temporary presence of potential viewers and the location. Therefore, the impact on the visual character of the site and its surroundings would be *less than significant*; whereas there would be *no impact* on scenic roadways, resources, or vistas at this site.

Impact Conclusion: Less than Significant

Sites 4, 12, 13, 14, 15, and 18 (Alternate)

Site 4

Site 4 would be located on a lot adjacent to Park Plaza Drive in the southwest corner of the Garden Village Elementary School grounds. The site is atop a slope above the school's playing fields covered with grassy vegetation. It is adjacent to single-family residences that front onto 87th Street to the south and other single-family residences across Park Plaza Drive fronting onto White Street to the west. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderately high visual exposure, visual quality, and overall visual sensitivity.

Construction activities associated with the fenced well facility at Site 4 (see Figure 3-6) would be visible from Park Plaza Drive and 87th Street, the Garden Village Elementary School and from single-family residences located to the south and west (see Figure 3-12). Pipeline construction along Park Plaza Drive would also be visible from multi-family housing to the north and the Ben Franklin Intermediate School athletic field. However, the location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, no scenic vistas or scenic roadways would be affected and *no impact* on such resources would be generated.

The visual quality and overall visual sensitivity of the site are identified as moderately high since the site is visible by motorists, recreationalists, and residences. In addition to the trimming of two trees on adjacent properties that may be needed, construction activities at Site 4 would require the removal of up to 19 acacia and five Monterey cypress trees. The removal of these trees would be permanent, as the SFPUC's Integrated Vegetation Management Policy requires vegetation of any size not be allowed to grow within certain critical portions of its rights-of-way (SFPUC 2007). Although not designated visual resources or of a "protected status", the removal of these trees would change the site's appearance and open the area up to views otherwise blocked by existing vegetation within the construction area boundary. This, coupled with a direct view of construction activities and materials storage, would constitute a high degree of visual change in the site's appearance during the three-month construction period and would constitute a *significant* impact.

Implementation of Mitigation Measure M-AE-1a (Site Maintenance) would reduce visual impacts to *less-than-significant* levels through maintaining a relatively clean and inconspicuous construction area. With this mitigation measure, coupled with the three-month temporary construction period, the resulting visual impact would be considered *less than significant with mitigation*.

> ***Mitigation Measure M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate])***
> The SFPUC shall require the contractor to ensure that construction-related activity is as clean and inconspicuous as practical by storing construction materials and equipment at areas of the

construction site that are generally away from public view, and by removing construction debris promptly at regular intervals.

Site 12

Site 12 is currently comprised of the Garden Chapel Funeral Home parking lot, a grassy area with a dirt access for the SFPUC right-of-way, and a dense row of Monterey pine, Monterey cypress, eucalyptus, and Aleppo pine shielding it from view from El Camino Real (see Figures 3-29 and 3-30). These trees are contributing resources in the City of South San Francisco's streetscape plan for El Camino Real, as noted in General Plan Implementing Policy 3.4-1-1. The site is partially screened by fences and vegetation from the single-family residences to the southwest fronting on Fairway Drive. The site is not visible from publicly accessible areas in the residential neighborhood. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, moderate visual sensitivity, moderate visual quality, and moderately high overall visual sensitivity to funeral home visitors and motorists.

Construction of a 1,495-square-foot well and chemical treatment facility at Site 12 (see Figure 3-7), including pipeline construction, would be visible from El Camino Real, Southwood Drive, residences to the west, and from the Garden Chapel Funeral Home. Because the construction area would be about 20 feet from the funeral home and clearly visible, the view of construction activities could be disturbing to funeral home visitors. Facility and pipeline construction activities would occur over a 16-month period and potentially scenic resources would be affected, given that 10 Monterey cypress, 13 Monterey pine, nine dwarf blue gum, three Tasmanian blue gum, and one Aleppo pine tree would be removed at this location to accommodate construction of the well facility at Site 12, including installation of the proposed pipeline that would extend along El Camino Real to the southeast, toward the intersection with West Orange Avenue. To accommodate the temporary construction activities, the removal of these trees would be permanent, as the SFPUC's Vegetation Management Policy (SFPUC 2007) requires vegetation of any size not be allowed to grow within certain critical portions of its rights-of-way.

The overall visual sensitivity of this site is considered moderately high and the change in visual contrast would be considered moderate, given the visual environment at and around this site as described above. The Project would have a *significant* impact to visual resources, as discussed below.

The removal of these 36 mature trees would have a *significant* impact on the visual character of the site and its surroundings. These trees, identified as contributing resources in the City of South San Francisco streetscape plan for El Camino Real, enhance the visual character and quality of this site (see the discussion of Site 12 in Section 5.3.1.3 [Individual Project Well Facility Sites], above, and Chapter 4, Plans and Policies, Section 4.2.4.1 [General Plans]). Their removal would open up views of the construction equipment, materials, and activities and result in a *significant* impact.

However, Mitigation Measure M-AE-1b (Tree Protection Measures) and Mitigation Measure M-AE-1c (Develop and Implement a Tree Replanting Plan) would reduce aesthetic impact at this site to a *less-than-significant* level through identification of trees that would be protected during construction, protection of the trees identified, and by replanting trees along El Camino Real to replace the trees removed or damaged during construction of the pipeline for Site 12. In addition, since the location is not within a scenic vista nor would it be visible from any nearby scenic roadways, there would be *no impact* on designated scenic roadways, resources, or vistas at this site.

Mitigation Measure M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]) [5]

The SFPUC shall identify trees to be protected and retained during construction and minimize potential impact to these trees by implementing the following measures:

- Construction activities within the dripline of trees to be retained adjacent to construction area boundaries or adjacent to pipeline routes shall be avoided.
- A qualified arborist shall identify the location of exclusion fencing to be installed around trees to be retained.
- Prior to the start of construction, the SFPUC or its contractor shall install exclusion fencing around the dripline of trees to be retained and within 50 feet of any grading or construction activity.
- Prior to construction, the SFPUC shall verify that the temporary construction fencing is installed and approved by a qualified arborist. Any encroachment within these areas must first be approved by a qualified arborist and the SFPUC. Temporary fencing shall be continuously maintained by the contractor until all construction activities near the trees are completed. No construction activities shall occur within the exclusion fencing.
- For trees on slopes, exclusion fencing shall consist of a silt fence that will be installed at the upslope base of the tree to prevent soil from moving into the root zone (defined as the extent of the tree dripline) if work is performed upslope of any protected trees.
- Pruning of trees to be retained shall be completed by either a certified arborist or by the contractor under supervision of either an International Society of Arboriculture qualified arborist, American Society of Consulting Arborists consulting arborist, or a qualified horticulturalist.

[5] Impact AE-1 is not significant for Sites 3, 4, 7, 10, 11, 13, 14, and 17 (Alternate), however the sites are listed here because tree protection measures are required to reduce impacts to trees protected by local tree preservation ordinances as described under Impact BR-4 in the Biological Resources section.

Mitigation Measure M-AE-1c: Develop and Implement a Tree Replanting Plan (Site 12)

The SFPUC shall develop and implement a tree replanting plan to address the removal of trees along El Camino Real at Site 12. The tree replanting plan shall include planting locations (which may include non-SFPUC properties), native tree and shrub species (consistent with those near the well facility site), planting ratios, and irrigation requirements. Tree replanting activities occurring on SFPUC properties or right-of-way shall be consistent with the requirements of the SFPUC's Integrated Vegetation Management Policy (SFPUC 2007). The planting ratio for replacement trees shall be a minimum of 1:1, or in substantial compliance with the City of South San Francisco's tree preservation ordinance (Chapter 13.30.080, Replacement of Protected Trees). Replanting shall occur the first year after completion of construction. The SFPUC shall monitor the replacement trees annually for five years after project completion to ensure that the trees survive; if necessary, the SFPUC shall implement additional measures, such as replanting for trees that did not survive.

Considering the presence of equipment and the duration of construction, and the visibility of the construction area, these activities would have a temporarily *significant* impact on the visual character of the site and its surroundings, as viewed from the funeral home and nearby residences. However, implementation of Mitigation Measure M-AE-1a (Site Maintenance) at this site would mitigate this temporary aesthetic impact to a *less-than-significant* level by requiring that construction activities be as inconspicuous as practical by keeping construction materials and equipment away from public view and keeping staging areas clean. The location is not within a scenic vista, nor would it be visible from any nearby scenic roadways. As a result, there would be *no impact* on scenic roadways or scenic vistas at this site.

Mitigation Measure M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate])

(See Impact AE-1, Site 4 for a description)

Site 13

Site 13 would be located on an undeveloped parcel on the southeast side of South Spruce Avenue covered with unmaintained grassy vegetation (see Figure 3-31). It is bordered by a two-story retail/office building and parking lot on the west and a large beverage distribution warehouse on the east. Between the warehouse and the site is the Centennial Way Trail, with an interpretive panel with a trail map at the entrance on South Spruce Avenue. A fenced-in, buried utility vault is located between the site and the pathway. The trail continues immediate across South Spruce Avenue with a large industrial bakery to the north and single-family residential neighborhood to the south of the trail. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure – though moderate visual sensitivity, moderate visual quality, and moderately high overall visual sensitivity.

Construction of a 2,095-square-foot, well, chemical treatment, and filtration facility at Site 13 (see Figures 3-8 and 3-31) would be visible from South Spruce Avenue, the commercial and industrial uses in the area (i.e., Freeman Warehouse, a credit union, a car wash, San Mateo County offices, Orowheat commercial bakery), the Francisco Drive residential neighborhood across South Spruce Avenue, and from the Centennial Way Trail. The site is not visible from publicly accessible areas in the residential neighborhood. The Centennial Way Trail is directly adjacent to the proposed location for Site 13. Utility pipeline construction would happen concurrently with the well facility construction and would be visible from Huntington Avenue and the commercial and office uses in this area (e.g., County offices, Tanforan Professional Center, Century Plaza theaters). However, the location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, no scenic vistas, resources, or roadways would be affected.

With the presence of the trail, the overall visual sensitivity of this site is considered moderately high and the change in visual contrast would also be considered moderately high. Given the presence of equipment, construction materials and 16-month construction period, these activities would have a temporary *significant* impact on the visual character of the site and its surroundings, as viewed from nearby residences and by trail users, passers-by, and patrons of nearby commercial establishments. However, with implementation of Mitigation Measure M-AE-1a (Site Maintenance), this temporary aesthetic impact would be mitigated to a *less-than-significant* level by requiring that construction activities are screened from view at street level and staging areas are kept clean. There would be *no impact* on scenic roadways, resources, or vistas at Site 13.

> ***Mitigation Measure M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate])***
> (See Impact AE-1, Site 4 for a description)

Site 14

Site 14 would be located on the northern side of the GGNC within a grassy area of the SFPUC right-of-way between the gravesites and close to an existing unused pump station, tank, and well in the cemetery (Figures 3-34 and 3-35). The facility would be in proximity to the single-family neighborhood adjacent to the north along Greenwood and Rockwood Drives, which are screened from the site by fences and mature trees. Site 14 would not be visible from the public roads surrounding the cemetery (i.e., Sneath Lane) due to distance, topography, and intervening trees, but it would be visible from internal roadways in this section of the cemetery. The conveyance pipeline connecting the well at Site 14 with the treatment facility at Site 15 and the site's storm drain would be within the SFPUC right-of-way and the pipelines would traverse the cemetery to Sneath Lane. Through landscape vegetation, construction of the pipeline would be partially visible from publicly accessible areas of the Peninsula Place apartment complex at Sneath Lane and Cherry Avenue. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure, visual quality, and overall visual sensitivity.

Construction of a well facility at Site 14 (see Figure 3-6) – including a small 700-square-foot building and approximately 1,100 feet of pipeline in the SFPUC right-of-way through the cemetery and along Sneath Lane – would be visible from the GGNC and partially visible from single-family residences to the north, the Peninsula Place apartment complex, and from Sneath Lane, a locally designated scenic roadway.

Construction would require up to 16 months to complete (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]) for the well, well building, pipeline, and storm drain. As noted in the description of Site 14 in Section 5.3.1.3 (Individual Project Well Facility Sites), there is an unused pump station, tank, and well in the cemetery in close proximity to Site 14. The Project may include demolition and removal of the existing unused well enclosure and tank, which would remove an existing structure that is aesthetically inconsistent with the visual character of the site and surrounding area, given its location in a military cemetery. The removal of that structure would partially offset the impact of the substantial visual change with the proposed new facility.

Construction of the 1,100-foot pipeline would take two to four weeks. Visitors to the northeastern portion of the cemetery would see the pipeline construction and would need to pass the construction area to reach gravesites on both sides of the pipeline route. Another 650 feet of pipeline would be constructed in Sneath Lane adjacent to the cemetery, requiring two to three weeks. This pipeline construction would be concurrent with construction of the well facility building. This pipeline construction in Sneath Lane would not be highly visible from the street level along publicly accessible areas at Peninsula Place apartments due to intervening vegetation. None of the construction area would be visible from the main cemetery entrance and circular monument, which is located about 1,600 feet away to the west.

Well facility and pipeline construction would be visible to visitors in the cemetery. However, the relatively brief and likely infrequent nature of visits to the cemetery by any one individual means that relatively few visitors would be affected by construction activities over the 16-month duration at this location. Therefore, given the low level of traffic and low numbers of viewers over the 16-month construction period, construction activities at Site 14 are considered to have low visual change or contrast. Although construction would be viewed by relatively few people over the construction period, given the high visual quality and the high visual sensitivity of the area, the Project would result in *significant* aesthetic impacts due to its strong contrast with the cemetery during construction. However, implementation of Mitigation Measure M-AE-1a (Site Maintenance) would reduce visual impacts to a *less-than-significant* level through maintaining a relatively clean and inconspicuous construction area during the entire construction period and for all phases of construction in the GGNC. The impact would be further reduced by the requirement in Mitigation Measure M-CR-1a (Minimize Construction-related Impacts on Elements of the Historical Resource at Site 14) to restore grass over the pipeline trench following pipeline installation. With these mitigation measures, coupled with the 16-month temporary construction period, the resulting visual impact would be *less than significant with mitigation*.

Mitigation Measure M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate])
(See Impact AE-1, Site 4 for a description)

Mitigation Measure M-CR-1a: Minimize Construction-related Impacts on Elements of the Historical Resource at Site 14
(See Impact CR-1 in Section 5.5, Cultural and Paleontological Resources for a description)

Site 14 would not be visible from a State designated scenic roadway (e.g., I-280) nor from a scenic vista. Construction of the storm drain and pipeline connection to Site 15 would be visible in Sneath Lane, a locally designated scenic roadway. However, pipeline and storm drain construction is expected to take place concurrently over a two to four week period. Given this relatively short duration, the Project would have a *less-than-significant impact* on such aesthetic resources.

Site 15

Site 15 would be located within the GGNC, situated on a grassy area along the southern edge of the cemetery between Sneath Lane and the cemetery's operations and maintenance yard, which includes buildings designed to be sensitive to the surrounding portions of the cemetery (see Figure 3-36). This site is located at an auxiliary entrance to the GGNC from Sneath Lane. A commercial/office park and a Veteran's Administration Medical Clinic are located to the south across Sneath Lane and are shielded from view somewhat by mature trees and landscaping. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure, moderately high visual quality, and moderately high visual sensitivity.

Construction of a 2,095-square-foot, well, chemical treatment, and filtration site facility at Site 15 (see Figure 3-8), including pipeline construction, would be visible from the GGNC and from Sneath Lane, which is a locally designated scenic route. Construction would last approximately 16 months. Construction of the well facility at Site 15 would require the removal of one elm tree next to one of the operations and maintenance buildings north of Sneath Lane at the GGNC auxiliary entrance (see photo in Figure 5.3-13 [Visual Simulation of Site 15], with the caption "Visual Simulation of Site 15 without Mitigation"). With the primary view being from Sneath Lane, removal of the tree would alter views of the site.

In addition, the pipeline in Sneath Lane would be approximately 650 feet and would be constructed in two to four weeks concurrent with the well facility structure. This pipeline construction would not be highly visible from the street level along publicly accessible areas at the Peninsula Place apartment complex at Sneath Lane and Cherry Avenue due to intervening vegetation. Also, none of the construction area would be visible from the main cemetery entrance and circular monument, which is located about 1,600 feet away to the west. Well facility construction would be limited to a narrow area between Sneath Lane and the existing cemetery operations and maintenance building.

The overall visual sensitivity and change in visual contrast of this site is considered moderately high, given the varied visual environment at and around this site located within the GGNC. Construction of the well facility at Site 15 would result in a *significant* aesthetic impact on Sneath Lane given that Sneath Lane is a scenic roadway, the number of passers-by and the peaceful visual nature of the cemetery. However, implementation of Mitigation Measure M-AE-1a (Site Maintenance), Mitigation Measure M-AE-1d (Construction Area Screening), and Mitigation Measure M-AE-1b (Tree Protection Measures) at this site would reduce this aesthetic impact to a *less-than-significant* level by requiring that construction activities are screened from view at street level, construction areas are kept as clean and inconspicuous as feasible, and protects the existing elm tree from removal.

Mitigation Measure M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate])
(See Impact AE-1, Site 12 for a description)

Mitigation Measure M-AE-1d: Construction Area Screening (Site 15)

The SFPUC and its contractors shall screen the construction area at the facility site at Site 15. Screening shall be designed to minimize view of construction equipment and construction activities from views from Sneath Lane and the surrounding areas. Vehicles and other construction equipment shall be parked in the screened construction area at night and when equipment is not actively being used for pipeline construction along Sneath Lane.

Mitigation Measure M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate])

(See Impact AE-1, Site 12 for a description)

Pipeline and treatment facility construction associated with Site 15 would occur along Sneath Lane, a locally designated scenic roadway. However, the location is not within a State designated scenic roadway (e.g., I-280) nor a scenic vista. As a result, there would be a *no impact* on scenic vistas or resources at this site.

Site 18 (Alternate)

Site 18 (Alternate) would be located on an undeveloped parcel in a residential neighborhood along Alta Loma Drive on a knoll at street level overlooking a lower, moderately sloped grassy swale (see Figure 3-39). The site is densely vegetated with a small stand of willows that is about 15 feet high and covering approximately 3,400 square feet. It is adjacent to single-family residences to the southwest fronting on Del Monte Avenue and others directly across Alta Loma Drive. Single-family residences also front on Camaritas Avenue to the east. Vivid elements in the vicinity include views to forested hillsides to the south and San Bruno Mountain to the north. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure – though moderately high viewer concern, moderate visual quality, and moderately high overall visual sensitivity.

Construction of a 1,495-square-foot well and chemical treatment facility at Site 18 (Alternate) (see Figure 3-7) would be visible from Alta Loma Drive and from single-family residences on Alta Loma Drive, Del Monte Avenue, and Camaritas Avenue. To accommodate construction activities, the small stand of willows on the site would be removed; grading and other site preparation activities would be required for construction of both the well facility and staging area. Facility and pipeline construction activities would occur concurrently over a 16-month period at this site. However, the location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, there would be *no impact* on scenic roadways, resources, or vistas at this site.

Nevertheless, construction activities would occur within this residential neighborhood, with the presence of heavy construction equipment and materials. The overall visual sensitivity of this site is considered moderately high and the change in visual contrast would also be considered moderately high, given the visual environment at and around this site (see Section 5.3.1.3 [Individual Project Well Facility Sites], above). The removal of the willow trees would open up the view of the construction site and contribute to the visual impact, as the SFPUC's Integrated Vegetation Management Policy requires vegetation of any size not be allowed to grow within certain critical portions of its rights-of-way (SFPUC 2007). Considering the presence of equipment and duration of construction, these construction activities would have a temporarily *significant* impact on the visual character of the site and its surroundings, as viewed from nearby residences.

Implementation of Mitigation Measure M-AE-1a (Site Maintenance) would require daily site clean-up, storing construction materials and equipment away from public view, and removing debris promptly to reduce the visual impact of Project construction. With implementation of this measure, coupled with the temporary 16-month construction period, the impact of Project construction to the aesthetic character of Site 18 (Alternate) would be *less than significant with mitigation*. Implementation of the mitigation measure would ensure that the construction areas remain clean and orderly and that equipment would be stored out of public view.

> ***Mitigation Measure M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate])***
> (See Impact AE-1, Site 4 for a description)

Impact Conclusion: Less than Significant with Mitigation

Site 7 (Consolidated Treatment at Site 6 and On-site Treatment options)

Site 7 is an undeveloped grassy parcel. A mausoleum is located immediately to the east of the site on an adjacent property and a Greenlawn Memorial Park maintenance building is to the immediate west (see Figures 3-17 and 3-21). The mausoleum is visually separated from the site by a mature stand of trees, which is identified as a "tree mass"[6] in the Town of Colma's General Plan. The utilitarian maintenance building is the only constructed element in an otherwise predominantly vegetated setting. The proposed pipeline route connecting Site 7 to Site 6, for the consolidated treatment option, would traverse the grounds of the Woodlawn Memorial Park. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, moderately low visual quality, and moderately high overall visual sensitivity.

If there are no constraints (e.g., existing infrastructure) that would prevent the installation of pipelines from Site 7 to Site 6 (for consolidating treatment at Site 6, as proposed by the SFPUC), the proposed well facility at Site 7 would include a well with a fenced enclosure (see Figure 3-6), plus a pipeline to convey water from the well to Site 6 for treatment (see Figure 3-14). This would require a construction duration of three months at the well facility site and four to seven weeks for pipeline construction across the cemetery. Construction activities at Site 7, in general, would be visible from Colma Boulevard, Woodlawn Memorial Park, Greenlawn Memorial Park, and the Metro Center shopping center to the west. The

[6] The Town of Colma's General Plan identifies specific tree masses throughout the Town. The General Plan and Tree Ordinance use several terms to when discussing tree masses, including "major" tree masses, "significant" tree mass, and designated tree mass. These terms are used interchangeably throughout these Town policy documents. For consistency, this EIR uses the more general terms "tree mass" or "designated" tree mass.

overall visual sensitivity of this site is considered moderately high, although the change in visual contrast would be considered moderate, given the lack of constant viewers.

If there are constraints that would prevent consolidating treatment at Site 6, the facility at Site 7 would include a well with a 2,095-square-foot well and chemical treatment building (see Figure 3-7), requiring construction duration of 16 months. Construction activities at Site 7 would be visible from Colma Boulevard, Woodlawn Memorial Park, Greenlawn Memorial Park, and the Metro Center shopping center to the west.

Construction of the facility at Site 7 would be visible from a small section of a publicly accessible area of Woodlawn Memorial Park at its southeastern edge. Existing views from this portion of the cemetery in the direction of Site 7 include a cemetery maintenance building, a large stand of mature eucalyptus trees, the vacant grassy slope where Site 7 is proposed, and Greenlawn Memorial Park across Colma Boulevard. Visitors to the Greenlawn Memorial Park could have a view of the construction area at Site 7. Viewer concern would be moderately high during visits to the memorial park; although it is assumed that cemetery visits would be infrequent and potentially brief.

To clear the SFPUC right-of-way for construction, a number of trees would be removed, including many trees within a major tree mass identified in the Town of Colma's General Plan. Although this tree mass is comprised primarily of eucalyptus, or Tasmanian blue gum (an non-native invasive species[7]), given the height of the trees and conspicuous location relative to viewers along El Camino Real and Colma Boulevard, this tree mass is a prominent contributor to the immediate area's visual context. Construction of the well facility and pipelines at this location would require the removal of up to 54 out of approximately 70 trees within the SFPUC right-of-way. Of the trees to be removed, 41 would be part of the identified tree mass in the eastern portion of the right-of-way, while the remaining 13 are along the western right-of-way boundary. An additional 15 trees adjacent to the northeast part of the construction area boundary may be trimmed to accommodate construction. The remainder of the tree mass identified in the Town of Colma's General Plan would not be affected by construction.

The removal of these trees would be permanent as the SFPUC's Integrated Vegetation Management Policy (SFPUC 2007) requires that vegetation of any size not be allowed to grow within critical portions of its right-of-way and only approved vegetation be allowed to grow in other areas of its right-of-way. During construction at Site 7, portions of the tree mass within the right-of-way cannot remain due to the construction safety hazard they present (i.e., equipment conflict, falling limbs, work space constriction, etc.), which would result in a *significant* aesthetic impact at this site. Nevertheless, Mitigation Measure M-AE-1e (Tree Removal and Replacement) is proposed to reduce the visual impact of that would result from the removal of the trees at this site. However, implementation of this mitigation measure would be limited by the requirements of the SFPUC's Integrated Vegetation Management Policy, in terms of where

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[7] The Tasmanian blue gum has been classified by the California Invasive Plant Council as an invasive plant species, which has given it an inventory rating of 'moderate':
http://www.cal-ipc.org/ip/management/plant_profiles/Eucalyptus_globulus.php

the on-site re-plantings could occur, the allowable tree species to be re-planted, and the visual characteristics of the allowable replacement trees. In addition, even with implementation of this mitigation measure, the resulting impact at Site 7 would be a noticeable change in the appearance of the designated tree mass. The existing tree mass is comprised of tall eucalyptus trees. The SFPUC's Integrated Vegetation Management Policy lists tree species approved for planting on its right-of-way and expressly forbids the planting of eucalyptus within the SFPUC right-of-way. The composition of the tree mass within the SFPUC right-of-way would permanently change as a result of construction at Site 7; and therefore, removal of these trees would have a *significant and unavoidable impact with mitigation* on the visual character of the site and to a tree mass specifically identified in the Town of Colma's General Plan.

Mitigation Measure M-AE-1e: Tree Removal and Replacement (Site 7)
Prior to the removal of any trees within the construction area boundary at Site 7, the SFPUC shall determine if any trees within the Town-designated tree mass can be retained without causing conflicts with construction equipment and/or safety risks during construction at this site. A qualified arborist shall conduct the tree retention survey. Any trees found not to conflict with construction activities or create a safety risks shall be protected during construction.

For each tree to be removed, the SFPUC shall plant replacement trees on-site to the extent allowable by its Integrated Vegetation Management Policy (Section 13.006) (SFPUC 2007). Each replacement tree shall be in a minimum 15-gallon container and shall be of species listed in the vegetation management policy. The on-site plantings shall be located such that the visual continuity of the existing tree mass is restored to the extent feasible. To the extent tree replacement on-site is not feasible, replacement trees shall be planted off-site in substantial compliance with the Town of Colma's Tree Cutting and Removal ordinance.

In all cases, the planting ratio shall be a minimum of 1:1 (i.e., one tree planted for each tree removed). Replanting shall occur within the first year after completion of construction. The SFPUC shall monitor plantings annually for five years after project completion to ensure that the replacement planting(s) has developed and that the trees survive. If necessary, the SFPUC shall implement additional measures (e.g., replanting, installation of irrigation) to address continued survival of the plantings, and shall re-plant additional trees should a significant amount of the original plantings not survive during the monitoring period.

The direct views of the site from surrounding locations during the temporary construction period would be of construction equipment, materials and activities, a substantial change in the site's appearance and visual character, given the moderately high visual sensitivity of this area. Therefore, the temporary impact on the visual character of the site and its surroundings would be *significant*. Nevertheless, implementation of Mitigation Measure M-AE-1a (Site Maintenance) would reduce the visual impacts to a *less-than-significant* level through maintaining a relatively clean and inconspicuous construction area.

Mitigation Measure M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate])
(See Impact AE-1, Site 4 for a description)

Under the proposed consolidated treatment option at Site 6, construction of the pipeline from Site 7 to Site 6 would be visible to pedestrians on D Street in front of the Colma BART Station and within Woodlawn Memorial Park, as the SFPUC right-of-way crosses the cemetery. The proposed pipeline route through the cemetery would be approximately 2,120 feet long and would take approximately four to seven weeks to construct based on an installation rate of 300 to 600 feet per week (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). This pipeline installation would occur concurrently with construction of the well facility structure. Visitors would see the pipeline construction and would need to pass the construction area to reach the gravesites.

Pipeline construction would be highly visible to the occasional visitor to Woodlawn Memorial Park over the four to seven week construction period. Visual quality in the area is high, as is the viewer sensitivity. However, the relatively brief and likely infrequent nature of visits to the cemetery by any one individual means that relatively few visitors would be affected by construction activities over the four to seven week duration at this location. Therefore, given the low level of traffic and low numbers of viewers over the four to seven week construction duration, the Site 7 pipeline construction area would have limited visual contrast. The pipeline-related visual impact would be *less than significant*, in spite of the high visual quality and high visual sensitivity within the cemetery.

The construction activities associated with the well facility at Site 7 and the pipeline to convey water from Site 7 to Site 6 for treatment are not within a scenic vista nor visible from any nearby scenic roadways. As a result, there would be *no impact* to scenic vistas, resources, or roadways at this location.

Impact Conclusion: Significant and Unavoidable with Mitigation

Impact AE-2: Project construction would not create a new source of substantial light that would adversely affect day or nighttime views in the area. (Less than Significant)

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

As noted in Chapter 3, Project Description, Section 3.5.3.1 (Construction Hours), all construction activities would occur during the day from 7:00 a.m. to 7:00 p.m., Monday through Friday, and if necessary, construction work may occasionally occur on Saturdays between the hours of 7:00 a.m. and 5:00 p.m., except for well drilling, which would require day/night work during drilling and other drilling-related activities (for seven consecutive days/nights), as well as pump tests for the wells (for a continuous 12- to 48-hour period). No nighttime work would be required for any other construction elements of the Project (e.g., site preparation, building construction, pipeline trenching).

Night lighting would be needed during nighttime drilling-related activities and pump tests, which are expected to last for up to seven consecutive nights and nine nights in total. The drilling-related activities and the pump testing may not occur in a single continuous event, but could occur in two distinct events of seven nights and two nights, respectively (see Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]). Access paths to work areas would be illuminated as necessary.

Lighting at staging areas would also be used on an as-needed basis. Staging areas would not have security lighting that would be illuminated overnight. Lighting would be used only when workers need access at night.

As part of the Project, a lighting plan would be developed to guide the use of lighting during Project construction in such a way as to minimize nuisance and inconvenience to neighboring properties (see Chapter 3, Project Description, Section 3.5.1.5 [Temporary Lighting]). The contents of this lighting plan are proposed to include – but not be limited to – information regarding: time of use, placement relative to sensitive viewers (i.e., SFPUC Standard Construction Measure #10), type of mechanism(s), specifications (e.g., type of shades, bulbs).

Sites 2, 5, 6, 7, 8, 10, 11, 13, 17 (Alternate), and Westlake Pump Station

As noted in Chapter 3, Project Description Section 3.5 (Project Construction), there are six facility sites that already have existing test wells. In these cases, the wells have been pump tested and would be converted to production wells as part of the Project. No well drilling or pump testing would occur at Sites 2, 5, 6, 8, 10, and 13, as well as the Westlake Pump Station. This would eliminate the need for nighttime work and lighting at these locations. As no other Project construction activities would require nighttime work and lighting, the Project would have *no impact* relative to lighting at these locations.

As noted in Section 5.3.1.3 (Individual Project Well Facility Sites), each of these three sites would be located in areas devoid of viewers sensitive to nighttime views (i.e., residential areas). Sites 7 and 17 (Alternate) would be close to cemeteries and commercial uses. Site 11 would be on a relatively undeveloped parcel, with the exception of the BART ventilation structure. The parcel sits below grade of any potential viewers along El Camino Real and any development within view of the site would not be occupied by sensitive nighttime viewers. The Centennial Way Trail is unlikely to be used during nighttime hours. Construction at these sites would create a new temporary source of nighttime lighting in the area during well drilling and pump testing events. However, the amount of nighttime lighting necessary for 24-hour drilling operations would not be substantial, in that such lighting would be directed downward, covering only the area occupied by the drill rig and its immediate surroundings as would be required in the Project lighting plan. Therefore, given the lack of nighttime views (i.e., sensitive viewers) in the vicinity of these sites, *no impact* relative to nighttime lighting would occur at this site during construction.

Impact Conclusion: No Impact

Sites 1, 3, 4, 9, 12, 14, 15, 16, 18 (Alternate), and 19 (Alternate)

As described in Section 5.3.1.3 (Individual Project Well Facility Sites) each of these would be located in areas occupied by viewers that may be sensitive to the quality of existing nighttime views. In the cases of each these sites, the sensitive nighttime viewers would be those living in the single-family neighborhoods or multi-family residential complexes near the sites.

Construction at these sites would create a new temporary source of nighttime lighting to the nearby residential uses. However, the amount of nighttime lighting necessary for 24-hour drilling and pump testing operations would not be substantial, in that such lighting would be directed downward, covering only the area occupied by the drill rig and its immediate surroundings as would be required in the Project lighting plan. In addition, being located in an urban/suburban area with existing street lighting, commercial lighting, etc., causing reduced nighttime viewing opportunities, there are no nighttime views in the area that could be adversely affected. The nearby residences would not be substantially affected by the downcast lighting due to the temporary nature of the potential impact, which would last for up to seven consecutive days and nights for drilling, with one subsequent additional pump-testing period lasting up to 48 hours. Therefore, this would be a *less-than-significant* aesthetic impact from construction at these sites.

Impact Conclusion: Less than Significant

5.3.3.5 Operation Impacts and Mitigation Measures

The following discussion presents the potential permanent impacts of the operation and maintenance of the proposed Project relative to each site's overall visual sensitivity and visual contrast. The significance criteria and analysis approach are described in Sections 5.3.3.1 (Significance Criteria) and 5.3.3.2 (Approach to Analysis), respectively. Briefly, the overall visual sensitivity is a single, consolidated measure comprised of visual quality (high, medium, low), affected viewers and exposure conditions, and viewer sensitivity/concern, and represents a site's overall susceptibility to adverse impacts. The overall visual sensitivity is compared against the anticipated visual change, or contrast, created by the Project (see Table 5.3-3 [Visual Impact Scale]). This comparison is then applied to each of the significance criteria for this Project to determine the level of impact.

With the exception of the Westlake Pump Station, the Project at each site would include a well facility, underground distribution piping, aboveground or buried utility connections, and an access driveway (where an existing one would not be used). As explained in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types), four well station types are proposed for the Project, dependent on the functional needs at each site. The conceptual layouts for each type of facility are shown in Figures 3-6, 3-7, and 3-8. A brief description of each follows, relative to this analysis of aesthetics and lighting. Nevertheless, specific landscaping and architectural design mitigation measures are described in the analysis to specifically address potentially significant impacts at individual sites, as needed.

Well with fenced enclosure: The conceptual layout for the "well with fenced enclosure" well facility type includes either an eight-foot-high, black vinyl-coated fence with one-inch mesh or an eight-foot-high metal picket fence with ¾-inch black pickets to house the wellhead, pump, piping, and associated electrical controls that would be located in a weather-proof control panel. An optional concrete wall may be added as shown in Figure 3-6.

Well with building: The "well with building" well facility type includes a 35- by 20-foot building to house the wellhead, pump, piping and associated electrical controls (Figure 3-6). The building would be about eight feet above finished grade. The building would be concrete and finished with a gray or earth tone stone finish. A galvanized decorative gate would provide access into the building.

Well plus chemical treatment building: There are two conceptual layouts for a well with a chemical treatment building, as illustrated on Figure 3-7. The building's horizontal dimensions would be approximately 44 by 34 feet, or 75 by 20 feet, depending on the number of chemical treatment rooms needed at the site. The building would be concrete and finished with a gray or earth tone stone finish. A galvanized decorative gate would provide access into the building.

Well plus chemical treatment and filtration building: There are two conceptual layouts for well stations with chemical treatment and filtration associated with iron/manganese removal, as shown in Figure 3-8. The dimensions of the building would be 91 by 23 feet, or 103 by 29 feet, depending upon the size of the filtration system needed and the number of rooms at the site. The building would be concrete and finished with a gray or earth tone stone finish. A galvanized decorative gate would provide access into the building. This well station type would be larger than the other types to provide space for the filtration vessels.

Impact AE-3: Project operation would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings. (Less than Significant with Mitigation)

The impact analysis for each well facility site references site layout figures found in Chapter 3, Project Description, in addition to the site photographs and simulations included this chapter. The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

Sites 5 (Consolidated Treatment at Site 6), 16, and Westlake Pump Station

Westlake Pump Station

The Westlake Pump Station is within a fenced public works yard adjacent to the Westlake Village Apartments on the north, the Ben Franklin Intermediate School grounds to the south and east, and a single-family residential neighborhood to the west (see Figure 3-13). As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and low overall visual sensitivity.

The well treatment equipment that would be installed at the Westlake Pump Station would be inside the existing buildings or outside within the existing fence. This would not change the visual character of this pump station site. The location is not within a scenic vista nor would it be visible from any nearby scenic roadways; no such resources would be affected. As a result, the effect on overall visual sensitivity would be low and there would be no change in visual contrast. Therefore, the Project would have *no impact* on the visual character of the site and its surroundings, as well as *no impact* on scenic roadways, scenic vistas, or scenic resources.

Site 5 (Consolidated Treatment at Site 6)

Site 5 would be located in a vacant paved lot between a State Farm Insurance Agency office and a single-family residence. The parking lot for the former Serra Bowl is adjacent to the south, with the Serra Bowl building beyond the parking lot. B Street creates the north border of the site; an automobile dealership is located across B Street from the site. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, low visual quality, and moderately low overall visual sensitivity.

The well facility at Site 5 would be a well with fenced enclosure (see Figure 3-6) if treatment is consolidated at Site 6 (see Figures 3-14 and 3-15). The well facility would be visible to surrounding commercial buildings, travelers along B Street, and the single-family residence just east of the site. However, the location is not within a scenic vista nor would it be visible from any nearby scenic roadways (e.g., I-280). As a result, no scenic vistas or scenic roadways would be affected. As the site is currently fenced, and given the largely developed urban visual environment at and around this site, the proposed well with fenced enclosure would have moderately low visual sensitivity and would not generate a change the visual contrast (see Section 5.3.1.3 [Individual Project Well Facility Sites], above). Therefore, the preferred option at Site 5, with treatment activities consolidated at Site 6, would have *no impact* to aesthetic resources at this location.

Site 16

Site 16 would be located in the SFPUC right-of-way behind the Orchard Supply Hardware store along El Camino Real (see Figure 3-37). To the east are the Caltrain line and a large electrical substation with tower. To the south is the three-story Millbrae Manor Apartments separated from the site by an alley, two fences, and a small storage yard. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and low overall visual sensitivity.

The 1,480-square-foot well and chemical treatment facility at Site 16 (see Figure 3-7) would be visible from portions of the Orchard Supply Hardware store parking lot, riders on Caltrain, and from the north facing apartments at the three-story Millbrae Manor Apartments to the south, as shown on Figure 3-37. The structure would have a gray or stone concrete finish, as described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types). The location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, no scenic vistas or scenic roadways would be affected and, since no trees would be removed to develop the well facility, no scenic resources would be affected. The overall visual sensitivity of this site is considered low and the change in visual contrast would also be considered low, given the visual environment at and around this site (see Section 5.3.1.3 [Individual Project Well Facility Sites], above). As a result, the addition of a well facility in this location would not change the visual quality of the area since the surrounding area includes commercial buildings. Therefore, the Project would have *no impact* potential impact on the visual character of the site and its surroundings, or on scenic roadways, scenic vistas, or scenic resources at this site.

Impact Conclusion: No Impact

Sites 1, 2, 3, 5 (On-site Treatment), 6, 8, 9, 10, 11, 12, 13, 17 (Alternate), and 19 (Alternate)

Site 1

Site 1 would be located in the northeastern corner of the Lake Merced Golf Club, a privately owned and operated golf club. This site is approximately 50 feet away from the fairways, not in direct line of view from these fairways and lined by mature trees on the east, which partially obscure the view of I-280 to the east. The ground at this site is mostly bare. A restroom facility of concrete block construction is situated in the southern part of the site. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has low visual exposure – though moderate visual concern, moderate visual quality, and moderately low overall visual sensitivity.

The 1,480-square-foot well and chemical treatment facility at Site 1 (see Figure 3-7) would be visible from the end of Poncetta Drive, some fairways at the Lake Merced Golf Club, and from a portion of the Westlake Village Apartments to the north (Figure 3-11). The facility would be about 90 feet west of I-280, which is designated by Caltrans as eligible for the State Scenic Highway Program (see Table 5.3-2 [Designated State, County, and Local Scenic Roads in the Vicinity of Facility Sites]), but would be substantially screened by intervening vegetation. No scenic vistas or scenic roadways would be affected because of the small scale of the proposed structure and its relative isolation in the northeast corner of the golf club.

The proposed facility would remove the restroom facility currently on this site; the SFPUC would reimburse the golf club for replacement of the restroom. Views of the site from residences would be seen by only a few individuals in a private setting and not visible from public areas within the multi-family residential area. The site would be located above the golf links and golfers would have a relatively unobstructed view of the site, although it is not in direct line of sight from the golf links and the intervening vegetation would likely grow to sufficient height to provide visual screening. The views from the golf links would not be publicly accessible and would be available only to the members and workers of this private golf club. Also, the apartments provide a developed backdrop when the site is viewed from the golf club. In this context, the visual quality of the area is rated as moderate. Overall visual sensitivity and visual contrast at this site are thus moderately low. Therefore, the potential impact on the visual character of the site and its surroundings would be *less than significant*; whereas there would be *no impact* on scenic vistas or scenic roadways given that this site is, and would remain shielded from I-280 by existing trees.

Site 2

Site 2 would be located just outside the southwest corner of the Lake Merced Golf Club and south of the golf club maintenance access road. This site is located immediately off the street at the edge of an extensive open space area comprised of playing fields of the Garden Village Elementary School and athletic fields at the Ben Franklin Intermediate School. Site 2 is situated at the edge of this open space, demarcating a transition from the Westlake Village Apartments to the north. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, visual quality, and overall visual sensitivity.

The well with a fenced enclosure at Site 2 (see Figure 3-6) would be visible in the immediate foreground of Park Plaza Drive, as well as from the Ben Franklin Intermediate School's athletic field and portions of the main campus, a few single-family residences above the athletic field, and multi-family residences located to the northwest. The facility would be located south of the existing Lake Merced Golf Club access road as shown on Figure 3-12. The fenced facility would introduce a new, relatively small-scale public infrastructure element of appearance that would appear out of place in its landscaped, open space setting. Visual contrast of the facility, particularly chain link and potential concrete fencing, would be moderate given the current undeveloped and landscaped condition of the site. Therefore, in the context of moderate overall visual sensitivity of the setting, the impact on the visual character of the site and its surroundings would be *less than significant*.

Views of the facility would be substantially blocked from the Lake Merced Golf Club by trees and shrubs. No trees or other scenic resources would be affected. In addition, the location is not within a scenic vista, nor along a designated scenic roadway. As a result, no scenic vistas, resources, or roadways would be affected. Therefore, there would be *no impact* on scenic roadways, resources, or vistas at this site.

Site 3

Site 3 would be located in the southwest corner of the athletic field at the Ben Franklin Intermediate School. The site is covered in turf and located behind a baseball backstop on the field. It is at the foot of a slope, at the top of which single-family residences are located to the southwest; these residences front onto White Street and Maddux Drive. This location puts the site low in the field of view from these residential areas. A small wooded area of tall eucalyptus trees directly adjoins the site to the east and southeast. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, visual quality, and overall visual sensitivity.

The well with fenced enclosure at Site 3 (see Figure 3-6) would be visible from Park Plaza Drive, the Ben Franklin Intermediate School athletic field and portions of the main campus, single-family residences located to the south and southwest on White Street and Maddux Drive, and portions of the Westlake Village Apartments located to the north. The facility would be located adjacent to the athletic field near the southeast section of the school grounds as shown on Figure 3-12. The facility would introduce a new, relatively small-scale public infrastructure element that would contrast with the landscaped, open space setting adjacent to an athletic field. However, the visual contrast to motorists would be low due to distance. Visual contrast of the facility with its existing setting would be moderate as it would be situated in a remote corner of the athletic field and low in the field of view from publicly accessible portions of the surrounding residential areas. Therefore, in the context of moderate overall visual sensitivity, the impact on the visual character of the site and its surroundings would be *less than significant*.

No scenic vistas or scenic roadways would be affected. No trees would be removed and no scenic resources would be adversely affected. Therefore, there would be *no impact* on scenic roadways, scenic vistas, or scenic resources at these sites.

Site 5 (On-site Treatment)

Site 5 would be located in a vacant paved lot between a State Farm Insurance Agency office and a single-family residence. The parking lot for the former Serra Bowl is adjacent to the south, with the Serra Bowl building beyond the parking lot. B Street creates the north border of the site; an automobile dealership is located across B Street from the site. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, low visual quality, and moderately low overall visual sensitivity.

The 2,095-square-foot well, chemical treatment, and filtration facility (see Figure 3-8) would be constructed at the site as shown on Figure 3-19. The well facility would be visible to surrounding commercial buildings, travelers along B Street, and the single-family residence just east of the site. However, the location is not within a scenic vista nor would it be visible from any nearby scenic roadways (e.g., I-280). As a result, no scenic vistas or designated scenic roadways would be affected. In addition, with the architectural finish to be used on the treatment building (i.e., gray or earthtone concrete finish, as described in Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]), the visual character of the site and its surroundings would not be adversely affected. The overall visual sensitivity of this site is considered low and the change in visual contrast would also be considered low, given the largely developed urban visual environment at and around this site (see Section 5.3.1.3 [Individual Project Well Facility Sites], above). Therefore, the potential impact on the visual character of the site and its surroundings would be *less than significant*. There would be *no impact* on scenic roadways, scenic vistas, or scenic resources at this site.

Site 6

Site 6 would be situated on a grassy area along the south side of D Street, across from the Colma BART station, which dominates views of the area. The SamTrans Park and Ride lot is located upslope from this site to the southwest, beyond a row of trees. The pedestrian bridge over D Street linking the parking lot to the station has a clear view of this site. The Woodlawn Memorial Park is located to the south and upslope. The immediately adjacent portion of the cemetery is used for outdoor materials storage. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure – but low viewer concern, low visual quality, and low overall visual sensitivity.

The well, chemical treatment, and filtration facility at Site 6 (see Figure 3-8) would be visible to travelers along D Street, SamTrans Park and Ride patrons, and BART riders as shown on Figures 3-16 and 3-20. The facility structure would be 2,990 square feet in size if treatment for Sites 5 and 7 is conducted here or it would be 2,095 square feet if treatment is limited to the one on-site well. While El Camino Real is a Town-designated scenic corridor in Colma and its intersection with F Street is designated as a Town gateway, this site would not be visible from El Camino Real due to intervening topography, vegetation, and buildings. In addition, the location is not within a scenic vista. As a result, no scenic vistas or scenic roadways would be affected.

The well facility at Site 6 would not be visible from the publicly accessible portions of Woodlawn Memorial Park. The nearest portion of the memorial park from which it could be visible would be an outdoor materials storage area, which is not open to the public. Also, intervening topography and vegetation (i.e., trees) further block views of Site 6 from this cemetery. Existing views from this portion of Woodlawn Memorial Park in the direction of Site 6 include the Colma BART station, the SamTrans Park and Ride lot also adjacent to Site 6; however, this site would be out of view in these vistas as it would be below and out of the line of sight.

The overall visual sensitivity of this site is considered low given its low visual quality, limited numbers of viewers, and visual isolation from sensitive viewers in Woodlawn Memorial Park. The change in visual contrast would be considered moderate, given the visual dominance of the adjacent BART facilities. Therefore, the potential impact on the visual character of the site and its surroundings would be *less than significant*; whereas, there would be *no impact* on scenic roadways, scenic vistas, or scenic resources at this site.

Site 8

Site 8 would be located in a narrow grassy strip surrounded by various large-scale commercial establishments in a segment of Serramonte Boulevard lined by car dealerships, Kohl's Department Store and its associated parking. The streetscape is thus dominated by unscreened parked automobiles, little landscaping and low visual unity. Site 8 would be shielded from view on all sides except the northeast due to depressed topography. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and low overall visual sensitivity.

The 2,095-square-foot well, chemical treatment, and filtration facility structure at Site 8 (see Figure 3-8) would be on a level grassy parcel visible from Serramonte Boulevard, Kohl's Department Store's rear parking lot, and adjacent car dealerships, and distantly from Collins Avenue where it crosses the SFPUC's right-of-way. The facility layout is shown on Figure 3-22. The location is not within a scenic vista nor would it be visible from any nearby designated scenic roadways. As a result, no scenic vistas or scenic roadways would be affected. In addition, due to the proposed design of the well facility building and its compatibility with its existing surroundings, the visual character of the site and its surroundings would not be adversely affected. The overall visual sensitivity of the site is low, as would be the change in visual contrast given its limited views from publicly accessible areas. Therefore, the potential impact on the visual character of the site and its surroundings would be *less than significant*; whereas, there would be *no impact* on scenic roadways, scenic vistas, or scenic resources at this site.

Site 9

Site 9 would be located on an existing undeveloped parcel between the concrete-lined Colma Creek Diversion and San Mateo County Flood Control channels. The site, in a mixed commercial/residential area, is triangular in shape and covered with low-growing ruderal vegetation and has a lone tree at its center. The site and surroundings are devoid of vivid or attractive visual features, and dominated by the adjacent concrete flood channels and the neighboring Costco parking lot. As noted in Section 5.3.1.3

(Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and low overall visual sensitivity.

The 2,095-square-foot well, chemical treatment, and filtration facility at Site 9 (see Figure 3-8) would be visible from a portion of the Treasure Island Trailer Court, over the property fence and pedestrian path connecting the Verano Condominium complex on Mission Road to El Camino Real, as well as the Verano Condominiums and other detached residences on Mission Road to the southeast (see Figure 3-24). The power source for Site 9 would be an aerial line extended from an existing off-site source. There are no views of this site from public roadways. The site is not within a scenic vista nor would it be visible from any nearby designated scenic roadways. As a result, no scenic vistas, resources, or roadways would be affected.

Development of the well facility at Site 9 would require the removal of one Monterey pine. The removal of this mature tree would not have an adverse impact on the visual character of the site, given the low overall visual sensitivity of the site and its surroundings. For the same reason, the installation of the overhead power line would not have an adverse impact on the site's visual character, particularly given the presence of other aerial lines in the immediate area. The overhead power line would be consistent with the visual setting of the area. While the overall visual sensitivity of this site is considered low, the change in visual contrast would be moderate, given that a structure would be constructed on a currently undeveloped site. In addition, views of the facility from the residences would be seen by only a relatively few individuals in a private setting. The gray or stone architectural finish described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types) would soften the utilitarian appearance of the structure. Therefore, the Project's impact on the site's visual character and scenic resources would be *less than significant*. As noted above, there would be *no impact* on scenic roadways, resources, or vistas at this site.

Site 10

Site 10 would be located on an undeveloped grassy lot on the southwest corner of Hickey Boulevard and Camaritas Avenue. Trees line the west side of the lot, separating it from the single-family residences beyond Crown Circle to the west. The site slopes upward to the south and remains undeveloped, though single-family residences line Camaritas Avenue beyond stands of mature trees to the southeast. The Winston Manor Shopping Center is located to the east with a Chevy's Restaurant closest to the site across Camaritas Avenue. Immediately to the north across Hickey Boulevard, the topography slopes steeply upward providing partial views through mature trees of the fenced rear yards of single-family residences that front on Duval Drive. The site is in an area transitioning from commercial strip development of low visual quality to a residential one marked by substantial large-scale tree canopies and grass slopes. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure – though moderate visual sensitivity, moderately low visual quality, and moderate overall visual sensitivity.

The 2,095-square-foot well, chemical treatment, and filtration facility at Site 10 (see Figure 3-8) would be visible from Hickey Boulevard, Camaritas Avenue, the Winston Manor Shopping Center, and from single-family residences across Hickey Boulevard and on Camaritas Avenue as seen on Figure 3-25. However, the site would not be visible from publicly accessible points in this residential area. Drought tolerant native and or climate adapted landscape trees, shrubs, and grasses would be planted around the perimeter of the building when construction is complete. The structure would have a gray or stone concrete finish, as described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types). The site would not be visible from publicly accessible portions of the residential area to the west on Crown Circle, due to dense existing landscaping and topography. The site would not be within a scenic vista, nor would it be visible from any nearby designated scenic roadways. As a result, no scenic vistas or scenic roadways would be affected. Also, since no trees would be removed to develop the well facility, no scenic resources would be affected.

The overall visual sensitivity of this site is considered moderate and the change in visual contrast would be considered moderate with the landscaping around the facility. Therefore, the potential impact on the visual character of the site and its surroundings would be *less than significant*; whereas, there would be *no impact* on scenic roadways, scenic vistas, or scenic resources at this site.

Site 11

Site 11 would be located next to a BART ventilation structure between El Camino Real and Mission Road northwest of Chestnut Avenue and Antoinette Lane. The site is covered in gravel with the adjacent slope covered in unmaintained grasses and mature trees. The topography and a row of trees along this portion of El Camino Real obstruct views of the site and the BART ventilation structure just beyond. The BART ventilation structure partially obstructs views of the site from the Centennial Way Trail to the east. To the north of the site is a five-story parking garage and surface parking lot for the Kaiser Medical Center. The remainder of the surrounding land is vacant or commercial without any visually notable features. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has limited visual exposure, low visual quality, and moderately low overall visual sensitivity.

The 2,095-square-foot well, chemical treatment, and filtration facility at Site 11 (see Figure 3-8) would not be visible while traveling on El Camino Real, while it would be to pedestrians and bicyclists on the Centennial Way Trail along the Colma Creek Diversion Channel north of the site, as shown on Figure 3-28. However, the view from the trail would be mostly blocked by an existing BART ventilation structure which, with its industrial character, contributes to the setting's generally low visual quality and would partially screen the structure from the trail. An intervening stand of trees would also screen views of the structure from the trail. For these reasons, the facility would represent moderately low visual change to viewers on the trail. Trees along El Camino Real block the site from views of travelers along the roadway in both the northbound and southbound directions. Up to seven of these trees (Lombardy poplars and a Torrey pine) would be removed to accommodate installation of the water pipelines to connect the well to the existing regional water system. Removal of the trees would result in motorists along El Camino Real having views of the well facility following construction. However, views of the facility from the roadway would be fleeting, and mostly blocked by topography, as motorists and pedestrian pass the site. The area already includes the industrial character BART structure. The addition of a new well facility in the area would, therefore, generate a low change the visual character of the area. As a result, and in the context of moderately low overall visual sensitivity of this setting, this would be a *less-than-significant* aesthetic impact.

Site 12

Site 12 would be located adjacent to the Garden Chapel Funeral Home. The site includes a portion of the funeral home parking lot, a grassy area with a dirt access for the SFPUC right-of-way, and a dense row of Monterey pine, Monterey cypress, eucalyptus, and Aleppo pine shielding the well facility site from view from El Camino Real. These trees are contributing resources in the City of South San Francisco's streetscape plan for El Camino Real, as noted in General Plan Implementing Policy 3.4-1-1. The removal of trees and mitigation of the impact as a result of Project construction is addressed under Impact AE-1. The site is partially screened by fences and vegetation from the single-family residences to the southwest fronting on Fairway Drive. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites), and Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, moderate visual sensitivity, moderate visual quality, and moderately high overall visual sensitivity.

The 1,495-square-foot well and chemical treatment facility at Site 12 (see Figure 3-7) would be visible from El Camino Real, Southwood Drive, single-family residences to the west, and from the Garden Chapel Funeral Home (Figures 3-29 and 3-30). The structure would have a gray or stone concrete finish, as described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types). It would not be visible from publicly accessible points of the single-family residential neighborhood. Because the structure would be about 20 feet from the funeral home, it would be clearly visible to funeral home visitors and to neighboring residents that may look over their fences toward this area. However, the location is not within a scenic vista nor would it be visible from any nearby designated scenic roadways.

.No trees would be removed as part of operations at the site; therefore the aesthetic impacts related to Project operations would be *less than significant.* In addition, since the location is not within a scenic vista nor would it be visible from any nearby scenic roadways, there would be *no impact* on designated scenic roadways, resources, or vistas at this site.

Site 13

Site 13 would be located on an undeveloped parcel on the southeast side of South Spruce Avenue covered with unmaintained grassy vegetation. It is bordered by a two-story retail/office building and parking lot on the west and a large beverage distribution warehouse on the east. Between the warehouse and the site is the Centennial Way Trail, with an interpretive panel with a trail map at the entrance on South Spruce Avenue. A fenced-in, buried utility vault is located between the site and the pathway. The trail continues immediately across South Spruce Avenue with a large industrial bakery to the north and single-family residential neighborhood to the south. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure, but it has moderate visual sensitivity, moderate visual quality, and moderately high overall visual sensitivity.

The 2,095-square-foot well, chemical treatment, and filtration facility at Site 13 (see Figure 3-8) would be visible from South Spruce Avenue, the commercial and industrial uses in the area (i.e., Freeman Warehouse, credit union, a car wash, San Mateo County offices, Orowheat commercial bakery), Francisco Drive residential neighborhood across South Spruce Avenue, and from the Centennial Way Trail (Figures 3-31 and 3-32). The site would not be visible from publicly accessible points in the residential area. The

Centennial Way Trail has an interpretive panel with a trail map at the intersection of the pathway and South Spruce Avenue directly adjacent to Site 13. In Figure 5.3-11 (Visual Simulation of Site 13), a visual simulation of the well facility, driveway, and fencing shows that the well facility would be set back from the trail and interpretive panel. The Project at Site 13 also includes a landscape plan that proposes a mixture of drought-tolerant trees and shrubs and native grasses planted on three sides of the well facility to partially screen views of the facility from the trail and from South Spruce Street. The structure would have a gray or stone architectural finish, as described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types).

In the context of neighboring warehousing, food production, commercial, and government activities, the form of the well and treatment building would contrast to a moderate degree with the setting, as indicated in the simulation. Although the Centennial Way Trail has high exposure and moderately high overall visual sensitivity, the proposed landscaping would reduce the contrast to a moderately low level by providing a vegetative-screened view of the facility. Therefore, the aesthetic impact would be *less than significant*. In addition, the location is not within a scenic vista, nor would it be visible from any nearby scenic roadways. As a result, there would be *no impact* on scenic roadways, scenic vistas, or scenic resources at this site.

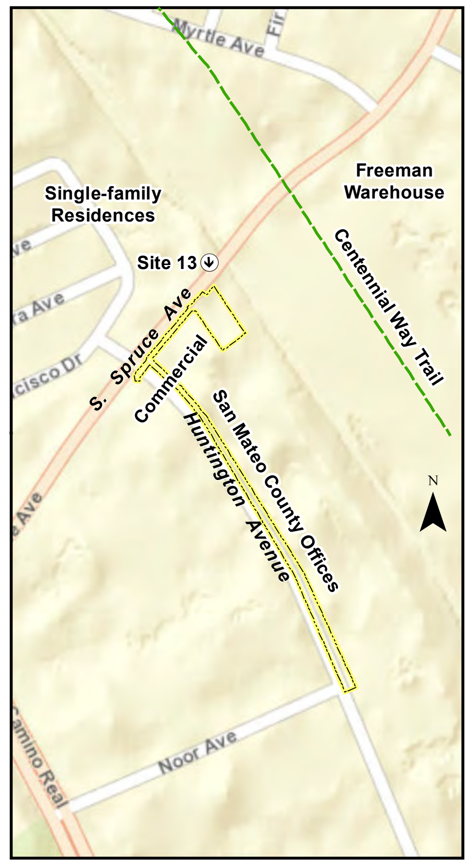
Site 17 (Alternate)

Site 17 (Alternate) would be located in a flat, grassy area adjacent to the SFPUC right-of-way and next to Standard Plumbing Supply on a relatively lightly traveled section of Collins Avenue. The right-of-way, which is covered in grass in this area, slopes up from Collins Avenue toward Cypress Lawn Memorial Park to the south, but is visually isolated from the cemetery by sloping terrain and tree cover. The Standard Plumbing Supply property, including this well facility site, is surrounded by chain link fence with exposed parking. The vicinity is typified by various commercial/light-industrial land uses. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure – though low visual sensitivity, moderate visual quality, and low overall visual sensitivity.

The 1,495-square-foot well and chemical treatment facility at Site 17 (Alternate) (see Figure 3-7) would be visible from Collins Avenue and the commercial land uses adjacent to the west and north of the site as shown on Figure 3-38. Site 17 (Alternate) would also be located just north of the Cypress Lawn Memorial Park, which is a representative example of picturesque cemetery design in Colma. Site 17 (Alternate) would be located near two tree masses identified in the Town of Colma General Plan. One tree mass is located approximately 100 feet to the east of the site across the SFPUC right-of-way and the other is located approximately 100 feet to the southwest behind the Standard Plumbing Supply building. Development of the site would not remove or damage these trees due to their distance away from this site.

Existing view of Site 13 looking south from South Spruce Avenue.

Visual Simulation of Site 13 from same vantage point with mature landscaping.



Legend

View Direction

Construction Area

Visual Simulation of Site 13

Regional Groundwater Storage and Recovery Project

Figure 5.3-11

Due to steep intervening topography and vegetation (i.e., tree clusters) to the south of the site, the well facility would not be visible from publicly accessible portions of Cypress Lawn Memorial Park. The portion of the Cypress Lawn Memorial Park to the west of the facility site includes a brick fence between the cemetery and Standard Plumbing Supply. The brick fence and the Standard Plumbing Supply building would block views of the well facility from the public use portions of the cemetery, east towards the proposed facility site. As the Standard Plumbing Supply building is immediately adjacent to the site, the visual character of the site to motorists and pedestrians on Collins Avenue would not be adversely impacted following construction of the well facility at this site.

The overall visual sensitivity of the site is low, as would be the change in visual contrast, given that this site is within a commercial area and not in view of publicly accessible portions of Cypress Lawn Memorial Park. The site is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, no scenic vistas or scenic roadways would be substantially affected by development of the well facility at this site. Therefore, the impact on the visual character of the site and its surroundings would be *less than significant*. There would be *no impact* on scenic roadways, scenic vistas, or scenic resources at this site.

Site 19 (Alternate)

Site 19 (Alternate) would be across Southwood Drive from Site 12 and situated between the Our Redeemer's Lutheran Church and single-family residences fronting on Fairway Drive. The site, covered in mowed grassy vegetation, is partially screened by fences and vegetation from these single-family residences. Multi-family residential developments are also located to the north of this site and have limited views of the site through intervening landscape vegetation and trees. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, visual quality, and overall visual sensitivity.

The fenced well facility at Site 19 (Alternate) would be visible from Southwood Drive, from single-family residences to the west that face on to Fairway Drive away from the site, from the rear of the Our Redeemer's Lutheran Church and R.W. Drake Preschool to the east, from the parking lot of the Garden Chapel Funeral Home across Southwood Drive to the southeast, and from publicly-accessible portions of the multi-family residential developments to the north, as shown on Figure 3-40. The fenced well facility would introduce a new visual element in an open area, which would result in a moderate contrast, as it would be an introduction of a public infrastructure facility among residential and quasi-public areas. However, given the moderate visual exposure, quality, and visual sensitivity of Site 19 (Alternative), this would be considered a *less-than-significant* impact to the visual environment.

The location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, there would be *no impact* on designated scenic roadways, resources, or vistas at this site.

Impact Conclusion: Less than Significant

<u>Sites 4, 7, 14, 15, and 18 (Alternate)</u>

Site 4

Site 4 would be located on a lot adjacent to Park Plaza Drive in the southwest corner of the Garden Village Elementary School grounds. The site is atop a slope above the school's playing fields covered with grassy vegetation. It is adjacent to single-family residences, which front onto 87th Street to the south and other single-family residences across Park Plaza Drive fronting onto White Street to the west. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderately high visual exposure, visual quality, and overall visual sensitivity.

The well with fenced enclosure at Site 4 (see Figure 3-6) would be visible from the immediate foreground of Park Plaza Drive, from 87th Street, the Garden Village Elementary School, and single-family residences located to the south and west (see Figure 3-12). The facility would introduce a new, relatively small-scale public infrastructure element that would be in contrast with the landscaped, open space setting. The absence of the 24 existing trees would represent a change to the visual quality of the site and its surroundings, and the fenced enclosure would be fully visible by nearby residences and along Park Plaza Drive. These changes would represent a moderately high level of contrast given the removal of trees and placement of a fenced well facility in an area predominately given to residences and community facilities.

The absence of the existing trees and addition of a well facility on the site would generate a high level of change in the visual contrast and character of the site and its surroundings given the prominent location. In the context of the moderately high visual sensitivity of the site, this would be a *significant* impact. However, the location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, no scenic vistas, resources, or roadways would be affected, creating *no impact* on these resources.

Implementation of Mitigation Measure M-AE-3a (Implement Landscape Screening) would reduce the aesthetic impact of placing a fenced well facility at this currently vacant location to *less than significant* levels by partially screening the facility from views along Park Plaza Drive and from residences immediately south of the well facility site.

> ***Mitigation Measure M-AE-3a: Implement Landscape Screening (Sites 4, 7, and 18 [Alternate])***
> The SFPUC shall develop and implement a landscape-screening plan to screen views of the well facility. The landscape plan shall include native trees and shrubs common to the surrounding areas. The landscape plan shall include plant species, planting specifications, and irrigation requirements necessary to screen the well facility. The SFPUC shall monitor landscape plantings annually for five years after project completion to ensure that sufficient ground coverage has developed and that the shrubs survive. If necessary, the SFPUC shall implement additional measures (e.g., replanting, temporary irrigation) to address continued survival of the plantings, and shall replant additional shrubs should a significant amount of the plantings not survive during the monitoring period.

Site 7

Site 7 is an undeveloped grassy parcel (see Figures 3-17 and 3-21). A mausoleum is located immediately to the east of the site on an adjacent property and a Greenlawn Memorial Park maintenance building is to the immediate west. The mausoleum is visually separated from the site by a mature stand of trees, which is identified as a “tree mass” in the Town of Colma’s General Plan. The utilitarian maintenance building is the only constructed element in an otherwise predominantly natural setting. The pipeline route connecting this site with Site 6, should consolidated treatment occur there, would traverse the grounds of the Woodlawn Memorial Park. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has moderate visual exposure, moderately low visual quality, and moderately high overall visual sensitivity.

The well facility at Site 7 would be a well with fenced enclosure (if treatment is consolidated at Site 6, see Figures 3-6 and 3-17), or a 2,095-square-foot well, chemical treatment, and filtration facility would be constructed to enclose onsite treatment facilities (if treatment is not consolidated at Site 6, see [Figure 3-8 and 3-21]). In either case, the well facility would be visible from Colma Boulevard, Woodlawn Memorial Park, Greenlawn Memorial Park, and the Metro Center shopping center to the west.

Consistent with the SFPUC’s Integrated Vegetation Management Policy (SFPUC 2007), trees removed from Site 7 in order to accommodate construction activities would not be replanted on site, so as not to conflict with the facility’s operation. As noted in the discussion of construction impact at Site 7 in Section 5.3.3.4 (Construction Impacts and Mitigation Measures), the SFPUC has adopted the Integrated Vegetation Management Policy to manage vegetation on distribution and collection system rights-of-way. Although small trees on the approved list can be planted within the right-of-way as long as they are at least 15 to 25 feet (depending on tree species) from any pipelines and are in containers above ground, the existence of large woody vegetation and water transmission lines is not compatible. Under no circumstances are eucalyptus or pine trees permitted within the right-of-way (SFPUC 2007). Plantings of large woody vegetation are not permitted on areas of the regional water system designated as critical portions of rights-of-way. The well facility at Site 7 and connection pipelines would be considered critical portions of the regional water system; therefore, it is assumed for this analysis that no trees would be planted on this portion of the SFPUC’s right-of-way.

The well facility would be visible from a small section of Woodlawn Memorial Park at its southeastern edge. Existing views from this portion of the cemetery in the direction of Site 7 include a cemetery maintenance building (on an adjacent parcel), the open grassy slope on the SFPUC right-of-way where Site 7 is proposed, and Greenlawn Memorial Park across Colma Boulevard. The site has moderate visual quality with moderate exposure to passing motorists along Colma Boulevard and periodic but potentially infrequent viewers that would be visiting the Greenlawn and Woodlawn memorial parks. These viewers would have moderately high concern about the views during cemetery visits, given the nature of such facilities. Therefore, the overall visual sensitivity is moderately high for the site.

The existence of the well facility at Site 7 – whether it is a well with fenced enclosure or with a treatment and filtration facility – would constitute a notable change in the character of the site. In the context of the moderately high visual sensitivity of the site, this would be a *significant* aesthetic impact. However, the location is not within a scenic vista nor would it be visible from any nearby scenic roadways. As a result, no scenic vistas, resources, or roadways would be affected, creating *no impact* on these resources.

Implementation of Mitigation Measure M-AE-3a (Implement Landscape Screening) would reduce the aesthetic impact of placing a new well facility at this currently vacant location to a *less-than-significant* level by partially screening the well facility from the Greenlawn Memorial Park and reducing the visual contrast.

> ***Mitigation Measure M-AE-3a: Implement Landscape Screening (Sites 4, 7, and 18 [Alternate])***
> (See Impact AE-3, Site 4 for a description)

Site 14

Site 14 would be located on the northern side of the GGNC within the grassy area of the SFPUC right-of-way between the gravesites and close to an existing, unused pump station, tank and well in the cemetery (see Figures 3-34 and 3-35). It would be near the single-family neighborhood adjacent to the north along Greenwood and Rockwood drives, which are screened from the site by fences and mature trees. Site 14 would not be visible from the public roads surrounding the cemetery (i.e., Sneath Lane) due to distance, topography, and intervening trees, but is visible from internal roadways in this section of the cemetery. The proposed water connection pipeline conveying water from Site 14 to Site 15 would be within the SFPUC right-of-way and cross the cemetery to Sneath Lane then follow along Sneath Lane to Site 15. The proposed storm drain would cross the cemetery to Sneath Lane. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure, visual quality, and visual sensitivity.

The 700-square-foot enclosed well facility at Site 14 (see Figure 3-6) would be visible within the GGNC and from the rear of single-family residences to the west and north that face onto Greenwood Drive away from the site. The new well would be housed in an enclosure as shown in the visual simulation in Figure 5.3-12 (Visual Simulation Site 14; see photo with the caption "Visual Simulation of Site 14 without Mitigation"). The new well facility building, would be concrete and finished with a gray or earth tone stone finish (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]). A driveway would provide access to the well would be accessible along the SFPUC right-of-way from an internal cemetery roadway. Access would be constructed using grass pavers to provide a stable surface while allowing grass to grow through the gaps of the pavers. Water from Site 14 would be conveyed to the facility at Site 15 for treatment, and the potential visual impacts for the well facility at Site 15 are discussed separately below.

As noted above in Section 5.3.1.3 (Individual Project Well Facility Sites), the overall visual sensitivity of Site 14 is considered high. Visual change/contrast of the facility would also be considered high as viewed from nearby viewpoints within the cemetery (see photo in Figure 5.3-12 with the caption "Visual Simulation of Site 14 without mitigation"), given that the Project would introduce a noticeable structure of public works character into a highly distinctive and formal visual setting consisting of open lawn, highly regular rows of uniform tombstones, and scattered, isolated trees. The form, scale, and character of the facility would not be consistent with the character of the surroundings and potentially in conflict with the visual expectations of visitors to the cemetery. In this highly sensitive and formally ordered setting, the form, scale, and character of the facility would, therefore, represent a high level of visual change. The facility at Site 14 would thus represent a *significant* aesthetic impact.

Demolition and removal of the existing unused well enclosure and tank would remove an existing structure that is aesthetically inconsistent with the visual character of the site and surrounding area, given its location in a military cemetery. The removal of that structure would partially offset the impact of the substantial visual change with the proposed new facility, which would be mitigated by implementation of Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14).

Even with removal of the existing structure, the aesthetic impact would remain *significant* with the presence of the well building enclosure. Implementation of Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14) would reduce this aesthetic impact to *less-than-significant* levels by requiring the development of a compatible architectural design for this GGNC site (i.e., structure height, cladding material, screening plantings, etc.). The mitigation measure requires that the well facility be located as close to the north GGNC fence as practicable to reduce its intrusion on the orderly rows of gravestones. It also requires the use of plywood temporarily placed on the ground to access the well facility, thereby eliminating the need for permanent grass pavers unless the type and use of grass pavers proposed are determined by SHPO to be compatible with, and not adversely impact, the historic resource as discussed in Section 5.5, Cultural and Paleontological Resources. A visual simulation showing the well facility with the proposed mitigation is presented on Figure 5.3-12 (see photo with the caption "Visual Simulation of Site 14 with application of Mitigation Measure M-CR-5a"). The figure also includes a simulation of the existing conditions at Site 14 and a simulated view of the proposed Project at the site.

> ***Mitigation Measure M-CR-5a: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14***
> (See Impact CR-5 in Section 5.5, Cultural and Paleontological Resources for a description)

In addition, Site 14 is not within a scenic vista nor would it be visible from any nearby scenic roadways, and no scenic resources such as trees would be removed by development of this site. Therefore, there would be *no impact* on designated scenic roadways, resources, or vistas at this site.

Existing View of Site 14 looking north.

Visual Simulation of Site 14 with application of Mitigation Measure M-CR-5a.

Visual Simulation of Site 14 without mitigation.

Legend

View Direction

Construction Area

Visual Simulation of Site 14

Regional Groundwater Storage and Recovery Project

Figure 5.3-12

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Site 15

Site 15 would be located within the GGNC, situated in a grassy area on the southern edge of the cemetery between Sneath Lane and the cemetery's operations and maintenance yard (see Figure 3-36). This site is located just east of an auxiliary entrance to the GGNC from Sneath Lane. A commercial/office park and a Veteran's Administration Medical Clinic are located to the south across Sneath Lane and are shielded from view somewhat by mature trees and landscaping. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure, moderately high visual quality, and moderately high visual sensitivity.

The 2,095-square-foot well, chemical treatment, and filtration facility at Site 15 (see Figure 3-8) would be visible from the GGNC and from Sneath Lane, which is a locally designated scenic route. However, the location is not a designated scenic vista.

The overall visual sensitivity of this site is considered moderately high and the change in visual contrast of the proposed building addition would potentially be high, given the prominent position of the site in the immediate foreground of Sneath Lane and associated views of the cemetery grounds. The proposed facility would be viewed in the context of the existing operations and maintenance buildings, characterized by distinctive period architectural design (see Figure 5.3-13 [Visual Simulation of Site 15], with the caption "Visual Simulation of Site 15 without mitigation"). The building and fencing for Site 15 would be designed to integrate visually with the surrounding structures (including the existing maintenance buildings) and landscape, as described for the site in Chapter 3, Project Description, Section 3.4.3 (Facility Sites). Still, the Project would introduce an additional structure of public works character into a highly distinctive and formal visual setting consisting of open lawn, highly regular rows of uniform gravestones, and scattered, isolated trees. The structure could potentially be in conflict with the visual expectations of visitors to the cemetery – many of whom may use the auxiliary entrance on Sneath Lane. In this highly sensitive, formally ordered, and prominent setting, the well facility would, therefore, represent a high level of visual change because the form, scale, and character of the facility could be out of character with the surroundings. The facility at Site 15 would thus represent a *significant* aesthetic impact.

Implementation of Mitigation Measure M-CR-5b (Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 15) would reduce this aesthetic impact to a *less-than-significant* level. It requires the development of a compatible architectural design more closely resembling the existing GGNC maintenance and operations buildings, minimizing the dimensions of the well facility to the extent practicable, moving the structure further away from the auxiliary entrance, and using landscaping that would be in visual harmony with the site's surroundings. A visual simulation showing the well facility at Site 15 with the prescribed mitigation elements presented below is found in Figure 5.3-13 with the caption "Visual Simulation of Site 15 with application of Mitigation Measure M-CR-5b". The figure also shows the existing conditions at Site 15 and the proposed Project.

Mitigation Measure M-CR-5b: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 15

(See Impact CR-5 in Section 5.5, Cultural and Paleontological Resources for a description)

In addition, Site 15 is not within a scenic vista, although it would be visible from a locally designated scenic roadway and require removal of scenic resources such as trees. Again, with implementation of Mitigation Measure M-CR-5b, the impact on designated scenic roadways and resources would be *less than significant with mitigation*.

Site 18 (Alternate)

Site 18 (Alternate) would be located on an undeveloped parcel in a residential neighborhood along Alta Loma Drive on a knoll at street level overlooking a lower, moderately sloped grassy swale (see Figure 3-39). The site is densely vegetated with a small stand of willows that is about 15 feet high and covering approximately 3,400 square feet. It is adjacent to single family residences to the southwest fronting on Del Monte Avenue and others directly across Alta Loma Drive. Single-family residences also front on Camaritas Avenue to the east. Vivid elements in the vicinity include views to forested hillsides to the south and San Bruno Mountain to the north. As noted in Section 5.3.1.3 (Individual Project Well Facility Sites) and in Table 5.3-1 (Summary of Visual Sensitivity Findings), this site has high visual exposure, but it has moderately high visual sensitivity, moderate visual quality, and moderately high overall visual sensitivity.

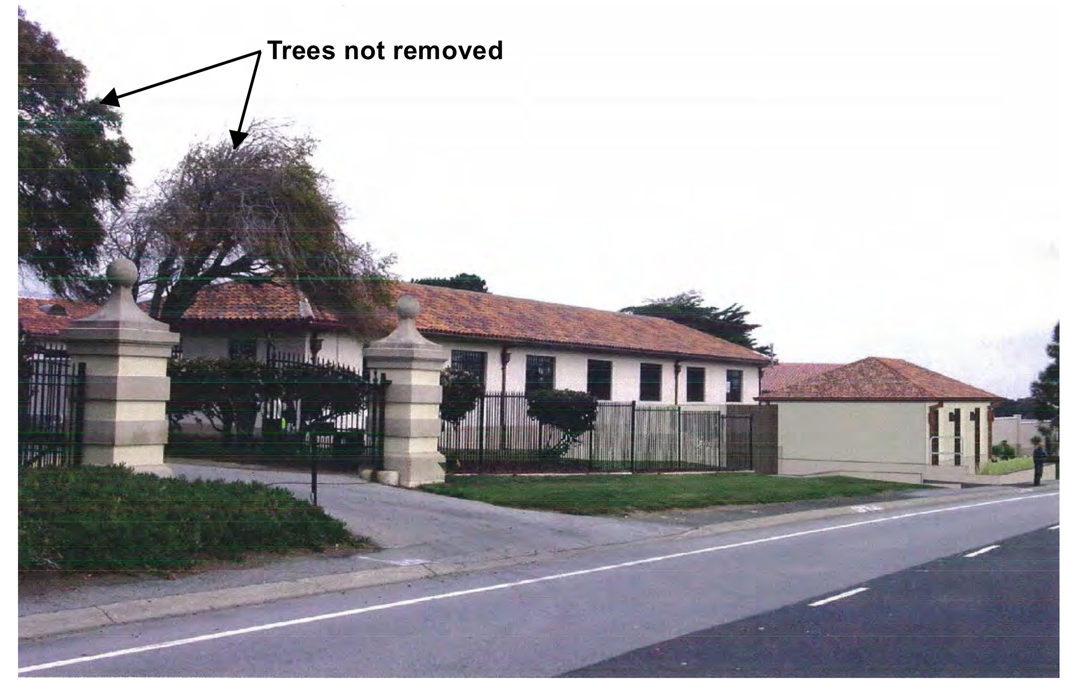
The 1,495-square-foot well and chemical treatment facility at Site 18 (Alternate) (see Figure 3-7) would be visible from Alta Loma Drive and from single-family residences on Alta Loma Drive, Del Monte Avenue, and Camaritas Avenue. A small stand of willows on the site would be removed and grading and other site preparation activities may be required to accommodate construction of the well facility and staging area. The well structure would introduce a new visual public works element in a residential neighborhood that could appear incompatible and out of character with the existing open space setting, even though it is actually an existing utility right-of-way. The structure would have a gray or stone concrete finish, as described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types). The introduction of a new public infrastructure would represent a significant visual change, even though the proposed well facility would be of smaller scale and height to surrounding residences of the area and the building's stone finish would moderate the contrast. Therefore, in the context of the moderately high overall visual sensitivity of the setting and a moderately high visual contrast given the introduction of an infrastructure facility in what may appear to be an open space area within a residential neighborhood, the potential impact on the visual character of the site and its surroundings would be *significant*. However, there would be *no impact* on scenic roadways, scenic vistas, or scenic resources at this site.

Taken together with the well facility's design, implementation of Mitigation Measure M-AE-3a (Implement Landscape Screening) would reduce the aesthetic impact of placing a new well and chemical treatment facility at this currently vacant location to a *less-than-significant* level by partially screening the facility from the surrounding residential area.

> ***Mitigation Measure M-AE-3a: Implement Landscape Screening (Sites 4, 7, and 18 [Alternate])***
> (See Impact AE-3, Site 4 for a description)

Impact Conclusion: Less than Significant with Mitigation

Existing View of Site 15 from Sneath Lane looking north.



Visual Simulation of Site 15 with application of Mitigation Measure M-CR-5b.

Visual Simulation of Site 15 without mitigation.

Legend

View Direction

Construction Area

Visual Simulation of Site 15

Regional Groundwater Storage and Recovery Project

Figure 5.3-13

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Impact AE-4: Project operation would not create a new source of substantial light that would adversely affect day or nighttime views in the area. (Less than Significant)

As described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types), the well facilities would have permanent outside lighting meeting the requirements of Title 24 of the California Code of Regulations. Use of outside lighting during nighttime hours would be temporary and random, based on unscheduled, as-needed maintenance events. Outside lighting would be controlled by motion sensor or switch by maintenance staff when they arrive at the well facilities. This outside lighting would be limited to the extent practicable and activated with manual switching with automatic shut-off. To further reduce the impact, the lighting would be placed and shielded to direct light downward. Scheduled and routine maintenance would be conducted during daytime hours, when outdoor lighting would not be necessary. Therefore, the Project would have a *less-than-significant* impact attributable to lighting at any of the facility sites.

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

<u>Sites 6, 7, 8, 11, 17 (Alternate), and Westlake Pump Station</u>

Sites 6, 7, 8, 11, and 17 (Alternate) would not be located near any stationary sensitive views or viewers that would be affected by the appearance and intermittent frequency of the nighttime lighting occasionally necessary during Project maintenance. It is assumed that any operational activities or routine maintenance would occur during daylight hours. Any transient viewers passing near these sites would likewise not be impacted by the appearance and intermittent frequency of the nighttime lighting proposed, given the use of shielding, focused illumination, and placement. Also, these sites are located in urban and suburban areas where nighttime lighting (e.g., street lighting, security lighting) is already used on adjacent parcels and streets. In these situations, any lighting produced at these sites would blend into the existing surrounding lighting. In the case of the Westlake Pump Station, no new permanent lighting is proposed. As a result, *no impact* from operational nighttime lighting would occur at these sites.

Impact Conclusion: No Impact

<u>Sites 1, 2, 3, 4, 5, 9, 10, 12, 13, 14, 15, 16, 18 (Alternate), and 19 (Alternate)</u>

These proposed sites are located in areas that have nearby stationary sensitive views or viewers. These views and viewers could be affected by the appearance and intermittent frequency of the nighttime lighting occasionally necessary during Project maintenance, due to the added presence of a lighting source that did not exist before. However, as noted above, illumination of outside lighting during nighttime hours would be temporary and random, based on unscheduled, as-needed maintenance events. It is assumed that any operational activities or routine maintenance would occur during daylight hours. Any transient viewers passing near these sites would likewise not be impacted by the appearance and intermittent frequency of the nighttime lighting proposed, given the use of shielding and as-needed use, as described in Chapter 3, Project Description. Also, these sites are located in urban and suburban areas where nighttime lighting (e.g., street, security, ornamental, commercial) is already used on adjacent parcels. In these situations, any lighting produced at these sites would blend into the existing surrounding lighting. Given the presence of stationary sensitive views and viewers – but also given the intermittent and random nature of outside lighting use for the Project – permanent lighting impacts attributable to the Project are considered *less than significant*.

Impact Conclusion: Less than Significant

5.3.3.6 Cumulative Impacts and Mitigation Measures

Impact C-AE-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to scenic resources and visual character. (Less than Significant with Mitigation)

The geographic scope for the analysis of cumulative impacts on aesthetic resources consists of each proposed GSR facility site (including the construction area for the well, the well facility, and the pipelines), and the immediate vicinity around each of these sites.

Construction

Scenic vistas, scenic resources, and visual character

The construction area of some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would be visible to viewers who can also view proposed GSR Project construction areas (in the event that both the proposed GSR Project and cumulative projects were constructed at the same time): the Peninsula Pipelines Seismic Upgrade (PPSU) Project Colma Site (cumulative project D-1) would be visible from the vicinity of GSR Sites 8 and 17 (Alternate); the PPSU Project South San Francisco Site (cumulative project D-2) would be visible from the vicinity of GSR Sites 12 and 19 (Alternate); the Mission & McLellan Project (cumulative project F) would be visible from the vicinity of GSR Site 9; the PG&E Transmission Pipeline Replacement Project (cumulative project H) would be visible from the vicinity of GSR Sites 11, 12, and 19 (Alternate), and the Centennial Village Project (cumulative project I) would be visible from the vicinity of the pipeline construction areas for proposed GSR Site 13 (see Figures 5.3-5, 5.3-6, 5.3-7, 5.3-8, and 5.3-10 for photographs of these locations). None of these areas of visual overlap include scenic corridors, scenic vistas, or scenic resources. No cumulative projects have been identified that would be visible to viewers who would also be in view of construction areas at Sites 1, 2, 3, 4, 5, 6, 7, 10, 14, 15, 16, or 18 (Alternate).

As described in Impact AE-1, construction of the GSR Project would have less-than-significant impacts at GSR Sites 8, 9, 11, 17 (Alternate), and 19 (Alternate), and significant impacts at Sites 12 and 13, due to some degradation of visual quality from the construction staging areas, equipment, materials storage areas, and tree removal. Depending on the extent of overlap among the construction schedules, the cumulative impacts related to visual quality during construction could be *significant*. Therefore, the GSR Project's contribution to this cumulative impact could be cumulatively considerable given that the GSR Project would require construction staging areas, construction equipment, and material storage in areas with high visual quality.

However, as discussed in Impact AE-1, the GSR Project's impacts related to construction-period impacts on the visual quality in the vicinity of Sites 12 and 13 would be reduced to a less-than-significant level with implementation of Mitigation Measure M-AE-1a (Site Maintenance), Mitigation Measure M-AE-1b (Tree Protection Measures), and Mitigation Measure M-AE-1c (Develop and Implement a Tree Planting Plan at Site 12) (see Impact AE-1, above, for description). Implementation of these mitigation measures would ensure that the construction area is maintained by storing construction materials and equipment generally away from public view and by removing construction debris promptly at regular intervals, and tree removal is minimized. With implementation of these mitigation measures, the GSR Project's contribution to cumulative impacts related to visual quality during construction would not be cumulatively considerable (*less than significant*).

New sources of substantial light

If constructed at the same time, the construction area of some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would be visible to viewers who can also view proposed GSR Project construction areas, as listed above. None of the cumulative projects listed above under the heading of *Scenic vistas, scenic resources, and visual quality* would be expected to require nighttime construction for which lighting would be required. Although not likely, construction staging areas for these cumulative projects may require nighttime lighting.

As described in Impact AE-2, the GSR Project would have less-than-significant impacts with regard to the creation of new sources of substantial light at GSR Sites 9, 12, and 19 (Alternate), because a lighting plan for those sites that require nighttime construction would be prepared and implemented, ensuring that lighting would be directed downward, covering only the area to be occupied by the drilling rig.

Depending on the extent of overlap between the construction schedules for the projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), implementation of these projects together with the proposed GSR Project at Sites 9, 12, and 19 (Alternate) could result in a cumulative impact relative to the creation of new sources of substantial light. However, these impacts would be temporary (only as-needed during construction) and brief (only during drilling for approximately seven days and up to 48 hours for pump testing). Due to the limited need for lighting on the GSR Project and the controls required in the GSR Project's lighting plan, the potential cumulative impact resulting from the creation of new sources of substantial light associated with construction-related activities would be *less than significant*.

Operation

Scenic vistas, scenic resources, and visual character

Two of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would be visible to viewers who can also view proposed GSR Project permanent facilities at Sites 9 and 13. The Mission & McLellan Project (cumulative project F) and Site 9 would be visible to viewers at and in the area of the Verano Condominiums. The Centennial Village Project (cumulative project I) and Site 13 would be visible to those traveling along South Spruce Avenue. These areas of visual overlap would not include scenic corridors, scenic vistas, and scenic resources.

As described in Impact AE-3, the permanent well facilities at GSR Sites 9 and 13 would have a less-than-significant impact upon visual character, because of the low visual quality of GSR Site 9, the landscaping to be used at GSR Site 13, and the low degree of visual change resulting from placement of the GSR well facilities at both sites.

Implementation of the Mission & McLellan Project (cumulative project F) and the Centennial Village Project (cumulative project I) together with the proposed GSR Project would not result in a significant impact on visual quality. There is no reason to believe that the Mission & McLellan Project (cumulative project F), once constructed, would be out of character with the multi-family residential and public institutional land uses in the vicinity. Likewise, there is no reason to believe that the Centennial Village Project (cumulative project I) would be out of character with the surrounding commercial district.

As discussed in Impact AE-3, the GSR Project would have no impacts or less-than-significant impacts at most well facility sites, because the environment surrounding the sites is of low or moderately low overall visual quality or because aesthetic impacts were associated with construction and not operations of the Project. The same would be true for cumulative projects that are proximate to GSR sites including cumulative projects near Sites 8, 9, 11, 12, 13, 17 (Alternate), and 19 (Alternate). Cumulative projects in proximity to these sites are not the types to permanently place receptors in view of these sites. Therefore, the potential cumulative impact on visual quality would be *less than significant*.

New sources of substantial light

Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would likely have nighttime lighting, such as the Mission & McLellan Project (cumulative project F) near GSR Site 9 and the Centennial Village Project (cumulative project I) near GSR Site 13. Others may require infrequent nighttime maintenance, which would require outside nighttime lighting, such as the Cal Water Well Replacement SSF1-25 Project (cumulative project G) and Daly City "A" Street Well Replacement Project (cumulative project C) near GSR Sites 11 and 5, respectively). As described in Impact AE-4, the GSR Project would have no or less-than-significant impacts relative to the creation of new sources of substantial light, because the use of outdoor nighttime lighting during maintenance would be infrequent and because the proposed GSR well facilities are located in urban areas with existing nighttime lighting. The same would be true for the cumulative projects. For these reasons, the potential cumulative impact on nighttime lighting from maintenance activities would be *less than significant*.

5.3.4 References

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5.4 POPULATION AND HOUSING

This section analyzes the potential for the Project-specific aspects of the proposed Project to induce substantial population growth, displace housing, create a substantial demand for additional housing in the Project area, or necessitate the construction of housing outside the Project area. The growth-inducement effects of the Project within the context of the San Francisco Public Utilities Commission's (SFPUC) Water System Improvement Program (WSIP) and the overall regional water system, as well as the indirect effects of that growth, are analyzed in the Program Environmental Impact Report (PEIR) on the WSIP. That analysis is incorporated into this EIR by reference (San Francisco Planning Department 2008) and is summarized in Chapter 2, Introduction and Background, Section 2.2.2 (SFPUC Water System Improvement Program) and in Chapter 6, Other CEQA Issues, Section 6.1 (Growth Inducement).

5.4.1 Setting

Facilities for the proposed Project would be constructed and operated in the cities of Daly City, South San Francisco, San Bruno, and Millbrae, as well as the Town of Colma and the Broadmoor neighborhood in unincorporated San Mateo County. These places comprise the Project study area for this analysis. Existing land uses in the Project vicinity include a variety of residential (low, medium, and high density), commercial, industrial, and public/quasi-public uses. Other land uses in the area include golf clubs, cemeteries, and urban parks. Refer to Section 5.2, Land Use, for additional information regarding land uses in the Project vicinity.

In 2011, San Mateo County (including the incorporated jurisdictions within the County) was home to approximately 724,702 residents and had approximately 271,428 housing units (State of California Department of Finance 2011). The estimated population and housing units for the various jurisdictions within the Project study area are summarized in Table 5.4-1 (Estimated Population and Housing Units in 2011).

TABLE 5.4-1
Estimated Population and Housing Units in 2011

Jurisdiction	Estimated Population	Estimated Number of Housing Units
City of Daly City	101,920	32,609
Unincorporated San Mateo County (Broadmoor)[a]	4,176	1,392
Town of Colma	1,805	586
City of South San Francisco	64,067	21,805
City of San Bruno	41,842	15,516
City of Millbrae	21,714	8,383
TOTAL	235,524	80,291

Sources: State of California Department of Finance 2011; U.S. Census Bureau 2010

Note:

(a) Broadmoor is a "census designated place" (CDP) as defined by the U.S. Bureau of the Census and is delineated for each decennial census as a statistical counterpart of incorporated places, such as municipalities.

5.4.2 Regulatory Framework

There are no federal, State, or local regulations governing population and housing that apply to the proposed Project.

5.4.3 Impacts and Mitigation Measures

5.4.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on population or housing if it were to:

- Induce substantial population growth in an area, either directly or indirectly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).
- Displace substantial numbers of existing housing units or create demand for additional housing, necessitating the construction of replacement housing.
- Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere.

5.4.3.2 Approach to Analysis

Due to the nature of the proposed Project, no impacts would occur related to the three impact criteria listed above for the reasons presented below:

Induce substantial population growth in an area, either directly or indirectly. During the approximate 21-month construction period, the average daily number of persons necessary for all construction activities is estimated to be up to 193 construction workers (refer to Chapter 3, Project Description, Section 3.5.1.2 [Construction Methods for Well Facilities])[1]. It is expected that the construction workforce requirements could be met with the local labor force within the San Francisco Bay Area (Bay Area). While some workers might temporarily relocate from other areas, the increase would be minor (not more than 193 workers) and temporary (up to 21 months). Long-term operation and maintenance of the well facilities is discussed in Chapter 3, Project Description, Section 3.8 (Operations and Maintenance) and would be executed by existing staff from the SFPUC or the Partner Agencies. The proposed Project does not include the construction of new homes or

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[1] Table 3-8 (Estimated Daily Worker and Construction Equipment Trips for Well Facilities Construction) in Chapter 3, Project Description, Section 3.5.1.2 (Construction Methods for Well Facilities), describes the typical daily construction worker trips for each Project construction component/phase, and identifies the facility sites to which that phase applies. The average daily construction workers was determined by multiplying the typical daily construction worker trips for each phase by the number of facility sites to which that phase applies. Then the results for all phases were added together. A total of 193 average daily construction workers is a conservative figure, because it assumes the simultaneous construction of all phases and all facility sites. However, in actuality, while 19 wells would be constructed (including some test wells being converted to production wells), only 16 facilities would be constructed. Additionally, construction of all 16 facilities would only overlap for a portion of the 21-month construction period.

businesses in the area or extend new roads or other infrastructure into undeveloped areas. Therefore, construction and operational activities associated with the proposed Project would not in themselves result in a substantial increase in the local population and there would be no growth-inducement impact associated with the Project.

As a WSIP facility improvement project, the proposed Project would be a contributing factor in the growth-inducement potential of the overall WSIP. Growth inducement relative to this Project is discussed in Chapter 6, Other CEQA Issues, Section 6.1 (Growth Inducement). Indirect effects of the Project on population and housing growth, due to growth-inducement potential and secondary effects of growth are also discussed in Chapter 6, Other CEQA Issues, Section 6.1.

Displace substantial numbers of housing units or people or create demand for additional housing. There are 80,291 housing units in the larger study area; however, none are situated within the construction area boundary for any well facility site. Therefore, neither construction nor operation of the Project would displace housing units or people.

A maximum of 193 construction workers per day would be employed as part of the proposed Project (refer to Chapter 3, Project Description, Section 3.5.1.2 [Construction Methods for Well Facilities]), but it is expected that the construction workforce requirements could be met by the local labor force within the Bay Area and would not create demand for additional housing. Therefore, no impacts related to the creation of additional housing to accommodate construction workers would be attributable to the Project. In addition, operations and maintenance responsibilities associated with the Project would be performed by existing staff of the SFPUC and Partner Agencies and would not create the need for additional housing. Therefore, the significance criteria are not applicable to the proposed Project and are not discussed further.

5.4.3.3 Construction and Operational Impacts and Mitigation Measures

As discussed above, there would be no additional growth-inducing impact beyond that considered in the WSIP PEIR. The Project would be a groundwater storage and recovery system that would not, independently and separately from its contribution as part of the overall WSIP, result in Project-level impacts to population and housing. Therefore, no mitigation measures related to this resource topic are required.

5.4.3.4 Cumulative Impacts and Mitigation Measures

Because the GSR Project would not result in Project-specific impacts related to population or housing, implementation of the Project would not result in cumulative impacts beyond the secondary and indirect impacts of growth associated with the proposed Project within the context of the WSIP, as described in this EIR in Chapter 6, Other CEQA Issues, Section 6.1 (Growth Inducement).

5.4.4 References

San Francisco Planning Department. 2008. *Final Program Environmental Impact Report on the San Francisco Public Utilities Commission Water System Improvement Program.* (Case No. 2005.0159E, State Clearinghouse No. 200509206). October 30.

State of California, Department of Finance. 2011. *E-5 Population and Housing Estimates for Cities, Counties, and the State, with 2010 Benchmark*. May.

U.S. Census Bureau. 2010. *American Fact Finder. Broadmoor CDP, California. DP-1: Profile of General Population and Housing Characteristics: 2010*. Website accessed March 27, 2012 at: http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml.

5.5 CULTURAL AND PALEONTOLOGICAL RESOURCES

Cultural resources include historic architectural resources, archaeological resources, paleontological resources and human remains. This section evaluates the potential for implementation of the San Francisco Public Utilities Commission's (SFPUC's) proposed Regional Groundwater Storage and Recovery (GSR) Project to result in adverse impacts to historical resources, including historic-period architectural and archaeological, as well as paleontological resources. This EIR evaluates both historic and unique archaeological resources, as defined in Section 5.5.2.2 (State Regulations). Mitigation measures to reduce impacts to a less-than-significant level are identified, where appropriate.

5.5.1 Setting

5.5.1.1 CEQA Area of Potential Effects

For the purpose of environmental review under the California Environmental Quality Act (CEQA), the definition of the CEQA Area of Potential Effects (C-APE) presented below is modeled after that of the federal Area of Potential Effects (APE) described in the Code of Federal Regulations (36 CFR 800.16[d]):

> The C-APE is the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character or use of historical resources (i.e., California Register-eligible resources), if any such properties exist. The C-APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

A portion of the Project (GSR Sites 14 and 15) would be located on lands managed by the U.S. Department of Veterans Affairs (VA) at the Golden Gate National Cemetery (GGNC); therefore, the Project is subject to review under Section 106 of the National Historic Preservation Act, as amended. As part of the Section 106 review process, the VA must identify the federal APE for the well facilities at Sites 14 and 15. It is expected that the VA would determine that the architectural and archaeological federal APEs are identical to the C-APE for Sites 14 and 15.

Architectural C-APE

The C-APE for architectural resources takes into consideration the proposed Project effects on the built environment, including the potential for directly or indirectly altering the setting, character, or use of historical resources. Architectural C-APEs for each well facility site are presented in Table 5.5-1 (Architectural C-APEs), which includes a Notes column that summarizes the assumptions that guided the creation of the C-APEs. The table also includes a summary of the information presented in the Historic Architectural Resources Technical Report (Carey & Co. 2011b). In general, the C-APEs for architectural resources include all parcels where Project activities would occur, including pipeline trenching locations for both proposed and alternate pipeline connections. Adjacent parcels are included for a few of the proposed well sites where the potential for indirect impacts was identified. The limited size of the architectural C-APEs is based on the small footprint and scale of the proposed well facilities and the developed character of the area surrounding the majority of proposed Project locations. However, for proposed well facilities where construction activities would occur within a potential historical landscape[1], such as a cemetery, the entire landscape area is included in the architectural C-APE. This approach is taken for all well sites where construction activities are proposed within or directly adjacent to cemeteries that are 45 years old or older. For example, Project activities associated with well facilities at Sites 14 and 15 would occur within the VA's GGNC property; therefore, the C-APEs for these well facilities include the entire cemetery. The architectural C-APE for Site 7 also includes the adjacent cemeteries containing buildings or structures that may incur indirect impacts from proposed Project activities, such as introducing elements (e.g., new structures) that have the potential to be out of character with the historic setting. This includes the Woodlawn Memorial Park to the north and a maintenance building and mausoleum managed by the Greenlawn Memorial Park (owned by the Greek Orthodox Memorial Park), adjacent to the Site 7. In general, indirect impacts were not identified for proposed pipeline trenching, as these areas would be returned to their general pre-construction condition following construction and would not introduce permanent above-ground structures or other elements that could affect the historic setting. The C-APEs for architecture consider the proposed removal of trees or vegetative landscaping, as such features can contribute to a historic landscape or the setting of a historical resource.

[1] National Register Bulletin 18 defines a designed historic landscape as "a landscape that has significance as a design or work of art; was consciously designed and laid out by a master gardener, landscape architect, architect, or horticulturalist to a design principle, or an owner or other amateur using a recognized style or tradition in response or reaction to a recognized style or tradition; has a historical association with a significant person, trend, event, etc. in landscape gardening or landscape architecture; or a significant relationship to the theory or practice of landscape architecture."

TABLE 5.5-1
Architectural C-APEs

Well Facility	Site Description	Well Station Type	Proposed Connection Point	Architectural C-APE	Notes
Site 1	Lake Merced Golf Club	Well plus chemical treatment	SFPUC pipeline	Construction area within the golf club property	No impact expected outside of construction area.
Site 2	Park Plaza Meter	Well with fenced enclosure	Daly City pipeline	Construction area	No impact expected outside of construction area.
Site 3	Ben Franklin Intermediate School	Well with fenced enclosure	Daly City pipeline	Construction area and the access road and the parcel it crosses	Assumes no indirect impacts on adjacent parcels due to small size of fenced well enclosure.
Site 4	Garden Village Elementary School	Well with fenced enclosure	Daly City pipeline	Construction area	No impact expected outside of construction area.
Westlake Pump Station	Westlake Pump Station	N/A	Daly City pipeline	Construction area and adjacent parcel	Work entails upgrades to existing pump station. Assumes no potential impact on pump station or adjacent property, since work would occur inside the existing building.
Site 5	Right-of -Way at Serra Bowl	Well with fenced enclosure (Consolidated Treatment at Site 6 Option) or Well plus chemical treatment and filtration (On-site Treatment Option)	SFPUC pipeline	Construction area and adjacent parcel to the east	The San Pedro Valve Lot across the street is not a historical resource.

TABLE 5.5-1
Architectural C-APEs

Well Facility	Site Description	Well Station Type	Proposed Connection Point	Architectural C-APE	Notes
Site 6	Right-of-Way at Colma BART	Well plus chemical treatment and filtration	SFPUC pipeline	Construction area and the parcel boundaries	No impact expected outside of construction area. Assumes no potential for indirect impacts on the nearby cemetery.
Site 7	Right-of-Way at Colma Boulevard	Well with fenced enclosure (Consolidated Treatment at Site 6 Option) or Well plus chemical treatment and filtration (On-site Treatment Option)	SFPUC pipeline	Construction area and nearby Woodlawn Memorial Park, Greenlawn Memorial Park, and Greek Orthodox Memorial Park grounds	Assumes the potential for indirect impacts on the Woodlawn Memorial Park and the Greek Orthodox Memorial Park due to proximity to the construction area. Assumes potential for impacts on Greenlawn Memorial Park due to its historic and current association with buildings adjacent to construction area. Assumes that these cemeteries may be designed historic landscapes and that the entire landscape will be evaluated to determine potential indirect impacts.
Site 8	Right-of-Way at Serramonte Boulevard	Well plus chemical treatment and filtration	Cal Water pipeline	Construction area and parcel	Assumes no potential indirect impacts due to proposed connection pipelines or utility trenching outside of the SFPUC right-of-way.
Site 9	Treasure Island Trailer Court	Well plus chemical treatment and filtration	SFPUC pipeline	Project area and the trailer park	Assumes potential indirect impacts to trailer park due to size of buildings in relation to proposed construction. Included entire trailer park parcel in C-APE.
Site 10	Right-of-Way at Hickey Boulevard	Well plus chemical treatment and filtration	Daly City pipeline	Construction area	No impact expected outside of construction area.

TABLE 5.5-1
Architectural C-APEs

Well Facility	Site Description	Well Station Type	Proposed Connection Point	Architectural C-APE	Notes
Site 11	South San Francisco Main Area	Well plus chemical treatment and filtration	Cal Water pipeline	Construction area	No impact expected outside of construction area.
Site 12	Garden Chapel Funeral Home	Well plus chemical treatment	SFPUC pipeline	Construction area, including developed parcels where construction activity would occur	Assumes potential for indirect impacts on parcels through which construction area runs.
Site 13	South San Francisco Linear Park	Well plus chemical treatment and filtration	San Bruno pipeline	Construction area	No impact expected outside of construction area
Site 14	Golden Gate National Cemetery (GGNC)	Well with building or solid wall enclosure	San Bruno pipeline	Construction area, cemetery and developed parcel where construction activity would occur	The GGNC is considered a historical resource. C-APE assumes that the entire landscape needs to be studied to determine potential impacts.
Site 15	Golden Gate National Cemetery (GGNC)	Well plus chemical treatment and filtration	San Bruno pipeline	Construction area, cemetery and developed parcel where construction activity would occur	The GGNC is considered a historical resource. C-APE assumes that the entire landscape may need to be studied to determine potential impacts.
Site 16	Millbrae Corp Yard	Well plus chemical treatment	SFPUC	Construction area and building adjacent to spoil area	Assumes no potential impact on Orchard Supply Hardware building next to proposed connection pipeline or power line excavation to adjacent parcels.

TABLE 5.5-1
Architectural C-APEs

Well Facility	Site Description	Well Station Type	Proposed Connection Point	Architectural C-APE	Notes
Site 17 (Alternate)	Standard Plumbing Supply	Well plus chemical treatment	Cal Water pipeline	Project area along with Standard Plumbing Supply parcel.	Assumes no indirect impacts on the National Register-eligible Cypress Lawn Memorial Park District. Includes Standard Plumbing Supply parcel as construction would occur within the parcel boundaries.
Site 18 (Alternate)	Alta Loma Drive	Well plus chemical treatment	SFPUC pipeline	Construction area and adjacent parcel to the west.	Assumes potential for indirect impacts on the adjacent parcel at the corner of Del Monte Avenue and Alta Loma Drive due to the proximity of proposed construction to this single-family home. Assumes that there are no construction activities, other than those shown on Figure 3-39 in Chapter 3.0 Project Description, occurring within the construction area to the east of buildings fronting on Del Monte Avenue.
Site 19 (Alternate)	Garden Chapel Funeral Home	Well with fenced enclosure	SFPUC pipeline	Construction area, including developed parcels where construction activity would occur.	Assumes potential for indirect impacts on parcels through which construction area runs.

Source: Carey & Co. 2011b

Archaeological C-APE

The C-APE for archaeological resources takes into consideration the proposed Project effects on potential surface and subsurface archaeological deposits that could be affected by Project activities at each of the 16 well facility sites, as well as at the three alternate sites (19 sites in total) and the Westlake Pump Station. Therefore, the archaeological C-APEs have both a horizontal and vertical component. As the Project consists of 19 discrete well facility sites and a pump station site, the archaeological C-APE consists of a series of discrete pieces of land. The horizontal C-APE for each well facility site consists of the entire well facility construction area as shown on Figures 3-11 through 3-40, which encompasses: the location of the well facility; the chemical/filtration treatment building, where needed; other temporary and permanent improvements, such as paving and parking; and the construction staging area. The horizontal extent of the C-APEs varies from 0.4 acre for Site 1 to 3.0 acres for Sites 2, 3, and 4 combined, depending upon local site conditions and the types of improvements proposed at each location. The vertical C-APE for each well facility site is five feet, which is the proposed depth of construction-related ground disturbance. The horizontal C-APE for pipeline (both proposed and alternate pipeline connections) and utility installation consists of a 20-foot wide swath along pipeline and utility line routes. The vertical C-APE for pipelines is six feet, and for utilities is five feet. The vertical C-APE for the groundwater wells is in excess of 100 feet, and for geotechnical borings is 50 feet.

Paleontological C-APE

The C-APE for paleontological resources includes all areas that could potentially experience subsurface excavation into fossil-bearing geologic units during Project construction. The paleontological C-APE is similar to the archaeological C-APE, except that activities that disturb only the ground surface are excluded. Surface-disturbing activities (e.g., grading at staging areas or for site access) would affect surface soils only, which have already been disturbed by regional urbanization, and not the underlying fossil-bearing geologic units which, therefore, are not considered to be within the paleontological C-APE.

Significant paleontological resources are fossils and fossiliferous deposits, consisting of identifiable vertebrate fossils, large or small, uncommon invertebrate, plant and trace fossils, and other data that provide evolutionary and geologic information. Paleontological resources are considered to be older than recorded human history and/or older than the middle Holocene epoch (i.e., older than about 5,000 radiocarbon years) (SVP 2012b).

5.5.1.2 Paleontological Setting

Paleontological resources are the fossilized remains of plants and animals, including vertebrates (animals with backbones), invertebrates (e.g., starfish, clams, ammonites and marine coral) and fossils of microscopic plants and animals (microfossils). The age and abundance of fossils depend on the location, topographic setting and particular geologic formation in which they are found. Fossil discoveries not only provide a historical record of past plant and animal life but can assist geologists in dating rock formations. In addition, fossil discoveries can expand our understanding of the time periods and the geographic range of existing and extinct flora or fauna.

Paleontological Assessment Standards

The Society of Vertebrate Paleontology (SVP) has established guidelines for the identification, assessment and mitigation of adverse impacts on nonrenewable paleontological resources (SVP 1996, 2012a). Most practicing paleontologists in the United States adhere closely to the SVP's assessment, mitigation and monitoring requirements as outlined in these guidelines, which were approved through a consensus of professional paleontologists and are the standard against which all paleontological monitoring and mitigation programs are judged. Many federal, State, county and city agencies have either formally or informally adopted the SVP's standard guidelines for the mitigation of adverse construction-related impacts on paleontological resources. The SVP has helped define the value of paleontological resources and, in particular, indicates the following:

- Vertebrate fossils and fossiliferous (fossil-containing) deposits are considered significant nonrenewable paleontological resources and are afforded protection by federal, State and local environmental laws and guidelines.
- A paleontological resource is considered to be older than recorded history, or 5,000 years before present, and is not to be confused with an archaeological resource.
- Invertebrate fossils are not significant paleontological resources unless they are present within an assemblage of vertebrate fossils or they provide undiscovered information on the origin and character of the plant species, past climatic conditions, or the age of the rock unit itself.
- A project paleontologist, local paleontologist, specialist, lead agency, or local government can designate certain plant or invertebrate fossils as significant.

In accordance with these principles, the SVP outlined criteria for screening the paleontological potential of rock units and established assessment and mitigation procedures tailored to such potential (SVP 2012a).

Table 5.5-2 (Criteria for Determining Paleontological Potential) lists the criteria for high-potential, undetermined and low-potential rock units.

TABLE 5.5-2
Criteria for Determining Paleontological Potential

Paleontological Potential	Description
High	Geologic units from which vertebrate or significant invertebrate or plant fossils have been recovered. Only invertebrate fossils that provide new information on existing flora or fauna or on the age of a rock unit would be considered significant.
Undetermined	Geologic unit(s) for which little to no information is available.
Low	Geologic units that are not known to have produced a substantial body of significant paleontological material.

Source: SVP 1996, 2012a

Paleontological Potential in Project Area

The following discussion of paleontological resources divides the rock units underlying the Project area into geologic units with a high and low potential to yield significant fossils. Information was compiled based on a review of published geologic maps, geologic unit descriptions and a fossil collections database at the University of California Museum of Paleontology (UCMP) undertaken for the Project by Dr. Kenneth Finger in 2009 (Finger 2009). No new mapping or field study for paleontological resources was conducted during the preparation of this EIR.

Nearly all of the proposed well facility sites are located on surface deposits mapped as the Colma Formation; the exceptions are Site 9, which is on Holocene colluvium, and a portion of Site 10, which is on artificial fill (Brabb et al. 1998). The Colma Formation is of early late Pleistocene age. Its total thickness is unknown, but may be as great as 60 meters (approximately 200 feet). The depositional setting 125,000 years ago for the Colma Formation is that of a narrow straight or coastal embayment that is also thought to have been present during prior deposition in the Pliocene to middle Pleistocene epoch of the estuarine Merced Formation (Lajoie 1986).

Although vertebrate remains in Holocene colluvium are too young to be fossiliferous, thus having low paleontological potential, any such vertebrate remains in this stratum could be of scientific interest to paleontologists, but would not be considered significant paleontological resources. However, artificial fill is material that has been disturbed by previous construction activities. Hence, these mapped units have no paleontological potential.

The Colma Formation, on the other hand, has produced significant marine and terrestrial fossils in the past and, therefore, is considered to have high paleontological potential. Bones and teeth of mammoth and extinct bison have been reported from sand and clays of the Colma Formation that overly the metamorphic Franciscan Complex. Associated fossil diatoms[2] and pollen indicate deposition in an estuarine environment. A leg bone of a ground sloth (*Glossotherium* sp.) previously recovered from the shallow well in the vicinity of the bones and teeth of the mammoth and bison, has been related to the same bed (Rodda and Baghai 1993). Other vertebrate fossil localities have been listed in the San Francisco Bay region (Savage 1951), which might also be associated with the Colma Formation. Fossil plant remains and a peat layer at the top of the Colma Formation have been reported as possibly representing "an old soil that developed in or near local marshes or lakes." Marine deposits within the Colma Formation have produced marine megafossils (large fossils), marine and nonmarine algae (Schlocker 1974).

5.5.1.3 Prehistoric Setting

The following information is taken from Historic Context and Archaeological Survey Report for the Regional Groundwater Storage and Recovery Project Area, San Mateo County, California (Archeo-Tec 2011a).

Prehistoric Context

Current archaeological evidence suggests humans have continuously occupied California since at least 13,500 years before present (B.P.), beginning during the Pleistocene-Holocene Transition. However, the earliest traces of human habitation on the San Francisco Peninsula date to around 6,000 years B.P., during the Middle Holocene. Since that time, human occupation of the northern part of the peninsula may have been continuous. During the Middle Holocene, people began to exploit more diversified animal species than during the earlier Pleistocene-Holocene Transition and shifted to an increased reliance on plants and

[2] Microscopic one-celled or colonial algae.

seeds. This resource diversification required a lifestyle of seasonal migrations in order to access different environments throughout the year. Consequently, the "tool kit" of prehistoric peoples became more specialized, expanding to include varied methods of food processing. The diverse habitats and year-round availability of food in central California also contributed to the shift to exploitation of resources other than big game. The increasingly prominent role of seed collecting is reflected in the archaeological record by large numbers of food grinding implements (Wallace 1978). As the utilization of acorns became more predominant, heavy, deep-basined mills and handstones came into use. Middle Holocene archaeological sites often contain human remains and moderate to substantial artifact assemblages are found in multi-activity sites (Rosenthal and Meyer 2004).

Based on evidence from linguistics and burial patterns, this early population movement into the San Francisco Peninsula was possibly a wave of Penutian-speaking Costanoan ancestors either replacing or assimilating their Hokan-speaking predecessors (Moratto 1984). The earliest site found in San Francisco to date is the fragmentary human remains discovered during the course of excavation for the Bay Area Rapid Transit (BART) Civic Center Station. This find points to the possibility of the existence of early, deeply buried prehistoric resources throughout San Francisco. Despite these finds, there are relatively few sites older than 4,500 B.P. on the actual bayshore. This could represent two possible scenarios: 1) the bayshore was inhabited before 4,500 B.P., abandoned when rising sea levels inundated the land, and then reoccupied after the sea retreated; or 2) occupation began after 4,500 B.P., when the marshes began to stabilize.

Beginning around 4,000 B.P., which is the start of the Late Holocene, the climate began to shift from the warm and dry Altithermal period to cooler and wetter conditions. The general cultural trend observed in California was one of adjusting to new environmental conditions. For example, many of the archaeological sites dating to the Late Holocene in the San Francisco Bay region are shellmounds, midden sites containing large quantities of mollusk shells. This site type in the Bay Area includes the West Berkeley shellmound (Wallace 1978), and the nearby Emeryville shellmound, which is an example of a Late Holocene shellmound on a massive scale, over 30 feet (nine meters) in height and spanning the period of time from 2,700-650 B.P. As at West Berkeley, the Emeryville shellmound yielded an extensive array of worked stone and bone, beads and faunal remains that allowed for a detailed analysis of resource exploitation and subsistence at the time (Broughton 1997, 1999). More broadly, N. C. Nelson recorded over 400 of these shellmounds around the edge of the San Francisco Bay in the early twentieth century (Nelson 1909, 1910). This period is characterized by further niche specialization, a refinement of various technologies and specialized exploitation of plant and animal species. Archaeological sites dating to the Late Holocene also have been found in San Francisco, primarily in the South of Market region. These sites are all multi-activity shellmound and midden sites. The oldest date from an occupation site in San Francisco is 2,200 B.P. (Pastron and Ambro 2005).

Ethnohistoric Context

When the Spanish first explored northern California in the last quarter of the eighteenth century, the San Francisco peninsula was territory occupied by the Costanoan people, who are sometimes referred to as the Ohlone in the anthropological and historical literature (e.g., Levy 1978). The Costanoan (Ohlone) language was the most widespread of five distinct languages spoken in the vicinity of the San Francisco

Bay at the time of contact with Spanish explorers (Milliken 1995). An average of about 15 individuals – although this varies considerably – made up an Ohlone household (Broadbent 1972). The next larger social unit was the clan (Harrington 1933). Additionally, the Ohlone were divided into moieties[3] following the common central California practice (Kroeber 1925). The largest social unit was the tribelet, or group of interrelated villages under the leadership of a single headman (Heizer 1978), and consisted of about 200 to 400 people (Levy 1978; Milliken 1995). While in some areas of California the families composing a tribelet would share a single central village location for most of the year, tribelets in the Bay Area were settled in a more dispersed fashion (Milliken 1995).

The Ohlone people were primarily collectors and hunters of fish and game. Of significant importance to the aboriginal diet were various molluscan resources, including clams, ocean and bay mussels and oysters. These food sources are well documented in the archaeological record from excavated shellmounds around the bay. Many other littoral food resources, including varieties of gastropods and crustaceans, contributed protein to the Ohlone diet (Greengo 1951, 1952, 1975). Other sources of meat included many species of land and waterfowl, as well as large and small terrestrial and sea mammals (Levy 1978). Fish contributed a large measure of protein to the Ohlone diet and were taken by net, trap, hook, spear and poison (Harrington 1921; Crespi 1927; Font 1930; Bolton 1933).

In common with most Native American groups throughout what today is California, plant foods probably contributed the majority of calories to the diet. The staple was the acorn, pounded by stone mortar and pestle to form mush, gruel, or bread (Gifford 1955). Buckeye yielded edible nuts. Many species of berries were harvested, as were roots, shoots and seeds (Levy 1978). In addition to providing primary subsistence, the flora and fauna of a rich natural habitat provided the remainder of life's necessities for the Ohlone people.

Tules were harvested and utilized as building materials for structures (Kroeber 1925) and for crude balsa canoes (Heizer and Massey 1951). Vegetal resources also provided the fiber for net and cord manufacture and, especially, basket material. Animal parts – bone, tooth, beak, and claw – provided awls, pins, daggers, scrapers, knives, and other tools. Pelts and feathers provided clothing and bedding (Kroeber 1925; Levy 1978). Sinew was used for bow support and bow strings (Harrington 1921). Feather, bone and especially shell were used for items of ornamentation (Mason 1916).

Local rock and mineral sources provided chert, as well as metamorphic and igneous materials for tool manufacture and highly indurate local sandstone yielded suitable material for grinding and pounding tools. Exotic materials, such as steatite and particularly obsidian, could be obtained in trade. The Bay Area inhabitants bartered with locally available commodities, such as cinnabar and hematite (Heizer and Treganza 1972). Other valuable local resources used in trade with inland peoples included salt, shellfish meat and shell as raw material for ornament manufacture (Davis 1961).

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[3] Either of two kinship groups based on unilateral descent that together make up a tribe or society.

5.5.1.4 Historic-Period Setting

The following information is taken from Historic Context and Archaeological Survey Report for the Regional Groundwater Storage and Recovery Project Area, San Mateo County, California (Archeo-Tec 2011a) and Historic Resources Technical Report for the Regional Groundwater Storage and Recovery Project, San Mateo County, California (Carey & Co. 2011b).

The first Spanish explorer to reach the San Francisco Bay was Gaspar de Portolá and his party in 1769. In the spring of 1776, Captain Juan Bautista de Anza established both the Mission Dolores and Presidio of San Francisco. By April 1 of that year, de Anza's men had traveled through San Francisco and down the peninsula, passing near several of the sites proposed for well facilities (Milliken 1995).

The establishment of Mission Dolores in 1776 began the "Mission Period" in the San Francisco Bay area. At its peak in the 1820s, Mission Dolores controlled the entire San Francisco Peninsula as far south as San Francisquito Creek (which forms the border between San Mateo and Santa Clara counties), including the Project area (Bancroft 1886; Dwinelle 1867; Hittell 1897; Soulé et al. 1855). El Camino Real, also known as the California Mission Trail, connected Alta California's missions; many of the proposed well facility sites are located near or alongside El Camino Real (Hackel 1998). Vast tracts of land on the peninsula, including land where the well facility sites would be located, served as grazing land for cattle belonging to Mission Dolores or the Presidio. In 1833, the Mexican Congress passed a bill that secularized the Missions of Upper and Lower California (Hittell 1897).

Rancho Period (1835-1846)

After the secularization of the Missions, the former Mission lands were granted to citizens in recognition of their services to the Mexican government. The area containing the proposed well facility sites was divided into two ranchos: Rancho Laguna de la Merced, granted to José Antonio Galindo; and Rancho Buri Buri, granted to José Antonio Sánchez. GSR Sites 1 through 6 are situated within the former Rancho Laguna de la Merced, Sites 13 and 16 are within former tidal salt marshes that were thus considered public land, and the remaining well facility sites are situated within the former Rancho Buri Buri.

Rancho Laguna de la Merced

José Jesús Castro, the governor of the Mexican state of Alta California, granted 2,200 acres of land around and including Lake Merced to cattle rancher José Antonio Galindo in 1835. The property was named Rancho Laguna de la Merced. Galindo most likely used the land for cattle grazing; an early map he commissioned of the property shows no standing structures, but "ojos de agua" (springs) are labeled at the southern border of the lake. The Galindo Palizada dwelling was built in 1835 and was likely located at the south end of the lake. In 1837, Galindo sold the land to Francisco de Haro, who later became the first alcalde (mayor) of San Francisco. De Haro moved his family into the house built by Galindo and also built another house near the same spot in 1837, which he occupied for a time; after which he built another house, farther towards the north, at the south-eastern extremity of Lake Merced (Hillyer 1906).

Rancho Buri Buri

In 1835, the same year that José Jesús Castro granted Rancho Laguna de la Merced to Galindo, he also granted almost 15,000 acres to José Antonio Sánchez (Stanger 1938). Sánchez improved the land, building an adobe, a grain mill, and a mill house. The adobe was built just off the San Jose Stage Road (present-day El Camino Real) near what is now Capuchino High School in San Bruno. The locations of the other two structures are not known. After Sánchez's death in 1843, the rancho passed into the hands of his 10 children (Igler 2001). By the time of its formal survey by an engineer in 1848, three of his sons had built their own homesteads on the property: José de la Cruz near Capuchino Golf Course, Isidro at South San Francisco and José Isidro in North Burlingame (Stanger 1938). Comparing the 1848 map with a modern topographical map, none of the houses were near any of the proposed well facility sites.

American Period (1846-1900)

The date of July 8, 1846 marked the conversion of California from Mexican to American jurisdiction. Although the transition was peaceful and uneventful in most of northern California, it had important implications for ranchers and other landowners. In 1851, the United States Congress passed the California Land Claims Act to settle the many conflicting land titles that had arisen from the changes in jurisdiction. The Act held that all holders of Spanish and Mexican land grants were to present their titles for confirmation before the Board of California Land Commissioners; any land that the Board could not confirm reverted to public land. Following is a description of the disposition of the two ranchos discussed above.

Rancho Laguna de la Merced

Upon landholder Francisco de Haro's death in 1849, Rancho Laguna de la Merced passed jointly to his heirs, who brought their claims to Rancho Laguna de la Merced before the Board of Land Commissioners in March 1852. It took the courts 16 years to confirm the title (Baggett 1880). Many challenges to this title arose during this period and as a result of subsequent claims by squatters seeking title on the assumption that it would be declared public land, and by errors on the part of de Haro's heirs (Tuttle 1882; Hillyer 1906), a speculator named John Mahoney was granted title to the shares of at least five of the seven heirs and almost half of that of a sixth. The court records indicate that he gave or sold about 300 acres to others (Tuttle 1882). Later correspondence offering to sell the lake and 1,000 acres surrounding it to the City of San Francisco implies that in 1877, Mahoney, Sharp and P. Donohue considered themselves to be joint and full owners of Lake Merced and the area surrounding it (Mendell 1877). Presently, the Lake Merced Golf Club occupies a portion of the old Rancho.

Rancho Buri Buri

Sánchez's 10 children faced similar obstacles to the land claim as de Haro's heirs. In the final settlement, 11 years later, less than four percent of the original ranch was owned by Sánchez heirs. Title to the other 96 percent was held by 50 different owners (Stanger 1938).

City Period

With the ranchos broken up and divided among dozens of property owners, the stage was set for the foundation of cities and development within the former ranchos. The proposed well facility sites are located in what would become six different municipalities: Daly City, Broadmoor (unincorporated San Mateo County), Colma, South San Francisco, San Bruno and Millbrae. The following presents a brief description of the history of the municipalities.

Daly City (Sites 1, 2, 5, 6, and the Westlake Pump Station Site)

Daly City is named after John Daly, who spent his youth working on a dairy farm in San Mateo County. By 1868, he had purchased 250 acres at the heart of what would become Daly City and established the San Mateo Dairy. Other shops and houses began to cluster along the railroad tracks and El Camino Real. In the early 1890s, a streetcar line was extended from San Francisco over the hill to Daly City and beyond, into the heart of San Mateo County. By the end of the century, the idea of incorporation was being considered, but was largely rejected by the independent farmers who owned much of the land (Gillespie and Gillespie 2011).

After the 1906 earthquake and fires devastated San Francisco, former residents streamed south to Daly City and elsewhere to seek refuge. Agricultural fields were covered in temporary shelters. By 1907, John Daly had subdivided his property and the new lots were quickly occupied by “temporary” refugee houses. With this new population, making the area more residential and town-oriented than before, the residents of Daly City voted to incorporate in 1911 (Gillespie and Gillespie 2011).

Daly City changed little during the war years, but experienced the same post-war housing boom experienced by other Peninsula cities in the late 1940s and early 1950s. Entire planned-development housing communities were constructed, some of which were annexed into Daly City and others of which, like Broadmoor, remained unincorporated. Westlake, which contains Sites 1 and 2 and the northern portion of the Westlake Pump Station site, was a planned community built by Henry Doelger on land that had formerly been sand dunes and cabbage fields; it was annexed to Daly City in 1948 (Gillespie and Gillespie 2011). Folk singer Malvina Reynolds immortalized the pastel colored houses of Westlake in the 1961 song “Little Boxes” (Gillespie 2008).

Broadmoor (Sites 3 and 4)

Entirely surrounded by Daly City, this portion of unincorporated San Mateo County is known as Broadmoor. From the late nineteenth through the early twentieth centuries, this area was characterized as consisting “mostly of hog and dairy farms, and fields of potatoes and artichokes” (Broadmoor Police 2010). Beginning in 1947, a series of single-story houses was constructed and collectively identified as Broadmoor Village. Since then, portions of the unincorporated area have been annexed by Daly City. Today, Broadmoor consists of three separate urban islands, each surrounded by Daly City and/or Colma. Broadmoor contains about 2.5 square miles of land and 7,000 people (Broadmoor Police 2010).

Colma (Sites 7, 8, and 17 [Alternate])

The area known as Colma during the nineteenth century was all of the land between the San Francisco and South San Francisco borders, west to the Pacific Ocean and east to San Bruno Mountain. When the town incorporated in 1924, however, it encompassed only the 2.2 square miles that it consists of today (Shoup and Brack 1994). Colma's community formed in the 1800s as a collection of homes and businesses along El Camino Real, also known as the California Mission Trail. The community also developed along the San Francisco and San Jose Rail Road line, which became operational in 1863, having the School House Station stop in Colma (1869 U.S. Coast Survey map). Valued mainly as a transportation corridor, Colma's accessible rural setting close to, but outside of, the City and County of San Francisco (CCSF) soon became very desirable.

By the 1880s a shortage of land was being felt in San Francisco and areas that had been set aside for cemeteries during earlier years became desirable for other uses. At the turn of the century, the San Francisco Burial Ordinance passed, banning further burials within the City. Eviction notices were sent to all cemeteries to remove the bodies and monuments in 1914. Cemetery owners began to look for new, less expensive property to bury the dead of San Francisco (CHA 2007).

The Rural Cemetery Movement and its Evolution Relative to Colma

In the 1830s a new and different type of cemetery developed in the eastern U.S., specifically in Massachusetts. The initial form of this style was called the rural cemetery, which later developed into the lawn-park, and most recently into the memorial park type of cemetery. While the rural and lawn-park type of cemeteries were principally by and for the rich, the memorial park, while coming out of this tradition, represents a kind of burial place more accessible to the majority of Americans. The rural cemetery was located in the countryside and was based on a naturalistic design with preservation of the natural landscape with winding access roads following existing terrain.

The lawn-park type of cemetery became dominant during the late nineteenth century. It presented a streamlined landscape, open and park-like, less cluttered and less vegetation. Scientific planning, regularity and formality, as well as naturalism, were the watchwords. The most recent modification of the rural cemetery theme has been the memorial park, first established at Forest Lawn in Los Angeles in the twentieth century. Three aspects of the memorial park are central and make it distinctive. First, strict hierarchical control was from the top by professional managers to control the cemetery landscape and assure its appearance and efficiency. Lawns were the main natural features. Second, the banishment of an emphasis on death, in order to preserve the happiness of the living, was a main theme. Public monuments of statuary were used to evoke the values which owners of the park wanted to stress which make this type of cemetery as much a kind of an outdoor museum as a memorial park and visitors were encouraged to have an enjoyable visit. Evergreen trees were planted instead of trees whose leaves fall during winter. As a memorial park, nature was mainly a passive backdrop to artistic memorials (Shoup and Brack 1994).

Having limited natural resources, Colma's chief value has been its location as a transportation corridor and accessible rural area close to, but outside, San Francisco. Always a lightly populated area, it offered what San Francisco needed (i.e., rural scenic space).

A number of cemeteries were set up there during the late nineteenth and early twentieth centuries. In 1887, Holy Cross, the first cemetery in Colma, received its first interment (Archaeological/Historical Consultants 1994). Cypress Lawn opened in 1892. It is the most famous of the cemeteries and boasts the greatest concentration of San Francisco's elite (Shoup and Brack 1994).

With its new focus, Colma underwent an economic boom. In 1889, just as the first cemeteries were being established, Dun's Mercantile Agency Reference Book had five businesses listed for the Colma Area, including a blacksmith, a saloon, a general store, a hotel and a distillery (Dun and Company 1889). By 1901, this list grew to 28 listings (Dun and Company 1901). Once cemeteries became the main business of Colma, the place became known as a necropolis, or city of the dead. The community was run by the Cemetery Association, which was made up of a representative from each cemetery.

Colma remained unincorporated until 1924, when fears that Daly City would try to expand its borders prompted the incorporation of Colma as the "City of Lawndale." The name remained until 1941, when the town was renamed Colma. As of 1990, Colma had increased its living population to approximately 1,100, with a number of shopping centers and other retail. However, the numerous cemeteries, and more than one million interments, still account for the majority of business in Colma today.

South San Francisco (Sites 9, 10, 11, 12, 13, 18 [Alternate], and 19 [Alternate])

The area encompassing Sites 9, 10, 11, 12, 13, 18 (Alternate), and 19 (Alternate) once belonged to Charles Lux and Henry Miller, who joined forces to create Miller & Lux, one of California's most powerful nineteenth century landowners. Lux and Miller continued the Buri Buri ranching tradition by keeping cattle on the land (South San Francisco Historical Society 2004). Early structures in South San Francisco included the Twelve Mile House, a stage coach stop built in 1851 and demolished in 1977 (San Mateo 1986), and Lux's own estate, which was built in 1858 and included a mansion, barns, out buildings and an orchard (South San Francisco Historical Society 2004).

Following the death of Lux in 1887, Gustavus Swift, president of Chico-based Swift and Co., one of the largest meat packing companies in the country, set his sights on Lux's estate as an ideal location to construct not only Chicago-style meat packing plants and related industrial facilities, but also to build an entire planned community that catered to the meat packing industry. In 1890, Peter Iler acquired 3,400 acres, including the Lux estate, and transferred the property to the South San Francisco Land & Improvement Company. A new meat packing facility was opened in 1892, marking the beginning of the modern industrial town of South San Francisco (Blum 1984). After the deaths of Lux and Miller, the land was divided and town plots were laid out. The town, now a company town, was renamed "South San

Francisco" in the tradition of Swift's Meat Company, whose other plants were "South Chicago" and "South Omaha" (South San Francisco Historical Society 2004).

From its incorporation in 1908, the City of South San Francisco lived up to its nickname as "The Industrial City." Meat packing, marble, brick and paint production plants rose east of the newly built train yards on Point San Bruno. West of the Chestnut Avenue city limits spread vegetable, flower and duck farms. Dairy cattle and horses roamed the hills west of the El Camino Real stagecoach road (South San Francisco 2011a). The years after World War I saw dozens more industrial concerns become established in South San Francisco, primarily in the meat, chemical and steel industries (South San Francisco 2011b). The well-known sign on the side of Sign Hill was first painted onto the ground in 1923; the 60-foot concrete letters identifying South San Francisco as the Industrial City were added five years later (South San Francisco 2011c). Treasure Island Mobile Home Park, located adjacent to Site 9, most likely was established in response to the Golden Gate International Exposition on Treasure Island of 1939 to provide accommodations to throngs of people who traveled to the Bay Area to attend the fair. It appears to be one of several such parks that opened in San Mateo County before World War II (Foster 1980; Wallis 1991). By mid-century, South San Francisco had firmly established itself as the home of industries vital to the City of San Francisco. In the post-World War II era, housing development patterns changed as the federal government encouraged construction of simple, economical residential units. With these new residential suburbs came the development of commercial areas, as well as religious structures (Shoup and Brack 1994).

The 1925 Sanborn map of South San Francisco shows that Sites 12 and 19 (Alternate) were on land belonging to Baden Farm, the largest buildings of which were a milking barn and a feed storage barn and a neighboring farm. Buildings in the vicinity of Sites 12 and 19 (Alternate) were a bunkhouse, a small farmhouse and several unidentified outbuildings. By 1950, the farms had been converted to a housing development and vacant land belonging to the San Francisco Water Company. Sites 12 and 19 (Alternate) were within the vacant San Francisco Water Company right-of-way, and later the SFPUC right-of-way.

The City of South San Francisco embarked on a vigorous deindustrialization program leading to the closure of the stockyards and slaughterhouse in 1959; the last steel plant closed in 1983. Industrial parks and light industry moved in, and with the establishment of Genentech Corporation in 1976, South San Francisco could claim to be the birthplace of the biotech industry (Blum 1984). Large suburban developments to the west of El Camino Real opened as well, including Buri Buri, Winston Manor and Westborough.

San Bruno (Sites 14 and 15)

The earliest structures in what would become the City of San Bruno were way stations along the stage road between San Francisco and San Jose, which was also El Camino Real. The Fourteen-Mile House was built in the early 1850s at what is now the intersection of El Camino Real and San Mateo Avenue; it survived as a drinking and gambling establishment until it was torn down in 1949 (San Bruno 2011). The San Bruno House was a hotel built along El Camino Real in 1862; it burned down several times and was never rebuilt after the third fire in 1901 (San Bruno 2011). Agriculture was the most common economic activity in San Bruno, particularly dairy farming. The largest of these farms was more than 3,000 acres owned by Richard Sneath. In 1906, he joined forces with John Daly, of San Mateo Dairy, to form Dairy Delivery Company. In the 1930s, the United States Army acquired 140 acres of Richard Sneath's dairy farm to create the GGNC (San Bruno 2011).

San Bruno continued to develop as a rest and recreational destination with the construction of Tanforan racetrack in 1899. Twice the racetrack served wartime activities. During World War I it was a military training post, and during World War II Tanforan was transformed into a temporary internment camp for 8,000 of the Japanese and Japanese Americans who were evacuated from the Pacific Coast under Executive Order 9066. Horse stables became homes and 170 hastily constructed wooden barracks filled the interior field (Federal Writers Project 1984; Uchida 1998).

Like the rest of the San Francisco Peninsula, San Bruno's history changed significantly during the postwar period. Its farmlands turned into suburban tract housing and its population boomed, more than quadrupling its size from 1940 to 1960. By the 1960s, as all of the cities on the Peninsula had developed, the City of San Bruno had become geographically boxed in, stabilizing its population near its current levels. Single-family housing tracts dominated development through the 1960s, with multi-unit complexes developed during the 1970s (San Bruno 2011).

Millbrae (Site 16)

Darius Ogden Mills, after whom Millbrae is named, bought a share of Rancho Buri Buri, which grew to reach from what is now Skyline Boulevard in the west, Bayshore Highway (U.S. Highway 101) in the east, Millbrae Avenue in the north, and Trousdale Drive in the south (Millbrae 2011). Together with his business partner Alfred Green, Mills established Millbrae Dairy along the east side of El Camino Real, which provided milk and other dairy products to residents of San Francisco and elsewhere (Fredericks 2009). He built a mansion where Spring Valley School stands today. Mills secured the right-of-way for a train depot to be constructed near his home. He also opened a dairy that served his estate and was the primary employer in Millbrae for many years. A porcelain works, farms and nurseries, an electric railway, a commercial street and the telephone came to Millbrae in due time (Millbrae Historical Society 2007).

Originally, a cow pasture owned by Mills, Mills Field was constructed on 150 acres of land in the swamps east of El Camino Real in 1927. It is now San Francisco International Airport. An entire hillside, where the Millbrae Meadows subdivision is now located, was bulldozed during the 1940s to provide landfill for a major expansion effort at the airport (Millbrae 2011; Millbrae Historical Society 2007).

In 1946, after an attempt at annexation by Burlingame, the residents of Millbrae voted to incorporate (Millbrae Historical Society 2007). However, legal battles between Millbrae and Burlingame prevented the incorporation from taking place for three years (Millbrae Historical Society 2007). In the 1950s, the Mills Mansion burned to the ground and the Millbrae Dairy was demolished to make way for new development (Millbrae Historical Society 2007; Fredericks 2009).

A 1949 map of Millbrae shows that the location of Site 16 was owned by the San Francisco Water Department, Peninsula Division. Several storage buildings, an auto repair shop and small garage or carport buildings were located in the vicinity of Site 16.

5.5.1.5 Archaeological Methods, Survey and Results

Records Search and Literature Review

A records search and literature review was conducted by Archeo-Tec Consulting Archaeologists (Archeo-Tec) in May 2009 at the Northwest Information Center (NWIC) of the California Historical Resources Information System at Sonoma State University (Archeo-Tec 2011b). The records search and literature review encompassed the area within a 0.25-mile radius of each archaeological C-APE (NWIC File Number 08-1395). The purpose of the records search was to determine the nature and extent of any previous cultural resources studies and to identify the locations of any recorded cultural resources. The literature reviewed included published overviews of the archaeology and ethnohistory of California (Moratto 1984; Jones and Klar 2007; Heizer 1978; Kroeber 1925), as well as inventories of historic structures and sites (Hoover et al. 1990; Gudde 1969; California Department of Parks and Recreation 1988, 1992; Hendry and Bowman 1940). The literature reviewed also included: the San Mateo County historical atlas; General Land Office Plat Maps; Sanborn Company maps; aerial and satellite photographs and topographic maps of the Project sites; and the Peninsula Watershed Management Environmental Impact Report (San Francisco Planning Department 2001).

The literature review found that the National Register of Historic Places (National Register) had no listings for archaeological sites within the review area. Plat maps exhibited as evidence in Land Commission cases settling title disputes to Rancho Laguna de la Merced and Rancho Buri Buri showed that in 1866 there were two houses at Rancho Laguna de la Merced that were within 0.25 mile of the archaeological C-APEs for Sites 2, 3, and 4. These probably belonged to William Higgins, whose lodgings Hittell described as being "at the most southerly end of Laguna de la Merced in San Mateo County" (Hittell 1897; Schussler 1916).

The 1858 General Land Office Plat Map shows that the San Jose Stage Road followed the course of the current railroad tracks, passing near Sites 7, 8, 9, 10, 11, 12, 16, 17 (Alternate), and 19 (Alternate). The maps also show that the former San Bruno House was within 0.25 mile of the C-APEs for Sites 11 and 12, and that the former Irish House and Frenchman's House were within 0.25 mile of the C-APEs for Sites 12 and 19 (Alternate). The 1925 Sanborn map of South San Francisco shows that Sites 12 and 19 (Alternate) were on land belonging to Baden Farm, the largest buildings of which were a milking barn and a feed storage barn and a neighboring farm. Buildings in the vicinity of Sites 12 and 19 (Alternate) C-APEs are a bunkhouse, a small farmhouse and several unidentified outbuildings. By 1950 the farms had been converted to a housing development and vacant land belonging to the San Francisco Water Company; the Sites 12 and 19 (Alternate) C-APEs were within the vacant San Francisco Water Company right-of-way.

The 1949 Sanborn map of Millbrae shows that the location of Site 16 was owned by the San Francisco Water Department, Peninsula Division. Several storage buildings, an auto repair shop, and small garage or carport buildings were located in the vicinity of the Site 16 C-APE.

The records search revealed that 37 cultural resource studies have been conducted within the 0.25-mile radius of the archaeological C-APEs that comprise the Project area. These studies included cultural resources overviews, subsurface archaeological surveys, resource evaluations and archaeological excavation and construction monitoring reports. Four of the archaeological surveys included a portion of 12 of the C-APEs for the proposed Project. An Archaeological Reconnaissance prepared for the SFPUC's San Andreas Pipeline No. 3 project transected the C-APEs for Sites 5, 7, 8, 10, 12, 14, 17 (Alternate), 18 (Alternate), and 19 (Alternate) (Baker 1979). A cultural resources assessment of alternative routes for PG&E's Jefferson-Marin Transmission Line (Brown et al. 2003) transected the extreme northern portion of Site 8 and included the routes of the pipelines along Sneath Lane for Sites 14 and Site 15. An archaeological reconnaissance for a Caltrans road widening project crossed the pipeline route for Site 11 (Young n.d.). An archaeological survey for the BART-San Francisco Extension Project encompassed Site 11 and touched the northeast corner of Site 13 (Rice 1994a).

As a result of these cultural resources studies, four archaeological sites (CA-SMA-100, -101, -209H and -343H) have been recorded within a 0.25-mile radius of Sites 11, 12, 14, 15, 16, and 19 (Alternate). Archaeological sites CA-SMA-100 and -101, two prehistoric middens, are within 0.25 mile of Site 15; archaeological site CA-SMA-209H, Tanforan, is within 0.25 mile of Sites 14 and 15; archaeological site CA-SMA-355, a prehistoric shell midden, is approximately 0.25 mile from 11, 12, and 19 (Alternate); and archaeological site CA-SMA-343H, a historic-era artifact concentration, is located within 0.25 mile of Site 16. In addition, CA-SMA-299, a prehistoric shell midden, was identified within the archaeological C-APE for Site 11. A brief description of these archaeological sites and their location in relation to well facility sites are provided in Table 5.5-3 (Recorded Archaeological Sites Near the Proposed Project). The archaeological site that is within the C-APE for Site 11 (CA-SMA-299) is described in more detail below.

TABLE 5.5-3
Recorded Archaeological Sites Near the Proposed Project

Archaeological Site Number	Description	Distance to Nearest Well Facility Site(s)
CA-SMA-100	Low domed earth midden with some shell content; very rich and dark in some places.	0.25 mile from Site 15
CA-SMA-101	Similar to SMA-100; was impacted and possibly destroyed by construction of I-280/I-380 interchange.	0.25 mile from Site 15
CA-SMA-209H	Tanforan racetrack, used as a Japanese internment center during WWII. Currently a shopping center.	0.25 mile from Sites 14 and 15
CA-SMA-299	Shell midden with poorly defined boundaries; condition unknown.	Within Site 11
CA-SMA-343H	Historic-era artifact concentration along east side of railroad tracks.	0.25 mile from Site 16
CA-SMA-355	Shell midden buried under 5-24 feet of overburden with unknown boundaries.	0.25 mile from Sites 11, 12 and 19 (Alternate)

Archaeological site CA-SMA-299 was first reported in 1988 as a large prehistoric shell midden. However, a year later when it was formally recorded, it was described as having been completely destroyed by creek channelization, placement of railroad tracks and other construction and removal of midden for a commercial soil operation. All that remained were occasional patches of shell and fire-cracked rock. In 1994, subsurface testing of the site was undertaken that consisted of placement of 20 shovel auger test bores to depths of six to 39 inches throughout its boundaries (Rice 1994b). No cultural remains were visible on the ground surface or in the 20 test bores. Subsequent to the 1994 subsurface testing of the CA-SMA-299, substantial but currently unknown subsurface changes have occurred near and possibly within the Site 11 C-APE. Railroad tracks that had lain on the surface of the ground were removed, Colma Creek was rechanneled and a BART subway was excavated to depths varying from 30 to 39 feet. It is possible that some or all of the C-APE has already been disturbed to depths greater than depths proposed for construction of the Project (Baker 1999a, 1999b; Archeo-Tec 2011b).

Sites CA-SMA-299 and CA-SMA-355 are situated in close proximity to each other and their nearest boundaries are unknown. It is possible that they, in fact, compose a single archaeological site. If the two sites are a single site, any remaining archaeological deposit would probably be located more than three feet below the ground surface within the C-APE for Site 11.

Sites 7, 14, 15, and 17 (Alternate) would be located within existing cemeteries. Although the C-APEs for these sites do not include the burial areas of the cemeteries, the possibility of burials or burial-related deposits outside of the officially sanctioned burial areas cannot be entirely discounted.

Based upon the results of the records search and literature review, Archeo-Tec concluded that the archaeological sensitivity of the 19 sites and the Westlake Pump Station ranges from low to high as listed in Table 5.5-4 (Archaeological Sensitivity of Well Facility Sites and Pump Station), below. Sites 11, 12, 15, and 19 (Alternate) have been determined to have a high sensitivity for prehistoric archaeological resources based on their proximity to known prehistoric archaeological resources and to terrain features, such as Colma Creek. Site 11 in particular bears high sensitivity as it is located between two buried midden deposits, the boundaries of which are unknown. In addition, Sites 11, 14, 15, and 16 have been determined to have a high sensitivity for historic-era archaeological resources, based on their proximity to known historic resources.

TABLE 5.5-4
Archaeological Sensitivity of Well Facility Sites and Pump Station

Site	Archaeological Sensitivity[a]	
	Historic	Prehistoric
Site 1	Low	Moderate
Site 2	Low	Moderate
Site 3	Low	Moderate
Site 4	Low	Moderate
Westlake Pump Station	Low	Moderate
Site 5	Low	Moderate
Site 6	Low	Moderate
Site 7	Moderate	Moderate
Site 8	Moderate	Moderate
Site 9	Low	High-Moderate
Site 10	Low	Moderate
Site 11	High	High
Site 12	Moderate	High
Site 13	Low	Moderate
Site 14	High	Moderate
Site 15	High	High
Site 16	High	Moderate
Site 17 (Alternate)	Moderate	Moderate
Site 18 (Alternate)	Low	Moderate
Site 19 (Alternate)	Moderate	High

Source: Archeo-Tec 2011b

Notes:

(a) High Sensitivity: Archaeological resources are very likely to be present. Resources are known to exist at this location or immediately adjacent to it.

Moderate Sensitivity: Archaeological resources may be present. Although no resources have been recorded at this location, historical and cultural factors indicate they may be present.

Low Sensitivity: Archaeological resources are unlikely to be present. Either resources were probably never present or portions of the location that may have contained resources have been so heavily disturbed that archaeological remains are unlikely to have survived.

Native American Contacts

On June 3, 2009 the San Francisco Planning Department sent a letter to the Native American Heritage Commission (NAHC) describing the proposed Project and requesting a review of the Sacred Land file to determine if the Project would encroach on any area deemed sacred to the Native American community, as well as requesting a list of Native American individuals/organizations that may have knowledge of cultural resources in the Project area (Sokolove 2009). A letter response from the NAHC dated September 14, 2009 indicated that a search of the Sacred Land file failed to indicate the presence of recorded Native American cultural resources in the immediate Project area. A list of seven Native American individuals/organizations who may have knowledge of cultural resources in the Project area was enclosed (Pilas-Treadway 2009).

In December 2009, the San Francisco Planning Department sent letters to the seven Native American contacts requesting input regarding any concerns about the proposed Project, as well as any comments or input regarding cultural resources, prehistoric and/or ethnographic land uses, or sites of Native American traditional or cultural value known to exist within the project vicinity. The San Francisco Planning Department send follow up letters to the same Native American contacts in February 2013. As of April 2013, no responses have been received from any of the contacts.

Archaeological Field Survey Methods

Archeo-Tec performed a pedestrian surface survey at all proposed well facility sites except Site 5, which is completely paved (Archeo-Tec 2011b). Archeo-Tec also performed extended archaeological surveys (EAS) at Sites 11, 12, 14, 15, 16, and 19 (Alternate) because of their high sensitivity for containing prehistoric and/or historic-era resources as listed in Table 5.5-4 (Archaeological Sensitivity of Well Facility Sites and Pump Station). The EASs employed different strategies at each of these six sites because each site bears a different form of sensitivity. Also, ideal survey methods for one well facility site may not be appropriate at another. Each well facility site was explored using a different method: coring (Site 11), mechanical trenching (Sites 12 and 19 [Alternate]), remote sensing (Sites 14 and 15) and hand excavation (Site 16). The purpose of both the surface surveys and the EASs was to determine the likelihood that any archaeological resources, whether known or unknown, exist within each C-APE.

Surface Survey

Surface surveys of unpaved areas within each C-APE were performed by a crew of two archaeologists from July 27 through July 31, 2009. The survey was conducted on foot employing 6-foot-wide transects.

Extended Archaeological Survey

Following completion of the archaeological surface surveys, EASs were conducted at six of the proposed well facility sites in April 2010 and January 2011. Four different EAS techniques were employed at the sites, reflecting current conditions at each site and the types of resources expected to be found. These are described below by well facility site.

Site 11

The EAS at Site 11 was conducted by ICF Jones & Stokes on January 31, 2011. Site 11 would be adjacent to CA-SMA-299. The primary purpose of the EAS within Site 11 was to determine if CA-SMA-299 is present within the C-APE. Ten geotechnical cores were excavated within the C-APE, starting in the northwest corner where the potential for site CA-SMA-299 to exist is greatest. Of these 10 cores, three encountered impenetrable material at three feet below the surface, well within the current fill layer, and were therefore abandoned. Seven successfully reached depths that might have contained material associated with CA-SMA-299. Each successful core was taken to a depth of eight feet. Each core was drilled using a hollow bore so that extracted subsurface material could be inspected by the archaeologist. Two archaeologists and an Ohlone Native American monitor were present to examine the material from the cores.

The archaeologists examined the soil for stratigraphy and soil changes. Material was then screened for shell, charcoal, bone and stone, any of which might be evidence of archaeological materials. Notes about each core were recorded on testing logs documenting the date, time, bore ID number and location, and a description of the soils as they were removed (ICF International 2011).

Sites 12 and 19 (Alternate)

The EAS at Sites 12 and 19 (Alternate) was conducted by Archeo-Tec on April 6, 2010. Three mechanically excavated trenches were employed within the construction area encompassing Sites 12 and 19 (Alternate). The crew consisted of the backhoe operator and four archaeologists. One trench was placed in the unpaved area along El Camino Real, near the proposed location for the Site 12 well facility, while the other two were placed in the unpaved areas surrounding Site 19 (Alternate) – one near where the well facility is proposed to be placed and the other near Southwood Drive. The trenches were placed to offer good coverage of the site while avoiding existing infrastructure and trees.

The trenches were excavated by a backhoe fitted with a flat-edged bucket. Trenches were three feet wide and 10 to 12 feet long. The backhoe scraped away the overburden in 6-inch layers, stockpiling the removed soil for inspection by the archaeological team. The trenches were excavated to the full depth of expected impacts – generally five or six feet – and were backfilled at the conclusion of the excavation. Trench forms were completed for each trench giving dimensions, stratigraphy, soil types, artifacts observed, and observations; additionally, a profile drawing was completed for each trench and a site plan map was maintained showing the location of each trench.

Sites 14 and 15

The EAS at Sites 14 and 15 was conducted by Archeo-Tec on April 15, 2010. The primary purpose of the EAS within Sites 14 and 15 was to determine if unmarked or misplaced historical burials exist within the C-APEs. However, as these two sites are within a cemetery, the EAS could not disturb the ground in these areas. Accordingly, a program of archival research was carried out to identify grave locations that may extend outside marked areas and into the C-APEs. This consisted of a search of records held at the National Archives regarding the founding of the cemetery, a search of historic maps and an interview with cemetery personnel.

Additionally, as the research was inconclusive, a ground-penetrating radar (GPR) survey of the construction area was performed on April 15, 2010, in an attempt to locate any subsurface anomalies that may indicate human remains. The GPR survey was conducted by two geotechnical scientists and an archaeologist.

Site 16

The EAS at Site 16 was conducted by Archeo-Tec on April 7 through 9, 2010. Site 16 is within 0.25 mile of historic-era site CA-SMA-343H, which was recorded along the edges of the railroad tracks that pass along the northeast side of the well site. The primary purpose of the EAS within Site 16 was to determine if a similar historical deposit, or a continuation of CA-SMA-343H, exists within the C-APE. Accordingly, two shovel test units, each approximately three feet by three feet, were placed within the C-APE in the unpaved area along the railroad tracks. Excavation was carried out by a crew of four archaeologists. The test units were continued to approximately three feet below the surface, at which point the archaeologists determined the historical layers had been exhausted.

Field Survey Results

No archaeological sites were identified during the surface surveys or the EASs, nor was evidence found suggesting that archaeological sites might be present[4]. Archaeological site CA-SMA-299 was recorded adjacent to Site 11, but no evidence of it was found during the surface survey or EAS. This is consistent with the 1994 records of subsurface testing of a portion of CA-SMA-299 that found no evidence of the site. The explanations offered in those records were that the site was intentionally destroyed in the mid-twentieth century by its sale as “Colma loam” for gardening and landscaping, by creek channelization and/or by the construction of the BART trackway and ventilation structure adjacent to the C-APE.

[4] During the surface survey, ground surface visibility was very limited at many of the well facility sites, where large portions of the C-APE were paved over. At other sites, surface visibility was entirely clear. In many cases, the unpaved portions of the C-APE were landscaped. Additionally, at the time of survey, work was in progress at many of the well facility sites to place monitoring wells; construction activities at these well facility sites limited the area that the archaeologists were able to survey. Some of the EASs faced additional constraints. Placement of test trenches at Sites 12 and 19 (Alternate) was limited by the need to keep a certain distance away from existing utility pipelines. The EAS at Sites 14 and 15, which involved the use of GPR, was hampered by a network of shallow irrigation lines that may have obscured objects deeper in the earth.

The EAS at Sites 12 and 19 (Alternate) encountered isolated twentieth century artifacts near the surface, but these artifacts either appeared to be less than 45 years old[5] or were not in any association with each other. At deeper levels, no artifacts were found.

The EAS at Sites 14 and 15 detected many anomalies that could indicate human remains, but these were determined to be sprinkler and other infrastructure trenches. It is possible, however, that anomalies may be present below utility lines and, therefore, not visible via remote sensing.

As with Sites 12 and 19 (Alternate), the EAS at Site 16 encountered a handful of scattered twentieth century artifacts below the railroad berm, but the artifacts were not in any association with each other and were determined to not represent an archaeological site. Deeper levels of the test pits were found to be devoid of cultural materials.

5.5.1.6 Architectural Methods, Survey and Results

Records Search and Literature Review

In addition to the records search and literature review conducted by Archeo-Tec in May 2009, as described in Section 5.5.1.5 (Archaeological Methods, Survey and Results), a supplementary record search was conducted by Carey & Company on June 8, 2009 (NWIC File Number 08-152) (Vanderslice and McNeill 2011). The records search encompassed the area within a 0.25-mile radius of each of the architectural C-APEs and consisted of a review of the Office of Historic Preservation Historic Property Data File for San Mateo County, dated May 27, 2009. This data file includes resources listed in the National Register, the California Register of Historical Resources (California Register), California Historical Landmarks, the California Inventory of Historic Resources and the Caltrans Bridge Inventory for San Mateo County. Carey & Company also conducted additional literature review that included historical resource inventories created by local agencies with jurisdiction over the 19 well facility sites, including San Mateo County Historical Resources Inventory, South San Francisco Historic Resource Inventory, Town of Colma's Historical Resources Element and the City of San Bruno Historical Resources Inventory. Also reviewed were other SFPUC Water System Improvement Program (WSIP) cultural resources documents and documents on historic properties produced by the VA, particularly the *National Cemeteries and Soldiers Lots listed in the National Register of Historic Places and designated a National Historic Landmark*. Historical documents and maps also were consulted, including plat maps, historic topographic maps and aerial photographs and Sanborn Company fire insurance maps (Carey & Co. 2011b).

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[5] Fifty years is a general estimate of the time needed to develop historical perspective on the events or individuals associated with the resource, and to evaluate a resource's historic significance. California's Office of Historic Preservation 45-year criterion recognizes the approximate five-year lag between resource identification and implementation of planning decisions (OHP 1995).

Field Survey Methods

Carey & Co. surveyed the sites over the course of six days in July 2009 and in March and July 2010 (Carey & Co. 2011a, 2011b). During the field surveys, any buildings, structures and objects were noted, particularly those that appeared to be at least 45 years old. Each location was documented with digital photography and written notes. Photographs were limited to views from the public right-of-way. At GGNC and Woodlawn Memorial Park, the survey team walked the entire grounds and took photographs from and towards the well facility sites, as well as photographs of significant buildings on the grounds and the general landscape. Primary and secondary research was completed to write a context statement and histories of individual resources. Primary sources included: historic topographical and Sanborn Maps; archival photographs from the South San Francisco Historical Society; photographic collections at the Bancroft Library at the University of California, Berkeley; the United States Census; California Register of Voters; telephone and city directories; and historic newspapers and other publications. Secondary sources focused on the histories of Daly City, Broadmoor Village, Colma, San Bruno, Millbrae, cemeteries, significant persons associated with individual resources, trailer parks, postwar suburban development and residential architecture, and postwar church architecture.

Records Search and Literature Review and Field Survey Results

The resource descriptions presented below include reference to the eligibility criteria for the National Register and the California Register, as applicable. These criteria are explained in detail in Sections 5.5.2.1 (Federal Regulations) and 5.5.2.2 (State Regulations).

Records Search and Literature Review Results

The records searches and literature reviews revealed that 18 cultural resource investigations have been previously conducted within 0.25 mile of the architectural C-APEs for the facility sites. These investigations include historic resources literature and record reviews, cultural resources overviews, and historic properties/resources surveys, inventories and evaluations.

Two previously recorded historical resources were identified within the architectural C-APEs. The Woodlawn Entry Gatehouse and Office Building is a potential National Register-eligible resource identified by the Town of Colma (Colma 1999) and falls within the C-APE for Site 7. The GGNC, which is within the C-APE for Sites 14 and 15, was formally determined eligible for the National Register in the 1970s and, thus, is eligible for the California Register (VA 2010). The VA is producing an Inter-World War Multiple Property Submission (MPS) that includes the GGNC (VA n.d.). The MPS is in the process of being nominated to the National Register for its association with military action in defense of the country. The Baden Valve Lot at Site 19 (Alternate) was evaluated in 2007-2008 as part of an SFPUC WSIP project (Carey & Co. 2007). The consultant recommended that it be considered ineligible for the both the California Register and National Register.

Fifteen additional historical resources were identified in the 0.25-mile record search area, but outside the C-APEs. The following first discusses the two historical resources identified within the C-APEs and then briefly discusses the historical resources found within 0.25 mile of the C-APEs.

Historical Resources within the Architectural C-APE

Golden Gate National Cemetery (GGNC). The GGNC was one of many cemeteries planned by the U. S. Army in the 1930s and completed in the early 1940s. It is within the architectural C-APE for Sites 14 and 15. The Army designed these cemeteries specifically to provide abundant burial opportunities in or near cities with large veteran populations. As San Francisco had long banned interments within city limits, the Army chose to locate the GGNC in San Bruno, to the south of the Colma cemeteries. Congress authorized construction of the GGNC in 1937 and the first interments occurred in 1941. The cemetery was officially dedicated on Memorial Day, May 30, 1942. In 1973, 82 national cemeteries were transferred from the U.S. Department of the Army to the Veterans Administration, since renamed the U.S. Department of Veterans Affairs. As noted above, this national cemetery is currently undergoing nomination to the National Register by the VA.

Woodlawn Gatehouse Entry**.** This office and entry building stands at 1000 El Camino Real within the Woodlawn Memorial Park and in the architectural C-APE for Site 7. The building is located approximately 500 feet to the north of the proposed well facility site. The Town of Colma concluded that this building is eligible for the National Register under Criterion C (Colma 1999) (see Section 5.5.2.1 [Federal Regulations], for a list of National Register criteria). Designed by San Francisco architect Thomas Patterson Ross, it combines elements of the Gothic Revival and Richardsonian Romanesque styles. Built in 1904, it also represents an early use of structural concrete.

Historical Resources in the Record Search Area, but Outside the Architectural C-APE

In addition to identifying known resources within the C-APE, it is useful for historians/architectural historians to identify nearby resources, even though they are outside the architectural C-APE and would not be impacted by the Project, to assist in designing the field survey strategy and in providing an understanding of the physical and historical context for the resources within the APE. The historical resources listed in Table 5.5-5 (Historical Architectural Resources in the Record Search Area, but Outside the Architectural C-APE), were previously identified within a 0.25-mile record search radius around the architectural C-APE for eight of the proposed well facility sites, but are located outside the limits of the architectural C-APE. These resources include two National Register-eligible buildings/structures, five National Register-eligible historic districts, two buildings listed in the California Inventory of Historical Resources, three buildings listed in the Office of Historic Preservation Historic Property Data File and one property listed as a California Landmark. In addition, two cemeteries in the record search area were found to be ineligible as individual historic properties, but may be eligible as contributors to a cemetery district that would include pre-mid-twentieth century cemeteries in the Town of Colma that retain their integrity. To date, such a district has not been formally proposed or evaluated.

Table 5.5-5 provides the name and federal, State and local listing status of each resource and the closest well facility sites. The designation in parenthesis following the name of the resources is the State Office of Historic Preservation Historic Property Data File number.

TABLE 5.5-5
Historical Architectural Resources in the Record Search Area, but Outside the Architectural C-APE

Well Facility Site Area	Resource Name	National/California Register Status
Site 7 Area	Italian Cemetery District (P-41-001708)	National Register-eligible district
Site 7 Area	Eternal Home Cemetery (P-41-001723)	Not individually eligible for the National or California registers, but may be eligible as a contributor to a Colma cemetery district
Site 7 Area	Salem Memorial Park (P-41-000402)	Not individually eligible for the National or California registers, but may be eligible as a contributor to a Colma cemetery district
Sites 8 &17 (Alternate) Area	Salem Memorial Park Office Building (P-41-001659)	National Register-eligible building
Sites 8 & 17 (Alternate) Area	Cypress Lawn Memorial Park District (P-41-001750)	National Register-eligible district
Sites 8 & 17 (Alternate) Area	Holy Cross Cemetery District (P-41-001778)	National Register-eligible district
Sites 8 & 17 (Alternate) Area	Home of Peace Cemetery/Hills of Eternity Memorial Park District (P-41-001724)	National Register-eligible district
Site 9 Area	The Lagomarsino Farm District (P-41-00396)	National Register-eligible district
Site 11 Area	W. J. Martin Home	Listed in the California Inventory of Historical Resources
Site 11 Area	Twelve Mile House	Listed in the California Inventory of Historical Resources
Site 11 Area	1053 Grand Avenue (Residence)	Listed in the Office of Historic Preservation Historic Property Data File (significant at the local level)

TABLE 5.5-5
Historical Architectural Resources in the Record Search Area, but Outside the Architectural C-APE

Well Facility Site Area	Resource Name	National/California Register Status
Site 11 Area	Santa Cristo Hall (Community Hall)	Listed in the Office of Historic Preservation Historic Property Data File
Site 11 Area	Lux Kitchen/Weiss Home	Listed in the Office of Historic Preservation Historic Property Data File
Site 13 Area	Arched Cut Stone Bridge/Culvert (P-41-000309	National Register-eligible structure
Sites 14 & 15 Area	The site of the Tanforan Assembly Center	California Landmark 934

Field Survey Results

As a result of the field survey, Carey & Co. identified 13 historic architectural resources within architectural C-APEs that required further research and evaluation. The associated architectural C-APE/closest well facility site, address, name (where applicable), construction year for each resource is provided in Table 5.5-6 (Additional Architectural Resource Identified During Field Surveys), along with the National Register and California Register evaluation. The properties were evaluated for their association with significant events, people and architectural importance; as well as for having the potential to yield information important in prehistory or history. Detailed discussion of evaluation criteria for California Register and National Register follows in Section 5.5.2 (Regulatory Framework).

TABLE 5.5-6
Additional Architectural Resources Identified During Field Surveys

Closest Well Facility Site/ Architectural C-APE	Address of Resource	Name of Resource	Year Constructed	National/California Register Evaluation
Site 5	160 B Street, Daly City	Unnamed residential structure	1925	Not Eligible
Site 7	1000 El Camino Real, Colma	Woodlawn Memorial Park	1904	Gatehouse Entry individually eligible for the National Register and California Register. Memorial Park would be eligible as a contributor to a potential Colma historic cemetery district
Site 7	1100 El Camino Real, Colma	Greenlawn Memorial Park	1903	Would be eligible as a contributor to a potential Colma historic cemetery district
Site 7	1148 El Camino Real, Colma	Greek Orthodox Memorial Park	1934	Would be eligible as a contributor to a potential Colma historic cemetery district
Site 9	1700 El Camino Real, South San Francisco	Treasure Island Mobile Home Park	c. 1939	Not Eligible
Sites 10 & 18 (Alternate)	772 Del Monte Avenue, South San Francisco	Unnamed residential structure	1953	Not Eligible
Sites 10 & 18 (Alternate)	776 Del Monte Avenue, South San Francisco	Unnamed residential structure	1953	Not Eligible
Sites 10 & 18 (Alternate)	780 Del Monte Avenue, South San Francisco	Unnamed residential structure	1953	Not Eligible
Sites 10 & 18 (Alternate)	784 Del Monte Avenue, South San Francisco	Unnamed residential structure	1953	Not Eligible

TABLE 5.5-6
Additional Architectural Resources Identified During Field Surveys

Closest Well Facility Site/ Architectural C-APE	Address of Resource	Name of Resource	Year Constructed	National/California Register Evaluation
Sites 12 & 19 (Alternate)	321 Fairway Drive, South San Francisco	Unnamed residential structure	1942	Not Eligible
Sites 12 & 19 (Alternate)	609 Southwood Drive, South San Francisco	Our Redeemer's Lutheran Church	1955	Not Eligible
Sites 14 & 15	1300 Sneath Lane, San Bruno	Golden Gate National Cemetery (GGNC)	1937-1941	Already formally determined eligible for the National Register and California Register
Sites 14 & 15	54 Greenwood Drive, South San Francisco	Unnamed residential structure	1948	Not Eligible

Source: Carey & Co. 2011b

Of the resources listed in Table 5.5-6, the Gatehouse Entry at Woodlawn Memorial Park appears to be individually eligible for the National Register and California Register, and the Memorial Park itself would be eligible as a contributor to a potential Colma historic cemetery district. The GGNC has already been determined eligible for the National and California Registers. Greenlawn Memorial Park and Greek Orthodox Memorial Park would be eligible as contributors to a potential historic Colma historic cemetery district. The other nine resources listed in Table 5.5-6 do not appear to be eligible for the National Register or the California Register either individually or as contributors to a potential historic district.

The following provides a description and California Register and National Register evaluations for these four National/California Register eligible and potentially eligible resources. Descriptions and evaluations for the other nine resources listed in Table 5.5-6 are contained in the report titled *Historic Architectural Resources Technical Report for the Regional Groundwater Storage and Recovery Project, San Mateo County, California* (Carey & Co. 2011b).

Resource Description and Evaluation

Site 7

1000 El Camino Real, Woodlawn Memorial Park, Colma (1904)

Description: A monumental, rusticated gray stone building designed in a neo-Gothic, Richardsonian Romanesque style divides the entrance drive off El Camino Real from the mortuary grounds at Woodlawn Memorial Park. The building divides into six parts. At the southern end stands a two-story building with a steeply slanted hipped roof and gable dormer. Full-height rounded turrets mark the northern and southern corners of the east (primary) façade. To the north, a massive Roman arch flanked by two smaller Roman arches, connects the southern structure to a central tower. The Roman arches and neo-Gothic building to the north of the tower mirror those to the south. A single-story, flat-roof addition with square windows extends to the north.

Beyond the gates, a series of broad, winding pathways guide visitors around the gently sloping cemetery grounds. Vast expanses of lawn dotted with funeral monuments fill the spaces between the pathways. Two identical, mid-century modernist mausoleums stand at the summit of the cemetery grounds. Directly to their east, a stone wall surrounds The Pillars of Peace, four ionic columns with a shared cornice. A Mission Bell marking the El Camino Real route through the State also stands on the eastern edge of the cemetery grounds, towards its northern boundary along El Camino Real.

Evaluation: Preliminary research indicates that Woodlawn Memorial Park hosts a number of historic figures who are significant to the history of San Francisco, the State and the nation. If further research was undertaken to identify persons buried in the cemetery and it was determined that multiple people of transcendent importance were buried at Woodlawn, the site could be included in the National Register[6].

The Gatehouse Entry at Woodlawn Memorial Park appears to be individually significant under California Register Criterion 3 and National Register Criterion C. Multiple master architects designed the entrance gates to Woodlawn Memorial Park, which stand out as unique in Colma and as excellent examples of both early twentieth century Richardsonian Romanesque architecture, as well as a modernist adaptation of this style. T. Patterson Ross designed the original chapel, arch, offices and tower, while Bernard Maybeck and William Gladstone Merchant designed the northern arch and offices that mirror Ross's design. Merchant and Maybeck also designed the modernist northern addition to the building. The distinguished architecture and its association with master architects render it individually eligible for the California Register and the National Register. The period of significance of the entrance gates ranges from 1904 when it was constructed to 1950 when the last addition was completed. This encompasses all three master architects work on the structure. The building's character-defining features include rusticated gray stone, steeply pitched roofs, round turrets and narrow arched stained glass windows. The character-

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[6] The potential National Register eligibility of Woodlawn Memorial Cemetery would be under Criterion A, if sufficient evidence supported the conclusion that it is the burial place of persons of transcendent importance.

defining features of the modernist additions to the building are stucco or stone cladding, flat roofs and large windows.

For a historical resource to be considered eligible for the California Register and the National Register, it must retain sufficient integrity to express its significance. Neither the entrance gates nor the grounds have moved and a landscape dominated by other cemeteries still surrounds them. Thus, Woodlawn Memorial Park retains its integrity of location and setting. The property continues to be used as a cemetery, with the entrance building still serving as a gate, administrative offices and a chapel. Thus, the property retains its integrity of association. New mortuary architecture has been added to the landscape over time, including two mid-century modernist mausoleums, and the landscaped grounds have grown in size, but such changes are germane to cemeteries. Thus, the landscape retains excellent integrity of design. The entrance gates have undergone significant additions, but these were both designed by master architects and have achieved significance in their own right. Thus, the building retains integrity of design, materials and workmanship. Woodlawn Memorial Park appears to retain sufficient integrity to express its historical significance.

If the Colma Cemetery Historic District is established, Woodlawn Memorial Park may be eligible for the California Register, under Criterion 1, as a contributor to the District because of its role in the interrelated histories of the City of San Francisco and Town of Colma and the discrete theme of cemeteries in the Town of Colma. At this time the potential historic district has not been fully identified. The landscape's architecture of the cemetery is not distinguished, but it would, together with the other cemeteries in the area, contribute to a potential district under Criterion 3 of the California Register of Historical Resources.

1100 El Camino Real, Greenlawn Memorial Park, Colma (1903)

Description**:** Colma Boulevard runs east-west through Greenlawn Memorial Park from El Camino Real towards Junipero Serra Boulevard. Only a small, flat patch of the cemetery occupies the area to the north of Colma Boulevard; the gently sloping hill of the cemetery grounds is located mostly to the south. Vast expanses of lawn dominate the landscape, which has a simple road pattern and mostly flat headstones or headstones of modest height. The cemetery features a small number of family crypts. At the end of the first road that runs south from Colma Boulevard stand two buildings. The smaller of the two is a single-story office building with a flat roof, stucco cladding and large metal sash windows. Immediately to its east is a mausoleum, also single-story in height with stucco cladding and a shed roof that slopes to the south. The entrance and two windows that flank it feature a lancet arch and fixed metal windows comprise the entirety of the stepped-back wall to the east of the entrance.

Evaluation: If the Colma Cemetery Historic District is established, Greenlawn Memorial Park may be eligible for the California Register as a contributor to the District because of its role in the interrelated histories of the City of San Francisco and Town of Colma and the discrete theme of cemeteries in the Town of Colma. Greenlawn Memorial Park may be eligible under Criteria 1 and 3 for the California Register as a contributor to a potential Colma Cemetery Historic District. The landscape architecture of the cemetery is not distinguished, but it would, together with the other cemeteries in the area, contribute to a potential district under Criterion 3 of the California Register. The property appears to be eligible for the National Register under Criteria A and C as part of a potential historic district.

1148 El Camino Real, Greek Orthodox Memorial Park, Colma (1934)

Description: Greek Orthodox Memorial Park is L-shaped in plan and characterized by low headstones on open expanses of lawn. The cemetery's chapel is a single-story gable building with stucco cladding and topped by a small dome. A flat-roofed, full-length addition extends to the south and houses administrative offices. A large mausoleum also stands towards the southern end of the grounds. It is an open-air compound of eight rectangular buildings with flat roofs and stucco siding. They step down with the hillside and form a central courtyard.

Evaluation: If the Colma Cemetery Historic District is established, the Greek Orthodox Memorial Park may be eligible for the California Register as a contributor to the District because of its role in the interrelated histories of the City of San Francisco and Town of Colma and the discrete theme of cemeteries in the Town of Colma. The Greek Orthodox Memorial Park may be eligible under Criterion 1 as a contributing property to a potential Colma Cemetery Historic District. The landscape architecture of the cemetery is not distinguished, but it would, together with the other cemeteries in the area, contribute to a potential district under Criterion 3 of the California Register. The property does appear to be eligible for the National Register under Criteria A and C as part of a potential historic district.

Sites 14 and 15

1300 Sneath Lane, Golden Gate National Cemetery, San Bruno (1937-1941)

Description: GGNC is a nearly 162-acre historic designed landscape. It is L-shaped in plan with asphalt-covered roads planned in a large grid, except at the southwest corner, where the road spirals up a hill to a flagpole monument, which provides unobstructed, panoramic views. The cemetery has three groups of buildings or structures: the entrance gates, chapel maintenance building, and office/superintendent's residence in the southwest corner, at the corner of Sneath Lane and I-280; a maintenance yard located off Sneath Lane, along the eastern arm of the cemetery; and the aforementioned flagpole monument also at the southwest corner of the cemetery. A concrete bridge with stone facing spans a gully in the landscape to the east of the flagpole monument. Headstones are uniformly white and just over two feet in height, except for headstones along the flagpole monument hill, and those along the perimeter fence, which are flat and flush with the grass. . Wrought iron fencing with periodic concrete columns encloses a portion of the cemetery, with chain link fencing around the remaining perimeter.

The Mediterranean Revival Style entrance gates, completed on May 15, 1941, are comprised of three parts, – two grand arches flanking a central post – with wrought-iron gates spanning the distance between the three separate sections. The three parts are constructed of California granite.

The office/superintendent's residence and chapel/maintenance building are also identical in style and plan. The Mediterranean Revival structures, completed on May 15, 1941, are single-story buildings with clay tile covered hipped roofs. California granite veneer clads the hexagonal portion of the buildings, while stucco clads the remaining exterior walls. Primary windows are multi-lite casement. A segmental archway with a scroll keystone distinguishes the entrance to both the chapel and the office. The eastern end of the office building is residential; it features a rounded archway entrance and an exterior, stucco-clad chimney. Alterations to the office/superintendent's residence occurred during 1966 and 1979 and focused on the residential portion of the building; the original windows were replaced with metal sliders, the porch was enclosed, storm doors were installed, and a private yard off the rear of the building was enclosed. Alterations to the chapel/maintenance building are limited to the installation of storm windows.

The maintenance yard located on Sneath Lane includes three Mediterranean style buildings. All three buildings are one-story in height, rectangular in plan, with clay tile clad hipped roofs and stucco cladding. A concrete wall connects the three buildings and encloses the yard.

Constructed in 1952, the northwest building is comprised of three parts – a center gable section flanked by hipped roof wings. Multi-lite fixed and awning metal windows in a variety of configurations are found on each elevation. The center section, facing the interior yard, features three bays with large fixed multi-lite casement windows which were replaced in 2007. The second building, constructed in 1957 and closest to Well Facility Site 15, has a hip roof and seven identical bays facing the yard with new multi-lite metal garage doors. Both buildings were constructed of concrete block and clad in stucco with simple detailing. The third building, constructed in 2007, functions as a garage and matches the other two structures in style.

Located near the maintenance yard is a secondary entrance to the cemetery. Two large concrete posts, constructed in 1941 and finished in stucco mark this entrance. Arched wrought-iron vehicular gates span these posts. West along Sneath Lane is an identical entrance with stuccoed finished posts and wrought-iron gates. This entrance, constructed in 1941, has been permanently closed with small native shrubs planted along the Sneath side.

The focal point of the cemetery is Flagpole Circle, which is 195 feet in diameter and rises above the surrounding landscape. Atop the manmade mound is a circular monument constructed of California granite. Three sets of steps lead from a paved area to the octagonal granite base which supports the large flagpole. Native plantings surround Flagpole Circle.

North of Flagpole Circle, low, rolling hills are full of rows of perfectly aligned headstones with trees interspersed. An asphalt loop, divided by three intersecting roads, dissects the landscape. East of Flagpole Circle is a gully, which is spanned by a concrete reinforced bridge clad in Raymond Gray Granite. The single-arch bridge, completed in 1942, leads directly down the middle of the cemetery's east leg. Numerous cemetery roadways cut through the relatively flat terrain of the east leg.

Two SFPUC easements run through the property. Pipelines that were laid well before construction of GGNC run through the property in these easements, and at these locations no burials have occurred. The easement within which Well Facility Site 14 is located has two belowground pipelines which were constructed in 1928 and 1979. The easements run from Sneath Lane, south of the cemetery, to the Brentwood neighborhood in the north. Within these easements are various pipes and concrete vaults, most of which are set close to the ground.

<u>Evaluation</u>: The Keeper of the National Register previously deemed Golden Gate National Cemetery eligible for listing in the National Register of Historic Places in 1977. It is deemed nationally significant for its association with the expansion of the National Cemetery System during the period between World War I and World War II. The National Register nomination form states "Continuing and expanding upon

memorial efforts established during the Civil War and the first national cemeteries, [this] inter-war cemetery [is a] symbolic display of the continuing sacrifices of the U.S. military" (VA n.d.). Therefore, because GGNC was determined eligible for listing in the National Register, it is eligible for listing in California Register, but as of now is not listed in either register. It is significant under Criterion 1 of the California Register for its association with events that have made a significant contribution to the broad patterns of California's history and cultural heritage. GGNC will be formally nominated for listing in the National Register as a historic district (NPS 2011).

According to the National Register Eligibility of National Cemeteries – A Clarification of Policy:

> National cemeteries regardless of the date of acquisition or construction, the overall acreage within the boundaries of the national cemetery that has been developed for cemetery purposes is considered one contributing site for National Register purposes. The site includes commemorative sections of the cemetery containing existing graves and memorials, sections having the infrastructure necessary to receive new interments and memorials (for example, streets, utilities, pre-placed crypts, columbaria, and memorial walkways), and areas of the cemetery developed for administrative and maintenance purposes (offices, restrooms, garages, and maintenance yards). [….] Certain smaller-scale features, such as grave markers, street signs, water fountains, curbs and culverts, and plantings are considered integral to the overall contributing site and its identity as a national cemetery (NPS 2011).

Therefore, all built environment features and the designed landscape within GGNC are considered contributing elements to the district.

Character-Defining Built Environment and Landscape Features of the GGNC

Character-defining features refer to distinct aspects of design, style, materials, or qualities of a historic property that contribute to the physical character of the site. Architecturally the GGNC site is defined by one-story structures, the majority with low-sloped hipped roofs. Cladding materials of the structures include stucco and granite. Red clay tile is found on the low sloping roofs and roofs with overhangs have detailed wood rafter tails. Most buildings have multi-lite windows. The buildings near the entrance feature more detail and multiple wall cladding materials, while the structures in the maintenance yard have very little detail and a single wall cladding material (i.e., stucco). Buildings on the site are near the edge of the property and are clustered around primary and secondary gates.

The prominent landscape feature of the site is the rows of perfectly aligned marble headstones, which stand two feet tall among the neatly manicured grass. Grass covers the majority of the acreage. Interspersed among the headstones are varieties of native and non-native trees including Monterey pines, eucalyptus, California *myoporum*, and Monterey cypress and other deciduous, evergreens and palms. Hedges of small trees and shrubs line the fences along the property's edge, Flagpole Circle and the maintenance yard. Annual and perennial flowers are planted around the main entry gate. The rows of headstones are transected by a system of paved roads that allow access to various parts of the cemetery. A quarter-round concrete curb lines the paved roads. The property is partly enclosed by wrought-iron fencing punctuated by stucco posts with limestone hipped caps; and in some locations decorative stucco walls with a curved top and an oval cutout stand between two posts. More detailed posts mark secondary entrances to the cemetery and a three-part granite gate marks the main entry to the site. Flagpole Circle is the only feature on the cemetery land that is taller than a one-story structure. Together, the previously mentioned built environment and landscape features define the character of Golden Gate National Cemetery.

Historical Contacts

The San Francisco Planning Department sent letters on July 10, 2009 to the following local historical societies and museums in San Mateo County: Colma Historical Association and Museum, Historical Society of South San Francisco, History Guild of Daly City-Colma, Millbrae Historical Society and San Mateo County History Museum, describing the Project and requesting information about known architectural or archaeological resources at the facility sites.

Sylvia Payne with the South San Francisco Historical Society contacted Diana Sokolove, San Francisco Planning Department, on July 14, 2009. Ms. Payne stated that she is unaware of any archaeological or architectural resources of significance in the Project study area. Dana Neitzel, curator of the San Mateo County Historical Association, emailed Diana Sokolove on July 21, 2009, to inform her that the Association does have relevant research materials on file. Carey & Co. visited this facility and reviewed the materials. No other responses have been received to date.

5.5.2 Regulatory Framework

5.5.2.1 Federal Regulations

National Historic Preservation Act

Cultural resources are protected through the National Historic Preservation Act (NHPA) of 1966, as amended (16 USC 470f), and its implementing regulations. Before a federal agency can engage in an "undertaking," Section 106 of the NHPA requires the agency – as the "lead agency" – to consider the effects of the undertaking on historic properties (i.e., properties listed in or eligible for listing in the National Register) and to afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on the undertaking.

Federal review of undertakings is referred to as the "Section 106 process." This process is the responsibility of the federal lead agency. The Section 106 review typically involves a four-step procedure, which is described in detail in the implementing regulations (36 CFR 800):

- Identify historic properties in consultation with the State Historic Preservation Officer (SHPO) and interested parties;
- Assess the effects of the undertaking on historic properties;

- Consult with the SHPO, other agencies, and interested parties to develop an agreement that addresses the treatment of historic properties and notify the Advisory Council on Historic Preservation; and
- Proceed with the project according to the conditions of the agreement.

National Register of Historic Places

Under the NHPA, a property is considered significant if it meets the National Register listing criteria at 36 CFR 60.4, as stated below:

The quality of significance in American history, architecture, archaeology, engineering and culture is present in districts, sites, buildings, structures and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association and that:

a) Are associated with events that have made a significant contribution to the broad patterns of our history; or

b) Are associated with the lives of persons significant in our past; or

c) Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

d) Have yielded, or may be likely to yield, information important in prehistory or history.

For a property to qualify under one or more of these Criteria for Evaluation, it must also retain "historic integrity of those features necessary to convey its significance." While a property's significance relates to its role within a specific historic context, its integrity refers to the "property's physical features and how they relate to its significance." To determine if a property retains the physical characteristics corresponding to its historic context, the National Register has identified seven aspects of integrity: location, design, setting, materials, workmanship, feeling, and association (DOI 1997).

In addition to the Criteria for Evaluation, the National Register maintains a list of property types or circumstances that generally do not qualify for the National Register. These are: cemeteries, birthplaces or graves of historical figures; properties owned by religious institutions or used for religious purposes; structures that have been moved from their original locations; reconstructed historic buildings; properties primarily commemorative in nature; and properties that have achieved significance within the past 50 years.

However, the National Register also provides for special consideration if a property described above is either an "integral" contributor to a district that qualifies under the Criteria for Evaluation or one of the following:

a) A religious property deriving primary significance from architectural or artistic distinction or historical importance; or

b) A building or structure removed from its original location but which is significant primarily for architectural value, or which is the surviving structure most importantly associated with a historic person or event; or

c) A birthplace or grave of a historical figure of outstanding importance if there is no appropriate site or building directly associated with his or her productive life; or

d) A cemetery which derives its primary significance from graves of persons of transcendent importance, from age, from distinctive design features, or from association with historic events; or

e) A reconstructed building when accurately executed in a suitable environment and presented in a dignified manner as part of a restoration master plan, and when no other building or structure with the same association has survived; or

f) A property primarily commemorative in intent if design, age, tradition, or symbolic value has invested it with its own exceptional significance; or

g) A property achieving significance within the past 50 years if it is of exceptional importance (DOI 1997).

5.5.2.2 State Regulations

California Environmental Quality Act

CEQA, as codified in California Public Resources Code (PRC) Section 21000, et seq., is the principal statute governing the environmental review of projects in the State. CEQA requires lead agencies to determine if a proposed project would have a significant effect on historical resources and unique archaeological resources. The CEQA Guidelines define a historical resource as: (1) a resource listed in the California Register; (2) a resource included in a local register of historical resources, as defined in PRC Section 5020.1(k), or identified as significant in a historical resource survey meeting the requirements of PRC Section 5024.1(g); or (3) any object, building, structure, site, area, place, record, or manuscript that a lead agency determines to be historically significant or significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political, military, or cultural annals of California, provided the lead agency's determination is supported by substantial evidence in light of the whole record.

If a lead agency determines that an archaeological site is a historical resource, the provisions of PRC Section 21084.1 and CEQA Guidelines Section 15064.5 would apply. If an archaeological site does not meet the CEQA Guidelines criteria for a historical resource, then the site may meet the threshold of PRC Section 21083 regarding unique archaeological resources. A unique archaeological resource is an archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

- Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information;
- Has a special and particular quality, such as being the oldest of its type or the best available example of its type; or
- Is directly associated with a scientifically recognized important prehistoric or historic event or person (PRC Section 21083.2[g]).

The CEQA Guidelines note that if a resource is neither a unique archaeological resource nor a historical resource, the effects of a project on that resource shall not be considered a significant effect on the environment (CEQA Guidelines Section 15064[c][4]).

California Register of Historical Resources

The California Register is "an authoritative listing and guide to be used by state and local agencies, private groups and citizens in identifying the existing historical resources of the state and to indicate which resources deserve to be protected, to the extent prudent and feasible, from substantial adverse change" (PRC Section 5024.1[a]). The criteria for eligibility to the California Register are based on National Register criteria (PRC Section 5024.1[b]). Certain resources are determined by the statute to be automatically included in the California Register, including California properties formally determined eligible for or listed in the National Register.

To be eligible for the California Register as a historical resource, a prehistoric or historic-period resource must be significant at the local or State level under one or more of the following criteria:

1) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage;
2) Is associated with the lives of persons important in our past;
3) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values; or
4) Has yielded, or may be likely to yield, information important in prehistory or history (CEQA Guidelines Section 15064.5 [a][3]).

For a resource to be eligible for the California Register, it must also retain enough integrity to be recognizable as a historical resource and to convey its significance. The seven aspects of integrity are: location, design, setting, materials, workmanship, feeling and association. A resource that does not retain sufficient integrity to meet the National Register criteria may still be eligible for listing in the California Register. A resource that has lost its historic character or appearance may still have sufficient integrity for the California Register if it maintains the potential to yield significant scientific or historical information or specific data (OHP 2011).

California's list of special considerations is shorter than the criteria considerations for the National Register listed above. It includes some allowances for moved buildings, structures, or objects, as well as requirements for proving the significance of resources that are less than 50 years old and discussion of the eligibility of reconstructed buildings. Additionally, unlike the criteria considerations for the National Register, cemeteries do not come under the scrutiny of special considerations for the California Register. In addition to separate evaluations for eligibility for the California Register, the State automatically lists in the California Register resources that are listed or formally determined eligible for the National Register.

California Public Resources Code

As part of the determination made pursuant to PRC Section 21080.1, the lead agency must determine whether a project would have a significant effect on archaeological and paleontological resources.

Several sections of the PRC protect cultural resources and PRC Section 5097.5 protects vertebrate paleontological sites located on public land. Under Section 5097.5, no person shall knowingly and willfully excavate upon, or remove, destroy, injure, or deface, any historic or prehistoric ruins, burial grounds, archaeological or vertebrate paleontological site (including fossilized footprints), inscriptions made by human agency, rock art, or any other archaeological, paleontological, or historical feature situated on public lands, except with the express permission of the public agency that has jurisdiction over the lands. Violation of this section is a misdemeanor.

PRC Section 5097.98 states that if Native American human remains are identified within a project area, the landowner must work with the Native American Most Likely Descendant as identified by the NAHC to develop a plan for the treatment or disposition of the human remains and any items associated with Native American burials with appropriate dignity. These procedures are also addressed in Section 15046.5 of the CEQA Guidelines. California Health and Safety Code Section 7050.5 prohibits disinterring, disturbing, or removing human remains from a location other than a dedicated cemetery. Section 30244 of the PRC requires reasonable mitigation for impacts on paleontological and archaeological resources that occur as a result of development on public lands.

California Health and Safety Code

California Health and Safety Code Section 7050.5 regulates the treatment of human remains. In the event of discovery or recognition of any human remains in any location other than a dedicated cemetery, there shall be no further excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent remains until the coroner of the county in which the human remains are discovered has determined that the remains are not subject to his or her authority. If the coroner recognizes the human remains to be those of a Native American, or has reason to believe that they are those of a Native American, he or she shall contact the NAHC by telephone within 24 hours.

5.5.2.3 *Local Regulations*

San Francisco Historic Preservation Commission and Planning Code, Articles 10 and 11

The San Francisco Historic Preservation Commission is a seven-member body that makes recommendations on the designation of landmark buildings, historic districts and significant buildings within the CCSF. The Historic Preservation Commission replaces and retains most of the responsibilities of the Landmarks Preservation Advisory Board (Landmarks Board). The Landmarks Board was a nine-member body appointed by the Mayor that served as an advisory board to the San Francisco Planning Commission and San Francisco Planning Department. The Landmarks Board was established in 1967 with the adoption of Article 10 of the Planning Code. The work of the Landmarks Board, San Francisco Planning Department and San Francisco Planning Commission has increased public awareness about the need to protect the CCSF's architectural, historical and cultural heritage.

The Historic Preservation Commission makes recommendations to the San Francisco Board of Supervisors on landmark designations, historic district designations and individual resource designations within historic districts. The Commission may also review and comment on projects affecting historical resources that are subject to environmental review under CEQA or projects subject to review under Section 106 of the NHPA. The Commission also approves Certificates of Appropriateness for Landmarks and properties within Article 10, Historic Districts (explained below).

The State Office of Historic Preservation has included the CCSF on its list of Certified Local Governments, which means that San Francisco has an approved historic preservation ordinance, Historic Preservation Commission and other formal processes related to historic preservation and cultural resources management. CCSF reviews the historical resources designated under Articles 10 and 11 of the San Francisco Planning Code when it evaluates project impacts on historical resources within the CCSF. Article 10 describes procedures regarding the preservation of sites and areas of special character or special historical, architectural, or aesthetic interest or value, such as officially designated city landmarks and buildings included within locally designated historic districts.

Article 11 of the Planning Code designated six downtown conservation districts. There are no CCSF-designated landmarks or properties that contribute to designated historic districts in the Project C-APEs.

5.5.3 Impacts and Mitigation Measures

5.5.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on cultural and paleontological resources if it were to:

- Cause a substantial adverse change in the significance of a historical resource as defined in CEQA Guidelines Section 15064.5, including those resources listed in Article 10 or Article 11 of the San Francisco Planning Code;
- Cause a substantial adverse change in the significance of a unique archaeological resource pursuant to Section 15064.5;
- Directly or indirectly destroy a unique paleontological resource or site or unique geological feature; or
- Disturb any human remains, including those interred outside of formal cemeteries pursuant to California Health and Safety Code Section 7050.5.

5.5.3.2 Approach to Analysis

There would be potential for the Project to adversely affect cultural resources in both the construction and operational phases. Ground disturbance and excavation during construction activities could disturb or destroy known and previously unrecorded buried cultural resources, including archaeological and paleontological resources and human remains. Project operations would not cause additional ground disturbance, and thus would not result in impacts to archaeological or paleontological resources, or human remains. However, the permanent physical presence of aboveground Project elements could adversely change the context or integrity of a historical resource, thereby affecting its significance. The permanent physical changes resulting from the Project are addressed in Section 5.5.4 (Operational Impacts and Mitigation Measures).

Architectural Resources

Potential impacts on historic architectural resources were assessed by determining whether proposed Project activities and facilities could cause a substantial adverse change in the significance of any such resources within the architectural C-APE. A substantial adverse change in the significance of a historic architectural resource means "physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of the historical resource would be materially impaired" (CEQA Guidelines Section 15064.5[b][1]). A historic architectural resource can be materially impaired through demolition or alteration of the resource's physical characteristics that convey its historical significance and that justify its inclusion in the California Register (CEQA Guidelines Section 15064.5[b][2][A]). For Sites 14 and 15, which are located on federal land and therefore subject to the National Historic Preservation Act, potential impacts on historic architectural resources were assessed by determining whether proposed Project activities and facilities could alter, directly or indirectly, any of the characteristics of the property that qualify it for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association (36 CFR 800.5[1]).

Archaeological Resources

The significance of most prehistoric and historic-period archaeological sites is usually determined based on National Register Criterion D and/or California Register Criterion 4, presented above. This criterion stresses the importance of the information potential contained within the site rather than its significance as a surviving example of a type or its association with an important person or event. Archaeological resources may also be assessed under CEQA as unique archaeological resources, defined as archaeological artifacts, objects, or sites that contain information needed to answer important scientific research questions.

Paleontological Resources

For this analysis, "unique paleontological resource" is deemed to include resources that qualify as significant under SVP criteria (see Section 5.5.1.2 [Paleontological Setting]). Potential Project effects on paleontological resources are limited to construction-related disturbance and are discussed below under Impact CR-3. Operation of the proposed Project would not result in impacts on paleontological resources.

Human Remains

Human remains, including those buried outside of formal cemeteries, are protected under several State laws, including PRC Section 5097.98 and Health and Safety Code Section 7050.5. Impacts include intentional disturbance, mutilation, or removal of interred human remains.

5.5.3.3 Summary of Impacts

Table 5.5-7 (Summary of Impacts – Cultural and Paleontological Resources), lists the proposed Project's cultural and paleontological impacts and significance determinations.

TABLE 5.5-7
Summary of Impacts – Cultural and Paleontological Resources

	Construction				Operations	Cumulative
Site	**Impact CR-1: Project construction could cause an adverse change in the significance of a historical resource.**	**Impact CR-2: Project construction could cause an adverse change in the significance of an archaeological resource.**	**Impact CR-3: Project construction could result in a substantial adverse effect by destroying a unique paleontological resource or site.**	**Impact CR-4: Project construction could result in a substantial adverse effect related to the disturbance of human remains.**	**Impact CR-5: Project facilities could cause an adverse change in the significance of a historical resource.**	**Impact C-CR-1: Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains.**
Site 1	NI	LSM	LSM	LSM	NI	LSM
Site 2	NI	LSM	LSM	LSM	NI	LSM
Site 3	NI	LSM	LSM	LSM	NI	LSM
Site 4	NI	LSM	LSM	LSM	NI	LSM
Westlake Pump Station	NI	NI	NI	NI	NI	NI
Site 5 (Consolidated Treatment and On-site options)	NI	LSM	LSM	LSM	NI	LSM
Site 6 (Consolidated Treatment and On-site options)	NI	LSM	LSM	LSM	NI	LSM

TABLE 5.5-7
Summary of Impacts – Cultural and Paleontological Resources

	Construction				Operations	Cumulative
Site	**Impact CR-1: Project construction could cause an adverse change in the significance of a historical resource.**	**Impact CR-2: Project construction could cause an adverse change in the significance of an archaeological resource.**	**Impact CR-3: Project construction could result in a substantial adverse effect by destroying a unique paleontological resource or site.**	**Impact CR-4: Project construction could result in a substantial adverse effect related to the disturbance of human remains.**	**Impact CR-5: Project facilities could cause an adverse change in the significance of a historical resource.**	**Impact C-CR-1: Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains.**
Site 7 (Consolidated Treatment and On-site options)	LS	LSM	LSM	LSM	LS	LSM
Site 8	NI	LSM	LSM	LSM	NI	LSM
Site 9	NI	LSM	NI	LSM	NI	LSM
Site 10	NI	LSM	LSM	LSM	NI	LSM
Site 11	NI	LSM	LSM	LSM	NI	LSM
Site 12	NI	LSM	LSM	LSM	NI	LSM
Site 13	NI	LSM	LSM	LSM	NI	LSM
Site 14	LSM	LSM	LSM	LSM	LSM	LSM
Site 15	LSM	LSM	LSM	LSM	LSM	LSM
Site 16	NI	LSM	LSM	LSM	NI	LSM
Site 17 (Alternate)	NI	LSM	LSM	LSM	NI	LSM

TABLE 5.5-7
Summary of Impacts – Cultural and Paleontological Resources

	Construction				Operations	Cumulative
Site	**Impact CR-1: Project construction could cause an adverse change in the significance of a historical resource.**	**Impact CR-2: Project construction could cause an adverse change in the significance of an archaeological resource.**	**Impact CR-3: Project construction could result in a substantial adverse effect by destroying a unique paleontological resource or site.**	**Impact CR-4: Project construction could result in a substantial adverse effect related to the disturbance of human remains.**	**Impact CR-5: Project facilities could cause an adverse change in the significance of a historical resource.**	**Impact C-CR-1: Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains.**
Site 18 (Alternate)	NI	LSM	LSM	LSM	NI	LSM
Site 19 (Alternate)	NI	LSM	LSM	LSM	NI	LSM

Note:

NI = No Impact

LS = Less than Significant

LSM= Less than Significant with Mitigation

5.5.3.4 Construction Impacts and Mitigation Measures

Impact CR-1: Project construction could cause an adverse change in the significance of a historical resource. (Less than Significant with Mitigation)

The evaluation that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts and sites with significant impacts.

<u>Sites 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

There were no historic-period resources identified at these sites; therefore, there would be *no impacts* to historical resources.

Impact Conclusion: No Impact

<u>Sites 7, 14, and 15</u>

Two historic-period architectural resources could be affected by proposed Project construction activities at Site 7 and at Sites 14 and 15: the Gatehouse Entry at Woodlawn Memorial Park (Site 7) and the GGNC (Sites 14 and 15). Both of these resources have been determined to be eligible for listing in the National Register and are, therefore, also eligible for listing on the California Register. As a result, they are considered historical resources for the purposes of CEQA evaluation. In addition, if a Colma Cemetery Historic District is established, Woodlawn Memorial Park may be eligible for the California Register and National Register as a contributor to the District for its role in the interrelated histories of the City of South San Francisco and Town of Colma and the discrete theme of cemeteries in the Town of Colma; the landscape's design would fit the character-defining features of the District.

Site 7

The Woodlawn Memorial Park Gatehouse Entry building is located approximately 500 feet to the north of Site 7. As noted above, the Woodlawn Gatehouse Entry was determined by the Town of Colma to be eligible for listing in the National Register under Criterion C, as it embodies the distinctive characteristics of an architectural type and method of construction. In general, the significance of architectural resources could be materially impaired by a project's construction through physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings. However, construction of the Project would not demolish, destroy, relocate, or physically alter this historical resource or its immediate surroundings. If the option to consolidate treatment at Site 6 were implemented, trenching for placement of a water pipeline from Site 7 to Site 6 would pass within approximately 180 feet of – and within view of – the Gatehouse Entry building. The presence of construction vehicles and equipment, as well as the disturbance of landscaped grounds by trenching, would be out of character with the resource. But, because trenching activities in the vicinity of the entryway would only take an estimated one week to complete (based on the proposed pipeline installation rate of 300 to 600 feet per week) and the trenching locations would be restored to their general pre-construction condition at the conclusion of construction, these temporary impacts would not cause an adverse change in the significance of this historical resource. Therefore, the impact on this historical resource would be *less than significant*.

Impact Conclusion: Less than Significant

Sites 14 and 15

The GGNC is eligible for listing in the National Register as a historic district under Criterion A for its association with the expansion of the National Cemetery System during the period between World War I and World War II. In general, the significance of an architectural historical resource could be materially impaired by a project's construction if the project involves physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings. Because all built environment features and the designed landscape within GGNC are considered contributing elements to the district, any damage or alteration of features within the cemetery, including buildings, landscape, or hardscape (e.g. roadways, curbs, and fencing) features would be considered significant impacts. For purposes of this evaluation, the entire GGNC is considered one historical resource, and all of the individual landscape and constructed features of the GGNC are elements of the resource that contribute to its significance. References to "the historical resource" pertain to the entire GGNC.

Site 14

Site 14 would be located within the SFPUC's easement near the northern property line of the GGNC. The easement is approximately 60 feet wide where the proposed well facility would be located. Rows of headstones, approximately two feet in height, are located to the east and west; the closest being five to 10 feet from the proposed well facility. The activities associated with construction of the well structure, the disturbance of landscaped grounds for trenching for the water line, storm drain, underground electrical equipment, and installation of grass pavers would potentially affect the historical resource. The presence of construction vehicles and equipment and their operation could damage or destroy nearby headstones, or otherwise have an adverse effect on the landscaped grounds by the loss of existing turf where the equipment would be traveling/operating. The staging area appears to be adequately separated from the headstones, but the storage of materials and other activities would adversely affect the landscaped grounds by damaging existing turf. Any impacts to the built environment features or designed landscape at the GGNC would constitute a significant impact. The construction activities associated with the proposed removal of the existing unused pump building, well, and tank would have the potential to affect the historical resource. The presence of construction vehicles and equipment and their operation could damage or destroy nearby headstones, or otherwise have an adverse effect on the landscaped grounds by damaging existing turf where the equipment would be traveling/operating. At this location, approximately eight headstones are within five to 10 feet of the pump building, which contributes to the possibility that they could be negatively affected by removal activities. Therefore, this potential impact is *significant*. The majority of the proposed water pipeline and storm drain between Sites 14 and 15 traverses a portion of the GGNC within the SFPUC easement. However, a segment of the pipeline would run along Sneath Lane next to the historic wrought-iron fence, masonry posts, and an unused secondary entrance, all of which were constructed at the edge of the cemetery between 1941 and 1942 and are contributing elements of the historical resource. The activities associated with construction of the water line and storm drain within the SFPUC easement would affect elements contributing to the historical resource, because the presence of construction vehicles and equipment and their operation could damage or destroy nearby headstones, or otherwise have an adverse effect on the landscaped grounds by the loss of existing turf upon which the construction vehicles/equipment would be traveling/operating. The perimeter wrought-iron fence and masonry posts face similar potential impacts during construction. Any impacts that would cause an adverse change in the significance of the GGNC due to pipeline construction would constitute a *significant* impact.

However, Mitigation Measure M-CR-1a (Minimize Construction-related Impacts to Elements of the Historical Resource at Site 14) would be implemented to mitigate the potential impacts from construction at Site 14, including pipelines. Implementation of this mitigation measure would minimize the potential construction impacts on the historical resource to *less-than-significant* levels by requiring the SFPUC and its contractors to implement physical and administrative measures to protect elements of the historical resource during construction. Therefore, this potential impact on historical resources would be *less than significant with mitigation*.

Mitigation Measure M-CR-1a: Minimize Construction-related Impacts to Elements of the Historical Resource at Site 14

The SFPUC and its contractor shall implement the following measures during construction at Site 14 to protect elements of the historical resource:

- The SFPUC shall lay plywood or other material down temporarily for access between the cemetery access road and the construction area during construction.
- Temporary protective barriers shall be constructed for protection of the headstones during construction, including those near the existing pump structure to be removed.
- Final plans and specifications shall be submitted to the VA prior to construction.
- Construction workers shall undergo a training program to be made aware of the importance of the site and the contributing elements of the historical resource that would be affected by the proposed work. The training program shall be approved by either a qualified historical architect or architectural historian.
- Through measurements and photographs, a historical architect shall document the roads and concrete curbs where trenching would occur. This documentation shall serve as a reference for replacing the curbs to match the existing curbs where removed for trenching. The SFPUC shall replace curbs removed for trenching with new curbs to match the existing curbs.
- Grass shall be restored where removed for trenching.

Site 15

Site 15 would be located along the southern property line of the cemetery between the GGNC operations and maintenance buildings and Sneath Lane. The area is approximately 40 feet wide where the proposed well facility would be located. In addition to the well facility, paving for parking would be installed next to the Cemetery's entry gate and maintenance yard.

Construction activities associated with the proposed well, well building, and concrete driveway, as well as trenching for placement of water lines, storm drain, and sanitary sewer have the potential to adversely affect elements that contribute to the GGNC's eligibility for listing in the National Register, including the 1952 maintenance complex and the 1940 entry gate. The presence of construction vehicles and equipment and their operation could inadvertently damage the nearby entrance gate and the southern maintenance building. Any impacts that would cause an adverse change in the significance of National Register-eligible properties would constitute a significant impact. As discussed previously, the construction of pipelines associated with Site 15 could impact elements of the historical resource because the presence of construction vehicles and equipment and their operation could damage or destroy nearby headstones, or otherwise materially impair the landscaped grounds by removing turf upon which the construction vehicles/equipment would be traveling/operating. The perimeter wrought-iron fence and masonry posts face similar threats during construction. Any impacts that would cause an adverse change in the significance of National Register-eligible properties due to pipeline construction would constitute a significant impact.

Construction activities for the proposed well facility at Site 15 could affect contributing elements of the historical resource, including the 1952 maintenance complex and the 1941 entry gate, because construction activities associated with the drilling and installation of the well could result in excessive vibrations, which would have the potential of damaging the nearby buildings and result in a *significant* impact. However, vibration studies have been conducted for this site (see Section 5.7, Noise and Vibration) and implementation of Mitigation Measure M-NO-2 (Reduce Vibration Levels during Construction of Pipelines) requires that the construction of pipelines within 25 feet of the structures near Site 15 use either non-vibratory means of compaction or controlled low strength materials (CLSM) as backfill so that compaction is not necessary thereby reducing significant vibration levels near the building to below 0.25 in/sec PPV (this threshold is discussed in detail in Section 5.7). Therefore, this impact would be *less than significant with mitigation*.

> ***Mitigation Measure M-NO-2: Reduce Vibration Levels during Construction of Pipelines (Sites 3, 4, 12, 15, and 18 [Alternate])***
> (See Impact NO-2 in Section 5.7, Noise and Vibration for a description)

Implementation of Mitigation Measure M-CR-1b (Minimize Construction-related Impacts on Elements of the Historical Resource at Site 15) would minimize impacts on historical resources to *less-than-significant* levels by requiring the SFPUC and its contractors to implement physical and administrative measures to protect elements of the historical resources during construction. Therefore, this potential impact on historical resources would be *less than significant with mitigation*.

Mitigation Measure M-CR-1b: Minimize Construction-related Impacts on Elements of the Historical Resource at Site 15

The SFPUC and its contractor shall implement the following measures during construction at Site 15 to protect elements of the historical resource:

- Temporary protective barriers shall be constructed for protection of the adjacent building to the north during construction.
- Final plans and specifications shall be submitted to the VA prior to construction.
- Construction workers shall undergo a training program to be made aware of the importance of the building adjacent to Site 15 and the contributing elements of the historical resource that would be affected by the proposed work. The training program shall be approved by either a qualified historical architect or architectural historian.
- Through measurements and photographs, a historical architect shall document the roads and concrete curbs where trenching would occur. This documentation shall serve as a reference for replacing the curbs to match the existing curbs where removed for trenching. The SFPUC shall replace curbs removed for trenching with new curbs to match existing. Grass shall be restored where removed for trenching

Impact Conclusion: Less than Significant with Mitigation

Impact CR-2: Project construction could cause an adverse change in the significance of an archaeological resource. (Less than Significant with Mitigation)

The evaluation that follows discusses sites with no impacts first, followed by sites with significant impacts.

<u>Westlake Pump Station</u>

There would be no ground disturbing activities at the Westlake Pump Station. All construction activities would occur within the existing pump station building. Therefore, there would be *no impact* on archaeological resources at this location.

Impact Conclusion: No Impact

<u>Sites 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 (Alternate), 18 (Alternate), and 19 (Alternate)</u>

No potentially California Register-eligible archaeological sites or unique archaeological resources were identified within any of the archaeological C-APEs for the Project and, given the results of the field surveys, extended archaeological surveys (EASs), and Native American contacts described in Section 5.5.1.5 (Archaeological Methods, Survey and Results), it is unlikely that undiscovered resources are present, either on or below the ground surface. However, at Site 11, despite the negative results of archaeological test investigations at the site, there is some potential that remnants of a known prehistoric archaeological site (CA-SMA-299) are located below the ground surface. Any impacts to this known resource would be *significant*. Nevertheless, implementation of Mitigation Measure M-CR-2 (Discovery of Archaeological Resources) would ensure immediate identification of the resource should it be encountered during construction, and would require the SFPUC and its contractors to adhere to appropriate procedures and protocols for minimizing impacts to the resource. Therefore, this potential impact on archaeological resources would be *less than significant with mitigation*.

Although Project construction would have no impact on known archaeological resources at the remaining sites and there is a low potential for the presence of previously unrecorded and buried (or otherwise obscured) archaeological resources, their presence cannot be entirely ruled out. Excavation, grading, and the movement of heavy construction vehicles and equipment could expose and disturb or damage any such previously unrecorded archaeological resources. Any such impacts on potentially California Register-eligible or unique archaeological resources would be *significant*. However, Mitigation Measure M-CR-2 (Discovery of Archaeological Resources) would be implemented during Project construction. Implementation of this measure would reduce impacts on any previously unrecorded and buried (or otherwise obscured) archaeological deposits to *less-than-significant* levels by requiring the SFPUC and its contractors to adhere to appropriate procedures and protocols for minimizing such impacts, in the event that a possible archaeological resource is discovered during construction activities associated with the Project. Therefore, this potential impact on archaeological resources would be *less than significant with mitigation*.

Mitigation Measure M-CR-2: Discovery of Archaeological Resources (All Sites except Westlake Pump Station)

Archaeological Monitoring Program. Despite the negative results of archaeological test investigations at Site 11, there is some potential that remnants of a known prehistoric archaeological site (CA-SMA-299) are located below the ground surface. Consequently, an archaeological monitoring plan shall be prepared and implemented for construction at Site 11. The monitoring plan shall specify the location and duration of monitoring activities and shall be subject to review by the Environmental Review Officer (ERO). The scope of the monitoring plan shall conform to MEA WSIP Archaeological Guidance No. 4.

Accidental Discovery. To avoid potential adverse effects on accidentally discovered archaeological resources, the SFPUC shall distribute the San Francisco Planning Department's archaeological resource "ALERT" sheet to: the Project prime contractor; any subcontractors (including firms subcontracted to perform demolition, excavation, grading, foundation, pile driving, etc.); and/or any utilities firm involved in soil-disturbing activities within the archaeological C-APE for each well facility site. Prior to any soil-disturbing activities, each contractor shall be responsible for ensuring that the ALERT sheet is circulated to all field personnel, including machine operators, field crew, pile drivers, supervisory personnel, etc. The SFPUC shall provide the ERO with a signed affidavit from the responsible parties (prime contractor, subcontractor(s), and utilities firm) confirming that all field personnel have received copies of the ALERT sheet.

If potential archaeological resources are uncovered, the discovery site shall be secured, personnel and equipment shall be redirected, and the ERO shall be notified immediately. If the ERO determines that an archaeological resource may be present within the C-APE, the SFPUC shall retain the services of a qualified archaeological consultant. For construction at Site 11, an archaeological monitoring plan shall be prepared and implemented. The monitoring plan shall specify the location and duration of monitoring activities and shall be subject to review by the ERO.

If archaeological resources are discovered at Site 11 or any of the other well facility sites, the archaeological consultant shall advise the ERO as to whether the discovery is an archaeological resource that retains sufficient integrity and is of potential scientific/historical/cultural significance. If an archaeological resource is present, the consultant shall identify and evaluate the archaeological resource. The archaeological consultant shall make a recommendation as to what action, if any, is warranted. Based on this information, the ERO may require, if warranted, specific additional measures to be implemented by the SFPUC.

Measures might include: preservation in situ of the archaeological resource; an archaeological monitoring program; or an archaeological evaluation program. If an archaeological monitoring program or archaeological testing program is required, it shall be subject to review by the ERO. The ERO may also require that the SFPUC immediately implement a site security program if the archaeological resource is at risk from vandalism, looting, or other damaging actions.

For any discovery of an archaeological resource, the archaeological consultant shall submit an archaeological data recovery report (ADRR) to the ERO which, in addition to the usual contents of the ADRR, shall: include an evaluation of the historical significance of any discovered archaeological resource; describe the archaeological and historical research methods employed in the archaeological monitoring/data recovery program(s) undertaken; and present, analyze and interpret the recovered data. Information that may put at risk any archaeological resource shall be provided in a separate removable insert within the final report. Once approved by the ERO, copies of the ADRR shall be distributed as follows: the relevant California Historical Resources Information System Information Center shall receive one copy, and the ERO shall receive one copy of the transmittal letter of the ADRR to the Information Center. The San Francisco Planning Department, Environmental Planning Division, shall receive three copies of the ADRR along with copies of any formal site recordation forms (California Department of Parks and Recreation Form 523 series) and/or documentation for nomination to the National Register/California Register. The SFPUC shall receive copies of the ADRR in the number requested. In instances of high public interest in or high interpretive value of a resource, the ERO may require a different final report content, format and distribution than that presented above. All archaeological work performed under this mitigation measure shall be subject to review by the ERO or designee.

Impact Conclusion: Less than Significant with Mitigation

Impact CR-3: Project construction could result in a substantial adverse effect by destroying a unique paleontological resource or site. (Less than Significant with Mitigation)

The evaluation that follows discusses sites with no impacts first, followed by sites with significant impacts.

Site 9 and the Westlake Pump Station

Site 9 is located on surface deposits mapped as Holocene colluvium. Although vertebrate remains in Holocene colluvium are too young to be fossiliferous, they could be of scientific interest to paleontologists, but would not be considered significant paleontological resources. Therefore, there would be *no impact* on paleontological resources during construction at this site. At the Westlake Pump Station, there would be no ground disturbing activities and, therefore, there would be *no impact* on paleontological resources at this location, either.

Impact Conclusion: No Impact

Sites 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17 (Alternate), 18 (Alternate), and 19 (Alternate)

These sites would be located on surface deposits mapped as the Colma Formation, which is of late Pleistocene age. (Although Site 10 is partially underlain by artificial fill, a portion is located on Colma Formation Deposits.) As noted above, the Colma Formation has produced significant marine and terrestrial fossils in the past and is considered to have a high paleontological sensitivity for significant paleontological resources.

Based upon the results of a review of published geologic maps, geologic unit descriptions and a fossil collections database at the University of California Museum of Paleontology (UCMP) undertaken for the Project by Dr. Kenneth Finger in 2009 (Finger 2009), any Project-related activities that would encounter previously undisturbed subsurface sediments have the potential to impact significant paleontological resources. However, pre-construction paleontological field surveys or monitoring during construction are not recommended, because the surfaces of the sites have already been disturbed or covered, the potential for uncovering vertebrate fossils is generally low, and the construction-related excavation for the Project is not extensive (Finger 2009). Although the potential for encountering significant paleontological resources during Project construction is low, in the unlikely event that significant paleontological resources are encountered in undisturbed subsurface sediments, they could be adversely affected. Thus, the Project's potential construction-related impact on paleontological resources is *significant*. However, implementation of Mitigation Measure M-CR-3 (Suspend Construction Work if a Paleontological Resource is Identified) would minimize the Project's potential construction-related impacts on paleontological resources to *less-than-significant* levels by requiring that construction work be temporarily halted or diverted in the event of a paleontological resource discovery, as well as avoidance or salvage of any significant paleontological resources. Therefore, this potential impact on paleontological resources would be *less than significant with mitigation*.

Mitigation Measure M-CR-3: Suspend Construction Work if a Paleontological Resource is Identified (All Sites except Site 9 and Westlake Pump Station)

If a paleontological resource (fossilized invertebrate, vertebrate, plant or micro-fossil) is discovered during construction at any of the proposed well facility sites, all ground disturbing activities within 50 feet of the find shall be temporarily halted but may be diverted to areas beyond 50 feet from the discovery to continue working. An appointed representative of the SFPUC shall notify a qualified paleontologist, who will document the discovery as needed, evaluate the potential resource, and assess the nature and significance of the find. Based on the scientific value or uniqueness of the find, the paleontologist may record the find and allow work to continue, or recommend salvage and recovery of the material, if the SFPUC determines that the find cannot be avoided. The paleontologist shall make recommendations for any necessary treatment that is consistent with the SVP 2012 Guidelines (SVP 2012a) and currently accepted scientific practices. If required, treatment for fossil remains may include preparation and recovery of fossil materials so that they can be housed in an appropriate museum or university collection and may also include preparation and publication of a report describing the find. The paleontologist's recommendations shall be subject to review and approval by the ERO or designee. The SFPUC shall be responsible for ensuring that treatment is implemented and reported to the San Francisco Planning Department. If no report is required, the SFPUC shall nonetheless ensure that information on the nature, location and depth of all finds is readily available to the scientific community through university curation or other appropriate means.

Impact Conclusion: Less than Significant with Mitigation

Impact CR-4: Project construction could result in a substantial adverse effect related to the disturbance of human remains. (Less than Significant with Mitigation)

The evaluation that follows discusses sites with no impacts first, followed by sites with significant impacts.

Westlake Pump Station

There would be no ground disturbing activities at the Westlake Pump Station and, therefore, there would be *no impact* related to potential disturbance of human remains at this location.

Impact Conclusion: No Impact

Sites 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 (Alternate), 18 (Alternate), and 19 (Alternate)

No evidence of human remains was identified on the surface within any of the archaeological C-APEs and, given the results of the field surveys and EASs, including a ground-penetrating radar (GPR) survey of the C-APEs at Sites 14 and 15 described in Section 5.5.1.5 (Archaeological Methods, Survey and Results), it is unlikely that undiscovered human remains are present below the ground surface within the C-APEs. However, the potential for their presence cannot be entirely ruled out. Construction-related excavation and grading could expose and disturb or damage any previously undiscovered human remains. Therefore, the impact related to the potential disturbance of human remains during construction could be *significant*. However, Mitigation Measure M-CR-4 (Accidental Discovery of Human Remains) would be implemented during Project construction to minimize potential impacts on any buried human remains and associated or unassociated funerary objects that may be accidentally discovered during Project construction activities to *less-than-significant* levels by requiring the SFPUC to adhere to appropriate excavation, removal, recordation, analysis, custodianship, and final disposition protocols. Therefore, this potential impact on buried human remains would be *less than significant with mitigation*.

Mitigation Measure M-CR-4: Accidental Discovery of Human Remains (All Sites except Westlake Pump Station)

The treatment of any human remains and associated or unassociated funerary objects discovered during soil-disturbing activities shall comply with applicable State laws. Such treatment would include immediate notification of the San Mateo County Coroner and, in the event of the coroner's determination that the human remains are Native American, notification of the NAHC, which would appoint a Most Likely Descendant (MLD) (PRC Section 5097.98). A qualified archaeologist, the SFPUC and MLD shall make all reasonable efforts to develop an agreement for the treatment, with appropriate dignity, of any human remains and associated or unassociated funerary objects (CEQA Guidelines Section 15064.5[d]). The agreement would take into consideration the appropriate excavation, removal, recordation, analysis, custodianship, and final disposition of the human remains and associated or unassociated funerary objects. The PRC allows 48 hours to reach agreement on these matters. If the MLD and the other parties could not agree on the reburial method, the SFPUC shall follow Section 5097.98(b) of the PRC, which states that "the landowner or his or her authorized representative shall reinter the human remains and items associated with Native American burials with appropriate dignity on the property in a location not subject to further subsurface disturbance." All archaeological work performed under this mitigation measure shall be subject to review by the ERO or designee.

Impact Conclusion: Less than Significant with Mitigation

5.5.4 Operational Impacts and Mitigation Measures

Impact CR-5: Project facilities could cause an adverse change in the significance of a historical resource. (Less than Significant with Mitigation)

The evaluation that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts and sites with significant impacts.

<u>Sites 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

As noted in Section 5.5.1.5 **(**Archaeological Methods, Surveys and Results), there are no known historical resources at or near these sites and, therefore, there would be *no impact.*

Impact Conclusion: No Impact

Site 7

The Gatehouse Entry at Woodlawn Memorial Park has been determined to be eligible for listing in the National Register and is, therefore, also eligible for listing in the California Register and considered a historical resource for the purposes of CEQA evaluation. In addition, if a Colma Cemetery Historic District is established, Woodlawn Memorial Park may be eligible for the California Register and National Register as a contributor to the District for its role in the interrelated histories of the City of San Francisco and Town of Colma and the discrete theme of cemeteries in the Town of Colma.

The Woodlawn Memorial Park Gatehouse Entry building is located approximately 500 feet to the north of the proposed well facility at Site 7. As noted above, the Woodlawn Gatehouse Entry was determined by the Town of Colma to be eligible for listing in the National Register under Criterion C, as it embodies the distinctive characteristics of an architectural type and method of construction. However, the well facility at Site 7 would not disturb, alter, or destroy the Woodlawn Gatehouse Entry. In addition, the well facility at Site 7 would not affect the Gatehouse Entryway setting in a manner that would cause an adverse change in the significance of this historical resource because of the small scale of the proposed aboveground facilities, the distance of the facilities from the Gatehouse Entryway (500 feet), and the presence of intervening trees, which would serve to block views of the facilities from the Gate Entryway. In addition, because of the small-scale of the aboveground facilities, the siting of facilities at Site 7 would not cause an adverse change in the significance of the cemetery's landscape, or the landscape of the adjacent Greenlawn Memorial Park, or that of the Greek Orthodox Memorial Park, which also appear to be contributors to a potential Colma cemetery district. Therefore, the potential impact on historical resources from the well facility siting at Site 7 would be *less than significant*.

Impact Conclusion: Less than Significant

Sites 14 and 15

Sites 14 and 15 are located within the GGNC, which is eligible for the National Register of Historic Places as a historic district and is therefore considered a historical resource.

Site 14

Site 14 would be located within the SFPUC's easement near the northern property line of the GGNC. The easement is approximately 60 feet wide where the proposed well facility would be located. The structure enclosing the proposed well varies in height from 6.5 feet to eight feet and is approximately 35 feet long by 20 feet wide. Rows of headstones, approximately two feet in height, are located to the east and west. The Project also includes the removal of a portion of the existing lawn and replacement with grass pavers. The area would be reseeded after installation of the pavers. GGNC is eligible for listing in the National Register under Criterion A for its association with the expansion of the National Cemetery System during the inter-war period. The status of the GGNC as a historical resource under CEQA would be affected by any adverse alteration of a portion of the cemetery and its immediate surroundings, given the conclusion in the eligibility documents that all components of the cemetery are contributing elements and, therefore, the impact would be *significant*. The visual impact on the landscape of an eight- to 10-foot high rectangular structure, placed in the center of an open area, would be imposing when seen next to the two foot-high headstones. In this location, the headstones define the physical characteristic associated with the setting, feeling, and association of the historical resource. The removal of the existing well structure would alter the immediate setting and result in the loss of a contributing element to the site. This resource is a utilitarian structure whose contribution to the GGNC as a whole is minor; however it is still considered a contributing resource. A potential adverse change to this physical characteristic could materially impair the historical resource.

In addition to the well structure, the proposed Project at Site 14 includes removal of a portion of the existing lawn and its replacement with grass pavers. Natural grass is the predominant ground surface material throughout the cemetery. The use of another material, not already part of the designed roads and other hard surfaced areas, such as the Flag Pole Circle, could materially alter the character defining feature associated with the historical resource because it would be out of character with the setting, materials, and feeling. In addition to the proposed surface material, the area to be affected would be highly visible extending approximately 140 feet (by about 12 feet wide) from the roadway to the proposed well structure thereby upsetting the uniformity of the grass surface, which is uninterrupted from the eastern boundary of the cemetery at El Camino Real to a road to the west; approximately 2,085 feet and 1,260 feet, respectively. This impact would be *significant*. However, Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14) would minimize impacts by screening the new structure, decreasing its prominence on the existing landscape among the headstones, and allow for a design compatible with the overall site. This mitigation measure would further lessen the impacts on the setting, feeling, and association of the historical resource to *less-than-significant* levels by implementing measures to decrease the prominence of Project elements on the landscape. The documentation of the existing pump structure would record this contributing element before it is demolished. Recordation of the contributing element is necessary as this documentation would identify the character of this area of the cemetery prior to demolition. Therefore, this impact would be *less than significant with mitigation*.

Mitigation Measure M-CR-5a: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14

The SFPUC shall implement the following measures to minimize impacts on Site 14:

- The proposed well facility structure shall be located as close to the northern fence as feasible taking into consideration the need of the VA for vehicle access along this fence line. The SFPUC shall confirm with the VA the minimum width of the required access. The SFPUC shall construct a well facility building or a fenced enclosure to house the well and well appurtenances as discussed below:

- If the SFPUC constructs a building to house the well and well appurtenances, the proposed facility building shall be constructed at a height of no more than eight feet. Landscaping shall be planted around the new building to act as a screen, lessening the visual intrusion. Cladding materials for the proposed facility building shall be compatible with those existing on the site and the adjacent maintenance structures (i.e., stucco walls and clay tile hipped roofs). The design of the well facility, including the proposed screening plantings, shall meet any applicable VA planting guidance, and prior to construction shall be reviewed and approved by appropriate VA officials and a historical architect meeting the Secretary of the Interior's Professional Qualification Standards. The proposed building and associated outside areas shall be constructed in compliance with the Secretary of the Interior's Standards for Rehabilitation and be compatible with the existing maintenance buildings in the use of materials with minimal detailing.

- If the SFPUC constructs a wall around the well and well appurtenances, the wall shall be constructed at a height of no more than eight feet. Landscaping shall be planted around the new fence to act as a screen, lessening the visual intrusion. The design of the well facility, including the proposed screening plantings, shall be reviewed and approved by appropriate VA officials and a historical architect meeting the Secretary of the Interior's Professional Qualification Standards and any applicable VA planting guidance, prior to construction. The proposed fence and associated planted areas shall be constructed in compliance with the *Secretary of the Interior's Standards for Rehabilitation* and be compatible with the existing maintenance buildings in the use of materials with minimal detailing.
- The SFPUC shall lay plywood or other material down temporarily for access between the cemetery access road and construction area during construction, unless the type and use of grass pavers proposed are determined by SHPO to be compatible with the historical resource.
- The existing pump structure and ancillary equipment shall be documented prior to its demolition. The documentation shall follow the Historic American Buildings Survey guidelines. Although a contributing resource, this resource is a utilitarian structure whose contribution to the GGNC as a whole is minor. Therefore, the level of documentation of this resource (Level 1, Level II, Level III, or Level IV) shall be determined by VA officials and an architectural historian meeting the Secretary of the Interior's Professional Qualification Standards.

Site 15

Site 15 would be located near the southern property line of the cemetery between the maintenance yard and Sneath Lane. The area is approximately 40 feet wide where the proposed well facility structure would be located. The proposed well building footprint is approximately 2,095 square feet with an additional 455 square feet of paving for parking next to the cemetery's entry gate and maintenance yard. The GGNC is eligible for listing in the National Register under Criterion A for its "association with the expansion of the National Cemetery System during the inter-war period." The significance of this historical resource could be materially impaired by the Project through physical alteration of a portion of the resource and/or its immediate surroundings.

The visual impact of the structure on the landscape near the secondary entry would be noticeable as the preliminary design for the new building differs greatly from the existing structures and would be out of character with its setting, design, materials and feeling (this can be seen in Figure 5.3-13 [Visual Simulation of Site 15]). These are four of the seven aspects of a historical resource's integrity the others are location, workmanship, and association. In addition, the proposed well facility would affect two contributing elements of the historical resource: the 1952 maintenance complex and the 1941 entry gate. The location of the proposed well facility would be only several feet away from the historic building. This would have an adverse effect on the historic building to the north of the proposed structure, as the new building would almost completely block the entire south elevation of the historic structure.

The building design could result in a building that is not visually integrated with the surrounding structures and landscape. Further, the type of selected cladding materials, color, roofline, overall volume, and fenestration, could result in the building being incompatible with the surrounding structures. This potential impact would be *significant.* The proposed well building at Site 15 also is a visual intrusion at the cemetery's secondary entrance (see visual simulation of proposed Project presented in Figure 5.3-13 [Visual Simulation of Site 15]). The existing relationship between the maintenance buildings and entry gate would be disturbed. Currently the maintenance buildings are set back approximately 50 feet or more from Sneath Lane. The gate is located closer to the street, within 20 feet of Sneath Lane. Grass, trees, and other ornamental plantings are located in the space between the building and street. Forty linear feet of wrought-iron fence is located immediately next to the entry gate with chain link fencing beginning where the wrought-iron ends. The footprint of the proposed new building would be almost in line with the entry gate, thereby eliminating the plantings and separation of the cemetery facilities from the street. The proximity of the proposed structure also would diminish the importance of the gate. The fence is transparent, but the proposed building would be a solid mass obscuring the historic maintenance building from view. The VA has a potential future project to replace the existing fencing with wrought-iron fencing (VA 2011); however the construction schedule for their project is unknown. The potential impact would, therefore, be *significant.*

The proposed paved parking area would abut the entry gate, a contributing element of the historical resource. This impact would be *significant* because the setting and feeling of the entry gate would be altered.

However, Mitigation Measures M-CR-5b (Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 15) would minimize potential impacts on the setting, feeling, and association of the elements of the historical resource at Site 15 to *less-than-significant* levels by implementing measures to relocate or redesign Project facilities at the site to be in accordance with the *Secretary of the Interior's Standards for Rehabilitation*. "Generally, a project that follows […] the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings (1995), Weeks and Grimmer, shall be considered as mitigated to a level of less than a significant impact on the historical resource." (CEQA Guidelines Section 15064.5 [b][3]). Therefore, this impact would be *less than significant with mitigation*.

Mitigation Measure M-CR-5b: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 15

The SFPUC shall implement the following measures to minimize impacts on elements of the historical resource at Site 15:

- The proposed facility building and associated outside areas shall be constructed in compliance with the *Secretary of the Interior's Standards for Rehabilitation* and be compatible with the existing maintenance buildings in the use of materials with minimal detailing.

- The size and scale of the proposed facility building shall be smaller than that of the existing structure, so as not to overwhelm the existing maintenance building.
    - The height shall be below the eave of the adjacent maintenance building. The height of the new 8-foot high concrete wall with stucco finish, perpendicular to the existing building wall, shall be kept below the adjacent maintenance building's window sills.
    - The length shall be kept to the minimum and the building located farther to the east; the east elevation would align with the east elevation of the maintenance building.
    - The western elevation of the new building shall be set back (to the east) from the face of the western elevation of the existing building by at least 10 feet.
    - The fence line along Sneath Lane shall be maintained and shall not wrap around the new building; it is acceptable for the building to break the fence line.
- The proposed facility building shall be separated from the existing building by a minimum of approximately eight feet (the width of the planting area south of the existing maintenance building), to maintain the relationship of the historic maintenance buildings with the entry gates.
- Cladding materials for the proposed facility building shall be compatible with those existing on the site and the adjacent maintenance structures (i.e., stucco walls and clay tile hipped roofs).
- Paved parking shall be kept to the minimum necessary and shall not be within 10 feet of the entry gate.
- Wrought iron, or equivalent, fencing shall replace the existing chain link fencing.
- A landscaping plan shall be developed for the east, south and west elevations and shall reflect the landscaping around nearby structures. The row of existing street trees in front of the maintenance yard fence shall extend to the west to where the wrought iron fence begins. The SFPUC shall work with the VA to develop the landscaping plan.
- The design of the proposed facility, including landscape plantings, shall be reviewed and approved by appropriate VA officials and a historical architect meeting the Secretary of the Interior's Professional Qualification Standards to ensure that proposed structure and associated outside areas are constructed in compliance with the *Secretary of the Interior's Standards for Rehabilitation* and any applicable VA planting guidance, prior to construction.

Impact Conclusion: Less than Significant with Mitigation

5.5.3.5 *Cumulative Impacts and Mitigation Measures*

Impact C-CR-1: Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains. (Less than Significant with Mitigation)

The geographic scope for the analysis of cumulative impacts on cultural resources includes the cultural resources C-APE for the Project (which includes the architectural, archaeological, and paleontological C-APEs) and the immediate vicinity around each of the facility sites. The GSR Project would contribute to cumulative impacts on cultural resources, including historical, archaeological, and paleontological resources, if the GSR Project and other projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), were to adversely affect the same cultural resources affected by the Project or would cause impacts on other cultural resources in the Project vicinity. Refer to Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis) in Section 5.1, Overview, for the location of the cumulative projects.

Historical Resources

One of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), the Holy Cross Expansion project (cumulative project E) could cause an adverse change in the significance of a historical resource. As shown in Table 5.5-5 (Historical Architectural Resources in the Record Search Area, but Outside the Architectural C-APE), the Holy Cross Cemetery District is a National Register-eligible district. The Holy Cross Expansion project could have a direct and significant impact on historical resources if the project were to change the character of the cemetery in a way that would compromise its eligibility to be listed in the National Register. However, construction of GSR facilities at Sites 8 and 17, the closest sites to the cemetery, would have no effect on historic resources, so there would be no cumulative impact on the Holy Cross Cemetery District. There are no other cumulative projects with the potential to affect historical resources (*no impact*).

Archaeological Resources and Human Remains

Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) could result in impacts on previously unrecorded archaeological resources and on human remains that may have been interred outside of a formal cemetery. Cumulative projects in the proposed Project vicinity that would also involve excavation include the "A" Street Well Replacement (cumulative project C), the SFPUC Peninsula Pipelines Seismic Upgrade Project (cumulative project D), the California Water Service Company (Cal Water) Well Replacement SSF-25 (cumulative project G), and the PG&E Upgrade (cumulative project H). These projects could encounter previously unrecorded archaeological resources or human remains, which would be a *potentially significant cumulative* cultural resources impact.

As discussed in Impacts CR-2 and CR-4, construction and excavation associated with the GSR Project would have a *significant* impact related to the potential to encounter previously unrecorded archaeological resources and/or human remains interred outside of a formal cemetery. Therefore, since the GSR Project and other cumulative projects have the potential to adversely impact previously unrecorded resources and/or human remains, the potential cumulative impact is *significant* and the GSR Project's contribution to this cumulative impact could be cumulatively considerable given that Project's potential to significantly impact such resources that may be present at any of the well facility sites. However, the GSR Project's contribution to cumulative impacts related to the potential to encounter previously unrecorded archaeological resources and/or human remains would be reduced to a less-than-significant level with implementation of Mitigation Measures M-CR-2 (Discovery of Archaeological Resources) and M-CR-4 (Accidental Discovery of Human Remains), as discussed in Impacts CR-2 and CR-4. These measures require the SFPUC to distribute the San Francisco Planning Department's archaeological resource "ALERT" sheet to the Project prime contractor, subcontractors, and/or any utilities involved in soil-disturbing activities within the Project area. If the ERO determines that an archaeological resource may be present within the Project area, the SFPUC is required to retain the services of a qualified archaeological consultant to evaluate the find, make recommendations as to what action, if any, is warranted and submit an archaeological data recovery report to the ERO. With regard to the accidental discovery of human remains, in particular, the San Mateo County Coroner must be immediately notified, and, in the event the coroner determined that the remains were Native American, the NAHC must be notified. Implementation of these measures would effectively avoid significant damage to or loss of any such resources and little to no residual impact would remain after mitigation. With implementation of these mitigation measures, the Project's contribution to this cumulative impact would not be cumulatively considerable *(less than significant with mitigation).*

Paleontological Resources

Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) could encounter paleontological resources during construction. Cumulative projects in the GSR Project vicinity that would involve excavation in the same geologic units include the "A" Street Well Replacement (cumulative project C), the SFPUC Peninsula Pipelines Seismic Upgrade Project (cumulative project D), the Cal Water Well Replacement SSF-25 (cumulative project G), and the PG&E Upgrade (cumulative project H). These projects could encounter paleontological resources during construction, which would be a *potentially significant cumulative* paleontological resources impact.

As discussed in Impact CR-3, the GSR Project could have a *significant* impact related to the potential to encounter paleontological resources during excavation within the Colma Formation, which has a high paleontological potential. However, the potential for uncovering vertebrate fossils is generally low, and the construction-related excavation for the Project is not extensive (Finger 2009). Therefore, since the GSR Project and other cumulative projects have the potential to impact paleontological resources, the cumulative impact could be *significant* and the GSR Project's contribution to this impact could be cumulatively considerable given that the GSR Project has the potential to impact paleontological resources.

However, the GSR Project's impacts on paleontological resources would be limited to the Project construction areas and would be reduced to a *less-than-significant* level with implementation of Mitigation Measure M-CR-3 (Suspend Construction Work if a Paleontological Resource is Identified), as discussed in Impact CR-3. This measure requires the SFPUC to follow proper procedures in the event that potentially significant resources are unearthed, including the requirement for a paleontologist to assess and salvage any fossils discovered by the construction crews. Implementation of this mitigation measure would ensure that any paleontological resources encountered during construction would be avoided or recovered and appropriately managed. Therefore, implementation of this measure would effectively minimize to *less-than-significant* levels any damage to, or the potential loss of, significant paleontological resources and little to no residual impact would remain after mitigation. Therefore, with implementation of these mitigation measures, the GSR Project's contribution to this cumulative impact would not be cumulatively considerable *(less than significant with mitigation)*.

5.5.4 References

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April 2013

DRAFT
Environmental Impact Report

Volume 2 of 3

For the
San Francisco Public Utilities Commission's

Regional Groundwater Storage and Recovery Project

Important Dates:

Draft EIR Publication Date:	April 10, 2013
Draft EIR Hearing Dates:	May 14, 2013 in San Mateo County
	May 16, 2013 in San Francisco
Draft EIR Public Comment Period:	April 10, 2013 through May 28, 2013

San Francisco Planning Department
Case No. 2008.1396E
State Clearinghouse No. 2005092026

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Written comments should be sent to:

Sarah Jones, Acting Environmental Review Officer
Regional Groundwater Storage and Recovery Project
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

TABLE OF CONTENTS

Regional Groundwater Storage and Recovery Project Draft Environmental Impact Report

Volume 1

Page

Volume 1 (continued)

Volume 2

Volume 3

Appendices

List of Figures

List of Tables

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5.6 TRANSPORTATION AND CIRCULATION

This section describes the transportation conditions within the vicinity of the proposed Project area (i.e., the existing roadway network, mass transit and non-motorized travel, air traffic patterns, and emergency access). The section presents an assessment of the transportation impacts associated with construction and operation of the Project, as well as identifies mitigation measures, as appropriate.

The transportation and circulation study area extends beyond the individual facility site boundaries and includes the roadways and intersections that could be affected by the proposed Project, particularly during construction (see Figure 2-1 [Project Vicinity Map], in Chapter 2, Introduction and Background and Figures 3-3, 3-4, and 3-5 [Project location maps] in Chapter 3, Project Description).

5.6.1 Setting

5.6.1.1 Regional and Local Roadways

The proposed Project involves construction of facilities within unincorporated San Mateo County (Broadmoor), the Town of Colma, and the cities of Daly City, South San Francisco, San Bruno, and Millbrae. U.S. Highway 101 (U.S. 101) and Interstate 280 (I-280) provide regional access. Interstate 380 (I-380) connects these two freeways mid-way through the San Francisco Peninsula. El Camino Real (State Route 82 or SR-82) also is a major north/south regional access route. Table 5.6-1 (Daily Traffic Volumes on Regional Roadways), presents the average daily traffic volumes on the regional freeways in the vicinity of the Project, including the percentage of trucks. As noted above, Figures 2-1, 3-3, 3-4, and 3-5 show the locations of these regional roadways in relation to the proposed facilities.

In San Mateo County, the City and County Association of Governments (C/CAG) is designated as the Congestion Management Agency, which adopts, formally amends, and readopts a Congestion Management Program (CMP) every two years. According to the 2011 San Mateo County CMP, El Camino Real in the Project area currently operates at level-of-service (LOS[1]) A; I-280 in the Project area operates at LOS A/B/&D (LOS A/B from State Route 1 [north] to State Route 1 [south] and LOS D from State Route 1 [south] to San Bruno Avenue); U.S. 101 operates at LOS C; and, Interstate 380 (I-380) operates at LOS F. Each freeway is in compliance with LOS standards established for the roadways by the CMP (C/CAG 2011).

[1] LOS is a qualitative description of a facility's performance based on average delay per vehicle, vehicle density, or volume-to-capacity ratios. Levels of service range from LOS A, which indicates free-flow or excellent conditions with short delays, to LOS F, which indicates congested or overloaded conditions with extremely long delays.

TABLE 5.6-1
Daily Traffic Volumes on Regional Roadways

Location	Annual Average Daily Traffic Volumes (All Vehicles, including Trucks)[(a)]	Annual Average Daily Traffic Volumes (Trucks only)[(b)]	Trucks as a Percentage of Annual Average Daily Traffic Volumes
El Camino Real – at Hickey Boulevard	25,000	495	2
El Camino Real – at I-380 Interchange	36,000	526	2
El Camino Real – at Center Street	21,100	612	3
US 101 – at I-380 Interchange	242,000	INA[(c)]	INA[(c)]
US 101 – at Millbrae Avenue Interchange	238,000	10,472	4
I-280 – at Junipero Sierra Interchange	226,000	2,757	1
I-280 – at Hickey Boulevard Interchange	179,000	1,629	1
I-280 – at Westborough Boulevard Interchange	185,000	1,480	1
I-280 – at San Bruno Avenue Interchange	104,000	2,465	2
I-380 – at I-280 Interchange	139,000	2,989	2
I-380 – at US 101 Interchange	159,000	4,277	3

Source: Caltrans 2010a, 2010b

Notes:

(a) Annual average daily traffic is the total volume for all movements and all lanes at a location for the year divided by 365 days.

(b) Truck traffic is defined by Caltrans as trucks with two or more axles. The two-axle class includes 1.5 ton trucks with dual rear tires and excludes pickups and vans with only four tires.

(c) INA – Information Not Available.

The facility sites would be served by various collector and arterial streets. Collector and arterial streets are generally low-to-medium speed and low-to-medium capacity roadways that provide connections between neighborhood areas, commercial centers, and regional highways. Table 5.6-2 (Characteristics of Local Access Roadways for Facility Sites), summarizes the roadway characteristics (i.e., access routes, number of travel lanes, types of bicycle facilities, and public transit routes) for the local roadways in the Project area that would be directly affected by Project construction activities. Figures 3-11 through 3-40 in Chapter 3, Project Description show the location of each of the facility sites in relation to the nearest local access roadways.

5.6.1.2 Transit Service

The San Mateo County Transit District (SamTrans) operates fixed-route and paratransit bus service in the Project area. In 2012, the SamTrans fixed-route bus system consisted of 49 routes (SamTrans 2012). Public transit in the Project area is also provided by Caltrain and Bay Area Rapid Transit (BART). Table 5.6-2

(Characteristics of Local Access Roadways for Facility Sites) indicates the bus routes near the facility sites. Table 5.6-2 shows the routes in the study area that could be affected by the Project, and Project Description Figures 3-3 through 3-5 illustrate the location of the proposed facility sites and the roadways included in the table.

TABLE 5.6-2
Characteristics of Local Access Roadways for Facility Sites

Local Roadway *(Project Well Facility Site Construction Access Route)*	**Jurisdiction**	**Number of Travel Lanes**	**Bicycle Facility?**	**Sidewalks?**	**On-street Parking?**	**Public Transit?** (Route #)	**Closest Proposed Facility Site**
Poncetta Drive *(Poncetta Drive to Sheffield Drive to John Daly Boulevard to I-280)*	Daly City	2	No	No	Yes	No	1
South Plaza Park Drive *(South Park Plaza Drive to Park Plaza Drive to John Daly Boulevard to I-280)*	Daly City & Unincorporated San Mateo County	2	Class III	Yes	Yes	No	2, 3, 4
87th Street *(87th Street to South Park Plaza Drive to Park Plaza Drive to John Daly Boulevard to I-280)*	Daly City & Unincorporated San Mateo County	2	No	Yes	Yes	Yes (SamTrans 24, 121, 122)	4
Coronado Avenue *(Coronado Avenue to Park Plaza Drive to John Daly Boulevard to I-280)*	Daly City & Unincorporated San Mateo County	2	No	No	Yes	No	Westlake Pump Station
B Street *(B Street to Hill Street to D Street to I-280 or El Camino Real, or Hill Street to San Pedro Road to Washington Street to I-280)*	Daly City	2	No	Yes	Yes	No	5
Hill Street *(Hill Street to D Street to I-280 or El Camino Real, or Hill Street to San Pedro Road to Washington Street to I-280)*	Daly City	2	No	Yes	Yes	Yes (SamTrans 121, 123)	5, 6
D Street *(D Street to I-280 or El Camino Real or D Street to Hill Street to San Pedro Road to Washington Street to I-280)*	Daly City & Unincorporated San Mateo County	2-3	No	Yes	Yes	Yes (SamTrans 121, 123)	6

TABLE 5.6-2
Characteristics of Local Access Roadways for Facility Sites

Local Roadway *(Project Well Facility Site Construction Access Route)*	**Jurisdiction**	**Number of Travel Lanes**	**Bicycle Facility?**	**Sidewalks?**	**On-street Parking?**	**Public Transit?** (Route #)	**Closest Proposed Facility Site**
Colma Boulevard *(Colma Boulevard to Junipero Serra Boulevard to I-280)*	Colma	4	No	Yes	No	No	7
Serramonte Blvd *(Serramonte Boulevard to I-280 or Serramonte Boulevard to Junipero Serra Boulevard to Hickey Boulevard to I-280)*	Colma	4	No	Yes	No	No	8
San Mateo County Flood Control District Access Road (not public) *(Mission Road to Lawndale Boulevard to State Highway 82 to Hickey Boulevard to I-280)*	South San Francisco	1	No	No	No	No	9
Camaritas Avenue *(Camaritas Avenue to Hickey Boulevard to I-280 or State Highway 82)*	South San Francisco	2	No	Yes	Yes	Yes (SamTrans 35, 133)	10
Antoinette Lane *(Antoinette Lane to Chestnut Avenue / Westborough Boulevard to El Camino Real or I-280)*	South San Francisco	2	II	Yes	Yes	No	11
Southwood Drive *(Southwood Drive to El Camino Real or Southwood Drive to West Orange to Westborough Boulevard to I-280)*	South San Francisco	2	No	Yes	Yes	No	12, 19 (Alt)
South Spruce Avenue *(South Spruce Avenue to El Camino Real to I-380)*	South San Francisco	4	Class III	Yes	No	Yes (SamTrans 133)	13

TABLE 5.6-2
Characteristics of Local Access Roadways for Facility Sites

Local Roadway *(Project Well Facility Site Construction Access Route)*	**Jurisdiction**	**Number of Travel Lanes**	**Bicycle Facility?**	**Sidewalks?**	**On-street Parking?**	**Public Transit?** (Route #)	**Closest Proposed Facility Site**
Huntington Avenue *(Huntington Avenue to South Spruce Avenue to El Camino Real to I-380)*	South San Francisco	4	Class III	Yes	No	Yes (SamTrans 133)	13
Sneath Lane *(Sneath Lane to I-280 or to El Camino Real to I-380)*	San Bruno	4	Class II	Yes	No	Yes (SamTrans 43)	14, 15
El Camino Real (SR-82) *(El Camino Real to East Millbrae Avenue to U.S. 101)*	Millbrae	6	Class III	Yes	No	Yes (SamTrans 390)	16
Hemlock Avenue *(Hemlock Avenue to Hillcrest Boulevard to El Camino Real to East Millbrae Avenue to U.S. 101)*	Millbrae	2	No	Yes	Yes	No	16
Collins Avenue *(Collins Avenue to Serramonte Boulevard to I-280 or to Serramonte Boulevard to Junipero Serra Boulevard to Hickey Boulevard to I-280)*	Colma	2	No	Yes	Yes	No	17 (Alt)
Alta Loma Drive *(Alta Loma Drive to Camaritas Avenue to Hickey Boulevard to I-280)*	South San Francisco	2	No	Yes	Yes	Yes (SamTrans 35, 133)	18 (Alt)

Sources: Google Earth 2010; SamTrans 2010

Notes:

II – Class II Bicycle Facility (striped bicycle lanes)

III – Class III Bicycle Facility (signed as bicycle routes)

SamTrans – San Mateo County Transit District

5.6.1.3 Bicycle and Pedestrian Network

Responsibilities for planning and maintaining bicycle facilities in the study area rest with San Mateo County and the individual jurisdictions. Class I bicycle facilities are completely separated from motor vehicle traffic, such as an off-street pathway. Class II bicycle facilities, or bicycle lanes, are portions of the roadway that are marked with a line for use by bicyclists. Class III bicycle facilities are signed as bicycle routes that allow shared use by bicycles and vehicles, but do not have bicycle lane markings on the pavement.

Table 5.6-2 (Characteristics of Local Access Roadways for Facility Sites) identifies bicycle routes located on roadways adjacent to the proposed facilities. The majority of these routes are Class III bicycle routes. El Camino Real is a Class III bicycle route in both South San Francisco and Millbrae. Other Class III bicycle routes include Park Plaza Drive in Daly City, and South Spruce and Huntington avenues in South San Francisco. Sneath Lane is a Class II bicycle lane in San Bruno.

In addition to these bicycle routes on public roadways, the Centennial Way Trail in South San Francisco– connecting the South San Francisco BART station to the San Bruno BART station mostly along the BART right-of-way – is a Class I bicycle and pedestrian trail. The Class I trail is located within 230 feet and 60 feet of the GSR Site 11 and Site 13 construction areas, respectively. The trail then becomes a Class II bicycle lane within Antoinette Lane, which is located within 75 feet of the Site 11 construction area.

The level of pedestrian facilities (e.g., sidewalks versus edge-of-road paths) and pedestrian volumes varies in the vicinity of the facility sites, but the predominant mode of travel in the area is by automobile.

5.6.1.4 Existing Traffic Conditions

Existing traffic conditions were identified along local roadways that would be directly affected by the construction and operational traffic generated under the proposed Project. Requests for available traffic count data for roadways in the vicinity of the proposed facility sites were submitted to Daly City, Colma, South San Francisco, San Bruno, and Millbrae. The majority of the traffic counts obtained were conducted between 2005 and 2010; however, the traffic counts for seven roadway segments (Antoinette Lane, Chestnut Avenue, Southwest Drive, West Orange Avenue, South Spruce Boulevard, Millbrae Avenue, and Hillcrest Boulevard) were taken prior to 2005. To more accurately reflect existing conditions, the traffic counts for these seven roadway segments were augmented to account for the percentage of population growth that has occurred in the jurisdiction in which the roadway is located between the year the count was taken and 2010. For example, the most recent traffic count available for Antoinette Lane near Site 11 was from 2002. Between 2002 and 2010, the City of South San Francisco experienced a five percent increase in population growth. Therefore, for purposes of this analysis, the traffic count for Antoinette Lane was increased by five percent (i.e., a one for one percentage increase with population growth).

To assign an existing LOS to the roadway segments, the existing roadway capacities were assigned based on the roadway types identified in the Highway Capacity Manual Special Report 209 (Transportation Research Board 1985), including two-lane local streets, two-lane collectors, two-lane lane arterials with left-turn lane, four-lane undivided arterial, four-lane divided arterial with left-turn lane, and six-lane divided arterial with left-turn lane. The volume-to-capacity (V/C) ratio for each roadway segment was then calculated and compared to the following roadway segment LOS definitions, as reported in Highway Capacity Manual (Transportation Research Board 1985).

Level of Service	Traffic Conditions	Upper Vehicle-to-Capacity Threshold
A	Little or no congestion	0.60
B	Small amount of traffic congestion	0.70
C	Average traffic congestion	0.80
D	High traffic congestion	0.90
E	Very high traffic congestion	1.00
F	Oversaturated, stop-and-go conditions	>1.00

Table 5.6-3 (Local Roadway Existing Level of Service Conditions), presents the existing traffic volumes, capacity, V/C ratios, and LOS for the local roadways. Based on the available traffic counts obtained from local jurisdictions, the majority of the roadway segments in the Project area currently operate at LOSs that are in compliance with local standards. Exceptions include one roadway segment that, based on the available traffic counts and assumed roadway capacities, currently operates below established local standards (noted with gray shading in Table 5.6-3). This roadway segment is further described below.

Millbrae Avenue from El Camino Real to Rollins Road – Millbrae Avenue is a major arterial roadway in Millbrae that provides regional access to El Camino Real and U.S. 101. Millbrae Avenue is a six-lane divided arterial (with left-turn lane) with an assigned vehicle capacity of 4,914 vehicles during the peak hour. Millbrae Avenue may be utilized by construction traffic to access Site 16 off of U.S. 101, with the direction of Project construction-related vehicle trips being inbound (westbound) during the A.M. peak period and outbound (eastbound) during the P.M. peak period. The traffic counts on the segment of Millbrae Avenue from El Camino Real to Rollins Road indicate that the roadway operates at an LOS F (i.e., V/C ratio > 1.0) in both the A.M. and P.M. peak hours, which exceeds Millbrae's general standard of LOS D for this roadway segment. During the P.M. peak hour, both the westbound and eastbound roadway segments operate at LOS F.

TABLE 5.6-3
Local Roadway Existing Level of Service Conditions

Local Roadway Segment	Project Facility Sites Served by the Roadway	Existing Traffic Volumes[a]		Roadway Capacity[b]	Volume to Capacity (V/C) Ratio		Roadway Level of Service (LOS)		Local LOS Standard[c]
		A.M. Peak	P.M. Peak		A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	
Sheffield Drive south of John Daly Boulevard	1	449	525	1,092	0.41	0.48	A	A	C
Junipero Serra Boulevard from Pacific Plaza North Garage to John Daly Boulevard	1, 2, 3, 4, WLPS	2,765	2,765	4,914	0.56	0.56	A	A	C
John Daly Boulevard from I-280 to Sheffield Drive (total)	1, 2, 3, 4, WLPS	2,611	3,421	4,550	0.57	0.75	A	C	C
John Daly Boulevard from Sheffield Drive to Park Plaza Drive (total)	2, 3, 4, WLPS	2,015	2,810	4,550	0.44	0.62	A	B	C
Park Plaza Drive from John Daly Boulevard to Bel Mar Avenue	2, 3, 4, WLPS	789	1,039	1,638	0.48	0.63	A	B	C
Park Plaza Drive south of Southgate Avenue	2, 3, 4	572	785	1,092	0.52	0.72	A	C	C
Hill Street from San Pedro Road to B Street	5	187	248	1,092	0.17	0.23	A	A	C
D Street from Hill Street to Junipero Serra Boulevard	5, 6	802	881	3,276	0.24	0.27	A	A	C
San Pedro Road from Hill Street to Washington Street	5, 6	1,314	1,339	2,457	0.53	0.54	A	A	D
Washington Street from San Pedro Road to I-280	5, 6	874	1,099	2,457	0.36	0.45	A	A	D
F Street at El Camino Real	5, 6	296	378	1,092	0.27	0.35	A	A	D
Colma Boulevard from El Camino Real to Junipero Serra Boulevard	7	285	733	2,457	0.12	0.30	A	A	D
Junipero Serra Boulevard from Southgate Avenue to Serra Center	7	661	1,425	3,276	0.20	0.43	A	A	D
Junipero Serra Boulevard from Serra Center to Serramonte Boulevard	7	664	1,547	3,276	0.20	0.47	A	A	D
Serramonte Boulevard near El Camino Real	8	722	1,348	2,457	0.29	0.55	A	A	D

TABLE 5.6-3
Local Roadway Existing Level of Service Conditions

Local Roadway Segment	Project Facility Sites Served by the Roadway	Existing Traffic Volumes[a]		Roadway Capacity[b]	Volume to Capacity (V/C) Ratio		Roadway Level of Service (LOS)		Local LOS Standard[c]
		A.M. Peak	P.M. Peak		A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	
Serramonte Boulevard from Collins Avenue to Shopping Center	8	844	1,238	2,457	0.34	0.50	A	A	D
Collins Avenue from Serramonte Boulevard to El Camino Real	17 (Alt)	240	276	1,092	0.22	0.25	A	A	D
Junipero Serra Boulevard from Serramonte Boulevard to Hickey Boulevard	7, 8, 17 (Alt)	808	1,440	2,457	0.33	0.59	A	A	D
Mission Road from El Camino Real to McLellan Drive	9	502	609	1,092	0.46	0.56	A	A	D
McLellan Drive from Mission Road to El Camino Real	9	905	594	2,457	0.37	0.24	A	A	D
Hickey Boulevard from El Camino Real to Camaritas Avenue	9	1,721	1,931	3,276	0.53	0.59	A	A	D
Hickey Boulevard from Crown Circle to Hilton Avenue	9, 10, 18 (Alt)	1,808	2,060	3,276	0.55	0.63	A	B	D
Camaritas Avenue near Hickey Boulevard	10, 18 (Alt)	510	454	1,092	0.47	0.42	A	A	D
Hickey Boulevard from Hilton Avenue to Junipero Serra Boulevard	9, 10, 18 (Alt)	1,798	2,020	2,457	0.73	0.82	C	D	D
Hickey Boulevard west of Junipero Serra Boulevard	9, 10, 18 (Alt)	1,590	1,876	3,276	0.49	0.57	A	A	D
Antoinette Lane north of Chestnut Avenue	11	112	120	1,092	0.10	0.11	A	A	D
Chestnut Avenue from Antoinette Lane to El Camino Real	11	2,655	2,594	3,276	0.81	0.79	D	C	D
Westborough Boulevard from Camaritas Avenue to Junipero Serra Boulevard	11, 12, 19 (Alt)	2,749	2,733	3,276	0.84	0.83	D	D	D
Southwood Drive from Fairway Drive to El Camino Real	12, 19 (Alt)	59	61	182	0.32	0.33	A	A	D

TABLE 5.6-3
Local Roadway Existing Level of Service Conditions

Local Roadway Segment	Project Facility Sites Served by the Roadway	Existing Traffic Volumes[(a)]		Roadway Capacity[(b)]	Volume to Capacity (V/C) Ratio		Roadway Level of Service (LOS)		Local LOS Standard[(c)]
		A.M. Peak	P.M. Peak		A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	
West Orange Avenue south of Westborough Boulevard	12, 19 (Alt)	760	680	1,092	0.70	0.62	B	B	D
West Orange Avenue at El Camino Real	12	600	917	1,092	0.55	0.84	A	D	D
Huntington Avenue from South Spruce Avenue to Noor Avenue	13	595	856	2,457	0.24	0.35	A	A	D
South Spruce Avenue from Huntington Avenue to El Camino Real	13	2,011	2,280	2,457	0.61	0.70	B	B	D
Sneath Lane from I-280 to El Camino Real	14, 15	1,634	1,634	3,276	0.50	0.50	A	A	D
Millbrae Avenue between El Camino Real and Rollins Road	16	5,572	6,196	4,914	1.13	1.26	F	F	D
Hillcrest Boulevard at Hemlock Avenue	16	298	298	1,092	0.27	0.27	A	A	A

Notes:

(a) Traffic data obtained from Daly City, Colma, South San Francisco, San Bruno, and Millbrae (Daly City 2005-2007; Colma 2005-2007; South San Francisco 1984-2010; Millbrae 1999-2003). Traffic counts for Antoinette Lane, Chestnut Avenue, Southwest Drive, and West Orange Avenue, South Spruce Boulevard, Millbrae Avenue, and Hillcrest Boulevard were taken prior to 2005. In order to more accurately reflect existing conditions, the traffic counts for these roadways were augmented to account for the percentage of population growth in the city in which the count was taken between the year of the count and 2010.

(b) Roadway capacities were assigned based on roadway types identified in *Highway Capacity Manual Special Report 209* (Transportation Research Board 1985), including two-lane local streets, two-lane collectors, two-lane lane arterials with left-turn lane, four-lane undivided arterial, four-lane divided arterial with left-turn lane, and six-lane divided arterial with left-turn lane.

(c) LOS standards are defined for roadways and intersections in Daly City, Colma, South San Francisco, San Bruno, and Millbrae General Plans (Colma 1999; Daly City 1987; Millbrae 1998; San Bruno 2009; South San Francisco 1999).

5.6.2 Regulatory Framework

5.6.2.1 Federal

There are no federal regulations that address transportation impacts associated with the proposed Project.

5.6.2.2 State and Local

Transportation analysis in California is guided by policies and standards set at the State level by the California Department of Transportation (Caltrans) for highway facilities under State jurisdiction, as well as by local jurisdictions. Any work or traffic control within the State right-of-way requires an encroachment permit issued by Caltrans. In addition, work that requires movement of oversized or excessive load vehicles on highway facilities requires a transportation permit by Caltrans.

Local jurisdictions regulate speed limits and other driving standards on local roadways, including hauling permits for oversized or excessive load vehicles on city streets. South San Francisco Municipal Code Section Chapter 11.32, *Truck Routes*, includes streets designated as traffic routes for vehicles exceeding a maximum gross weight of three tons, such as Spruce Avenue, Chestnut Avenue, Mission Road, El Camino Real, Hickey Boulevard, Hillside Boulevard, and Junipero Serra Boulevard. Town of Colma Municipal Code Section Chapter 6.03.070, *Truck Routes*, designates truck traffic routes for vehicles exceeding three tons, including El Camino Real, Junipero Serra Boulevard, and all other streets, except for F Street and Olivet Parkway. The truck restriction on F Street in Colma is intended for the portion of the roadway east of El Camino Real (Colma 2012).

The Daly City Municipal Code Section 10.60, *Load Limits*, establishes gross tonnage weight limits for several streets, none of which are on access routes to the proposed facility sites. The Daly City Municipal Code also encourages truck traffic to remain on major and minor arterials to the extent possible through hauling permits. Millbrae determines truck-hauling routes on a Project-specific basis in accordance with the Millbrae Municipal Code, Chapter 4.40 Section 010, *Maximum Gross Vehicle Weights on Streets*. The City of San Bruno and San Mateo County do not have designated truck routes; however, each jurisdiction regulates appropriate truck routes through hauling permits (San Bruno 2011; San Mateo 2011).

Caltrans and local jurisdiction policies generally assess the impacts of long-term, not short-term, traffic conditions. These policies generally suggest maintaining a specific LOS, as follows: LOS C (Daly City, Caltrans[2]), and LOS D (San Mateo County, Colma, South San Francisco, San Bruno, and Millbrae[3]) on

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[2] Caltrans endeavors to maintain an LOS at the transition of LOS C and LOS D on State highways. However, Caltrans acknowledges that this may not always be feasible and recommends that the lead agency consult with Caltrans to determine the appropriate target LOS. If an existing State highway facility is operating at less than the appropriate target LOS, the existing measures of effectiveness should be maintained (Caltrans 2002).

[3] LOS standards vary throughout Millbrae. In the Project area, the LOS standard for El Camino Real and Millbrae Avenue in the morning peak hour is LOS D.

major streets during the peak periods of traffic flow. As noted in Section 5.6.1.1 (Regional and Local Roadways) the C/CAG is designated as the Congestion Management Agency in San Mateo County. The C/CAG adopts a CMP, which is formally amended and readopted every two years. The LOS standards for CMP roadways in the Project study area (U.S. 101, I-280, I-380, and El Camino Real) vary by roadway segment; LOS E for U.S. 101 and El Camino Real, LOS D and E for portions of I-280, and LOS F for I-380 (C/CAG 2011).

5.6.3 Impacts and Mitigation Measures

5.6.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on transportation and circulation if it were to:

- Conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system, taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit.
- Conflict with an applicable congestion management program, including but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways.
- Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location, that results in substantial safety risks.
- Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses.
- Result in inadequate emergency access.
- Conflict with adopted policies, plans, or programs regarding public transit, bicycle, or pedestrian facilities, or otherwise decrease the performance or safety of such facilities.

5.6.3.2 Approach to Analysis

This impact assessment evaluates the potential for Project-specific, short-term, construction-related impacts on roadways resulting from construction-related changes in roadway capacities, and increased traffic delays either from increases in construction-related traffic or lane closures. Construction activities are also evaluated to determine whether they would result in impacts on emergency access, or result in safety hazards to vehicular traffic, bicyclists, or pedestrians. Long-term impacts associated with operation of the facilities are also addressed.

Construction of the Project is proposed to begin in June 2014 and be completed by the end of February 2016. General work hours would be between 7:00 a.m. and 7:00 p.m. Monday through Friday except for construction of wells, which would require continuous operation of the drilling equipment until the desired depth is achieved and the well is constructed. Therefore, well installation would require nighttime and weekend activity during drilling and other drilling-related activities (for up to seven consecutive days and nights) and during subsequent pump testing (for up to one continuous 48-hour period). If necessary, construction could also occur occasionally on Saturdays between the hours of 7:00 a.m. and 5:00 p.m., independent of well drilling (see Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]).

As described in Chapter 3, Project Description, Section 3.5.1.3 (Water Distribution and Utility Pipeline Installation), travel lane closures would be managed such that one travel lane would be kept open at all times to allow alternating traffic flow in both directions along affected roadways, and the contractor would be required to use steel plates or trench backfilling to restore vehicle access at the end of each workday. Table 5.6-4 (Location and Duration of Partial Roadway Closures) summarizes the location and duration of partial roadway closures used in the following sections for the purpose of analysis; only those proposed facility sites that would require lane closures are listed in the table. Impacts associated with pipeline installation are based on the anticipated installation production rates of 300 to 600 feet per week, as discussed in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule). However, the duration of partial roadway closures for utility connections that extend perpendicularly from a site across a roadway were not estimated using the standard pipeline installation rates of 300 to 600 feet per week, because such connections take more time given the potential to encounter additional utilities, and the need to maintain through traffic. Therefore, it is conservatively assumed for this analysis that utility connections from a site to an existing pipeline within an adjacent roadway would take up to one week for installation of a single connection, and up to two weeks for connections of two or more utilities within the same area. However, in cases where the pipelines would encroach into only a small portion of the roadway (e.g., less than 10 feet at Site 18 [Alternate]), the duration of partial lane closures is estimated to be less than one week.

Increased congestion due to Project construction was evaluated by adding construction vehicle traffic to the current roadway volumes (see Section 5.6.1.4 [Existing Traffic Conditions]). Impacts of the Project on congestion were then assessed by comparing the predicted roadway volumes with the capacity of the roadway, and assigning an LOS based on the vehicle to capacity ratio. This predicted LOS was then compared to the local city and county congestion standards to determine if Project traffic would exceed local standards.

The reduction in roadway capacity through temporary lane closures at some sites could further increase congestion and delays for vehicles using the roadway. The actual impact of construction vehicle traffic on local and regional roadways would depend on the number and type of construction-related vehicles, the number of travel lanes on the roadways used as haul routes, existing traffic volumes on these roadways, road conditions, and other factors. Drivers would experience intermittent delays, particularly if they were traveling behind a construction truck. The impacts of construction traffic would be more noticeable in the immediate vicinity of the facility sites and less noticeable farther away on regional roadways.

TABLE 5.6-4
Location and Duration of Partial Roadway Closures

Site	Partial Travel Lane Closure	Pipelines and Utility Connections	Approximate Duration of Partial Travel Lane Closure
Site 4	Park Plaza Drive 87th Avenue and Park Plaza Drive Intersection	storm drain storm drain and electrical	1 week 1 week
Site 5 (Consolidated Treatment at Site 6)	B Street Hill Street D Street	storm drain and electrical proposed water connection proposed water connection	1 week 1 week 1 week
Site 5 (On-site Treatment)	B Street	storm drain proposed and alternate water connections, sanitary sewer, and electrical	1 week 2 weeks
Site 6 (On-site and Consolidated Treatment)	D Street	storm drain, sanitary sewer, and electrical	2 weeks
Site 7 (Consolidated Treatment at Site 6)	Colma Boulevard	storm drain and electrical	1 week
Site 7 (On-site Treatment)	Colma Boulevard	alternate water connection, storm drain, sanitary sewer, and electrical	2 weeks
Site 10	Camaritas Avenue	sanitary sewer	1 week
Site 12	Southwood Drive	storm drain and sanitary sewer	1 week
Site 13	South Spruce Avenue South Spruce / Huntington Intersection Huntington Avenue	proposed water connection or alternate water connection, storm drain, sanitary sewer, and electrical sanitary sewer proposed water connection	1 week 1 week 5 weeks
Site 14	Sneath Lane	proposed water connection	2 weeks
Site 15	Sneath Lane	proposed water connection, storm drain, sanitary sewer	4 weeks
Site 16	Hemlock Avenue	sanitary sewer	1 week
Site 17 (Alternate)	Collins Avenue	proposed water connection, sanitary sewer, storm drain, and electrical	1 week
Site 18 (Alternate)	Alta Loma Drive	alternate water connection	2 days
Site 19 (Alternate)	Southwood Drive	proposed water connection, storm drain, and electrical	2 weeks

Areas of No Project Impact

As explained below, the proposed Project would not result in impacts related to some of the above-listed significance criteria. The following criteria are not discussed further in the impact analysis, below, for the following reasons:

Conflict with an applicable congestion management program, including but not limited to level of service standards and travel demand measures, or other standards established by the county congestion management agency for designated roads or highways. The LOS standards established by the C/CAG CMP are intended to regulate long-term impacts due to future operation of Projects and were not developed for temporary construction projects. Therefore, this significance criterion is not applicable to Project construction. According to the 2011 CMP, El Camino Real in the Project area currently operates at LOS A, U.S. 101 operates at LOS C, I-280 operates at LOS A/B/&D (LOS A/B from State Route 1 [north] to State Route 1 [south] and LOS D from State Route 1 [south] to San Bruno Avenue), and I-380 operates at LOS F, each of which is in compliance with LOS standards (C/CAG 2011).

Operation and maintenance of the well facilities would, at most, require one maintenance visit per day on average when the wells are operating and, at maximum, one chemical delivery every two- to three-week period for wells with treatment facilities (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]). Therefore, when wells are operating, up to two trips per day could occur for sites with chemical treatment facilities (one for equipment checks and one for chemical delivery, given that different chemicals may require delivery on different trucks). During years with average and above-average precipitation (i.e., "normal" and "wet" years, respectively), the wells would typically be turned off, and regular exercising would be conducted on a weekly or monthly basis (see Chapter 3, Project Description, Section 3.8.3 [Maintenance]). The addition of one to two trips per day when the wells are operating would not have a long-term impact on LOS of CMP roadways in the Project area. Consequently, Project operation would not conflict with the approved CMP.

Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks. The proposed Project would not result in a change in traffic patterns, because it would not involve construction of structures tall enough to affect air traffic patterns. The maximum height of the proposed well facilities would be 15.5 feet (i.e., 15'-6") above finished grade. Therefore, the Project would have no impact with respect to a change in air traffic patterns that could result in safety risks. The Project proposes only ground-based travel; therefore, Project construction and operation would have no impact with respect to air traffic levels.

Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses. This significance criterion is intended to address facility siting and design impacts and does not apply to temporary construction impacts. Therefore, this significance criterion is not applicable to Project construction activities and is only evaluated as it relates to long-term operational impacts.

Result in inadequate long-term emergency access. As described above, operation and maintenance of the well facilities would, at most, require one maintenance visit per day on average when the wells are operating and, at maximum, one chemical delivery every two- to three-week period for wells with treatment facilities The proposed Project would not result in inadequate emergency access, because no roadway closures would occur during operation of the Project, and there would be no disruptions to emergency access to on-site well facilities or off-site roadways. Therefore, no impact would occur to emergency access from long-term operation of the Project, and emergency access and is only discussed as it relates to Project construction activities.

5.6.3.3 Summary of Impacts

Table 5.6-5 (Summary of Impacts – Transportation and Circulation), presents a summary of the Project's transportation and circulation impacts.

TABLE 5.6-5
Summary of Impacts – Transportation and Circulation

Sites	Construction			Operations	Cumulative
	Impact TR-1: The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system.	Impact TR-2: The Project would temporarily impair emergency access to adjacent roadways and land uses during construction.	Impact TR-3: The Project would temporarily decrease the performance and safety of public transit, bicycle, and pedestrian facilities during construction.	Impact TR-4: Project operations and maintenance activities would not conflict with an applicable plan or policies regarding performance of the transportation system or alternative modes of transportation.	Impact C-TR-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to transportation and circulation.
Site 1	LS	NI	NI	LS	LS
Site 2	LS	LSM	LS	LS	LSM
Site 3	LS	NI	LS	LS	LS
Site 4	LSM	LS	LS	LS	LSM
Westlake Pump Station	LS	NI	NI	LS	LS
Site 5 (Consolidated Treatment and On-site options)	LSM	LSM	LS	LS	LSM
Site 6	LSM	LS	LS	LS	LSM
Site 7 (Consolidated Treatment and On-site options)	LSM	LS	LS	LS	LSM
Site 8	LS	NI	NI	LS	LS
Site 9	LS	NI	NI	LS	LS
Site 10	LSM	LS	LS	LS	LSM
Site 11	LS	NI	NI	LS	LS
Site 12	LSM	LS	LSM	LS	LSM

TABLE 5.6-5
Summary of Impacts – Transportation and Circulation

Sites	Construction			Operations	Cumulative
	Impact TR-1: The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system.	**Impact TR-2: The Project would temporarily impair emergency access to adjacent roadways and land uses during construction.**	**Impact TR-3: The Project would temporarily decrease the performance and safety of public transit, bicycle, and pedestrian facilities during construction.**	**Impact TR-4: Project operations and maintenance activities would not conflict with an applicable plan or policies regarding performance of the transportation system or alternative modes of transportation.**	**Impact C-TR-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to transportation and circulation.**
Site 13	LSM	LSM	LSM	LS	LSM
Site 14	LSM	LS	LSM	LS	LSM
Site 15	LSM	LS	LSM	LS	LSM
Site 16	LS	LS	LS	LS	LS
Site 17 (Alternate)	LSM	LS	LS	LS	LSM
Site 18 (Alternate)	LSM	LS	LS	LS	LSM
Site 19 (Alternate)	LSM	LS	LSM	LS	LSM

Notes:

NI = No Impact

LS = Less than Significant

LSM = Less than Significant with Mitigation

5.6.3.4 Construction Impacts and Mitigation Measures

Impact TR-1: The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system. (Less than Significant with Mitigation)

Construction Traffic

Construction of the Project would result in short-term increases in construction-related vehicle trips on area roadways. Construction of each facility and its associated pipelines and utilities would result in vehicle trips by construction workers commuting to and from facility sites, haul-truck trips associated with the disposal of excavation materials, and material and equipment deliveries. The number of construction-related vehicles traveling to and from facility sites would vary on a daily basis. The greatest number of construction-generated vehicle trips would generally occur at the well facilities with treatment and filtration facilities, because these facilities are larger and require more materials to construct.

Haul truck trips and materials delivery trips would occur during daytime hours, from 7:00 a.m. to 7:00 p.m., Monday through Friday. If necessary, construction work could occasionally occur on Saturdays between the hours of 7:00 a.m. and 5:00 p.m. In addition, the nature of well installation requires continuous operation of the drilling equipment until the desired well depth is achieved to avoid the risk of the drill hole collapsing during construction (see Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]). Therefore, well installation would also require nighttime and weekend activity during drilling and other drilling-related activities (for up to seven consecutive days and nights) and during pump testing (for one continuous 48-hour period). The duration of construction for both well drilling and facility construction is estimated as 16 months for most individual facilities, with an overall 21-month period for construction of all wells and well facilities. Well drilling and facility construction would be completed in clusters with approximately four sites being constructed at approximately the same time in each cluster, with a total of four clusters required to complete construction of the Project (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). In some cases, construction of wells within separate clusters would overlap. For example, construction traffic associated with Sites 1, 3, and 4 in Cluster A would overlap with construction traffic associated with Sites 2 and the Westlake Pump Station in Cluster D. The analysis below accounts for these overlaps.

The first major phase of construction (production well), would last approximately six weeks and would include site preparation, pilot hole drilling, bore hole drilling, and testing. The second major phase of construction (well facility construction), would require a 14-month construction period for sites with well facilities. Sites with a fenced enclosure would require a three-month construction period, except for Site 2 (one-month construction period) and Site 3 (two, three-month construction periods). This phase would involve site preparation and grading, on-site pipeline installation, building construction, installing well pumps, and landscaping, and site restoration. Well facility construction may overlap with the third major phase of construction (utility pipelines).

Table 5.6-6 (Maximum Daily Construction Vehicle Round Trip Generation during the Highest Volume Construction Phase) summarizes the maximum daily construction trips for each well facility site and construction cluster on a daily basis. The maximum daily construction trips for each facility would range from eight to 23 daily trips.

TABLE 5.6-6

Maximum Daily Construction Vehicle Round Trip Generation during the Highest Volume Construction Phase[a]

Site	General Location	Jurisdiction	Highest Volume Construction Phase	Maximum Hauling Truck Trips[b]	Maximum Material and Equipment Delivery Trips[b]	Maximum Worker Trips[b]	Maximum Daily Trips[c]
Construction Cluster A							
Site 1	Poncetta Drive	Daly City	Facility + Pipeline	3	7	16	26
Site 3[d]	Plaza Park Drive	Daly City	Well Drilling	6	4	5	15
Site 4[e]	Plaza Park Drive	Daly City	Facility + Pipeline	17	4	4	25
Site 7 (Consolidated Treatment at Site 6)[d]	Colma Boulevard	Colma	Well Drilling	6	4	5	15
Total				32	19	30	81
Construction Cluster B with Alternate Site							
Site 12	Southwood Drive	South San Francisco	Facility + Pipeline	3	7	16	26
Site 14	Sneath Lane	San Bruno	Facility + Pipeline	3	7	16	26
Site 15	Sneath Lane	San Bruno	Facility + Pipeline	1	7	16	24
Site 16	Hemlock Avenue	Millbrae	Facility + Pipeline	1	7	16	24
Site 19 (Alternate)[d]	Southwood Drive	South San Francisco	Well Drilling	6	4	5	15
Total				14	32	69	115
Construction Cluster C with Alternate Site							
Site 9	El Camino Real or Mission Road	South San Francisco	Facility + Pipeline	1	7	16	24
Site 10	Camaritas Avenue	South San Francisco	Facility + Pipeline	5	7	16	28
Site 11	Antoinette Lane	South San Francisco	Facility + Pipeline	1	7	16	24
Site 13	South Spruce Avenue/ Huntington Avenue	South San Francisco	Facility + Pipeline	1	7	16	24

TABLE 5.6-6

Maximum Daily Construction Vehicle Round Trip Generation during the Highest Volume Construction Phase[(a)]

Site	General Location	Jurisdiction	Highest Volume Construction Phase	Maximum Hauling Truck Trips[(b)]	Maximum Material and Equipment Delivery Trips[(b)]	Maximum Worker Trips[(b)]	Maximum Daily Trips[(c)]
Site 18 (Alternate)	Alta Loma Drive	South San Francisco	Facility + Pipeline	3	7	16	26
Total				11	35	80	126
Construction Cluster D with Alternate Site							
Site 2[(e)]	Plaza Park Drive	Daly City	Facility + Pipeline	2	4	4	10
Site 5 (Consolidated Treatment at Site 6)[(d)]	B Street	Daly City	Well Drilling	0	4	5	9
Site 6 (Consolidated Treatment at Site 6)	D Street	Daly City	Facility + Pipeline	4	7	16	27
Site 8	Serramonte Blvd.	Colma	Facility + Pipeline	4	7	16	27
Westlake Pump Station[(d)]	Coronado Avenue	Daly City	Well Drilling	0	4	5	9
Site 17 (Alternate)	Collins Avenue	Colma	Facility + Pipeline	3	7	16	26
Total				14	33	61	108

Notes:

(a) The highest volume period varies. It occurs either during the removal of well cutting or during the overlap of well facility construction and utility pipeline installation.

(b) The three columns for Maximum Hauling Trips, Maximum Material and Equipment Delivery Trips, and Maximum Worker Trips are taken from Tables 3-8 (Estimated Daily Worker and Construction Equipment Trips for Well Facilities Construction) and 3-10 (Construction Soil Material Haul Amounts and Anticipated Haul Truck Trips) in Chapter 3, Project Description, for the highest volume construction phase listed in the fourth column of Table 5.6-6 (Maximum Daily Construction Vehicle Round Trip Generation during the Highest Volume Construction Phase).

(c) This column sums the highest daily truck volume, material and equipment delivery trucks, and worker trips to provide an estimate of the maximum daily trips.

(d) For the Westlake Pump Station and wells with fenced enclosures, the peak daily material and deliveries during the Well Drilling construction phase are estimated to be half that for well facilities with buildings.

(e) For wells with fenced enclosures, the peak daily construction workers during the Facility + Pipeline construction phase are estimated to be a quarter of that for well facilities with buildings, and the peak daily material and equipment deliveries are estimated to be half that for well facilities with buildings.

The haul routes used during off-site disposal of excavated materials, and delivery of concrete and other materials would be a combination of regional roadways (e.g., El Camino Real, U.S. 101, I-280, and I-380), major arterials, local arterials, and residential streets, depending on the geographic location of the construction activity. The SFPUC or its contractor(s) would be required to use truck routes approved by local jurisdictions as stated in conditions of approval for the hauling permits. The location of the disposal site for excavated materials would depend on the type of material to be disposed. Non-hazardous spoil would likely be disposed of at Allied Waste Ox Mountain Sanitary Landfill in Half Moon Bay (accessed via U.S. 101 or I-280 to SR 92). Excavated materials and construction debris found to contain hazardous materials (estimated to be less than one percent of overall spoil) would be disposed of at a licensed disposal site (see Section 5.17, Hazards and Hazardous Materials). Potential hazardous material disposal sites include Waste Management's Kettleman Hills Disposal Site in Kettleman City, CA and ECDC Environmental in East Carbon, UT.

Traffic impacts were analyzed during the construction period with the highest volume of trips as shown in Table 5.6-6 (Maximum Daily Construction Vehicle Round Trip Generation during the Highest Volume Construction Phase) which would generate the greatest amount of additional vehicles on area roads per day during construction. Table 5.6-7 (Peak Hour Construction Trips) presents the peak hour construction vehicle trips for local roadways, accounting for construction-related vehicles from different sites that would use the same local roadways. All workers are assumed to arrive during the A.M. peak hour and depart during the P.M. peak hour. For hauling trips, the highest daily truck volumes presented in Table 5.6-6 for either hauling or material and equipment delivery trips were used and were distributed evenly through an eight-hour work day. For this analysis, the total peak hour trips reported in Table 5.6-7 are assumed to occur both in the A.M. and P.M. peak hours.

The impact of the construction-related traffic on local roadways was quantitatively assessed using V/C ratios and the LOS impact thresholds of the local jurisdictions. Table 5.6-8 (Local Roadway Project Level of Service), presents the projected LOS of the roadway segments in the Project vicinity, with and without Project-generated vehicle trips (the gray shading highlights those segments with unacceptable LOS).

TABLE 5.6-7
Peak Hour Construction Trips

Local Roadway Segment	Facility Sites Contributing Construction Traffic to Roadway Segment	Peak Hour Worker Trips[(a)]	Peak Hour Haul Trips[(b)]	Total Peak Hour Trips[(c)]
Sheffield Drive south of John Daly Boulevard	1	16	2	18
Junipero Serra Boulevard from Pacific Plaza North Garage to John Daly Boulevard	1, 2, 3, 4, WLPS	34	7	41
John Daly Boulevard from I-280 to Sheffield Drive	1, 2, 3, 4, WLPS	34	7	41
John Daly Boulevard from Sheffield Drive to Park Plaza Drive	2, 3, 4, WLPS	18	6	24
Park Plaza Drive from John Daly Boulevard to Bel Mar Avenue	2, 3, 4, WLPS	18	6	24
Park Plaza Drive south of Southgate Avenue	2, 3, 4	13	5	18
Hill Street from San Pedro Road to B Street	5	5	1	6
D Street from Hill Street to Junipero Serra Boulevard	5, 6	21	2	23
F Street at El Camino Real	5, 6	21	2	23
San Pedro Road from Hill Street to Washington Street	5, 6	21	2	23
Washington Street from San Pedro Road to I-280	5, 6	21	2	23
Colma Boulevard from El Camino Real to Junipero Serra Boulevard	7	5	2	7
Junipero Serra Boulevard from Southgate Avenue to Serra Center	7	5	2	7
Junipero Serra Boulevard from Serra Center to Serramonte Boulevard	7	5	2	7
Serramonte Boulevard near El Camino Real	8	16	2	18
Serramonte Boulevard from Collins Avenue to Shopping Center	8	16	2	18
Collins Avenue from Serramonte Boulevard to El Camino Real	17 (Alt)	16	2	18
Junipero Serra Boulevard from Serramonte Boulevard to Hickey Boulevard	7, 8, 17 (Alt)	37	4	41
Mission Road from El Camino Real to McLellan Drive	9	16	1	17
McLellan Drive from Mission Road to El Camino Real	9	16	1	17

TABLE 5.6-7

Peak Hour Construction Trips

Local Roadway Segment	Facility Sites Contributing Construction Traffic to Roadway Segment	Peak Hour Worker Trips[(a)]	Peak Hour Haul Trips[(b)]	Total Peak Hour Trips[(c)]
Hickey Boulevard from El Camino Real to Camaritas Avenue	9	16	1	17
Hickey Boulevard from Crown Circle to Hilton Avenue	9, 10, 18 (Alt)	48	4	52
Camaritas Avenue near Hickey Boulevard	10, 18 (Alt)	32	2	34
Hickey Boulevard from Hilton Avenue to Junipero Serra Boulevard	9, 10, 18 (Alt)	48	4	52
Hickey Boulevard west of Junipero Serra Boulevard	9, 10, 18 (Alt)	48	4	52
Antoinette Lane north of Chestnut Avenue	11	16	1	17
Chestnut Avenue from Antoinette Lane to El Camino Real	11	16	1	17
Westborough Boulevard from Camaritas Avenue to Junipero Serra Boulevard	11, 12, 19 (Alt)	37	4	41
Southwood Drive from Fairway Drive to El Camino Real	12, 19 (Alt)	21	3	24
West Orange Avenue south of Westborough Boulevard	12, 19 (Alt)	21	3	24
West Orange Avenue at El Camino Real	12	16	2	18
Huntington Avenue from South Spruce Avenue to Noor Avenue	13	16	1	17
South Spruce Avenue from Huntington Avenue to El Camino Real	13	16	1	17
Sneath Lane from I-280 to El Camino Real	14, 15	32	3	35
Millbrae Avenue between El Camino Real and Rollins Road	16	16	1	17
Hillcrest Boulevard at Hemlock Avenue	16	16	1	17

Notes:

(a) Peak hour worker trips assumes all workers from facility sites contributing construction traffic to a local roadway segment would arrive and depart during the A.M. and P.M. peak hours.

(b) For hauling trips, the hauling truck trips and material and equipment delivery trips presented in Table 5.6-6 (Maximum Daily Construction Vehicle Round Trip Generation during the Highest Volume Construction Phase) are added together and then distributed evenly through an eight-hour work day.

(c) For this analysis, total peak hour trips are assumed to occur both in the A.M. and P.M. peak hours.

TABLE 5.6-8

Local Roadway Project Level of Service

Roadway Segment	Closest Project Facility Sites	Existing[a]				Existing plus Project[b]				Local LOS Standard[c]
		V/C Ratio		LOS		V/C Ratio		LOS		
		A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	
Sheffield Drive south of John Daly Boulevard	1	0.41	0.48	A	A	0.43	0.5	A	A	C
Junipero Serra Boulevard from Pacific Plaza North Garage to John Daly Boulevard	1, 2, 3, 4, WLPS	0.56	0.56	A	A	0.57	0.57	A	A	C
John Daly Boulevard from I-280 to Sheffield Drive	1, 2, 3, 4, WLPS	0.57	0.75	A	C	0.58	0.76	A	C	C
John Daly Boulevard from Sheffield Drive to Park Plaza Drive	2, 3, 4, WLPS	0.44	0.62	A	B	0.45	0.62	A	B	C
Park Plaza Drive from John Daly Blvd to Bel Mar Avenue	2, 3, 4, WLPS	0.48	0.63	A	B	0.50	0.65	A	B	C
Park Plaza Drive south of Southgate Avenue	2, 3, 4	0.52	0.72	A	C	0.54	0.74	A	C	C
Hill Street from San Pedro Road to B Street	5	0.17	0.23	A	A	0.18	0.23	A	A	C
D Street from Hill Street to Junipero Serra Boulevard	5, 6	0.24	0.27	A	A	0.25	0.28	A	A	C
San Pedro Road from Hill Street to Washington Street	5, 6	0.53	0.54	A	A	0.54	0.55	A	A	C
Washington Street from San Pedro Road to I-280	5, 6	0.36	0.45	A	A	0.37	0.46	A	A	C
F Street at El Camino Real	5, 6	0.27	0.35	A	A	0.29	0.37	A	A	D
Colma Blvd from El Camino Real to Junipero Serra Boulevard	7	0.12	0.30	A	A	0.12	0.30	A	A	D
Junipero Serra Boulevard from Southgate Avenue to Serra Center	7	0.20	0.43	A	A	0.20	0.44	A	A	D
Junipero Serra Boulevard from Serra Center to Serramonte Boulevard	7	0.20	0.47	A	A	0.20	0.47	A	A	D

TABLE 5.6-8
Local Roadway Project Level of Service

Roadway Segment	Closest Project Facility Sites	Existing[a]				Existing plus Project[b]				Local LOS Standard[c]
		V/C Ratio		LOS		V/C Ratio		LOS		
		A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	
Serramonte Boulevard near El Camino Real	8	0.29	0.55	A	A	0.30	0.56	A	A	D
Serramonte Boulevard from Collins Avenue to Shopping Center	8	0.34	0.50	A	A	0.35	0.51	A	A	D
Collins Avenue from Serramonte Boulevard to El Camino Real	17 (Alt)	0.22	0.25	A	A	0.24	0.27	A	A	D
Junipero Serra Boulevard from Serramonte Boulevard to Hickey Boulevard	7, 8, 17 (Alt)	0.33	0.59	A	A	0.35	0.60	A	A	D
Mission Road from El Camino Real to McLellan Drive	9	0.46	0.56	A	A	0.48	0.57	A	A	D
McLellan Drive from Mission Road to El Camino Real	9	0.37	0.24	A	A	0.38	0.25	A	A	D
Hickey Boulevard from El Camino Real to Camaritas Avenue	9	0.53	0.59	A	A	0.53	0.59	A	A	D
Hickey Boulevard from Crown Circle to Hilton Avenue	9, 10, 18 (Alt)	0.55	0.63	A	B	0.57	0.64	A	B	D
Camaritas Avenue near Hickey Boulevard	10, 18 (Alt)	0.47	0.42	A	A	0.50	0.45	A	A	D
Hickey Boulevard from Hilton Avenue to Junipero Serra Boulevard	9, 10, 18 (Alt)	0.73	0.82	C	D	0.75	0.84	C	D	D
Hickey Blvd west of Junipero Serra Boulevard	9, 10, 18 (Alt)	0.49	0.57	A	A	0.50	0.59	A	A	D
Antoinette Lane north of Chestnut Avenue	11	0.10	0.11	A	A	0.12	0.13	A	A	D
Chestnut Avenue from Antoinette Lane to El Camino Real	11	0.81	0.79	D	C	0.82	0.80	D	C	D
Westborough Boulevard from Camaritas Avenue to Junipero Serra Boulevard	11, 12, 19 (Alt)	0.84	0.83	D	D	0.85	0.85	D	D	D

TABLE 5.6-8

Local Roadway Project Level of Service

Roadway Segment	Closest Project Facility Sites	Existing[(a)]				Existing plus Project[(b)]				Local LOS Standard[(c)]
		V/C Ratio		LOS		V/C Ratio		LOS		
		A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	
Southwood Drive from Fairway Drive to El Camino Real	12, 19 (Alt)	0.32	0.33	A	A	0.45	0.47	A	A	D
West Orange Avenue south of Westborough Boulevard	12, 19 (Alt)	0.70	0.62	B	B	0.72	0.65	C	B	D
West Orange Avenue at El Camino Real	12	0.55	0.84	A	D	0.57	0.86	A	D	D
Huntington Avenue from South Spruce Avenue to Noor Avenue	13	0.24	0.35	A	A	0.25	0.36	A	A	D
South Spruce Avenue from Huntington Avenue to El Camino Real	13	0.61	0.70	B	B	0.62	0.70	B	B	D
Sneath Lane from I-280 to El Camino Real	14, 15	0.50	0.50	A	A	0.51	0.51	A	A	D
Millbrae Avenue between El Camino Real and Rollins Road	16	1.13	1.26	F	F	1.14	1.26	F	F	D
Hillcrest Boulevard at Hemlock Avenue	16	0.27	0.27	A	A	0.29	0.29	A	A	A

Notes:

(a) As reported in Table 5.6-3 (Local Roadway Existing Level of Service Conditions).

(b) V/C and LOS for local segments when total peak hour trips from Table 5.6-7 (Peak Hour Construction Trips) is added to the existing traffic volumes for local roadways presented in Table 5.6-3.

(c) LOS standards defined for roadways and intersections in Daly City, Colma, South San Francisco, San Bruno and Millbrae general plans.

Sites 1 through 15, 17 (Alternate), 18 (Alternate), 19 (Alternate), and Westlake Pump Station

As shown in Table 5.6-8 (Local Roadway Project Level of Service), the roadway segments in the vicinity of Sites 1 through 15, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station (see Figures 3-11 through 3-36, and 3-38 through 3-40) currently operate at acceptable LOSs during the A.M. and P.M. peak periods and the addition of construction vehicles would not substantially affect the peak-hour conditions or degrade the roadway segments to a lower LOS standard. Because the roadway segments in the vicinity of these sites have sufficient capacity to accommodate the temporary increase in construction traffic, and because the roadway segments would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from construction traffic at these sites would be *less than significant*.

Site 16

Construction of Site 16 (see Figure 3-37) would contribute up to 17 trips in the A.M. and P.M. peak hour on Millbrae Avenue from El Camino Real to Rollins Road, a segment of roadway that, based on traffic counts, currently operates at LOS F conditions during both the A.M. and P.M. peak hours. The direction of Project construction-related vehicle trips would be in-bound (i.e., westbound) during the A.M. peak period and out-bound (i.e., eastbound) during the P.M. peak period. Of the 17 trips during the peak hours, 16 of the trips would be construction worker vehicles and one trip would be a haul truck. The addition of 17 trips would represent an approximately 0.3 percent increase in traffic volumes along this roadway segment during the A.M. and P.M. peak periods. As shown in Table 5.6-8 (Local Roadway Project Level of Service), the results of the quantitative LOS analysis indicate that the addition of up to 17 construction-generated trips during both the A.M. and P.M. peak hours would not substantially affect baseline traffic levels on Millbrae Avenue. The V/C ratio would increase by .01 during the A.M. peak hour and would not result in a detectable increase during the P.M. peak hour. Although the roadway currently operates at LOS F during peak hours, the Project's contribution of construction traffic would be temporary and would not substantially affect the baseline traffic levels because the Project contribution would be negligible and barely perceptible; i.e., there would be no noticeable delay or increase in congestion given the small amount of trips added to the roadway during Project construction. Therefore, the temporary impact from construction traffic along this roadway segment would be *less than significant*.

Impact Conclusion: Less than Significant

Travel Lane Closures

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

Sites 3, 8, 9, 11, and Westlake Pump Station

Construction activities for Sites 3, 9, 11, and the Westlake Pump Station would not extend into adjacent roadways and would not require temporary lane closures (see Figures 3-12, 3-23, 3-27, and 3-13, respectively). Construction activities at Site 8 would extend into the Kohl's Department Store parking lot, but would not extend into any public roadways and would not require temporary lane closures (see

Figure 3-22). Therefore, since there would be no lane closures associated with construction activities for Sites 3, 8, 9, 11, and the Westlake Pump Station, and there would be *no impact* at these sites.

Impact Conclusion: No Impact

Sites 1, 2, and 16

Site 1

Construction of the alternate water connection to the Daly City water system at Site 1 would extend approximately 75 feet into the end of Poncetta Drive (see Figure 3-11) and, as a result, may require a partial closure of the roadway. However, Poncetta Drive ends at the facility site and construction activities would not block traffic along any portion of Poncetta Drive. Construction of the proposed water connection pipeline (to the SFPUC transmission pipeline) would not require lane closures. The portion of Poncetta Drive that would be temporarily closed would be at the end of the roadway and would not affect access to the Westlake Village Apartment residences, parking, or garbage dumpsters.

Site 2

Construction activities at Site 2 would extend along the sidewalk on the east side of Park Plaza Drive (see Figure 3-12). However, construction would not extend into the adjacent roadway. Construction would require trenching across a 20-foot private access road that leads to the maintenance facility of the Lake Merced Golf Club; however, this would not affect roadway capacity because it is not a public roadway, receives only minimal maintenance related traffic, and construction across the road could be completed within one day, assuming installation of pipelines at a rate of approximately 300 to 600 feet per week (see Section 3.5.1 [Construction Sequencing and Schedule]).

Site 16

Site 16 would require temporary partial closure of Hemlock Avenue (see Figure 3-37). However, Hemlock Avenue is not a through street at this location; therefore, construction would not affect through traffic. Because there would not be any construction within traffic lanes adjacent to these sites and travel lane closures would not be needed, potential impacts on traffic, relative to a temporary reduction in roadway capacity, increased traffic delays, or traffic safety hazards due to traffic lane closures would be *less than significant* at these sites.

Impact Conclusion: Less than Significant

Sites 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 (Alternate), 18 (Alternate), and 19 (Alternate)

Construction activities at Sites 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 (Alternate), 18 (Alternate), and 19 (Alternate) would require construction activities within the public right-of-way and temporary alternating travel lane closures. A summary of the travel lane closures for each of these sites is described in Table 5.6-4 (Location and Duration of Partial Roadway Closures). As described in Chapter 3, Project Description, Section 3.5.1.3 (Water Distribution and Utility Pipeline Installation), travel lane closures would be managed such that one travel lane would be kept open at all times to allow alternating traffic flow in both directions along affected roadways. Each closure is evaluated for impacts on traffic relative to temporary reductions in roadway capacity, increased traffic delays, or traffic safety hazards. Impacts relative to safety or performance of public transit, bicycle, or pedestrian facilities are evaluated under Impact TR-3, below.

Underground pipeline and electrical installation that requires work to be performed within paved streets would use the open trench construction method. As indicated in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule), pipeline construction would proceed at approximately 300 to 600 feet per week. Construction within streets could result in a temporary reduction in the number, or in the available width, of travel lanes, and, as a result, vehicles (including transit) using the affected roadways could encounter increased congestion and delays.

Within paved streets, the amount of roadway needed for construction would depend on where the pipelines would be located and whether on-street parking is currently provided; either two travel lanes, or one travel lane and a parking lane, would be needed to accommodate the construction zone. Some roadway segments would have sufficient pavement width outside of the construction zone to accommodate two-way traffic flow (e.g., Park Plaza Drive, South Spruce Avenue, Huntington Avenue, Alta Loma Drive). At some sites, pipeline connections would be installed across an entire roadway or intersection (e.g., B Street, Hill Street, D Street, Colma Boulevard, Camaritas Avenue, Southwood Drive, South Spruce Avenue, Sneath Lane, Collins Avenue, Southwood Drive). However, partial lane closures would result in additional vehicle delay when alternate one-way traffic operations are required, and some drivers might shift to other, potentially less convenient routes to access their destination, thereby increasing traffic on those roadways. Regardless, traffic would be delayed as it travels past the construction zone. At some locations, it could be necessary to temporarily interrupt traffic flow in both directions to facilitate construction vehicle turning movements into and out of the facility sites. These impacts would typically occur only during the day, because the contractor would be required to use steel plates or trench backfilling to restore vehicle access at the end of each workday, as discussed in further detail for each site, below, and as discussed in Chapter 3, Project Description, Section 3.5.1.3 (Water Distribution and Utility Pipeline Installation).

Site 4

Site 4 would be located just east of and adjacent to Park Plaza Drive in Daly City (see Figure 3-12). Construction of pipelines would require partial lane closures along an approximately 350-foot stretch of the parking and northbound travel lane of Park Plaza Drive from the northern end of 87th Street. As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), the partial lane closure along Park Plaza Drive would be needed for up to one week for installation of the storm drain. In addition, a partial lane closure at the intersection of 87th Avenue and Park Plaza Drive would be needed for up to one week for installation storm drain and electrical connections within the intersection.

The partial travel lane closure on Park Plaza Drive would result in a temporary reduction in roadway capacity; however, as shown in Table 5.6-8 (Local Roadway Project Level of Service), Park Plaza Drive south of Southgate Avenue operates at LOS A during the A.M. peak hour and at LOS C during the P.M. peak hour. Therefore, Park Plaza Drive would have sufficient capacity to accommodate the temporary reduction in roadway capacity and, because the roadway segments would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant*.

However, the partial closure of the intersection with 87th Street and Park Plaza Drive could have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles. Construction activities within the public right-of-way for this site would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards, and ensure worker safety in construction zones in accordance with local standards and specifications adopted by Daly City.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Park Plaza Drive and the intersection of Park Plaza Drive and 87th Street to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Park Plaza Drive and the 87th Street intersection would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones, and prescribing traffic detours (if needed) to reduce the potential impacts. As a result, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 4 to *less-than-significant* levels.

Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])[4]

Prior to construction, the SFPUC and its contractor(s) shall prepare and implement traffic control plans for each local jurisdiction in which construction would affect roadways and intersections. The traffic control plan shall be submitted to the applicable local jurisdiction for review as part of the encroachment permit process. Each contractor shall prepare a traffic control plan for the well facility sites under their contract, and where construction at well facility sites could occur within and/or across multiple streets in the same vicinity, the SFPUC and its construction contractors shall coordinate the traffic control plans to mitigate the impact of traffic disruption.

The traffic control plan shall include sufficient measures to address the overall Project construction, as well as appropriate site-specific measures, including measures to reduce potential impacts on traffic flows on roadways affected by Project construction activities. The traffic control plan shall comply with local jurisdiction and Caltrans requirements and be tailored to reflect site-specific traffic and safety concerns, as appropriate. The traffic control plan shall include, but not necessarily be limited to, the following measures as applicable to site-specific conditions:

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[4] Impact TR-1 is not significant for Site 2, but it is included here because a Traffic Control Plan is required under Impact TR-2, which is discussed below.

Traffic Controls

- Circulation and detour plans shall be developed to minimize impacts on local street circulation. Haul routes that minimize truck traffic on local roadways and residential streets shall be utilized to the extent feasible. Flaggers and/or signage shall be used to guide vehicles through and/or around the construction zone.
- A public information program to advise motorists, nearby residents, and adjacent commercial establishments of the impending construction activities (e.g., media coverage, direct distribution of flyers to impacted properties, email notices, portable message signs, informational signs at the job sites) shall be developed and implemented.
- Truck routes designated by local jurisdictions shall be identified in the traffic control plan and shall be utilized to the extent feasible to minimize truck traffic on local roadways and residential streets that are not identified locally as designated haul routes.
- Lane closures shall be limited during peak hours to the extent feasible. In addition, outside of allowed working hours, or when work is not in progress, roads shall be restored to normal operations, with all trenches covered with steel plates.
- Roadside safety protocols shall be implemented, such as advance "Road Work Ahead" warning signs, and speed control (including signs informing drivers of State-legislated double fines for speed infractions in a construction zone) shall be provided to achieve required speed reductions for safe traffic flow through the work zone.
- Roadway rights-of-way shall be repaired or restored to their general pre-construction condition (or better) upon completion of construction.
- The traffic control plan shall also conform to applicable provisions of the State's *Manual of Traffic Controls for Construction and Maintenance Work Areas.*

Private and Emergency Access

- Access to driveways and private roads shall be maintained, as feasible, by using steel trench plates. If access must be restricted for brief periods (more than one hour), property owners shall be notified by the SFPUC in advance of such closures.
- At locations where the main access to a nearby property is blocked, the SFPUC shall be required to have ready at all times the means necessary to accommodate access by emergency vehicles to such properties, such as plating over excavations, short detours, and/or alternate routes.
- Construction shall be coordinated with facility owners or administrators of land uses that may be more significantly affected by traffic impacts, such as police and fire stations, transit stations, hospitals, ambulance providers, and schools. Emergency responders, and other more significantly affected facility owners and/or operators shall be notified by the SFPUC in advance of the timing, location, and duration of construction activities and the locations and durations of any temporary detours and/or lane closures.

Transit Controls

- Construction shall be coordinated with local transit service providers to arrange the temporary relocation of bus routes or bus stops in work zones, if necessary.
- Prior to construction activities, the SFPUC shall work with SamTrans and the City of South San Francisco to temporarily relocate the SamTrans bus stop located along the southbound lane of El Camino Real near West Orange Avenue. The temporary bus stop shall be located in an acceptable location that minimizes impacts to bus users and meets safety requirements.
- Prior to construction activities, the SFPUC shall work with SamTrans and the City of South San Francisco to temporarily relocate the SamTrans bus stop located in the pipeline construction zone along the northbound lane of Huntington Avenue. The temporary bus stop shall be located at an acceptable location that minimizes impacts to bus users and meets safety requirements.

Pedestrian and Bicycle Access

- Pedestrian and bicycle access and circulation shall be maintained during Project construction where safe to do so. If construction activities encroach on a bicycle lane, warning signs shall be posted that indicate bicycles and vehicles are sharing the lane.
- Detours shall be included for bicycles and pedestrians in all areas potentially affected by Project construction. Notices shall be provided to advise bicyclists and pedestrians of any temporary detours around construction zones.

Site 5

Site 5 would be located adjacent to, and just south of, B Street in Daly City (see Figures 3-14, 3-15, 3-18, and 3-19). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), Site 5 (On-site Treatment) would require partial lane closures along B Street for up to three weeks for installation of the proposed or alternate water connection pipeline, storm drain, and electrical lines. Installation of the storm drain pipeline at the site would occur within the curb and sidewalk on the south side of B Street, which would restrict parking, but would likely allow for continued two-way traffic flow along the approximately 300-foot lane closure. As shown in Table 5.6-4, Site 5 (Consolidated Treatment at Site 6) would require partial lane closures along B Street for up to one week, as well as along Hill Street and D Street for up to one week each for installation of the water connection pipeline from Site 5 to Site 6.

The travel lane closures on B Street, Hill Street, and D Street would result in a temporary reduction in roadway capacity; however, as shown in Table 5.6-8 (Local Roadway Project Level of Service), Hill Street and D Street currently operate at LOS A conditions. Traffic counts were not available for B Street, though it is assumed to operate at similar LOS conditions as Hill Street given its isolated location and surrounding uses. Therefore, B Street, Hill Street, and D Street would have sufficient capacity to accommodate the temporary reduction in roadway capacity from the temporary lane closures and, because the roadway segments would continue to operate satisfactorily during construction, in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant*.

However, the travel lane closures on B Street (required for both configurations of Site 5), Hill Street, and D Street could have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles, including the potential confusion of drivers where traffic is routed into the travel lane adjacent to the work zone. Construction activities within the public right-of-way for this site would be required to provide for continuity of vehicle traffic, reduce the potential for traffic accidents, and ensure worker safety in construction zones in accordance with local standards and specifications adopted by Daly City.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on B Street, Hill Street, and D Street to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for these roadways would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 5 to *less-than-significant* levels.

Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
(See above for a description)

Site 6

Site 6 would be located adjacent to D Street in Daly City (see Figures 3-14, 3-16, 3-18 and 3-20); traffic conditions would be the same for both Project options (On-site Treatment at Sites 5, 6, and 7 versus Consolidated Treatment for those sites at Site 6). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), construction of pipelines at Site 6 would require partial lane closures along D Street for approximately two weeks to accommodate installation of the storm drain, sanitary sewer, and electrical connections.

The travel lane closures on D Street would result in a temporary reduction in roadway capacity; however, as shown in Table 5.6-8 (Local Roadway Project Level of Service), D Street operates at LOS A conditions. Therefore, D Street would have sufficient capacity to accommodate the temporary reduction in roadway capacity from temporary lane closures and, because the roadway segments would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant*.

However, the travel lane closures on D Street would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles, including the potential confusion of drivers where traffic is routed into the travel lane adjacent to the work zone. Construction activities within the public right-of-way of D Street would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards, and ensure worker safety in construction zones in accordance with local standards and specifications adopted by Daly City.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on D Street to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Site 6 would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones, and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 6 to *less-than-significant* levels.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See above for a description)

Site 7

Site 7 would be located adjacent to and just north of Colma Boulevard, which is a major thoroughfare between El Camino Real and Junipero Serra Boulevard, and is the access road for the 280 Metro Mall to the west (see Figures 3-14, 3-17, 3-18, and 3-21). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), Site 7 (On-site treatment) would require partial lane closures along Colma Boulevard for up to two weeks for installation of the alternate water connection, storm drain, sanitary sewer, and electrical lines. If the proposed water connection were implemented then Colma Boulevard would still be subject to lane closures for installation of the sanitary sewer and storm drain pipelines. For Site 7 (Consolidated Treatment at Site 6), construction would require partial lane closures along Colma Boulevard for up to one week for installation of a storm drain and electrical lines.

The travel lane closures on Colma Boulevard would result in a temporary reduction in roadway capacity; however, as shown in Table 5.6-8 (Local Roadway Project Level of Service), Colma Boulevard currently operates at LOS A conditions. Therefore, Colma Boulevard would have sufficient capacity to accommodate the temporary reduction in roadway capacity from temporary lane closures and, because the roadway would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant.*

However, the travel lane closures on Colma Boulevard would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles, including the potential confusion of drivers where traffic is routed into the travel lane adjacent to the work zone. Construction activities within the public right-of-way of Colma Boulevard would be required to provide for continuity of vehicle traffic, reduce the potential for traffic accidents, and ensure worker safety in construction zones in accordance with local standards and specifications adopted by Colma.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Colma Boulevard to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Colma Boulevard would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones, and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 7 to *less-than-significant* levels.

Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
(See above for a description)

Site 10

Site 10 would be located in the southwest corner of the intersection of Hickey Boulevard and Camaritas Avenue (see Figure 3-25). Pipeline construction would require the partial closure of an approximately 25-foot long section of the southbound lane of Camaritas Avenue and also partially affecting the northbound lane, as well as an egress/ingress to the Winston Manor shopping mall on the east side of Camaritas Avenue. As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), installation of the sanitary sewer at Site 10 would require partial lane closures along Camaritas Avenue for up to one week.

The travel lane closures on Camaritas Avenue would result in a temporary reduction in roadway capacity. However, as shown in Table 5.6-8 (Local Roadway Project Level of Service), Camaritas Avenue near Hickey Boulevard currently operates at LOS A conditions. Therefore, Camaritas Avenue would have sufficient capacity to accommodate the temporary reduction in roadway capacity from temporary lane closures and, because the roadway would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant*.

However, the travel lane closures on Camaritas Avenue would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles. Construction activities within the public right-of-way of Camaritas Avenue would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards, and ensure worker safety in construction zones in accordance with local standards and specifications adopted by South San Francisco.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Camaritas Avenue to a *less-than-significant* level, which would be accomplished by requiring that the SFPUC and/or its contractor implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Camaritas Avenue would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 10 to *less-than-significant* levels.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See above for a description)

Site 12

Site 12 would be located adjacent to Southwood Drive and El Camino Real (see Figures 3-29 and 3-30). The installation of pipelines for connection with the local sanitary sewer and storm drain would require a temporary closure of approximately 90 feet of the eastbound lane of Southwood Drive east of Fairway Drive. As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), partial lane closures along Southwood Drive would be needed for up to one week. In addition, installation of the pipeline to connect the well at Site 12 to the regional water system would require the closure of approximately 800 feet of the sidewalk south along El Camino Real to West Orange Avenue, though lane closures along El Camino Real itself would not be needed. Sidewalk closure would be required for the proposed water connection; however no such closures would be needed for the alternate water connection.

The travel lane closures on Southwood Drive would result in a temporary reduction in roadway capacity. However, as shown in Table 5.6-8 (Local Roadway Project Level of Service), Southwood Drive near El Camino Real currently operates at LOS A conditions. Therefore, Southwood Drive would have sufficient capacity to accommodate the temporary reduction in roadway capacity from temporary lane closures and, because the roadway would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant*.

However, the travel lane closures on Southwood Drive would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles. Construction activities within the public right-of-way of Southwood Drive would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards, and ensure worker safety in construction zones in accordance with local standards and specifications adopted by South San Francisco.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Southwood Drive to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Southwood Drive would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 12 to *less-than-significant* levels.

Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
(See above for a description)

Site 13

Site 13 would be located just south of, and adjacent to, South Spruce Avenue in South San Francisco (see Figures 3-31 and 32). Construction of water connection and sanitary sewer pipelines would require temporary closure of an approximately 300-foot stretch of the right-hand eastbound travel lane of South Spruce Avenue from Huntington Avenue to Site 13. The sanitary sewer would also connect to the west side of Huntington Avenue on South Spruce Avenue. The connection to the regional water system would also extend along Huntington Avenue from South Spruce Avenue to Noor Avenue, requiring temporary closure of an approximately 1,400-foot stretch of the right-hand northbound travel lane of Huntington Avenue.

As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), partial lane closures along South Spruce Avenue would be needed for just over one week. Partial lane closures along Huntington Avenue would be needed for up to five weeks. In addition, partial lane closures at the intersection of South Spruce Avenue and Huntington Avenue would be needed for one week. If the alternate water connection pipeline (to California Water Service Company [Cal Water) were installed instead of the proposed connection (to San Bruno), then pipeline construction impacts would be limited to South Spruce Avenue and would result in temporary lane closure for approximately two weeks; Huntington Avenue would not be affected.

The travel lane closures on South Spruce Avenue and Huntington Avenue would result in a temporary reduction in roadway capacities. However, as shown in Table 5.6-8 (Local Roadway Project Level of Service), South Spruce Avenue and Huntington Avenue currently operate at LOS B and A conditions, respectively. Therefore, South Spruce Avenue and Huntington Avenue would have sufficient capacity to accommodate the temporary reduction in roadway capacity from temporary lane closures and, because the roadway would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant*.

However, the travel lane closures on South Spruce Avenue and Huntington Avenue would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles. Construction activities within the public right-of-way of South Spruce Avenue and Huntington Avenue would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards and ensure worker safety in construction zones in accordance with local standards and specifications adopted by South San Francisco.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on South Spruce Avenue and Huntington Avenue to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for South Spruce

Avenue and Huntington Avenue would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 13 to *less-than-significant* levels.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See above for a description)

Sites 14 and 15

Sites 14 and 15 would be located within the Golden Gate National Cemetery (GGNC) (see Figures 3-34, 3-35, and 3-36). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), pipeline construction to connect Site 14 to Site 15 (see Figure 3-34) would require a partial lane closure along Sneath Lane for up to two weeks. The partial travel lane closure would occur on the westbound portion of Sneath Lane. In addition, construction of the pipeline connecting Site 14 to Site 15 would also require the temporary closure of the southern entrance to the GGNC for approximately one to two days.

Pipeline construction for Site 15 (see Figures 3-34 and 3-36) connecting it to the storm drain and sewer systems would require partial lane closures along Sneath Lane for up to four weeks (see Table 5.6-4 [Location and Duration of Partial Roadway Closures]). Partial lane closures would be needed for both the westbound and eastbound lanes. Construction at Site 15 would also require the temporary closure of the southern entrance to the GGNC for approximately one to two days.

The travel lane closures on Sneath Lane would result in a temporary reduction in roadway capacity. However, as shown in Table 5.6-8 (Local Roadway Project Level of Service), Sneath Lane currently operates at LOS A conditions. Therefore, Sneath Lane would have sufficient capacity to accommodate the temporary reduction in roadway capacity from temporary lane closures and, because the roadway would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant.*

However, the travel lane closures on Sneath Lane would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles. Construction activities within the public right-of-way of Sneath Lane would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards and ensure worker safety in construction zones in accordance with local standards and specifications adopted by San Bruno.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Sneath Lane to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Sneath Lane would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones, and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Sites 14 and 15 to *less-than-significant* levels.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See above for a description)

Site 17 (Alternate)

Site 17 (Alternate) would be located adjacent to Collins Avenue in Colma (see Figure 3-38). Pipeline installation would extend halfway into Collins Avenue, which would require a partial closure of the eastbound lane during construction of the water connection, sanitary sewer, and storm drain liness. As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), pipeline construction would require a partial lane closure along Collins Avenue for up to one week.

The travel lane closure on Collins Avenue would result in a temporary reduction in roadway capacity. However, as shown in Table 5.6-8 (Local Roadway Project Level of Service), Collins Avenue operates at LOS A conditions. Therefore, Collins Lane would have sufficient capacity to accommodate the temporary reduction in roadway capacity from a temporary alternating lane closure and, because the roadway would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant*.

The travel lane closures on Collins Avenue would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles. Construction activities within the public right-of-way of Collins Avenue would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards, and ensure worker safety in construction zones in accordance with local standards and specifications adopted by Colma.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Collins Avenue to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Collins Avenue would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 17 (Alternate) to *less-than-significant* levels.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See above for a description)

Site 18 (Alternate)

Site 18 (Alternate) would be located adjacent to Alta Loma Drive in South San Francisco (see Figure 3-39). If the alternate water connection at Site 18 (Alternate) were selected, it would require a partial closure of an approximately 25-foot stretch of the eastbound lane of Alta Loma Drive. As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), the partial lane closure along Alta Loma Drive would be needed for approximately two days to construct the alternate water connection pipeline (to Cal Water) whereas the proposed water connection pipeline (to the SFPUC) would not require lane closures in Alta Loma Drive. The alternating travel lane closure on Alta Loma Drive would result in a temporary reduction in roadway capacity. Traffic counts were not available for Alta Loma Drive, though it is assumed to operate at similar LOS conditions as Camaritas Avenue, given its location and surrounding land uses. As shown in Table 5.6-8 (Local Roadway Project Level of Service), Camaritas Avenue near Hickey Boulevard currently operates at LOS A conditions. Therefore, it is presumed that Alta Loma Drive would have sufficient capacity to accommodate the temporary reduction in roadway capacity from a temporary a lane closure and, because the roadway would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant.*

However, the travel lane closures on Alta Loma Drive would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles. Construction activities within the public right-of-way of Alta Loma Drive would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards and ensure worker safety in construction zones in accordance with local standards and specifications adopted by South San Francisco.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Alta Loma Drive to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Alta Loma Drive would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones, and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at Site 18 (Alternate) to *less-than-significant* levels.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See above for a description)

Site 19 (Alternate)

Construction of the well at Site 19 (Alternate) would require partial lane closures along Southwood Drive for up to two weeks for installation of the water connection line from the well at Site 19 (Alternate) to a treatment facility location at Site 12 and to install a storm drain and electrical line (see Table 5.6-4

[Location and Duration of Partial Roadway Closures]). The rest of the installation of the pipeline to connect the well at Site 19 (Alternate) to the regional water system would be the same as with Site 12.

The travel lane closures on Southwood Drive would result in a temporary reduction in roadway capacities. However, as shown in Table 5.6-8 (Local Roadway Project Level of Service), Southwood Drive near El Camino Real currently operates at LOS A conditions. Therefore, Southwood Drive would have sufficient capacity to accommodate the temporary reduction in roadway capacity from temporary lane closures and, because the roadway would continue to operate satisfactorily during construction in accordance with local LOS standards, the temporary impact from travel lane closures at this site would be *less than significant*.

However, the travel lane closures on Southwood Drive would have a *significant* impact on traffic relative to the potential for construction within the right-of-way to result in an increase in traffic safety hazards for vehicles sharing the road with construction vehicles. Construction activities within the public right-of-way of Southwood Drive would be required to provide for continuity of vehicle traffic, reduce the potential for traffic hazards, and ensure worker safety in construction zones in accordance with local standards and specifications adopted by South San Francisco.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would still be required to reduce the potential impact of increased traffic safety hazards resulting from travel lane closures on Southwood Drive to a *less-than-significant* level, which would be accomplished by requiring the SFPUC and/or its contractor to implement a traffic control plan to reduce potential impacts on traffic flows and safety hazards during construction activities. The traffic control plan for Southwood Drive would minimize the potential impact of lane closures on traffic and safety hazards by providing for continuity of vehicle traffic, ensuring worker and vehicle safety within construction zones and prescribing traffic detours (if needed) to reduce the potential impacts. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on traffic at 19 (Alternate) to *less-than-significant* levels.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See above for a description)

Impact Conclusion: Less than Significant with Mitigation

Impact TR-2: The Project would temporarily impair emergency access to adjacent roadways and land uses during construction. (Less than Significant with Mitigation)

Construction activities associated with the Project would be conducted primarily on sites within the SFPUC right-of-way. However, as discussed under Impact TR-1, some construction activities would cross or be within public roadways and could require temporary lane closures. Temporary travel lane closures, including the extent and duration of closures, are summarized previously in Impact TR-1.

Pipeline construction within or adjacent to public roadways that would result in a reduction in travel lanes or partial roadway closures could result in delays for emergency response vehicles or temporarily block access to driveways and cross-streets along the pipeline route. At facility sites that would require partial road closures, but would not affect access to properties, the travel lane closures could result in delays for emergency response vehicles where such vehicles are routed into the travel lane adjacent to the work zone. These impacts would only occur during the day when construction is ongoing because vehicle access would be restored at the end of each workday through the use of steel trench plates or trench backfilling (see Chapter 3, Project Description, Section 3.5.1.3 [Water Distribution and Utility Pipeline Installation]).

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

<u>Sites 1, 3, 8, 9, 11, and Westlake Pump Station</u>

Construction at Sites 1, 9, and the Westlake Pump Station would not require travel lane closures or prevent access to adjacent land uses. At Site 3, Ben Franklin Intermediate School is accessed from Stewart Avenue, which would not be affected during construction. Construction at Site 8 would temporarily limit access to the back of the Kohl's Department Store during installation of the electrical conduit for up to two days (see Figure 3-22 and Table 5.6-1 [Daily Traffic Volume on Regional Roadways]). Customers, delivery vehicles, and emergency vehicles would continue to access the store through the front entrance, and circulation around either side of the store would remain available during trenching for installation of the underground electrical connection. Access to Site 11 would occur adjacent to a BART ventilation structure. However, access to the structure from adjacent roadways would not be impeded during construction at Site 11, as can be seen in Figure 3-28. As a result, no impacts would occur relative to emergency access and access to adjacent land uses during construction for Sites 1, 3, 8, 9, 11, and the Westlake Pump Station during construction; *no impact* would occur.

Impact Conclusion: No Impact

<u>Sites 4, 6, 7, 10, 12, 14, 15, 16, 17 (Alternate), 18 (Alternate), and 19 (Alternate)</u>

Site 4

As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), a partial lane closure along Park Plaza Drive would be needed for up to one week for installation of the storm drain. A partial lane closure at the intersection of 87th Avenue and Park Plaza Drive would also be needed for up to one week for storm drain and electrical connections. The temporary lane closures along Park Plaza Drive at Site 4 would not block emergency access to surrounding residences, which are accessed by White Street and portions of 87th Street and Nimitz Drive that would not be affected by construction (see Figure 3-12). Although construction of the well at Site 4 would occur on Garden Village Elementary School property, the school is accessed via Village Lane, which would not be affected during construction. The potential impact of partial lane closures on emergency vehicles using Park Plaza Drive or traveling through the intersection of Park Plaza Drive and 87th Avenue would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 6

Construction at Site 6 would require partial lane closures along D Street for connection of pipelines (see Figure 3-16 and 3-20) under either option (i.e., On-site treatment at Site 6, or with Consolidated Treatment at Site 6). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), construction of storm drains, electrical lines, and water connection pipelines at Site 6 would require partial lane closures along D Street for approximately one week. The partial lane closures would not block emergency access to surrounding land uses during construction. The potential impact of partial lane closures on emergency vehicles using D Street would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 7

As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), on-site treatment at Site 7 (see Figure 3-21) would require partial lane closures along Colma Boulevard for up to two weeks. Construction of storm drain and electrical lines at Site 7 (with Consolidated Treatment at Site 6) would require partial lane closures along Colma Boulevard for up to one week (see Figure 3-17). The partial lane closures would not block emergency access to surrounding land uses during construction. Access to the retail area west of Site 7 would not be affected by construction activities, given that construction activities would only affect the two westbound lanes, and left-hand eastbound lanes, of Colma Boulevard. The entrance to the Woodlawn Memorial Park occurs from El Camino Real and would be unaffected by construction at Site 7. Access to the Greenlawn Memorial Park occurs immediately across Colma Boulevard from Site 7. Access would be maintained during installation of the pipeline in the roadway and during all other phases of construction at the site, given that construction activities would not completely obstruct the driveway at this location. Access to the Greenlawn Memorial Park maintenance building would also be maintained during construction of the well facility, given that it has a driveway that lies outside of the proposed construction area boundary. The potential impact of partial lane closures on emergency vehicles using Colma Boulevard would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 10

As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), construction of sanitary sewer pipelines at Site 10 would require partial lane closures along Camaritas Avenue for up to one week (see Figure 3-25). The partial lane closure would not block emergency access to surrounding land uses during construction. Ingress to and egress from the Winston Manor shopping center across Camaritas Avenue would not be affected by construction. This shopping center is also accessible from Hickey Boulevard and El Camino Real, which would remain unobstructed by Project construction. The potential impact of partial lane closures on emergency vehicles using Camaritas Avenue would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 12

Site 12 would be located adjacent to Southwood Drive and El Camino Real (see Figures 3-29 and 3-30). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), Site 12 would require partial lane closures along Southwood Drive for up to one week. The partial lane closures would not block emergency access to surrounding land uses during construction. Access to nearby properties by residents or emergency responders would not be impeded given that they are accessed via Fairway Drive, which would remain unaffected by the Project. Access to the Garden Chapel Funeral Home would remain open during construction. The potential impact of partial lane closures on emergency vehicles using Southwood Drive would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 14

As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), construction of the water connection pipeline from Site 14 to Site 15 (see Figure 3-34) would require a partial lane closure along Sneath Lane for up to two weeks. The partial travel lane closure would occur on the westbound portion of Sneath Lane. In addition, construction of the pipeline connecting Site 14 to Site 15 would also require the temporary closure of the southern entrance to the GGNC for approximately one to two days.

The partial lane closures would not block emergency access to surrounding land uses during construction. Although construction would affect the southern access to the GGNC, the main access to the cemetery, approximately 1,600 feet west of the construction boundary, would not be blocked and visitors and emergency vehicles could continue to access the cemetery via that entrance. In addition, the temporary roadway and lane closures on Sneath Lane would not completely impede access to properties south of Sneath Lane, given that their driveways are not located where the Project would need to trench across Sneath Lane. The potential impact of partial lane closures on emergency vehicles using Sneath Lane would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 15

As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), construction of storm drain, sanitary sewer, and water connection pipelines for Site 15 (see Figures 3-34 and 3-36) would require partial lane closures along Sneath Lane for up to four weeks. Partial lane closures would be needed for both the westbound and eastbound lanes. Construction at Site 15 would also require the temporary closure of the southern entrance to the GGNC for approximately one to two days.

Similar to Site 14, the partial lane closures along Sneath Lane would not block emergency access to surrounding land uses during construction. Although construction would affect the southern access to the GGNC, the main access to the cemetery would not be blocked and visitors could continue to access the cemetery via that entrance. As a result, emergency access to the GGNC would not be completely impeded, especially given that the closure of the southern entrance would be temporary. In addition, the temporary roadway and lane closures on Sneath Lane would not completely impede access to properties south of Sneath Lane, given that their driveways are not located where the Project would need to trench across Sneath Lane. The potential impact of partial lane closures on emergency vehicles using Sneath Lane would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 16

Site 16 may require installation of an approximately 750-foot pipeline through the Orchard Supply Hardware parking lot if the alternate water connection were installed between the well at this site and El Camino Real (see Figure 3-37). Installation of the alternate water connection pipeline would temporarily limit access through a portion of the parking lot for approximately two weeks, assuming the installation of pipelines at a rate of approximately 300 to 600 feet per week. Customers and emergency responders would continue to have access to the store through the two front entrances on either side of the pipeline and circulation would remain available during trenching. Therefore, the impact on access to the Orchard Hardware Store would be *less than significant*. In addition, as shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), the connection to the sanitary sewer at Site 16 would require a partial lane closure along Hemlock Avenue for up to one week, and would include trenching within Hemlock Avenue on the back side of a multi-family residential complex. The potential impact of the partial lane closure on emergency vehicles using Hemlock Avenue would be of short duration and, as proposed, access through the construction area would be maintained at all times. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 17 (Alternate)

Construction at Site 17 (Alternate) would require construction within the eastbound lane of Collins Avenue (see Figure 3-38). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), pipeline construction would require a partial lane closure along Collins Avenue for up to one week to install sanitary sewer, storm drain, electrical lines, and the alternate or proposed water connection pipelines.

The partial lane closures would not block emergency access to surrounding land uses during construction. Access to Standard Plumbing Supply adjacent to Site 17 (Alternate) would be maintained during installation of the pipeline and during all other phases of construction at the site, given that the construction boundary would not completely obstruct the driveway at this location. The potential impact of partial lane closures on emergency vehicles using Collins Avenue would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 18 (Alternate)

Site 18 (Alternate) would be located adjacent to Alta Loma Drive in South San Francisco (see Figure 3-39). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), if the alternate connection at Site 18 (Alternate) is selected, it would require a partial lane closure along Alta Loma Drive for approximately two days. The partial lane closure would not block emergency access to surrounding land uses during construction, which are accessed on the north side of Alta Loma Drive and Del Monte Avenue, and which would therefore not be affected by construction. The potential impact of partial lane closures on emergency vehicles using Alta Loma Drive would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Site 19 (Alternate)

Site 19 (Alternate) would require construction of pipelines across Southwood Drive (see Figure 3-40). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), partial lane closures along Southwood Drive would be needed for up to two weeks. The partial lane closures would not block emergency access to surrounding land uses during construction. Access to nearby properties by residents or emergency responders would not be impeded given that they are accessed via Fairway Drive, which would remain unaffected by Project construction. Although construction would require temporary closure of portions of the Garden Chapel Funeral Home parking lot, the remaining portions of the parking lot would remain available to business patrons during construction. Access to the Our Redeemer's Lutheran Church is from a portion of Southwood Drive that would be unaffected by construction. The potential impact of partial lane closures on emergency vehicles using Southwood Drive would be of short duration and, as proposed, access through the construction area would be maintained at all times to allow traffic flow in both directions. Therefore, impacts related to impaired emergency access and access to adjacent land uses would be *less than significant*.

Impact Conclusion: Less than Significant

<u>Sites 2, 5, and 13</u>

Site 2

Construction activities at Site 2 would extend along the sidewalk on the east side of Park Plaza Drive (see Figure 3-12). Construction would not extend into the adjacent roadway, but would require trenching across a 20-foot private access road to the maintenance facility of the Lake Merced Golf Club. Construction across the road could be completed within one day, assuming the installation of pipelines at a rate of approximately 300 to 600 feet per week, as proposed. There are no alternate routes readily available to access the Lake Merced Golf Club maintenance facility in the event of an emergency and, therefore, the temporary closure of the access road during construction could result in a *significant* impact on emergency access, though only for one day.

However, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact of blocked access to the Lake Merced Golf Club maintenance facility access road by requiring that access be maintained using steel trench plates and that the contractor have ready at all times the means necessary to accommodate access by emergency vehicles to this property, such as plating over excavations, short detours and/or alternate routes. Therefore, the impact on emergency access following mitigation would be *less than significant*.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See Impact TR-1 for a description)

Site 5

Site 5 would be located adjacent to, and just south of, B Street in Daly City (see Figures 3-15 and 3-19). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), Site 5 (On-site Treatment) would require partial lane closures along B Street for up to three weeks for installation of pipeline components. Installation of the storm drain pipeline at the site would occur within the curb and sidewalk on the south side of B Street, which would restrict parking, but would allow for continued two-way traffic flow.

As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), Site 5 (Consolidated Treatment at Site 6) would require partial lane closures along B Street for up to three weeks, as well as along Hill Street and D Street for up to one week each (see Figures 3-14 and 3-15).

As described in Chapter 3, Project Description, Section 3.5.1.3 (Water Distribution and Utility Pipeline Installation), travel lane closures would be managed such that one travel lane would be kept open at all times to allow traffic flow in both directions. The potential impact on emergency access on B Street would, therefore, be *less than significant*, given that any such impact would be short-term and access through the construction area would be maintained.

The connection to the storm drain from Site 5 (for either configuration) would require trenching in front of the driveway to the residence adjacent to Site 5, which would block vehicle access during the day for approximately one day (based on the proposed rate of construction), resulting in a short-term but potentially *significant* impact on access to the adjacent residence at this site.

However, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact of blocked access to the residence to a *less-than-significant* level by requiring that access be maintained using steel trench plates and that the contractor have ready at all times the means necessary to accommodate access by emergency vehicles to such properties, such as plating over excavations, short detours, and/or alternate routes. Therefore, the impact on emergency access following mitigation would be *less than significant*.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See Impact TR-1 for a description)

Site 13

Construction at Site 13 would require temporary alternating lane closures on segments of South Spruce Avenue and Huntington Avenue (see Figures 3-31 and 3-32). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), partial lane closures along South Spruce Avenue would be needed for just over one week. Partial lane closures along Huntington Avenue would be needed for up to five weeks. In addition, partial lane closures at the intersection of South Spruce Avenue and Huntington Avenue would be needed for one week.

Through traffic on South Spruce Avenue would not be blocked and the partial closure of the intersection would not impede access to any adjacent properties because they are accessed either via South Spruce Avenue or Huntington Avenue, but not via the intersection. Therefore, emergency access could occur along South Spruce Avenue during all phases of construction and along Huntington Avenue, up to its intersection with South Spruce Avenue. The potential impact on emergency access on the intersection of South Spruce Avenue and Huntington Avenue would, therefore, be *less than significant*, given that any such impact would be short-term and access through the construction area would be maintained, as proposed.

In addition to the intersection crossing, temporary closure of a 300-foot stretch of the right-hand eastbound travel lane of South Spruce Avenue from Huntington Avenue to Site 13, and temporary closure of an approximately 1,400-foot stretch of the right-hand northbound travel lane of Huntington Avenue, would be needed. The pipeline would be installed near the curb on these roadways, leaving sufficient pavement width outside of the construction zone to accommodate two-way traffic flow along both South Spruce Avenue and Huntington Avenue. Therefore, emergency access through these roadway segments could occur during construction and the potential impact on emergency access at these locations would be *less than significant*, given that any such impact would be short-term and access around the construction would be possible. However, access to the businesses and offices along Huntington Avenue could be temporarily impacted during construction as installation of the pipeline may limit driveway access. In addition, access to a bank adjacent to Site 13, which only has one driveway off South Spruce Avenue, would also be temporarily blocked for approximately one day during pipeline installation associated with this site. Therefore, these impacts on access to adjacent properties could be *significant.*

However, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact of blocked access to the businesses and offices along Huntington Avenue and South Spruce Avenue to a *less-than-significant* level by requiring that access be maintained using steel trench plates, and that the contractor have ready at all times the means necessary to accommodate access by emergency vehicles to such properties, such as plating over excavations, short detours, and/or alternate routes. Therefore, the impact on emergency access following mitigation would be *less than significant*.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See Impact TR-1 for a description)

Impact Conclusion: Less than Significant with Mitigation

Impact TR-3: The Project would temporarily decrease the performance and safety of public transit, bicycle, and pedestrian facilities during construction. (Less than Significant with Mitigation)

Because construction activities would temporarily alter the normal functionality of adjacent roadways, the potential exists for a decrease in the performance and safety of public transit, bicycle, and pedestrian facilities during construction of the Project, including potential for:

- Conflicts between construction vehicles (with slower speeds and wider turning radii than autos) and vehicles, bicyclists, or pedestrians using the roadways;
- Conflicts between the movement of traffic and construction activities, particularly where traffic is routed into the travel lane adjacent to the work zone;
- Confusion of drivers during alternating one-lane, two-way traffic operations;
- Confusion of bicyclists and pedestrians due to temporary alterations in bicycle and pedestrian circulation and on-street parking supply; and
- Distraction of drivers related to construction activities and nighttime lighting.

In general, construction contractors for any projects affecting public rights-of-way (e.g., roadways, sidewalks, and walkways) are required by local jurisdictions or the California Department of Transportation (Caltrans) to: provide for continuity of vehicle, pedestrian and bicycle traffic; reduce the potential for traffic accidents; and ensure worker safety in construction zones. Since work zone activities can disrupt mobility and access for bicyclists and pedestrians, and safe and convenient access would need to be maintained. Continuance of pedestrian and disabled access would be important on residential streets with sidewalks and where travel lanes and/or parking lane closures are anticipated.

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

<u>Sites 1, 8, 9, 11, and Westlake Pump Station</u>

Construction activities at Site 1 would extend approximately 75 feet into the end of Poncetta Drive (see Figure 3-11). However, Poncetta Drive ends at the facility site and does not have public transit, bicycle, or pedestrian facilities within the construction area boundary at Site 1. Construction activities at Sites 8, 9, 11, and the Westlake Pump Station would not require travel lane closures or affect public transit, bicycle, or pedestrian facilities, because no such facilities exist within the construction area boundary of these sites. A pedestrian and bicycle access pathway extends from the Verano Condominium complex on Mission Road to El Camino Real along the San Mateo County Flood Control Channel south and west of Site 9. The pathway is outside the construction area boundary and access would be unaffected by construction at Site 9. Therefore, there would be *no impacts* on public transit, bicycle or pedestrian facilities at these sites.

Impact Conclusion: No Impact

Sites 2, 3, 4, 5, 6, 7, 10, 16, 17 (Alternate), and 18 (Alternate)

Site 2

During the connection of Site 2 to the storm drain system (see Figure 3-12) approximately 200 feet of the sidewalk along the east side of Park Plaza Drive would be closed for up to one week, assuming the installation of pipelines at a rate of approximately 300 to 600 feet per week, as proposed. South Park Plaza Drive in this location is listed as a Class III bicycle route and, although construction would not encroach into the roadway at this location, construction activities would be close enough to the roadway that the bicycle access would likely be temporarily closed during installation of the pipeline. The potential impact on pedestrian and bicycle facilities at this location would be *less than significant*, given that any such impact would be short-term (approximately one week), would be performed during the summer when school is not in session (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]), and because alternate sidewalk and bicycle access would continue to be available on the west side of Park Plaza Drive. In addition, there would be *no impact* on the performance or safety of public transit facilities at this location given that no public transit facilities or routes are located along Park Plaza Drive.

Site 3

Construction activities for Site 3 would not require work within the right-of-way, although construction traffic would enter and exit the site using a temporary access driveway just south of the intersection of Park Plaza Drive and Coronado/Palmcrest Avenue. The potential impact on pedestrian and bicycle facilities at this location would be *less than significant*, given that construction would be performed during the summer when school is not in session (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]) and because the sidewalk and bicycle access would continue to be available at this location. In addition, there would be *no impact* on the performance or safety of public transit facilities at this location given that no public transit facilities are located within the construction area boundary.

Site 4

During construction at Site 4 (see Figure 3-12), approximately 350 feet of the sidewalk along the east side of Park Plaza Drive starting at the intersection with 87th Street would be closed. In addition, installation of the storm drain pipeline and the buried electrical lines extending from Site 4 to a location approximately 200 feet south of the well site would require temporary alternating lane closures of the intersection and the existing pedestrian crosswalk on the east side of the intersection. The potential impact on pedestrian and bicycle facilities at this location would be *less than significant*, given that any such impact would be short-term (alternating lane closures are conservatively estimated to last one week), and because sidewalk, crosswalks, and bicycle access would continue to be available on the west side of Park Plaza Drive and the intersection with 87th Street. Although 87th Street is used as a bus route by SamTrans (Routes 24, 121, and 122) (SamTrans 2010), there would be *no impact* on the performance or safety of public transit facilities at this location, given that no bus stops are located within the construction area boundary and because access through the construction area would be maintained.

Site 5

Construction of Site 5 (On-site Treatment) would require the temporary closure of approximately 300 feet of the sidewalk on the south side of B Street for installation of a storm drain line for up to one week, assuming the installation of pipelines at a rate of 300 to 600 feet per week, as proposed. For Site 5 (Consolidated Treatment at Site 6) installation of the water connection pipeline to Site 6 would also require temporary closures of sidewalks on Hill Street approximately 400 feet southeast of Site 5 and along D Street approximately 600 feet southeast, during the construction period. The potential impact on pedestrian facilities at these locations would be *less than significant*, given that any such impact would be short-term (approximately one week each) and because sidewalks would continue to be available on the opposite side of the roadways. Construction activities would not affect bicycle facilities, because no such facilities exist along roadways within the construction area. Although Hill Street and D Street are used as routes by SamTrans (Routes 121 and 123) (SamTrans 2010), there would be no impact on the performance or safety of public transit facilities along these roadways, because no bus stops are located within the construction area, the roadways currently operate at acceptable levels of service (see Impact TR-1), and the roadways would remain open to vehicle travel during construction.

Site 6

It is conservatively assumed for this analysis that Site 6 (either with on-site treatment at Sites 5, 6, and 7 or consolidated treatment at Site 6) would require the temporary closure of approximately 30 feet of the eastbound lane of D Street near Hill Street for connection of an alternate water connection for up to one day, and an approximately 100-foot section of roadway and sidewalk near the Colma BART station for up two days, depending on the extent of utilities in the construction area. Pedestrians accessing the Colma BART station would not be affected by Project construction at Site 6, regardless of the treatment scenario, because access around the construction zone would be available. The potential impact on pedestrian facilities at these locations would, therefore, be *less than significant*, given that any such impact would be short-term (one day near Hill Street and up to two days near Colma BART station) and on a short segment of sidewalk. Construction activities would not affect bicycle facilities because no such facilities exist along D Street. Although D Street is used as a bus route for SamTrans Routes 121 and 123 (SamTrans 2010), the potential impact on the performance or safety of public transit facilities along D Street would be *less than significant*, because no bus stops are located within the construction area, D Street currently operates at acceptable levels of service (see Impact TR-1) and D Street would remain open to vehicle travel during construction.

Site 7

Construction of Site 7 (On-site Treatment) would require the temporary closure of two sections of sidewalk on the north side of Colma Boulevard, approximately 75 feet and 20 feet in length, respectively, as well as temporary lane closures. It is conservatively assumed for this analysis that the temporary closure of the sidewalk and alternating travel lane closures would be needed for up to two weeks depending on the extent of utilities in the construction area. The construction activities would not affect public transit or bicycle facilities because no such facilities are provided along this stretch of Colma Boulevard. The potential impact on pedestrian facilities at these locations would, therefore, be *less than* *significant*, given that any such impact would be short-term (approximately two weeks) and because pedestrian access around the construction zone would be available on the opposite side of the roadway.

Site 10

Pipeline construction at Site 10 would require the partial closure of an approximately 25-foot long section of sidewalk on the west side of Camaritas Avenue during installation of a sanitary sewer connection, which would also affect the existing pedestrian crosswalk across Camaritas Avenue. Although construction would affect the pedestrian crosswalk, an additional pedestrian crosswalk at the intersection of Camaritas Avenue and Hickey Boulevard (approximately 125 feet north of the construction boundary) would not be blocked and would provide pedestrian access. As a result, the potential impact on pedestrian facilities would be *less than significant*. The construction activities would not affect bicycle facilities because no such facilities are provided along this stretch of Camaritas Avenue.

Camaritas Avenue is used as a bus route by SamTrans (Routes 35 and 133) and bus stops exist on both the northbound and southbound lanes near the Project area (SamTrans 2010). The bus stops would not be affected as they are located outside of the construction area boundary. The potential impact on the performance and safety of the public transit system at this location would be *less than significant*, given that the bus stops are not located within the construction area boundary and Camaritas Avenue would remain open to vehicle travel during construction.

Site 16

The connection to the sanitary sewer at Site 16 would require trenching within Hemlock Avenue on the back side of a multi-family residential complex. As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), it is assumed for this analysis that work within Hemlock Avenue would be needed for approximately one week. The construction activities would not affect public transit or bicycle facilities because no such facilities exist within the construction area as noted in Table 5.6-2 (Characteristics of Local Access Roadways for Facility Sites). The potential impact on pedestrian access at this location would, therefore, be *less than significant*, given that any such impact would be short-term (approximately one week) and because pedestrian access would be available on the opposite side of the complex.

Site 17 (Alternate)

Pipeline installation at Site 17 (Alternate) would require temporary closure of 100 feet of sidewalk on the south side (eastbound lane) of Collins Avenue. It is conservatively assumed for this analysis that work within the sidewalk would be needed for up to one week, as noted in Table 5.6-4 (Location and Duration of Partial Roadway Closures). The construction activities would not affect public transit or bicycle facilities because no such facilities exist along Collins Avenue in the area of construction as noted in Table 5.6-2 (Characteristics of Local Access Roadways for Facility Sites). The potential impact on pedestrian facilities at this location would, therefore, be *less than significant*, given that any such impact would be short-term, and because the sidewalk on the north side of Collins Avenue would remain open for pedestrian access around the construction zone.

Site 18 (Alternate)

The alternate water connection at Site 18 (Alternate) would require a temporary closure of an approximately 25-foot stretch of sidewalk along the eastbound lane of Alta Loma Drive to connect utility pipelines (see Figure 3-39). As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), work within the sidewalk would be needed for up to two days. The potential impact on pedestrian facilities at this location would be *less than significant*, given that any such impact would be short-term and because the sidewalk along the westbound lane of Alta Loma Drive would remain open for pedestrian access around the construction zone. The construction activities would not affect bicycle facilities, because no such facilities exist along Alta Loma Drive in the area of construction as noted in Table 5.6-2 (Characteristics of Local Access Roadways for Facility Sites). Alta Loma Drive is used as a bus route by SamTrans (Routes 35 and 133) and bus stops exist on both the eastbound and westbound lanes near the Project area (SamTrans 2010). The bus stops would not be affected as they are located outside of the construction area boundary. The potential impact on the performance and safety of the public transit system at this location would be *less than significant*, given that the bus stops are not located within the construction area boundary and Alta Loma Drive would remain open to vehicle travel during construction.

Impact Conclusion: Less than Significant

<u>Sites 12, 13, 14, 15, and 19 (Alternate)</u>

Site 12

Installation of the connection with the local sanitary sewer and storm drain would require a temporary closure of the sidewalk on the south side of Southwood Drive. It is conservatively assumed for this analysis that the sidewalk closure would be needed for up to one week. The potential impact on pedestrian facilities at this location would be *less than significant*, given that any such impact would be short-term (approximately one week) and because sidewalk access would continue to be available on the north side of Southwood Drive. In addition, installation of the pipeline to connect the well at Site 12 to the regional water system would require the closure of approximately 800 feet of the sidewalk along the west side of El Camino Real from 300 feet south of Southwood Drive to West Orange Avenue. The temporary closure of the sidewalk would be needed for up to three weeks, assuming the installation of pipelines at a rate of approximately 300 to 600 feet per week. Therefore, the potential impact on pedestrian facilities along El Camino Real would be *less than significant*, given that any such impact would be short-term (approximately three weeks) and because sidewalk access would continue to be available on the east (opposite) side of El Camino Real. Construction activities along Southwood Drive would not affect bicycle or public transit facilities because no such facilities exist along Southwood Drive.

A SamTrans bus stop on southbound El Camino Real near West Orange Avenue would be located within the construction area boundary of the proposed water connection pipeline for Site 12 (see Figure 3-29). If the alternate water connection associated with Site 12 were constructed, there would be no impact to the bus stop on El Camino Real. However, if the proposed water connection were constructed, the impact on the performance and safety of public transit at this location would be *significant*, given that the bus stop would be directly impacted by construction and would need to be temporarily relocated during pipeline construction. There is an existing bus stop near Southwood Drive; therefore, a relocated bus stop, if one were required, would likely be sited on the south side of West Orange Avenue and used for up to three weeks.

Nevertheless, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact of construction on the performance and safety of the southbound bus stop on El Camino Real near West Orange Avenue by requiring coordination with SamTrans and the City of South San Francisco to arrange the temporary relocation of the bus stop, as necessary. Given the presence of an existing bus stop near Southwood Drive, the likely area for temporary relocation of this bus stop, if needed, would be on the south side of West Orange Avenue. Therefore, the impact on the performance and safety of public transit at this location following mitigation would be *less than significant*.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See Impact TR-1 for a description)

Site 13

Construction of water and sewer pipelines would require temporary closure of an approximately 300-foot stretch of sidewalk, a Class III bicycle route, and the right-hand eastbound travel lane of South Spruce Avenue from Huntington Avenue to Site 13. The temporary closure along South Spruce Avenue would last up to one week, assuming the installation of pipelines at a rate of approximately 300 to 600 feet per week, as proposed. In addition, as shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), partial lane closures at the intersection of South Spruce Avenue and Huntington Avenue would be needed for up to one week, including the pedestrian crossing on the south side of the intersection. The connection to the regional water system would also extend along Huntington Avenue from South Spruce Avenue to Noor Avenue, requiring temporary closure of an approximately 1,400-foot stretch of sidewalk, a Class III bicycle route, and the right-hand northbound travel lane of Huntington Avenue. As shown in Table 5.6-4, the temporary closure along Huntington Avenue would last up to five weeks, assuming the installation of pipelines at a rate of approximately 300 to 600 feet per week, resulting in a short-term *significant* impact on bicycle and pedestrian facilities.

Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact on bicycle access in the northbound lane to a *less-than-significant* level by requiring that access be maintained during Project construction, where safe to do so. Warning signs would be posted that indicate bicycles and vehicles are sharing the lane, and detours would be provided for bicycles and pedestrians within construction areas, where safe to do so. Therefore, the impact on pedestrian and bicycle facilities following mitigation would be *less than significant*. In addition, a sidewalk, crosswalks, and bicycle access would continue to be available on the north side of South Spruce Avenue and west side of Huntington Avenue, and a Class I bicycle and pedestrian path is located to the east of the Project area, known as the Centennial Way Trail. Therefore, even if it is not safe to maintain bicycle and pedestrian access through the construction area along the northbound lane of Huntington Avenue, the impact would be *less than significant* given the availability of other access routes in the area around the construction zone.

Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
(See Impact TR-1 for a description)

South Spruce Avenue and Huntington Avenue are used as a bus route by SamTrans (Route 133) (SamTrans 2010). No bus stops would be impacted by construction on South Spruce Avenue. However, a bus stop on northbound Huntington Avenue would be located within the construction area boundary of the proposed water connection pipeline that would need to be temporarily relocated during construction. Therefore, the impact on the performance and safety of public transit at this location would be *significant*, given that the bus stop would be directly impacted by construction and would need to be relocated during the pipeline construction along Huntington Avenue.

However, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact of construction on the performance and safety of the northbound bus stop on Huntington Avenue by requiring coordination with SamTrans and the City of South San Francisco to arrange the temporary relocation of the bus stop, as necessary. The impact on the performance and safety of public transit at this location following mitigation would therefore be *less than significant*.

Sites 14 and 15

As shown in Table 5.6-4 (Location and Duration of Partial Roadway Closures), pipeline construction at Site 14 and Site 15 (see Figure 3-34) would require a partial lane closure along Sneath Lane. The partial travel lane closure would include work within a 700-foot stretch of sidewalk and a Class II bicycle lane along the westbound travel lane of Sneath Lane for up two weeks, assuming the installation of pipelines at a rate of approximately 300 to 600 feet per week, as proposed, resulting in a short-term *significant* impact on bicycle and pedestrian facilities.

Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact on pedestrian and bicycle access in the westbound lane to a *less-than-significant* level by requiring that access be maintained during Project construction, where safe to do so. Warning signs would be posted that indicate bicycles and vehicles are sharing the lane, and detours would be provided for bicycles and pedestrians within construction areas. Therefore, the impact on emergency access following mitigation would be *less than significant*. In addition, a sidewalk and Class II bicycle lane would continue to be available along the eastbound travel lane of Sneath Lane.

Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
(See Impact TR-1 for a description)

Although Sneath Lane is used as a bus route for SamTrans (Route 43) (SamTrans 2010), the potential impact on the performance or safety of public transit facilities along Sneath Lane would be *less than significant*, given that no bus stops are located within the construction area, the road currently operates at acceptable levels of service (see Impact TR-1), and Sneath Lane would remain open to vehicle travel during construction.

Site 19 (Alternate)

If Site 19 (Alternate) were selected for implementation, the entire width of Southwood Drive would need to be trenched to install the pipeline that would connect the well to the SFPUC water transmission system. It is conservatively assumed for this analysis that alternating travel lane closure on Southwood Drive would be needed for up to two weeks for construction of Site 19 (Alternate). If Site 19 (Alternate) were implemented, the potential impact on pedestrian facilities along Southwood Drive could be *significant*, given that sidewalk access on both sides of the roadway may be temporarily disrupted.

However, Mitigation Measure M-TR-1 (Traffic Control Plan) would reduce the impact of temporary sidewalk and pedestrian access along Southwood Drive by maintaining, where safe, pedestrian access and circulation and detours in areas affected by Project construction. Therefore, implementation of Mitigation Measure M-TR-1 would reduce potential impacts on pedestrian access along Southwood Drive to *less-than-significant* levels.

> ***Mitigation Measure M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])***
> (See Impact TR-1 for a description)

Impact Conclusion: Less than Significant with Mitigation

5.6.3.5 Operational Impacts and Mitigation Measures

Impact TR-4: Project operations and maintenance activities would not conflict with an applicable plan or policies regarding performance of the transportation system or alternative modes of transportation. (Less than Significant)

Operational Traffic

<u>All Sites</u>

As described in the Chapter 3, Project Description, Section 3.8.3 (Maintenance), during operation of the Project, each well station would be visited daily when wells are operating for routine equipment checks, for approximately 30 minutes each. During normal and wet years, the wells normally would be turned off, and regular exercising would be conducted on a weekly or monthly basis. As described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types), the proposed chemical building storage capacity allows for the frequency of chemical delivery to occur on a two- to three-week period. Therefore, when wells are operating, up to two trips per day at most could occur for each site (i.e., one for equipment checks and one for chemical delivery, given that different chemicals may require delivery on different trucks), but the frequency of up to two trips per day to any one site would only occur once every two to three weeks.

As shown in Table 5.6-8 (Local Roadway Project Level of Service), the roadway segments in the vicinity of Sites 1 through 15, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station currently operate at acceptable levels of service during the A.M. and P.M. peak periods. The potential impact of up to two additional operational trips distributed throughout the day on local roadway segments in the vicinity of these sites would be *less than significant*, given that the maintenance trips would be so few compared to the existing volumes of vehicles using the roadways.

Maintenance and chemical deliveries for Site 16 would contribute up to two trips per day on Millbrae Avenue once every two to three weeks when the well is operating. As described in Section 5.6.1.4 (Existing Traffic Conditions), and previously under Impact TR-1, based on traffic counts, Millbrae Avenue from El Camino Real to Rollins Road currently operates at LOS F conditions during both the A.M. and P.M. peak hours. However, the potential impact of up to two additional daily operational trips per day on Millbrae Avenue would be *less than significant*, given that the trips would be distributed throughout the day and that, accordingly, they would not substantially affect the existing traffic levels of service or delays.

Impact Conclusion: Less than Significant

Public Transit, Bicycle, or Pedestrian Facilities

<u>All Sites</u>

Operation of the Project would not introduce any new users of alternative modes of transportation into the study area, nor would it conflict with policies promoting bus turnouts, bicycle racks, or with pedestrian and bicycle paths, because these well facilities would be set back away from the routes of any alternative transportation modes. Therefore, it would not cause a substantial increase in transit demand that cannot be accommodated by existing or proposed transit capacity or alternative travel modes, and the potential impact would be *less than significant.*

Impact Conclusion: Less than Significant

Traffic Hazards or Incompatible Uses

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 14, 16, and Westlake Pump Station</u>

No new driveways onto a public roadway or any other traffic-related design feature would be constructed at Sites 1, 2, 3, 4, 5, 7, 8, 9, 11, 12, 14, 16, and the Westlake Pump Station. Therefore, *no impact* relative to increased traffic hazards would occur at these sites.

Impact Conclusion: No Impact

<u>Sites 6, 10, 13, 15, 17 (Alternate), 18 (Alternate), and 19 (Alternate)</u>

A new driveway would be constructed onto local roadways at Sites 6, 10, 13, 15, 17 (Alternate), 18 (Alternate), and 19 (Alternate). The potential impact of the new access points onto adjacent roadways would be *less than significant*, given that the access roads would be located perpendicular to the public roadways, would not result in sharp or blind curves or dangerous intersections and would be accessed by normal maintenance and chemical delivery trucks which would not be incompatible uses on the adjacent roadways.

Impact Conclusion: Less than Significant

5.6.3.6 Cumulative Impacts and Mitigation Measures

Impact C-TR-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to transportation and circulation. (Less than Significant with Mitigation)

The geographic scope for the analysis of cumulative impacts on transportation and circulation consists of the roadways affected by the proposed GSR Project and the areas in northern San Mateo County that use the same roadways as the Project.

Construction

Conflict with a plan or policy regarding performance of the traffic system

Most of the cumulative projects listed on Table 5.1-3 (Projects Considered for Cumulative Impacts), in Section 5.1, Overview, Section 5.1.7 (Cumulative Impacts) would result in construction-related incremental vehicle trip additions to the local roadways in northern San Mateo County if construction of these projects were to occur at the same time as construction of the GSR Project. For example, the SFPUC's Peninsula Pipelines Seismic Upgrade Project would, at its Colma and South San Francisco sites, as well as the Baden Valve Lot staging area (cumulative projects D-1, D-2, and D-3, respectively), use similar construction traffic routes as GSR Sites 8, 12, 17 (Alternate), and 19 (Alternate). The Daly City "A" Street Well Replacement Project (cumulative project C) could be constructed during the same timeframe as the GSR Project and may overlap with construction of GSR Sites 5, 6, and 7. The Cal Water Well Replacement SSF1-25 Project (cumulative project G) and the PG&E Transmission Pipeline Replacement Project in South San Francisco (cumulative project H) could overlap GSR construction at Sites 11, 12, and 19 (Alternate), and the construction access routes may be the same for both projects. In addition to the projects listed, it can be reasonably assumed that traffic volumes throughout the cumulative study area may increase slightly by the time GSR Project construction occurs in 2014 and 2015.

As described previously in Impact TR-1, the GSR Project would have *less-than-significant* impacts on the performance of the local roadway network, because proposed construction traffic volumes would be small (even during peak travel times) and because the local roadway system has available capacity for GSR Project-related construction trips.

To evaluate the cumulative effect of construction traffic on local roadways from the GSR Project plus cumulative projects with potentially overlapping construction schedules, the same methodology was applied as was utilized for the Project-specific analysis reported in Impact TR-1. Because data for construction traffic for the cumulative projects are not available, estimates of construction traffic taken from similar projects were utilized; see Table 5.6-9 (Cumulative Traffic Peak Hour Construction Trips), which lists cumulative projects that could contribute to cumulative traffic impacts on the same local roadway segments as the proposed GSR Project. In this analysis, Existing plus Project traffic volumes (without the effect of cumulative projects) were increased by the percentage of population growth between 2010 and 2015 as reported in the Association of Bay Area Governments (ABAG) 2009 Projections (ABAG 2009). The 2009 Projections are the most recent projections published by ABAG, and have been used in the San Mateo C/CAG *2011 Congestion Management Program*, the Metropolitan Transportation Commission's *Transportation Plan 2035* and the Bay Area Air Quality Management District's *Bay Area 2010 Clean Air Plan*. Both the *Transportation Plan 2035* and the *Bay Area 2010 Clean Air Plan* were subject to separate environmental review.

These future traffic volumes on roadways in the cumulative study area were compared to existing roadway capacities and a LOS was assigned to each V/C ratio (see Section 5.6.3.2 [Approach to Analysis] for further explanation of this methodology). Table 5.6-10 (Local Roadway Project plus Cumulative Projects Level of Service), presents the projected LOS of the roadway segments in the GSR Project vicinity with the addition of construction-related traffic from the GSR Project, cumulative projects and background growth in traffic volumes.

Table 5.6-10 (Local Roadway Project plus Cumulative Projects Level of Service), shows that most area roadways would continue to function at acceptable LOSs in the cumulative scenario, except for the segment of John Daly Boulevard from I-280 to Sheffield Drive (the gray shading in Table 5.6-10 highlights the segments with unacceptable LOS). As shown, this roadway segment is anticipated to operate at LOS C (V/C ratio 0.76) during the P.M. peak hour under Existing plus Project conditions, and at LOS D (V/C ratio 0.81) under the Existing plus Project plus Cumulative Projects scenario. Daly City currently employs a LOS C standard to determine impacts of new land uses on the City's roadway network and the need for intersection improvements. Under the City's Draft General Plan Update, for which a Draft EIR was circulated in October and November 2012, the City would employ a LOS D standard (Daly City 2012). Although Daly City may change its LOS standard in the future, this cumulative analysis conservatively uses the LOS C standard. Therefore, because the Existing plus Project plus Cumulative Projects scenario indicates that the segment of John Daly Boulevard from I-280 to Sheffield Drive would operate at LOS D, the temporary cumulative impact associated with construction-related traffic along this roadway segment would be *significant*.

In evaluating the direction of Project construction-related vehicle trips associated with the Project, it was determined that such trips would be westbound along John Daly Boulevard during the A.M. peak period and eastbound during the P.M. peak period. Traffic counts indicate that approximately 60 percent of traffic along John Daly Boulevard travels eastbound during the A.M. peak hour and westbound during the P.M. peak hour. Therefore, the contribution of the GSR Project and cumulative project traffic to these segments of John Daly Boulevard would be in the opposite direction of the peak traffic flows.

Additionally, an evaluation of existing plus cumulative traffic volumes (without the effect of the Project) indicates that the P.M. peak hour LOS for the segment of John Daly Boulevard from I-280 to Sheffield Drive would operate at LOS D (V/C ratio slightly above 0.80) without any contribution of traffic from the Project. With the addition of Project traffic to the cumulative scenario, the volume to capacity ratio of this segment during the P.M. peak hour would be increased to 0.81. However, the addition of Project construction traffic would not result in a change to a lower level of service (i.e., from LOS D to LOS E). Therefore, the construction traffic from the GSR Project would not make a considerable contribution to a significant cumulative traffic impact (*less than significant*).

Depending on the extent of overlap among the construction schedules for the projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) in Section 5.1, Overview, Section 5.1.7 (Cumulative Impacts), implementation of these projects together with the proposed GSR Project could result in a cumulative impact regarding a conflict with applicable plans or policies related to performance of the transportation system. However, these impacts would be temporary (only during construction) and small. For these reasons, the potential cumulative impact regarding a conflict with applicable plans or policies related to performance of the transportation system from construction-related activities would be (*less than significant)*.

TABLE 5.6-9

Cumulative Traffic Peak Hour Construction Trips[a]

Local Roadway Segment	Vista Grande Drainage Basin Improvement Project (B)[b]	Daly City "A" Street Well Replacement (C)[b]	Peninsula Pipelines Seismic Upgrade (D-1, D-2, and D-3)[b]	Holy Cross Cemetery Expansion (E)[b]	Mission & McLellan (F)[b]	Well Replacement SSF1-25 (Cal Water) (H)[b]	PG&E Transmission Pipeline Replacement (I)[b]	Centennial Village (J)[b]	Total Peak Hour Trips
Junipero Serra Boulevard from Pacific Plaza North Garage to John Daly Boulevard	20	---	---	---	---	---	---	---	20
John Daly Boulevard from I-280 to Sheffield Drive	20	---	---	---	---	---	---	---	20
John Daly Blvd from Sheffield Drive to Park Plaza Drive	20	---	---	---	---	---	---	---	20
D Street from Hill Street to Junipero Serra Boulevard	---	6	---	---	---	---	---	---	6
F Street at El Camino Real	---	6	---	---	---	---	---	---	6
Washington Street from San Pedro Road to I-280	---	6	---	---	---	---	---	---	6
Serramonte Boulevard near El Camino Real	---	---	12	---	---	---	---	---	12
Serramonte Boulevard from Collins Avenue to Shopping Center	---	---	12	---	---	---	---	---	12
Collins Avenue from Serramonte Boulevard to El Camino Real	---	---	12	---	---	---	---	---	12
Junipero Serra Boulevard from Serramonte Boulevard to Hickey Boulevard	---	---	12	---	---	---	---	---	12
Mission Road from El Camino Real to McLellan Drive	---	---	---	5	24	---	---	---	29
McLellan Drive from Mission Road to El Camino Real	---	---	---	5	24	---	---	---	29
Hickey Boulevard from El Camino Real to Camaritas Avenue	---	---	---	5	24	---	---	---	29
Hickey Boulevard from Crown Circle to Hilton Avenue	---	---	---	5	24	---	---	---	29

TABLE 5.6-9

Cumulative Traffic Peak Hour Construction Trips[(a)]

Local Roadway Segment	Vista Grande Drainage Basin Improvement Project (B)[(b)]	Daly City "A" Street Well Replacement (C)[(b)]	Peninsula Pipelines Seismic Upgrade (D-1, D-2, and D-3)[(b)]	Holy Cross Cemetery Expansion (E)[(b)]	Mission & McLellan (F)[(b)]	Well Replacement SSF1-25 (Cal Water) (H)[(b)]	PG&E Transmission Pipeline Replacement (I)[(b)]	Centennial Village (J)[(b)]	Total Peak Hour Trips
Hickey Boulevard from Hilton Avenue to Junipero Serra Boulevard	---	---	---	5	24	---	---	---	29
Hickey Blvd west of Junipero Serra Blvd	---	---	12	5	24	---	---	---	41
Chestnut Avenue from Antoinette Lane to El Camino Real	---	---	---	---	---	6	12	---	18
Westborough Boulevard from Camaritas Avenue to Junipero Serra Boulevard	---	---	12	---	---	6	12	---	30
West Orange Avenue south of Westborough Boulevard	---	---	12	---	---	---	---	---	12
Huntington Avenue from South Spruce Avenue to Noor Avenue	---	---	---	---	---	---	---	24	24
South Spruce Avenue from Huntington Avenue to El Camino Real	---	---	---	---	---	---	---	24	24

Notes:

(a) Peak hour construction vehicle trips for cumulative projects are based on conservative assumptions regarding project type. The trips reflect an assumed number of worker trips, material/equipment deliveries, and hauling trips that may typically arrive or depart during either the A.M. or P.M. peak hour.

(b) The letter notes the cumulative project number as identified in Table 5.1-3 (Projects Considered for Cumulative Impacts) in Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, Section 5.1.7.2 (List of Relevant Projects).

TABLE 5.6-10

Local Roadway Project plus Cumulative Projects Level of Service

Roadway Segment	Closest Project Facility Sites	Existing plus Project[a]				Existing plus Project plus Cumulative Projects[b]				Local LOS Standard[c]
		V/C Ratio		LOS		V/C Ratio		LOS		
		A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	
Junipero Serra Boulevard from Pacific Plaza North Garage to John Daly Boulevard	1, 2, 3, 4, WLPS	0.57	0.57	A	A	0.61	0.61	B	B	C
John Daly Boulevard from I-280 to Sheffield Drive	1, 2, 3, 4, WLPS	0.58	0.76	A	C	0.62	0.81	B	D	C
John Daly Blvd from Sheffield Drive to Park Plaza Drive	2, 3, 4, WLPS	0.45	0.62	A	B	0.48	0.66	A	B	C
D Street from Hill Street to Junipero Serra Boulevard	5, 6	0.25	0.28	A	A	0.27	0.29	A	A	C
Washington Street from San Pedro Road to I-280	5, 6	0.37	0.46	A	A	0.39	0.49	A	A	C
F Street at El Camino Real	5, 6	0.29	0.37	A	A	0.31	0.39	A	A	D
Serramonte Boulevard near El Camino Real	8	0.30	0.56	A	A	0.32	0.59	A	A	D
Serramonte Boulevard from Collins Avenue to Shopping Center	8	0.35	0.51	A	A	0.38	0.55	A	A	D
Collins Avenue from Serramonte Boulevard to El Camino Real	17 (Alt)	0.24	0.27	A	A	0.26	0.30	A	A	D
Junipero Serra Boulevard from Serramonte Boulevard to Hickey Boulevard	7, 8, 17 (Alt)	0.35	0.60	A	A	0.37	0.64	A	B	D
Mission Road from El Camino Real to McLellan Drive	9	0.48	0.57	A	A	0.52	0.63	A	B	D
McLellan Drive from Mission Road to El Camino Real	9	0.38	0.25	A	A	0.41	0.27	A	A	D
Hickey Boulevard from El Camino Real to Camaritas Avenue	9	0.53	0.59	A	A	0.57	0.63	A	B	D
Hickey Boulevard from Crown Circle to Hilton Avenue	9, 10, 18 (Alt)	0.57	0.64	A	B	0.60	0.68	A	B	D

TABLE 5.6-10

Local Roadway Project plus Cumulative Projects Level of Service

Roadway Segment	Closest Project Facility Sites	Existing plus Project[a]				Existing plus Project plus Cumulative Projects[b]				Local LOS Standard[c]
		V/C Ratio		LOS		V/C Ratio		LOS		
		A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	A.M. Peak	P.M. Peak	
Hickey Boulevard from Hilton Avenue to Junipero Serra Boulevard	9, 10, 18 (Alt)	0.75	0.84	C	D	0.80	0.90	C	D	D
Hickey Blvd west of Junipero Serra Blvd	9, 10, 18 (Alt)	0.50	0.59	A	A	0.54	0.63	A	B	D
Chestnut Avenue from Antoinette Lane to El Camino Real	11	0.82	0.80	D	C	0.86	0.84	D	D	D
Westborough Boulevard from Camaritas Avenue to Junipero Serra Boulevard	11, 12, 19 (Alt)	0.85	0.85	D	D	0.90	0.90	D	D	D
West Orange Avenue south of Westborough Boulevard	12, 19 (Alt)	0.72	0.65	C	B	0.76	0.69	C	B	D
Huntington Avenue from South Spruce Avenue to Noor Avenue	13	0.25	0.36	A	A	0.27	0.38	A	A	D
South Spruce Avenue from Huntington Avenue to El Camino Real	13	0.62	0.70	B	B	0.66	0.74	B	C	D

Notes:

(a) As reported in Table 5.6-8 (Local Roadway Project Level of Service).

(b) V/C and LOS for local segments when traffic counts are adjusted to account for year 2015 population projections and total peak hour trips from Table 5.6-9 (Cumulative Traffic Peak Hour Construction Trips) are added to the Existing plus Traffic volumes for local roadways presented in Table 5.6-8.

(c) LOS standards defined for roadways and intersections in Daly City, Colma, South San Francisco, San Bruno and Millbrae general plans.

Impair emergency access and create traffic hazards for alternative modes of transportation

Many of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would likely require temporary lane closures, for example, the PG&E Transmission Pipeline Replacement Project (cumulative project H) would require lane closures in El Camino Real adjacent to the proposed water connection pipeline route from GSR Site 12, which would be located in the sidewalk along the same block of El Camino Real.

Although lane closures would be over short segments (e.g., 25-foot to 1,400-foot stretches) and temporary (e.g., two days to five weeks), the proposed GSR Project would have a *significant* impact on emergency access as identified previously in Impact TR-2. As discussed in the analysis for TR-2, construction at GSR Sites 2, 5, and 13 may temporarily block emergency access to individual businesses during construction. Therefore, cumulative impacts related to emergency access during construction would be *significant* and the GSR Project's contribution to this cumulative impact could be cumulatively considerable.

However, as discussed previously in Impact TR-2 and Impact TR-3, the GSR Project's impacts related to maintenance of emergency access and the safety of pedestrians and bicyclists during construction would be reduced to a *less-than-significant* level with implementation of Mitigation Measure M-TR-1 (Traffic Control Plan) (see Impact TR-2 for description). In addition, implementation of Mitigation Measure M-C-TR-1 (Coordinate Traffic Control Plan with other SFPUC Construction Projects) would ensure that the SFPUC and its contractor coordinate with other SFPUC construction projects in the region to avoid or minimize impacts on emergency access and on the safety of pedestrians and bicyclists during construction of the GSR Project. With implementation of this mitigation measure, the GSR Project's contribution to cumulative impacts related to impairing emergency access and hazards for alternative modes of transportation during construction would not be cumulatively considerable (*less than significant with mitigation*).

Mitigation Measure M-C-TR-1: Coordinate Traffic Control Plan with other SFPUC Construction Projects (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])

Prior to construction, the SFPUC and its contractors shall coordinate with other SFPUC construction projects in the region and update traffic control plans to avoid overlapping construction schedules or, if not practical, to minimize impacts to congestion, emergency access, and alternative modes of transportation.

Operation

Of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), the two infill development projects, the Mission & McLellan Project (cumulative project F) near Site 9 and Centennial Village Project (cumulative project I) near Site 13, may generate additional traffic near the proposed GSR Project's facility sites, although both cumulative projects would be, at least partially, replacing existing uses. Given the existing traffic volumes and intersection conditions in these areas (see Table 5.6-10 [Local Roadway Project plus Cumulative Projects Level of Service]), the presence of adequate ingress and egress, and the lack of permanent conflict with public transit or other alternative modes of transportation, no significant operational cumulative traffic impact is anticipated to occur (*less than significant*).

5.6.4 References

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5.7 NOISE AND VIBRATION

This section evaluates the potential noise and vibration impacts that could result from implementation of the GSR Project, both with regard to temporary impacts during construction and long-term impacts from operation. The section describes the existing noise environment, presents relevant noise and vibration regulations and standards, identifies sensitive receptors to noise that could be affected by the Project, evaluates the potential effects of Project construction and operation on these receptors, and identifies mitigation measures as appropriate.

The Project area is defined as 19 potential well sites (only 16 of which would be operated) and the Westlake Pump Station, which are located within the City of Daly City, the community of Broadmoor in unincorporated San Mateo County, the Town of Colma, and the cities of South San Francisco, San Bruno, and Millbrae (refer to Figures 3-4, 3-5, and 3-6, as well as 3-11 through 3-40, in Chapter 3, Project Description). The study area for noise and vibration includes noise-sensitive land uses located within and/or adjacent to the proposed facility sites that have the potential to be adversely affected by noise or vibration.

5.7.1 Setting

5.7.1.1 Characteristics of Noise

Sound is a phenomenon occurring in a medium (such as air or water) that results from pressure waves caused by a vibrating object and is the objective cause of hearing. The manner in which sound travels through this medium is influenced by the physical properties of the medium. The amount of energy in the sound is proportional to the pressure generated in the medium. The sound pressure level has become the most common descriptor used to characterize the loudness of an ambient sound; the decibel (dB) scale is used to quantify sound intensity. Because sound can vary in intensity over one million times within the range of human hearing, a logarithmic scale is used to keep sound pressure numbers at a convenient and manageable range. Since the human ear is not equally sensitive to all sound frequencies within the entire spectrum, human response is factored into sound descriptions in a process called "A-weighting," expressed as "dBA." The dBA, or A-weighted decibel, refers to a scale of noise measurement that approximates the range of sensitivity of the human ear to sounds of different frequencies. On this scale, the normal range of human hearing extends from about 0 dBA to about 140 dBA. The zero on the decibel scale is based on the lowest sound level that the healthy, unimpaired human ear can detect. Each 10-decibel increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities. All sound levels discussed in this report utilize the A-weighting scale. Tables 5.7-1 (Definitions of Acoustical Terms) and 5.7-2 (Typical A-Weighted Sound Levels) provide background information regarding noise terminology.

Planning for acceptable noise exposure must take into account the types of activities and corresponding noise sensitivity for a generalized land use type. Some general guidelines are as follows: sleep disturbance may occur at levels above 35 dBA, interference with human speech begins at around 60 dBA, and hearing damage may result from prolonged exposure to noise levels in excess of 85 to 90 dBA (U.S. EPA 1974).

Time variations in noise exposure are typically expressed in terms of a steady-state energy level (called L_{eq}) that represents the acoustical energy of a given measurement. $L_{eq}(24)$ is the steady-state energy level measured over a 24-hour period. The most common averaging period is hourly, but L_{eq} can describe any series of noise events of arbitrary duration. Since the sensitivity to noise increases during the evening and at night because excessive noise interferes with the ability to sleep, 24-hour descriptors were developed that incorporate artificial noise penalties added to quiet-time noise events. The Community Noise Equivalent Level (CNEL) is a measure of the cumulative noise exposure in a community, with a 5 dBA penalty added to noise levels during evening hours (i.e., 7:00 p.m. - 10:00 p.m.) and a 10 dBA penalty addition to noise levels during night hours (10:00 p.m. - 7:00 a.m.). Another 24-hour noise descriptor, called the day-night noise level (L_{dn}), is similar to CNEL. While both add a 10-dBA penalty to all nighttime noise events between 10:00 p.m. and 7:00 a.m., L_{dn} does not add the evening 5-dBA penalty. In practice, the L_{dn} and CNEL usually differ by less than 1 dBA at any given location for transportation noise sources. Table 5.7-1 (Definitions of Acoustical Terms), provides definitions of sound metrics and other terminology used in this chapter. Table 5.7-2 (Typical A-Weighted Sound Levels), summarizes typical A-weighted sound levels for different noise sources.

For a sound source that produces a constant sound, the L_{eq} will equal L_{max}. A sound source that varies over time will have an L_{min} value and an L_{max} value over a given period of time. The L_{eq} value for that given period of time will not be a mathematical mean or average, but will be greater than the L_{min} value but less than the L_{max} value. The actual L_{eq} value will depend on the nature of the source.

Since decibels are logarithmic units, sound pressure levels cannot be added or subtracted by ordinary arithmetic means. For example, if one automobile produces a noise level of 70 dBA when it passes an observer, two cars passing simultaneously would not produce 140 dBA. Rather, they would combine to produce 73 dBA (Caltrans 1998). When combining sound levels, Table 5.7-3 (Decibel Addition), may be used to approximate the combined result.

TABLE 5.7-1
Definitions of Acoustical Terms

Term	Definitions
Decibel, dB	A logarithmic unit that is used to describe the amplitude of sound.
Sound Pressure Level, dB	Sound pressure is the sound force per unit area, usually expressed in micro Pascals (micro Newtons per square meter), where one Pascal is the pressure resulting from a force of one Newton exerted over an area of one square meter. The sound pressure level is expressed in decibels as 20 times the logarithm to the base 10 of the ratio between the pressures exerted by the sound to a reference sound pressure (e.g., 20 micro Pascals). Sound pressure level is the quantity that is directly measured by a sound level meter.
Frequency, Hz (hertz)	The number of complete pressure fluctuations per second above and below atmospheric pressure. Normal human hearing is between 20 Hz and 20,000 Hz. Infrasonic sounds are below 20 Hz and Ultrasonic sounds are above 20,000 Hz.
A-Weighted Sound Level, dBA	The sound pressure level in decibels as measured on a sound level meter using the A-weighting filter network. The A-weighting filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise.
Equivalent Noise Level, L_{eq}	The average A-weighted noise level during the measurement period.
Community Noise Equivalent Level, CNEL	The average A-weighted noise level during a 24-hour day, obtained after addition of five decibels in the evening from 7:00 p.m. to 10:00 p.m. and after addition of 10 decibels to sound levels in the night between 10:00 p.m. and 7:00 a.m.
Day/Night Noise Level, L_{dn}	The average A-weighted noise level during a 24-hour day, obtained after addition of 10 decibels to levels measured in the night between 10:00 p.m. and 7:00 a.m.
L_{01}, L_{10}, L_{50}, $L_{90,}$	The A-weighted noise levels that are exceeded 1%, 10%, 50%, and 90% of the time during the measurement period.
L_{max}, L_{min}	The A-weighted maximum and minimum noise levels during the measurement period.
Ambient Noise Level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	That noise which intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, and time of occurrence and tonal or informational content as well as the prevailing ambient noise level.

Source: Illingworth & Rodkin, Inc. 2012

TABLE 5.7-2
Typical A-Weighted Sound Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110	Rock band
Jet flyover at 1,000 feet	100	
Gas lawnmower at three feet	90	
Diesel truck at 50 feet at 50 mph	80	Food blender at three feet
Noisy urban area, daytime	70	Vacuum cleaner at 10 feet
Commercial area	65	Normal speech at three feet
Heavy traffic at 300 feet	60	Large business office
Quiet urban daytime	50	Dishwasher in next room
Quiet urban nighttime	40	Theater, large conference room (background)
	30	Library
Quiet rural nighttime	20	Bedroom at night, concert hall (background)
	10	Broadcast/recording studio

Source: Caltrans 1998, modified by GHD

TABLE 5.7-3[(a)]
Decibel Addition

When the Decibel Values Differ by:	Add this Amount to the Higher Value:
0 or 1 dB	3 dB
2 or 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0 dB

Source: Caltrans 1998

Note:

(a) The following are some examples of how this is table is used. If two sound sources are 50 and 58 dB, they differ by 8 dB and would therefore add up to 59 dB (58 dB plus 1 dB). If two sound sources are 64 dB and 67 dB, they differ by three and would therefore add up to 69 dB (67 dB plus 2 dB).

5.7.1.2 Characteristics of Groundborne Vibration

Operation of heavy construction equipment, particularly pile driving and other impact devices (e.g., pavement breakers), causes groundborne vibration. Vibration from operation of this type of equipment can result in effects ranging from annoyance of people to damage of structures. Vibration amplitudes will decrease with increasing distance as the energy dissipates. The rate of dissipation varies depending upon the soil composition.

If great enough, the energy transmitted through the ground as vibration can result in damage ranging from small noticeable cracks that do not affect the soundness of structures, to damage that affects the structural integrity of the building. To assess the potential for structural damage associated with vibration, the vibratory ground motion in the vicinity of the affected structure is measured in terms of peak particle velocity (PPV) in the vertical and horizontal directions (vector sum), typically in units of inches per second (in/sec). A freight train passing at 100 feet can cause vibrations of 0.1 in/sec PPV, while a strong earthquake can produce vibrations in the range of 10 in/sec PPV.

Vibration amplitude attenuates over distance and is a complex function of how energy is imparted into the ground and the soil conditions through which the vibration is traveling. Table 5.7-4 (Vibration Levels for Construction Equipment), summarizes typical vibration levels measured at a distance of 25 feet from various pieces of construction equipment. The following equation can be used to estimate the vibration level at a given distance for typical soil conditions. PPV_{ref} is the reference PPV from Table 5.7-4.

$$PPV = PPV_{ref} \text{ x } (25/\text{Distance})^{1.1}$$

Table 5.7-5 (Human Response to Construction Vibration), summarizes typical human annoyance response to construction vibration. Table 5.7-6 (Potential Vibration-induced Damage Thresholds for Buildings), summarizes potential building damage thresholds for various building types. Perceptible groundborne vibration is generally limited to areas within a few hundred feet of construction activities. With the exception of pile driving, damage caused by construction vibration is unusual because vibration levels are below the damage thresholds at a distance of approximately 25 feet from the equipment.

Groundborne noise occurs when groundborne vibration causes the ground surface and structures to radiate audible acoustical energy. It is primarily an issue for underground rail systems.

TABLE 5.7-4
Vibration Levels for Construction Equipment

Equipment	Inches per second PPV at 25 feet
Vibratory roller for compaction	0.210
Caisson drilling[(a)]	0.089
Loaded trucks	0.076
Jackhammer	0.035
Small bulldozer	0.003

Source: FTA 2006

Note:

(a) Vibration from a well drilling rig is similar to that of a caisson drilling rig.

TABLE 5.7-5

Human Response to Construction Vibration

	Maximum PPV (in/sec)[(a)]	
Human Response	**Transient Sources**	**Continuous/Frequent Intermittent Sources**
Barely Perceptible	0.04	0.01
Distinctly Perceptible	0.25	0.04
Strongly Perceptible	0.9	0.10
Severe	2.0	0.4

Source: Caltrans 2004

Note:

(a) Transient sources, such as blasting, create a single isolated vibration event. Continuous/Frequent Intermittent Sources include, among other equipment, pogo-stick compactors, crack-and-seat equipment, and vibratory compaction equipment.

TABLE 5.7-6

Potential Vibration-induced Damage Thresholds for Buildings

	Maximum PPV (in/sec)[(a)]	
Structure and Conditions	**Transient Sources**	**Continuous/Frequent Intermittent Sources**
Extremely fragile historic buildings, ruins, ancient monuments	0.12	0.08
Fragile buildings	0.2	0.1
Historic and some old buildings	0.5	0.25
Older residential structures	0.5	0.3
New residential structures	1.0	0.5
Modern industrial/commercial buildings	2.0	0.5

Source: Caltrans 2004

Note:

(a) Transient sources, such as blasting, create a single isolated vibration event. Continuous/Frequent Intermittent Sources include, among other equipment, pogo-stick compactors, crack-and-seat equipment, and vibratory compaction equipment.

5.7.1.4 Sensitive Noise Receptors

The study area for noise includes noise-sensitive land uses located within and/or adjacent to the proposed facility sites that have the potential to be adversely affected by noise. This section identifies those noise-sensitive land uses.

People in residences, motels and hotels, schools, libraries, religious institutions, hospitals, nursing homes, auditoriums, natural areas, parks, and some outdoor recreation areas are generally more sensitive to noise than are people at commercial and industrial establishments. Consequently, the noise impacts on these sensitive land uses are deemed more significant than those for less sensitive uses. Sensitive receptors in the vicinity of the proposed Project include residences, schools, religious facilities, and cemeteries.

Active parks, golf clubs, and playgrounds are not as sensitive to noise as residences, schools, or cemeteries, because the levels of background noise at parks, golf clubs, school playgrounds are elevated due to active recreational and sports uses. Open space or outdoor recreation areas that are used for passive recreational activities, such as picnicking, would be noise-sensitive uses if the noise environment is considered to contribute to the recreational experience (see Section 5.11, Recreation, for a discussion of impacts on recreational resources).

Sensitive receptors located adjacent to, or near, each facility site are listed in Table 5.7-7 (Summary of Nearby Sensitive Receptors).[1] For each receptor, the approximate distance to key components of the Project from both the nearest sensitive receptor building or gravesite and the nearest sensitive receptor property line is given. Sensitive receptors that occur within 25 feet of construction activity are listed as "<25." For the purposes of this analysis, it is assumed that the construction noise source would not be less than 25 feet from a given receptor, because it is infeasible to have multiple pieces of construction equipment operating within such close proximity.

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[1] Distances listed in Table 5.7-7 (Summary of Nearby Sensitive Receptors), differ from distances listed in Section 5.1, Land Use, Table 5.2-1 (Land Uses in the Vicinity of Facility Sites), because noise measurements are taken for specific analysis purposes as explained in Section 5.7.3.2 (Approach to Analysis) below, whereas the land use measurements are taken from the closest boundary of the construction zone to the closest edge of the land use, including parking areas for the land use.

TABLE 5.7-7
Summary of Nearby Sensitive Receptors

Site	Nearby Sensitive Receptor	Distance to the Nearest Sensitive Receptor Building or Gravesite (feet)			Distance to the Nearest Sensitive Receptor Property Line (feet)		
		From the Construction Activity Center (not including Pipelines)	From the Nearest Proposed Pipeline	From the Proposed Well or Well Facility	From the Construction Activity Center (not including Pipelines)	From the Nearest Proposed Pipeline	From the Proposed Well or Well Facility
Site 1	Multi-family Residential	90	40	50	60	Within	30
Site 2	Multi-family Residential	325	140	325	320	135	320
	Garden Village Elementary School	350	275	350	150	<25	150
Site 3	Single-family Residential	90	110	90	85	105	85
	Ben Franklin Intermediate School	250	200	250	Within	Within	Within
Site 4	Single-family Residential	75	<25	75	25	<25	25
	Garden Village Elementary School	425	250	425	100	30	100
WLPS	Multi-family Residential	75	No pipelines	<25	50	No pipelines	<25
Site 5 (Consolidated Treatment at Site 6)	Single-family Residential	50	25	50	40	<25	40
Site 6 (Consolidated Treatment at Site 6)	Cemetery	325	275	275	200	<25	200
	Multi-family Residential	600	500	555	400	365	455

TABLE 5.7-7
Summary of Nearby Sensitive Receptors

Site	Nearby Sensitive Receptor	Distance to the Nearest Sensitive Receptor Building or Gravesite (feet)			Distance to the Nearest Sensitive Receptor Property Line (feet)		
		From the Construction Activity Center (not including Pipelines)	From the Nearest Proposed Pipeline	From the Proposed Well or Well Facility	From the Construction Activity Center (not including Pipelines)	From the Nearest Proposed Pipeline	From the Proposed Well or Well Facility
Site 7 (Consolidated Treatment at Site 6)	Cemetery	60	50	60	35	<25	30
Site 5 (On-site Treatment)	Single-family Residential	50	25	35	40	<25	25
Site 6 (On-site Treatment)	Cemetery	325	275	275	200	200	200
	Multi-family Residential	600	500	555	400	400	455
Site 7 (On-site Treatment)	Cemetery	60	50	40	35	<25	<25
Site 8	Cemetery	500	460	470	475	435	445
	Senior Care Facility	600	450	630	600	450	630
Site 9	Trailer Court	75	25	30	70	<25	25
Site 10	Single-family Residential	250	180	250	220	175	220
Site 11	Single-family Residential	400	315	390	385	300	375
Site 12	Funeral Home	80	<25	50	45	<25	20
	Single-family Residential	140	80	130	110	60	90

TABLE 5.7-7
Summary of Nearby Sensitive Receptors

Site	Nearby Sensitive Receptor	Distance to the Nearest Sensitive Receptor Building or Gravesite (feet)			Distance to the Nearest Sensitive Receptor Property Line (feet)		
		From the Construction Activity Center (not including Pipelines)	From the Nearest Proposed Pipeline	From the Proposed Well or Well Facility	From the Construction Activity Center (not including Pipelines)	From the Nearest Proposed Pipeline	From the Proposed Well or Well Facility
Site 13	Single-family Residential	290	105	260	240	70	210
	Extended Stay Hotel	>1,000	80	>1,000	>1,000	25	>1,000
Site 14	Cemetery	25	<25	<25	25	<25	<25
	Single-family Residential	100	100	80	40	50	25
Site 15	Cemetery	100	30	60	Within	Within	Within
	Multi-family Residential	750	250	715	700	150	665
Site 16	Multi-family Residential	115	35	115	85	<25	85
Site 17 (Alternate)	Cemetery	200	200	180	150	150	130
	Senior Care Facility	500	425	490	435	385	425
Site 18 (Alternate)	Single-family Residential	35	<25	25	<25	<25	<25
Site 19 (Alternate)	Church and preschool	50	30	80	25	<25	45
	Single-family Residential	115	80	120	65	45	65

5.7.1.5 Existing Noise Environment

The GSR Project would be located within the City of Daly City, the community of Broadmoor in unincorporated San Mateo County, the Town of Colma, and the cities of South San Francisco, San Bruno and Millbrae. Noise survey data were collected on behalf of the San Francisco Planning Department in April 2009 by Wilson, Ihrig & Associates, Inc. (WIA) and in October 2009 by Illingworth & Rodkin, Inc. (I&R).

Table 5.7-8 (Summary of Measured Noise Levels at Representative Sites - April and October 2009), summarizes existing measured noise levels. The measurement locations were selected by WIA and I&R to characterize baseline noise levels at sensitive receptors potentially affected by noise from Project construction and operation. In April 2009, WIA conducted measurements of the existing noise environment at four locations adjacent to proposed well facility sites. Noise was measured in consecutive one-hour intervals over a six-day period from April 21 to April 28, 2009 at sensitive receptors near Sites 1, 5, 6, and 16. These locations were selected to document the noise environments at receptors near the sites that could already be affected by elevated noise levels under current conditions.

In October 2009, I&R conducted a noise monitoring survey and well site visits to observe conditions and further quantify the existing noise environment. The measurement locations were selected at sensitive receptors near the facility sites throughout the Project area. The noise monitoring survey included short-term (10-minute duration) measurements at Well Site 16 where a long-term measurement was also made and seven additional sites where short-term measurements were conducted. Major noise sources noted were traffic on I-280 and local roadways, Bay Area Rapid Transit (BART), Caltrain, and jet aircraft operating at San Francisco International Airport.

Noise measurements were not conducted at Sites 7, 8, 11, 13, 15, and 17 (Alternate), because the noise environment can be appropriately characterized by measurements at other representative sites. Noise levels at Sites 7, 8, and 17 (Alternate) would result primarily from vehicle traffic on El Camino Real. Therefore, noise measurements at Site 12, adjacent to El Camino Real, are presumed to be representative of noise levels at Sites 7, 8, and 17 (Alternate) for purposes of this analysis. Noise levels at Site 15 result primarily from aircraft flyovers and local traffic. Therefore, daytime ambient noise levels are presumed to be in the range of 60 to 70 dBA L_{eq} for purposes of this analysis, as characterized by ambient measurements at Site 14, which is within a similar noise setting (cemetery) and is in close proximity to Site 15.

At Site 11, the closest receptors are residences across El Camino Real, located behind a row of commercial buildings. Daytime noise levels at these receptors are presumed, for purposes of this analysis, to range from 60 to 65 dBA L_{eq} and nighttime noise levels are estimated to range from 50 to 55 dBA L_{eq} based on the projected noise contour map contained in the City of South San Francisco's General Plan (South San Francisco 1999). The General Plan concludes that projected traffic increases on U.S. 101, I-280, and major arterials within South San Francisco should not have an appreciable impact on noise levels in the City. The number of railroad trains passing through is not expected to change significantly and BART will remain underground. Aircraft noise may decrease slightly, and industrial noise may decrease due to an expected shift toward office-based uses.

TABLE 5.7-8
Summary of Measured Noise Levels at Representative Sites - April and October 2009

Site	Nearby Street (City)	Land Uses	Noise Environment	Noise (dBA)	
				Typical Daytime L_{eq}	Typical Nighttime L_{eq}
1	Poncetta Drive (Daly City)	Residential/ Golf Club	I-280 traffic	70	60 – 65
2, 4	Park Plaza Drive (San Mateo County)	School/ Residential	Local Traffic	59	INA[(a)]
3	End of White Street (San Mateo County)	Residential	Local Traffic	55	INA[(a)]
5	B Street (Daly City)	Residential	I-280/Junipero Serra Boulevard	62 – 65	55 – 57
6	D Street (Daly City)	Cemetery	Colma BART Station	64 – 66	50 – 55
9	Adjacent to the Treasure Island Trailer Court (South San Francisco)	Residential/ Commercial	Aircraft/ Local Traffic	59	INA[(a)]
12	El Camino Real (South San Francisco)	Funeral Home/ Residential	Aircraft/ Local Traffic	58	INA[(a)]
14	Greenwood Drive (San Bruno)	Residential	Aircraft/ Local Traffic	68	INA[(a)]
16	Hemlock Avenue (Millbrae)	Residential	Caltrain - Probable nighttime freight activity	56 – 68	52 – 65
10, 18 (Alt)	Alta Loma Drive (South San Francisco)	Residential	Local Traffic	61	INA[(a)]
19 (Alt)	Southwood Drive (South San Francisco)	Residential / Church and preschool	Aircraft/ Local Traffic	64	INA[(a)]

Source: WIA and Illingworth & Rodkin, Inc. 2009

Note:
(a) Information Not Available

Noise levels can be assumed to be substantially the same as they were projected to be because traffic is the major contributor to the noise environment, and because traffic levels along El Camino Real have not changed substantively since completion of the City of South San Francisco General Plan. For example, the 2011 Caltrans traffic volumes for El Camino Real north and south of Westborough Boulevard/Chestnut Avenue are less than the volumes that were reported as existing in the City of South San Francisco General Plan (Caltrans 2012). Similarly, daytime noise levels at the residential receptors closest to Site 13 are estimated to range from 60 to 65 dBA L_{eq} and nighttime noise levels are estimated to range from 50-55 dBA L_{eq} based on the local General Plan.

5.7.2 Regulatory Framework

5.7.2.1 Federal

No federal standards related to noise and vibration would be applicable to the Project.

5.7.2.2 State

No State standards related to noise and vibration would be applicable to the Project. However, the California Department of Transportation (Caltrans) has published guidelines for evaluating the potential vibration impact from construction as presented in Tables 5.7-5 (Human Response to Construction Vibration) and 5.7-6 (Potential Vibration-induced Damage Thresholds for Buildings) (Caltrans 2004).

5.7.2.3 Local

At the local level, noise is addressed through implementation of general plan policies, including noise and land use compatibility guidelines, and through enforcement of noise ordinances. General plan policies provide guidelines for determining whether a noise environment is appropriate for a proposed or planned land use. Noise ordinances regulate sources, such as mechanical equipment and amplified sounds, as well as prescribed hours of heavy equipment operation such as for construction. There are no local ordinances or policies regulating vibration that are applicable to the Project. As such, the local regulatory standards are evaluated only for noise.

Following is a description of the noise regulations for the local jurisdictions within which the Project would be located. Construction noise limits are discussed first, followed by operational noise limits.

Construction Noise Limits

City of Daly City

The Municipal Code of Daly City does not have specific restrictions on construction noise. Sections 9.22.010 and 9.22.030 of Title 9: Public Peace, Morals, and Welfare of the Municipal Code (Daly City n.d.) address disturbance of the peace and include no quantitative noise limits. As specified in Section 9.22.030 Noise, "between the hours of 10:00 p.m. and 6:00 a.m. of the following day, no person shall cause, create or permit any noise, music, sound, or other disturbance upon his property which may be heard by, or which noise disturbs or harasses, any other person beyond the confines of the property, quarters or apartment from which the noise, music, sound, or disturbance emanates" (Daly City n.d.). The Daly City General Plan Noise Element does not provide any additional criteria for the evaluation of construction noise impacts, though it references the Municipal Code hours (Daly City 1989).

County of San Mateo

In Chapter 4.88 (Noise Control), Section 4.88.360(e) of the San Mateo County Code (San Mateo County n.d.), construction noise is specifically exempt from the provisions of the ordinance noise limits (Table 5.7- 11 [San Mateo County General Noise Level Limits]), except for construction activity that occurs between the hours of 6:00 p.m. and 7:00 a.m. Monday through Friday; between 5:00 p.m. and 9:00 a.m. on Saturdays; and at any time on Sundays, Thanksgiving, or Christmas. Construction at night and on Sundays and holidays is not prohibited, but is subject to the noise limits listed and explained in Table 5.7-11. The L_{eq} for a time-varying source (such as construction activity) representative of the maximum noise environment that would still comply with the County ordinance exterior noise level standard is 57 dBA during the nighttime (WIA 2009). Section 4.88.380 of the San Mateo County Noise Ordinance states: "Whenever, for the good of the public, a government agency, public utility, or private utility determines a project must be done before 7:00 a.m., or after 6:00 p.m., or weekends, and so states in its contract, change order(s), or bid documents, said work shall be exempted from this chapter" (San Mateo County n.d.).

The San Mateo County General Plan Noise Element does not provide specific criteria for the evaluation of construction noise impacts (San Mateo County 1986a, 1986b).

Town of Colma

Section 5.04.120 of the Town of Colma Municipal Code (Colma n.d.) regulates construction noise within residential zones, and within 500 feet of residential zones. No person shall operate equipment that exceeds a noise level of 85 dBA measured at a distance of 25 feet from the source during the hours of 7:00 a.m. to 8:00 p.m. Monday through Friday (weekend and holiday hours of 10:00 a.m. to 6:00 p.m.), or 60 dBA at a distance of 25 feet from the source during the hours of 8:00 p.m. to 7:00 a.m. Monday through Friday (weekend and holidays hours 6:00 p.m. to 10:00 a.m.), unless a permit has been obtained from the Building Official. The Code also states that construction hours within all non-residential zoning districts shall be assigned on a project-by-project basis by the Building Official, based on evaluation of potential noise-related impacts on surrounding uses. The Town of Colma General Plan does not have any additional policies regarding construction noise (Colma 1999).

City of South San Francisco

The City of South San Francisco Municipal Code, Chapter 8.32 Noise Regulations, Section 8.32.050 (South San Francisco n.d.) exempts construction noise for activities authorized with a valid city permit from the maximum permissible sound levels (Table 5.7-9 [South San Francisco Noise Level Standards]) in Section 8.32.030 during the hours of 8:00 a.m. to 8:00 p.m. Monday through Friday (excluding holidays), 9:00 a.m. through 8:00 p.m. on Saturdays, and 10:00 a.m. to 6:00 p.m. on Sundays and holidays. However, each individual piece of construction equipment is limited to a maximum noise level of 90 dBA at a distance of 25 feet from the source or 90 dBA at the property plane. During other times, the noise limits in Table 5.7-9 would apply. The South San Francisco General Plan does not have any policies regarding construction noise (South San Francisco 1999).

TABLE 5.7-9
South San Francisco Noise Level Standards[(a)]

Affected Land Use Category	Time	Noise Level L_{50} dBA[(b)]
Single-family and Duplex Residential Uses	7:00 a.m. – 10:00 p.m. 10:00 p.m. – 7:00 a.m.	60 50
Multi-family Residential Uses or Mixed Use	7:00 a.m. – 10:00 p.m. 10:00 p.m. – 7:00 a.m.	60 55
Commercial Uses	7:00 a.m. – 10:00 p.m. 10:00 p.m. – 7:00 a.m.	65 60
Industrial Uses	Anytime	70

Source: City of South San Francisco Municipal Code, Chapter 8.32 (South San Francisco n.d.).

Notes:

(a) If the measured ambient level for any area is higher than the standard, then the ambient shall be the base noise level standard.

(b) For noise generated for more than 30 minutes in any hour. Adjustments to these levels may be allowed for noise of a shorter duration as follows: (1) noise standard plus 5 dB for no more than 15 minutes in any hour; (2) noise standard plus 10 dB for no more than five minutes in any hour; (3) noise standard plus 15 dB for no more than one minute in any hour; (5) noise standard plus 20 dB for any period of time.

City of San Bruno

Section 6.16.070 of the City of San Bruno Municipal Code requires that construction noise within any residential zone or within 500 feet of a residential zone be limited to 85 dBA as measured at 100 feet from the source between 7:00 a.m. and 10:00 p.m., or 60 dBA at 100 feet from the source between 10:00 p.m. and 7:00 a.m (San Bruno n.d.). The City of San Bruno Director of Public Works may grant a permit for construction work outside of these limits (Section 6.16.070). The San Bruno General Plan, Chapter 7, Health and Safety Element, Policy HS 38, requires developers to “mitigate noise exposure to sensitive receptors from construction activities” (San Bruno 2009).

City of Millbrae

The City of Millbrae Community Preservation Ordinance Section 6.–5.05.F.9 limits construction to the hours of 7:30 a.m. to 7:00 p.m. Monday through Friday; 8:00 a.m. to 6:00 p.m. on Saturdays; and 9:00 a.m. to 6:00 p.m. on Sundays and holidays, unless otherwise authorized by the city (Millbrae n.d.). The Millbrae General Plan has a policy regulating construction hours to reduce noise between 7:00 p.m. and 7:00 a.m (Millbrae 1998).

Construction Noise Limits Summary

Table 5.7-10 (Summary of Local Noise Regulations Pertaining to Construction), summarizes the local noise regulations and standards that pertain to construction. Time and noise limits specified in these ordinances are used to define significance of the Project's noise increases. This table summarizes construction time and decibel limits within each jurisdiction.

TABLE 5.7-10
Summary of Local Noise Regulations Pertaining to Construction

Jurisdiction	Construction Time Limits			Construction Noise Limit
	Weekdays	Saturdays	Sundays/ Holidays[a]	
City of Daly City[b]	6:00 a.m. to 10:00 p.m.	6:00 a.m. to 10:00 p.m.	6:00 a.m. to 10:00 p.m.	No noise limits specified
County of San Mateo[c]	7:00 a.m. to 6:00 p.m.	9:00 a.m. to 5:00 p.m.	Non-exempt[a]	Nighttime noise limit, 57 dBA L_{eq}. Construction noise outside of allowed hours is exempt if governmental agency determines it is for the good of the public.
Town of Colma[d]	7:00 a.m. to 8:00 p.m.	10:00 a.m. to 6:00 p.m.	10:00 a.m. to 6:00 p.m.[a]	In residential zones, daytime construction is limited to 85 dBA at 25 feet from the noise source. Nighttime construction is limited to 60 dBA at 25 feet from the noise source.
City of South San Francisco[e]	8:00 a.m. to 8:00 p.m.	9:00 a.m. to 8:00 p.m.	10:00 a.m. to 6:00 p.m.[a]	For daytime construction, any single piece of equipment is limited to 90 dBA at 25 feet or at the property plane. Maximum nighttime noise is limited to the L_{50} standards shown in Table 5.7-9.
City of San Bruno[f]	7:00 a.m. to 10:00 p.m. (daytime) 10:00 p.m. to 7:00 a.m. (nighttime)			Individual equipment limited to 85 dBA L_{max} at 100 feet (daytime) or 60 dBA L_{max} at 100 feet (nighttime) in residential zones or within 500 feet of residential zones.
City of Millbrae[g]	7:30 a.m. to 7:00 p.m.	8:00 a.m. to 6:00 p.m.	9:00 a.m. to 6:00 p.m.[a]	No noise limits specified

Notes:
(a) Applicable to holidays where noted.
(b) Daly City Municipal Code Section 9.22.030 (Daly City n.d.).
(c) San Mateo County Code Chapter 4.88 (Noise Control), Section 4.88.360(e) (San Mateo County n.d.).
(d) Town of Colma Municipal Code Section 5.04.120 (Colma n.d.).
(e) Time and noise limits specified in South San Francisco Municipal Code, Chapter 8.32, Sections 8.32.030 and 8.32.050 (South San Francisco n.d.). Construction activities are allowed during these hours if each piece of equipment produces a noise level of 90 dBA or less at 25 feet or at the property plane (any point in space above the boundary).
(f) San Bruno Municipal Code, Title 6, Chapter 6.16, Section 6.16.070 specifies noise regulations for construction (San Bruno n.d.).
(g) City of Millbrae Community Preservation Ordinance Section 6-5.05.F.9 (Millbrae n.d.).

Operational Noise Limits

Operational noise is also regulated by or subject to general plan policies of the jurisdictions within which the proposed facility sites would be located. Following is a discussion of these regulations and general plan policies by jurisdiction, followed by a summary in Table 5.7-12 (Summary of Local Noise Regulations and General Plan Policies Pertaining to Operations).

City of Daly City

The Daly City General Plan specifies policies related to operational-related noise levels (Daly City 1989). Policy 1.2 directs that the Noise and Land Use Compatibility Guidelines shall be used to assess the effect of noise. For land uses near the facility sites, this is summarized below.

- CNEL of 60 dBA (53 dBA L_{eq}) for single-family residential,
- CNEL of 65 dBA (58 dBA L_{eq}) for multi-family residential and schools,
- CNEL of 70 dBA (63 dBA L_{eq}) for office and commercial uses, and
- CNEL of 75 dBA (68 dBA L_{eq}) for golf courses.

The Daly City Municipal Code does not set quantitative standards for noise levels during Project operations.

County of San Mateo

The operational noise limits set by the San Mateo County Noise Ordinance (San Mateo County Code Section 4.88) (San Mateo County n.d.) are summarized in Table 5.7-11 (San Mateo County General Noise Level Limits). This table indicates the noise levels that may be exceeded for the cumulative time shown. The ordinance has specific cumulative time limits on a range of noise levels for any one-hour period, which are divided into five categories. In addition, the corresponding noise level for each cumulative time limit category is 5 dBA lower at night, as compared to daytime hours. Operational noise resulting from the Project would result from the steady operation of the above ground pump stations. For steady noise, the limits in Category 1 are equivalent to the L_{eq} and are appropriate limits to use as thresholds.

TABLE 5.7-11
San Mateo County General Noise Level Limits[a]

Category	Cumulative Number of Minutes[b] (in any one-hour time period)	Daytime on Weekdays[c] (dBA)	Nighttime[c], Sundays and Holidays (dBA)
1	30	55	50
2	15	60	55
3	5	65	60
4	1	70	65
5	0	75	70

Source: County of San Mateo Noise Ordinance (San Mateo County n.d.)

Notes:

(a) In the event the measured background noise level exceeds the applicable noise level standard in any category above, the applicable standard shall be adjusted in 5 dBA increments so as to encompass the background noise level.

(b) This refers to the number of minutes in any one hour that the specified noise level can be exceeded. For example, a noise at 55 dBA would be allowed to occur during any one hour period for up to a total of 30 minutes during the daytime, but only up to a total of 15 minutes at night, whether continuous or not.

(c) The daytime limits are applicable from 7:00 a.m. to 10:00 p.m. and the nighttime limits are applicable from 10:00 p.m. to 7:00 a.m.

In cases where the measured background noise level exceeds the applicable noise level standard, the Noise Ordinance requires that the applicable standard shall be adjusted upward in 5 dBA increments until it exceeds the background noise level; in this manner the Noise Ordinance standard would be 1 to 4 dBA higher than ambient noise levels. Also, the Ordinance requires that each of the noise level standards specified above must be reduced by 5 dBA for simple tonal noise, consisting primarily of speech or music, or for recurring or intermittent impulsive noise.

The San Mateo County General Plan does not have quantitative policies limiting noise levels (San Mateo County 1986a, 1986b).

Town of Colma

The Colma General Plan Noise Element indicates that the noise environment for residences, motels and hotels, schools, sports, and parks is normally acceptable at 60 dBA (CNEL), whereas noise environments from 60 to 70 dBA (CNEL) fall into the "conditionally acceptable" range for these land uses (Colma 1999). For cemeteries, noise environments up to 65 dBA (CNEL) are normally acceptable, with noise environments from 65 to 70 dBA (CNEL) falling into the conditionally acceptable range (Colma 1999). Per the Colma General Plan Noise Element, conditionally acceptable exceedances of the normally acceptable noise ranges require a detailed acoustic study to set forth design features that will reduce exterior noise levels. The Town of Colma Municipal Code does not include noise standards related to operational noise of the Project.

City of South San Francisco

Section 8.32.030 of the South San Francisco Municipal Code (South San Francisco n.d.) sets forth the maximum permissible sound levels as shown in Table 5.7-9 (South San Francisco Noise Level Standards). In the South San Francisco General Plan, Policy 9-I-7 requires the control of noise at its source through site design, building design, landscaping, hours of operation, and other techniques, for new noise-generating land uses. The General Plan Noise Element indicates that the noise environment for residences is satisfactory up to 65 dBA (CNEL), whereas noise environments from 65 to 70 dBA (CNEL) would require analysis of noise reduction techniques (South San Francisco 1999).

City of San Bruno

The San Bruno General Plan indicates that single-family residential noise environments up to 60 dBA L_{dn} are normally acceptable; multi-family residential and motel noise environments up to 65 dBA L_{dn} are normally acceptable; commercial, park, school, church, and hospital noise environments up to 70 dBA L_{dn} are normally acceptable; and cemetery and industrial noise environments up to 75 dBA L_{dn} are normally acceptable (San Bruno 2009). For noise environments above these levels, new development in such areas is required to implement a detailed analysis including noise reduction requirements and noise insulation features to be included in the design. Section 6.16.060 of the San Bruno Municipal Code (San Bruno n.d.) states that:

> No person shall operate any machinery, equipment, pump, fan, air conditioning apparatus or similar mechanical device in any manner so as to create any noise which would cause the noise level at the property plane of any property to exceed the ambient base noise level by more than ten decibels. However, during the period of 7:00 a.m. to 10:00 p.m. the ambient noise level may be exceeded by 20 decibels for a period not to exceed 30 minutes during any 24-hour period.

The Code establishes the baseline noise levels for residences at 60 dBA during the daytime and 45 dBA during the nighttime. Therefore, the Noise Ordinance prohibits daytime noise levels above 70 dBA and nighttime noise levels above 55 dBA when measured at residential uses.

City of Millbrae

The Millbrae General Plan Noise Element indicates that residential, school, church, and commercial noise environments up to 60 dBA (L_{dn} or CNEL) are normally acceptable. Park noise environments are normally acceptable up to 65 dBA. Conditionally acceptable exceedances of the normally acceptable noise ranges require new development in such areas to implement noise insulation features in the Project design (Millbrae 1998). The Millbrae Municipal Code and Community Preservation Ordinance do not have quantitative standards for noise levels (Millbrae n.d.).

TABLE 5.7-12
Summary of Local Noise Regulations and General Plan Policies Pertaining to Operation

Jurisdiction	**Summary of Local Noise Regulations and General Plan Policies pertaining to Operation**[(a)]
City of Daly City	CNEL of 60 dBA (53 dBA L_{eq}) for single-family residential, 65 dBA (58 dBA L_{eq}) for multi-family residential; 70 dBA (63 dBA L_{eq}) for office and commercial uses; 75 dBA (68 dBA L_{eq}) for golf clubs
County of San Mateo	55 dBA L_{eq} weekday daytime; 50 dBA L_{eq} during the nighttime and on weekends
Town of Colma	CNEL of 60dBA (53 dBA L_{eq}) for residential and parks; 65 dBA (58 dBA L_{eq}) for cemeteries
City of South San Francisco	60 – 70 dBA L_{eq} during the daytime; 50 – 70 L_{eq} during the nighttime[(b)]
City of San Bruno	L_{dn} of 60 dBA (54 dBA L_{eq}) for single-family residential uses; 65 dBA (59 dBA L_{eq}) for multi-family residential uses; 70 dBA (66 dBA L_{eq}) for commercial uses and parks; 75 dBA (69 dBA L_{eq}) for cemeteries and industrial uses. Noise Ordinance: 70 dBA daytime and 55 dBA nighttime at residential uses
City of Millbrae	L_{dn} or CNEL of 60 dBA (54 dBA L_{eq}) for residential uses, schools, churches, and commercial uses; 65 dBA (59 dBA L_{eq}) for parks

Notes:

(a) Given that operational noise is assumed to be continuous, the L_{eq} has been substituted in place of other noise level metrics (e.g., L_{50}), where appropriate.

(b) See Table 5.7-8 (Summary of Measured Noise Levels at Representative Sites - April and October 2009) for each type of affected land use.

Groundborne Vibration

The City of Daly City, County of San Mateo, Town of Colma, City of San Bruno, and City of South San Francisco do not have an ordinance or any general plan policies that regulate groundborne vibration.

The Municipal Code, Section 6.25.050 for the City of Millbrae prohibits, "emanation of noise or vibrations on a continuous and regular basis of such a loud, unusual, unnecessary, penetrating, lengthy or untimely nature as to unreasonably disturb, annoy, injure or interfere with or endanger the comfort, repose, health, peace, safety or welfare of users of neighboring property" (Millbrae n.d.).

5.7.3 Impacts and Mitigation Measures

5.7.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on noise and vibration if it were to:

- Result in exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.
- Result in exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.
- Result in a substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
- Result in a substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.
- For a project located within an airport land use plan area, or, where such a plan has not been adopted, in an area within two miles of a public airport or public use airport, expose people residing or working in the area to excessive noise levels.
- For a project located in the vicinity of a private airstrip, expose people residing or working in the project area to excessive noise levels.
- Be substantially affected by existing noise levels.

5.7.3.2 Approach to Analysis

The noise and vibration impact assessment evaluates short-term impacts associated with construction of the Project. It also assesses long-term operational impacts (e.g., those resulting from operation of the well facilities). The impact discussion analyzes substantial increases in ambient noise levels in the vicinity of the facility sites. In addition, this assessment uses local noise standards and applicable daytime exceptions as the basis for significance thresholds related to "established" noise standards. The assessment of potential noise impacts was conducted using information on existing ambient noise levels and the anticipated noise that would be produced during construction and operation of the Project. The assessment of vibration impacts was conducted using information on anticipated vibration during construction and operation of the Project.

For the purposes of this analysis, only construction noise is considered under the criterion that addresses temporary or periodic increase in ambient noise. Periodic noise increases are defined herein as intermittent or short-term, and only construction activities are consistent with this definition. Although the well facilities would only operate in dry years, in Take Years the well pumps could be operated continuously. Operation of well facilities is thus conservatively considered to result in a permanent increase in ambient noise levels; operation is thus not considered as a periodic increase in noise.

In a departure from the general organization of this EIR's other analysis sections, any applicable mitigation measures are presented at the end of each impact discussion, rather than following the discussion of each facility site or group of sites. Most of the noise mitigation measures apply to the majority of the facility sites. Therefore, it is more efficient to present and discuss the measure once, rather than with each site and referring the reader back to the measure's original discussion in the section.

Construction Noise

For construction noise, the potential for impacts was assessed by considering several factors, including the proximity of Project-related noise sources to noise-sensitive land uses (i.e., sensitive receptors), typical noise levels associated with construction equipment, the potential for construction noise levels to interfere with daytime and nighttime activities, the duration that sensitive receptors would be affected, and whether proposed activities would occur outside the construction time limits or noise limits established in local ordinances. For operational noise, the potential for impacts was assessed by evaluating the noise generation potential of proposed facilities, proximity of sensitive receptors, and the potential for operational noise to remain within the established local noise ordinance limits at the nearest receptors. Each impact discussion evaluates impacts on sensitive receptors at each facility site.

For both construction and operational noise, a "substantial" noise increase can be defined as an increase in noise levels to that which causes interference with activities normally associated with established nearby land uses during the day and/or night. As documented by the existing noise surveys prepared for this analysis, the existing daytime noise environment in some Project areas exceeds 65 dBA L_{eq}. In some areas, the existing nighttime noise environment exceeds 55 dBA L_{eq}; but in most areas, the nighttime noise is 50 L_{eq} or less, as is typical of urban environments. To be conservative, the local noise limits were not adjusted upward based on the ambient noise level. One indicator that noise could interfere with daytime activities normally associated with residential land uses (for example) would be speech interference; whereas, an indicator that noise could interfere with nighttime activities normally associated with residential uses would be sleep interference. This analysis, therefore, uses the following criteria to define whether a temporary or periodic increase in ambient noise levels in the Project vicinity above levels existing without the project would be substantial:

Speech Interference. Speech interference is an indicator of an impact on daytime and evening activities typically associated with residential land uses, but which is also applicable to other similar land uses that are sensitive to excessive noise levels. Therefore, a speech interference criterion, in the context of impact duration and time of day, is used to identify substantial increases in ambient noise levels.

Noise peaks generated by construction equipment could result in speech interference in adjacent buildings if the noise level in the interior of the building were to exceed 45 to 60 dBA[2]. A typical building can reduce noise levels by 25 dBA with the windows closed (U.S. EPA 1974). This noise reduction could be maintained only on a temporary basis in some cases, since it assumes windows must remain closed at all times. Assuming a 25 dBA reduction with the windows closed, an exterior noise level of 70 dBA (L_{eq}) adjacent to a building would maintain an acceptable interior noise environment of 45 dBA. It should be noted that such noise levels would be sporadic rather than continuous in nature, because different types of construction equipment would be used throughout the construction process. Therefore, an exterior noise level of 70 dBA L_{eq} with windows closed during peak noise periods is used as the threshold for substantial construction noise.

Sleep Interference. Based on available sleep criteria data, an interior nighttime level of 35 dBA is considered acceptable (U.S. EPA 1974). Assuming a 25 dBA reduction from a residential structure with the windows closed, an exterior noise level of 60 dBA adjacent to the building would maintain an acceptable interior noise environment of 35 dBA. Even with windows open, a typical house achieves an approximately 15-dBA reduction and, therefore, an exterior noise level of 50 dBA (L_{eq}) would be required to maintain an acceptable interior noise environment of 35 dBA. This nighttime threshold would apply equally to construction and operation of the Project.

The duration of exposure at any given noise-sensitive receptor is one consideration in determining an impact's significance. For example, this analysis generally assumes that temporary construction noise that occurs during the day for a relatively short period of time would not be significant. In addition, this analysis assumes that most people of average sensitivity that live in suburban or urban environments are accustomed to a certain amount of construction activity from time to time to maintain existing infrastructure. Therefore, for the purposes of this analysis, temporary exposure to construction noise during the daytime would not be considered to result in a substantial temporary increase in ambient noise levels if it is for durations of two weeks or less. As indicated in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule) pipeline construction is proposed to proceed at 300 to 600 feet per week[3]. As a result, this analysis assumes that, in most cases, any particular sensitive receptor along a pipeline route or underground electrical work would not be subject to pipeline construction noise for more than two weeks.

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[2] For indoor noise environments, the highest noise level that permits relaxed conversation with 100 percent intelligibility throughout the room is 45 dBA. Speech interference is considered to become intolerable when normal conversation is precluded at three feet, which occurs when background noise levels exceed 60 dBA.

[3] For example, a residence with an 80-foot frontage would be affected by noise over the threshold of 70 dBA when pipeline construction is within 200 feet of the residence in either direction. At a rate of 300 feet per week (the slowest rate), pipeline construction noise would exceed the threshold for up to five to eight working days.

Similarly, fenced enclosure construction, as proposed at Sites 2, 3, 4, 5 (Consolidated Treatment at Site 6), 7 (Consolidated Treatment at Site 6), and 19 (Alternate), is anticipated to occur over one month at Site 2; over six months at Site 3 (during two summer seasons), and over four months at the remaining sites. Noise-generating activities with substantial equipment use would occur in three phases: site preparation, foundation, and paving. Noise from on-site pipeline installation and production well installation are analyzed separately. The most intensive work phase would be site preparation, when equipment could operate up to eight hours per day for a period of five working days. For both the foundation (10 days) and paving (four days) phases, equipment would operate no more than one to two hours per day. As a result, this analysis assumes that temporary exposure to construction noise during the daytime, due to construction of a fenced enclosure, would not be considered to result in a substantial temporary increase in ambient noise levels.

The alternate water connection pipelines would have the same or less impact as the impacts associated with other project facilities (i.e., alternate pipelines are not closer to sensitive receptors than are other project facilities).

This analysis also assumes that cemeteries are sensitive to noise during the day primarily when outdoor graveside services are being performed. However, as described in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule), the SFPUC proposes to temporarily stop construction to accommodate graveside services, and would coordinate with the cemeteries to accomplish this. For the occasional individual small group that may be visiting the cemeteries for anything other than a formal burial ceremony, this analysis assumes that any construction-related noise impacts would be less than significant, due to the very limited exposure, lasting only as long as their visit.

Operational Noise

The analysis of operational noise is based on the following aspects of the Project proposal regarding well facility design and construction (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]):

- Standard construction methods would be used that include weatherproofing all wall/roof junctions to minimize cracks and gaps in the exterior building construction.
- Standard weatherproofed steel doors would be included in the building.
- The roof would be a standard built-up roof using roofing materials with sound reducing qualities.
- A limited amount of sound absorbing material would be included inside the enclosures to minimize a reverberant[4] buildup of noise.

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[4] Reverberant sounds are sound waves that bounce off of multiple surfaces before reaching the listener, but arrive at the listener's ears quite a bit later than early reflected sound.

Noise generated by the well pumps during operation would be continuous over long periods during dry years when the Project wells would be operated. In such instances, the pump noise would occur both during the day and night. The dominant sound transmission path from inside to outside the well facility buildings would be through the louvers or other ventilation paths. Acoustical louvers would be used to reduce noise transmission (see Section 3.4.2.2 [Well Facility Types]). The orientation of the louvers at each well facility is not known at this time, so the analysis conservatively assumes that louvers would be oriented in the direction of the noise-sensitive receptor. At well facilities that would have only a fenced enclosure, a submersible pump would be used to minimize noise (see Section 3.4.2.3 [Well Pumps]).

Residential land uses are sensitive to noise day and night. Because the well pumps would generate the same level of noise during both the daytime and nighttime, and nighttime noise limits are more restrictive than daytime limits, the sleep interference threshold constitutes the most restrictive threshold for operational noise. Similarly, at facility sites within local jurisdictions that have adopted applicable noise limits, the nighttime limits are also used as the impact threshold. At other land uses, such as schools, that are not sensitive to noise at night, daytime thresholds for speech interference and daytime ordinance limits are the impact thresholds.

Groundborne Vibration

The Caltrans guidelines for vibration listed in Table 5.7-5 (Human Response to Construction Vibration), and Table 5.7-6 (Potential Vibration-induced Damage Thresholds for Buildings), are the basis for the significance criteria for annoyance and potential building damage. No fragile buildings have been identified near proposed construction areas, but older structures exist (refer to Section 5.5, Cultural and Paleontological Resources, Impact CR-1, Site 15). Based on Caltrans guidance, this analysis establishes 0.25 in/sec PPV as the significance threshold for construction vibration to avoid damage to buildings from vibration sources. Also based on Caltrans guidance, this analysis establishes 0.1 in/sec PPV as the significance threshold for annoyance (the level at which vibration would be strongly perceptible). The SFPUC Water System Improvement Program (WSIP) has established criteria for groundborne vibration. The criterion for onset of damage to buildings is 0.2 in/sec PPV. The criterion for annoyance due to nighttime operations is 0.012 in/sec PPV. The WSIP criteria are conservative given that they are lower than those of Caltrans and other agencies.

Areas of No Project Impact

As explained below, the Project would not result in impacts related to four of the significance criteria listed in Section 5.7.3.1 (Significance Criteria). In addition, one issue related to noise levels caused by the well facilities collectively would not result in impacts during either construction or operation at any of the sites. These four criteria and the collective impacts of the well facilities will not be discussed further in the impact analysis for the following reasons:

Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels due to operation of the proposed Project. There would be no significant sources of groundborne vibration or groundborne noise associated with operation of the proposed Project, because well pumps are mounted so as to prevent vibration, and no other components of the well facility would generate vibration. Therefore, operation of the proposed Project would have no impact related to the exposure of persons to, or generation of, excessive groundborne vibration or groundborne noise.

Result in exposure of persons to or generation of excessive groundborne noise levels. As noted above, groundborne noise occurs when groundborne vibration causes the ground surface and structures to radiate audible acoustical energy. It is primarily an issue for underground rail systems and is not a concern for the type of construction proposed by the Project.

For a project located within an airport land use plan area, or, where such a plan has not been adopted, in an area within two miles of a public airport or public use airport, expose people residing or working in the area to excessive noise levels due to construction or operation of the Project. Sites 9, 10, 11, 12, 13, 14, 15, 16, 18 (Alternate), and 19 (Alternate) are located within the San Mateo County Airport Land Use Plan (ALUP) for the San Francisco International Airport (SFO) (C/CAG 1996). Sites 12, 13, 14, 15, 16, and 19 (Alternate) would be located within two miles of SFO. Construction workers could be exposed to airport-related noise from aircraft passing overhead. However, the exposure would be limited to the duration of construction, airport-related noise levels would generally be much lower than construction-related noise levels, and it is assumed for purposes of this analysis that construction workers would be required to use OSHA-mandated ear protection as necessary while on the job, regardless. In addition, many jurisdictions and land uses (e.g., residential areas, schools, parks, etc.) within the study area are already affected by overflight noise. Based on the noise measurement survey conducted by I&R, aircraft overflight noise levels in the Project area range from 59 to 89 dBA L_{max}. Airport noise contours show a maximum CNEL of 73.1 dBA (SFO n.d.). Nevertheless, the Project would not result in a permanent increase in the number of people exposed to aircraft overflight noise within the SFO ALUP because the Project would not cause additional people to move into the area (refer to Section 5.4, Population and Housing), and it is assumed that the construction workers that would be temporarily exposed to the overflight noise in the Project area would be using ear protection as required. Similarly, it is assumed for purposes of this analysis that maintenance workers that would be intermittently exposed to the overflight noise in the Project area would be required to use ear protection if necessitated by the ambient noise levels. However, it should be noted that OSHA does not require hearing protection for noise levels less than 90 dBA (OSHA, Occupational Safety and Health Standards, Subpart: G, Occupational Health and Environmental Control, Standard Number: 1910.95). Based on the airport noise contours described above, ambient noise levels associated with aircraft activity are not expected to result in exposure of maintenance workers to excessive noise levels.

For a project located in the vicinity of a private airstrip, expose people residing or working in the project area to excessive noise levels due to construction or operation of the Project. No private airstrips are in the Project vicinity. Therefore, the Project would not expose people working on the Project to excessive noise levels from a private airstrip.

Be substantially affected by existing noise levels due to operation of the Project. The proposed Project is a water utility project and would not be affected by existing noise levels. Since the Project is not a noise-sensitive land use, this criterion would not apply.

For construction and operation of the well facilities collectively. If a given sensitive receptor were located in close proximity to multiple sites, and some portion of the construction schedule were to occur simultaneously at one or more sites in close proximity to each other (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]), the simultaneous noise exposure due to this potential overlap in construction activities would not increase noise levels above those reported for the individual facilities. This is because each of the facilities would be sufficiently far apart that sensitive receptors that would experience noise from two or more facilities at once would not experience an increase in noise levels due to the simultaneous construction or operation of the facilities, as indicated below.

- For Sites 2, 3, and 4, there would be no increase as a result of construction of the three sites concurrently at the most affected receptors. The construction noise levels at the most affected receptors resulting from activities at the nearest site would be more than 10 dBA higher than construction noise levels resulting from activities at the other sites, which would not cause a perceptible increase in the combined noise exposure because the noise heard in the foreground would not be perceptibly amplified by the noise in the background due to the distances and noise levels involved. When calculating the combined noise level from two sources, if one source produces a noise level 10 dBA or greater than the other source, the noise from the quieter source would not result in a perceptible difference in total noise level (see Table 5.7-3 [Decibel Addition]).
- For Sites 12 and 19 (Alternate) there would be no increase as a result of construction of the two sites concurrently at the most affected receptors. The construction noise levels at the most affected receptors resulting from activities at the nearest site would be more than 10 dBA higher than construction noise levels resulting from activities at the other site, which thus would not cause an increase in the combined noise exposure.
- Sites 14 and 15 would be approximately 1,000 feet apart, and the construction noise levels at the most affected receptors resulting from activities at the nearest site would be more than 10 dBA higher than construction noise levels resulting from activities at the other site, which thus would not cause an increase in the combined noise exposure.
- Sites 9 and 10 would be over 1,500 feet apart, and the construction noise levels at the most affected receptors resulting from activities at the nearest site would be more than 10 dBA higher than construction noise levels resulting from activities at the other site, which thus would not cause an increase in the combined noise exposure.
- Sites 10 and 18 (Alternate) would be approximately 750 feet apart, and the construction noise levels at the most affected receptors resulting from activities at the nearest site would be more than 10 dBA higher than construction noise levels resulting from activities at the other site, which thus would not cause an increase in the combined noise exposure.

- Sites 5 and 6 would be over 1,000 feet apart, and there are no sensitive receptors in between the two sites that could be affected by both sites.
- For Site 8 and Site 17 (Alternate), the senior care facility would be located approximately 600 feet from Site 8 and 500 feet from Site 17 (Alternate). Because this noise sensitive land use is located at a similar distance from both sites, there is the potential for an increase in construction noise levels if the work were to occur simultaneously. However, because a large Kohl's Department Store building would be located between Site 8 and the senior care facility, there would be no increase in noise levels as a result of constructing Site 8 and Site 17 (Alternate), as the existing building would provide more than a 10 dBA noise reduction.

As a result, potential noise impacts from simultaneous construction or operation of the facilities is not anticipated to occur and is not discussed further.

5.7.3.3 Summary of Impacts

Table 5.7-13 (Summary of Impacts – Noise and Vibration), provides a summary of potential impacts related to noise and their significance determinations.

TABLE 5.7-13

Summary of Impacts – Noise and Vibration

Site	Construction				Operations	Cumulative
	Impact NO-1: Project construction would result in noise levels in excess of local standards.	**Impact NO-2: Project construction would result in excessive groundborne vibration.**	**Impact NO-3: Project construction would result in a substantial temporary increase in ambient noise levels.**	**Impact NO-4: Project construction would not result in a substantial temporary increase in ambient noise levels along construction haul routes.**	**Impact NO-5: Operation of the Project would result in exposure of people to noise levels in excess of local noise standards or result in a substantial permanent increase in ambient noise levels in the Project vicinity.**	**Impact C-NO-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to noise.**
Site 1	SUM	LS	SUM	LS	LSM	LSM
Site 2	NI	LS	LS	LS	NI	LS
Site 3	LSM	LSM	SUM	LS	NI	LS
Site 4	SUM	LSM	SUM	LS	NI	LS
Westlake Pump Station	NI	LS	LS	LS	LSM	LSM
Site 5 (Consolidated Treatment at Site 6)	NI	LS	LSM	LS	NI	LS
Site 5 (On-site Treatment)	NI	LS	SUM	LS	LSM	LSM
Site 6	NI	LS	LS	LS	LS	LS
Site 7 (Consolidated Treatment at Site 6)	LS	LS	LS	LS	NI	LS
Site 7 (On-site Treatment)	LS	LS	LS	LS	LSM	LSM
Site 8	LSM	LS	LS	LS	LS	LSM

TABLE 5.7-13

Summary of Impacts – Noise and Vibration

Site	Construction				Operations	Cumulative
	Impact NO-1: Project construction would result in noise levels in excess of local standards.	**Impact NO-2: Project construction would result in excessive groundborne vibration.**	**Impact NO-3: Project construction would result in a substantial temporary increase in ambient noise levels.**	**Impact NO-4: Project construction would not result in a substantial temporary increase in ambient noise levels along construction haul routes.**	**Impact NO-5: Operation of the Project would result in exposure of people to noise levels in excess of local noise standards or result in a substantial permanent increase in ambient noise levels in the Project vicinity.**	**Impact C-NO-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to noise.**
Site 9	SUM	LS	SUM	LS	LSM	LSM
Site 10	LSM	LS	LSM	LS	LS	LS
Site 11	LSM	LS	LSM	LS	LS	LSM
Site 12	SUM	LSM	SUM	LS	LSM	SUM
Site 13	LSM	LS	LSM	LS	LS	LS
Site 14	LSM	LS	SUM	LS	NI	LS
Site 15	LS	LSM	LSM	LS	NI	LS
Site 16	SUM	LS	SUM	LS	LS	LS
Site 17 (Alternate)	LSM	LS	LSM	LS	LS	LSM
Site 18 (Alternate)	SUM	LSM	SUM	LS	LSM	LSM
Site 19 (Alternate)	SUM	LS	SUM	LS	NI	SUM

Notes:

NI = No Impact

LS = Less than Significant

LSM = Less than Significant with Mitigation

SUM = Significant and Unavoidable with Mitigation

5.7.3.4 Construction Impacts and Mitigation Measures

This introduction to construction impacts and mitigation measures includes information regarding the Project construction equipment, construction phasing, and duration of construction activities that is applicable to the four construction impacts that follow. For Sites 5 and 7 two options were addressed; consolidated treatment at Site 6, which would reduce the facilities needed at Sites 5 and 7, and on-site treatment at Sites 5 and 7, which would require construction of treatment facilities at those sites.

Construction noise levels would vary at any given receptor depending on construction timing, equipment type and duration of use, distance between the noise source and receptor, and the presence or absence of barriers between the noise source and the receptor. The perception of construction noise by a given sensitive receptor also varies depending on the existing noise levels and shielding.

Daily construction hours proposed for the Project would typically be between 7:00 a.m. and 7:00 p.m. Monday through Friday, except for construction of production wells. If necessary, construction work may occasionally occur on Saturdays between the hours of 7:00 a.m. and 5:00 p.m. (refer to Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]). Drilling of production wells would take place 24-hours per day for a period of up to seven consecutive days; pump testing would take place for one continuous 48-hour period.

Typical construction equipment generates maximum (worst-case) noise levels ranging from about 70 to 90 dBA L_{max} at a distance of 50 feet from the source (FHWA 2006). The rate of attenuation (i.e., reduction) is about 6 dBA for every doubling of distance from a point source (Harris 1991). Table 5.7-14 (Noise Levels and Assumed Operational Parameters for Construction Equipment), identifies reference noise levels for construction equipment expected to be used during construction. The table provides information regarding the approximate percentage of use during a typical hour and the typical maximum noise level (L_{max}) and equivalent noise level (L_{eq}) at 50 feet from the source based on information provided by the Federal Highway Administration (FHWA 2006). Table 5.7-15 (Construction Activities, Equipment, Duration, and Maximum Estimated Noise Levels at 50 feet from Noise Sources), identifies the various activities associated with construction of the proposed Project (including production well installation, well facility [building] construction, and pipelines), the equipment to be used, the duration of construction for each construction activity, and the estimated noise levels that would be generated during construction of each activity, as detailed in Chapter 3, Project Description.

TABLE 5.7-14
Noise Levels and Assumed Operational Parameters for Construction Equipment

Construction Equipment	Approximate Usage per Hour	Noise Level (dBA) at 50 feet		Daytime/Nighttime Usage
		L_{max}	L_{eq} (one hour)	
Backhoe	40%	78	74	Day
Front-End Loader	40%	79	75	Day
Drill Rig	100%	79	79	Day/Night
Concrete Mixer	40%	79	75	Day
Compactor	20%	83	76	Day
Crane	16%	81	73	Day
Dump/Haul Truck	40%	77	73	Day
Concrete Pump Truck	20%	81	75	Day
Excavator	40%	81	77	Day
Generator	50%	81	78	Day
Pickup Truck	40%	75	71	Day
Pumps	50%	81	78	Day/Night
Arc Welder	40%	74	70	Day

Source: FHWA 2006

TABLE 5.7-15

Construction Activities, Equipment, Duration, and Maximum Estimated Noise Levels at 50 feet from Noise Source

Project Components and Construction Activities	Construction Vehicles and Equipment	Construction Duration	Maximum Estimated Noise Levels at 50 feet[(a)]
Production Well Installation			
Site preparation Pilot hole drilling Bore hole drilling Pump testing	Construction equipment is expected to include: mounted drill rig on a support truck, cement truck, pump truck, trailers, and pickup trucks.	Well construction, development and testing would require approximately four to six weeks. Pump testing would occur for 12 to 48 hours continuously.	81 dBA L_{max} 82 dBA L_{eq}
Well Facility (Building) Construction			
Site preparation and grading On-site pipeline installation Building foundation Building construction Pump Installation Landscaping and site restoration	Construction equipment is expected to include: a front end loader, backhoe, excavator, fork lift, telescopic crane, cement mixer, concrete pump truck, compactor, hauling trucks, pump-setting rig, and arc welder. Diesel generators with self-contained fuel tanks may be used during construction.	14 months total	85 dBA L_{max} 87 dBA L_{eq}
Utility Pipelines			
Vegetation removal and grading or pavement cutting depending on the location Trench excavation and shoring to stabilize the sides of the trench if necessary Pipeline installation Trench backfilling and compacting Surface restoration	Construction equipment is expected to include: excavator, front-end loader, hauling trucks, compactor, asphalt trucks, arc welder. Diesel generators with self-contained fuel tanks may be used.	300 to 600 feet per week	83 dBA L_{max} 82 dBA L_{eq}

Source: SFPUC, Illingworth & Rodkin and FHWA 2006

Note:

(a) The L_{max} represents the maximum noise level generated by the loudest single piece of construction equipment.

For this analysis, the reference noise levels for each site were calculated using the FHWA Roadway Construction Noise Model, which assumes that all of the equipment could be operated simultaneously and at the hourly usage factors for each piece of equipment presented in Table 5.7-14 (Noise Levels and Assumed Operational Parameters for Construction Equipment) (FHWA 2006). The corresponding noise levels at receptors were then predicted based on the approximate distance between the nearest noise-sensitive receptors and the construction area. Standard methods for acoustical analysis of construction sites are based on the distance from the "acoustical center" or construction activity center of the site to the nearest noise-sensitive receptor, as was the case for this analysis. In other words, the proposed pieces of construction equipment are not modeled at the construction area boundary, but rather at the approximate center of the area in which most construction activity is likely to occur. Distances to the nearest receptor property line were used for predicting noise levels in comparison with standards established by general plans and local noise ordinances; whereas, distances to the nearest receptor buildings where people reside and sleep (e.g., residences and hotels) were used for predicting noise levels in comparison with speech and sleep disturbance criteria. In addition, in the cities of South San Francisco and San Bruno, to determine if noise levels exceeded local standards (Impact NO-1) maximum construction noise levels from the individual loudest piece of equipment were predicted at a distance of 25 feet in South San Francisco and 100 feet in San Bruno, per the respective noise ordinance requirements. Finally, in South San Francisco, for construction noise occurring outside allowable noise ordinance hours, the L_{50} noise level metric is used to assess construction noise impacts. For the purposes of this analysis, the L_{50}, which is defined as the noise level which is exceeded 50 percent of the measurement period (one hour for the City of South San Francisco), can be assumed to equal the predicted L_{eq} noise level when the construction activity is continuous (i.e., well drilling and pump testing).

Peak noise-generating daytime construction activities associated with the proposed Project would occur during construction of a well facility building. In the case of well facilities with only a fenced enclosure and with no existing test well, peak noise-generating daytime construction activities would instead occur during production well installation. Peak noise-generating nighttime construction activities would occur during production well installation, in areas where new wells are proposed. As discussed in Chapter 3, Section 3.5.3.1 (Construction Hours), drilling of a production well would occur continuously for about a week (seven consecutive days and nights) after the site has been cleared and prepared. In addition to well drilling, well pumping tests would be performed sequential to final well development for a continuous period of 48 hours. The type of equipment for the pump tests would include a portable submersible pump, truck or rig, and possibly a generator. Noise resulting from the proposed pumping tests would therefore not be louder than from production well installation.

In the case where a sensitive receptor is located relatively far from a well site, but close to pipeline installation, this is evaluated on a case-by-case basis for each facility site.

Construction noise levels due to the proposed Project are estimated in Table 5.7-16 (Conflicts with Local Noise Ordinances during Construction) for daytime construction and Table 5.7-17 (Conflicts with Local Noise Ordinances during Nighttime Construction – Noise Levels with Mitigation Measure M-NO-1 [Noise Control Plan]) for nighttime construction.

Impact NO-1: Project construction would result in noise levels in excess of local standards. (Significant and Unavoidable with Mitigation)

The City of Daly City and the City of Millbrae ordinances do not contain specific construction noise performance standards (i.e., quantified standards), whereas, the cities of South San Francisco and San Bruno, the Town of Colma, and the County of San Mateo have noise performance standards that are applicable to construction (see Table 5.7-10 [Summary of Local Noise Regulations Pertaining to Construction]).

Table 5.7-16 (Conflicts with Local Noise Ordinances during Construction), identifies the daytime noise levels, predicted at the closest sensitive receptor property line, for the two jurisdictions with daytime performance standards (cities of South San Francisco and San Bruno). Construction noise levels are estimated using the reference noise levels presented in Table 5.7-15 (Construction Activities, Equipment, Duration, and Maximum Estimated Noise Levels at 50 feet from Noise Source), by construction type, and the distance to the nearest sensitive receptor property line. Table 5.7-16, also identifies the nighttime noise levels, predicted at the closest sensitive receptor property line, for the four jurisdictions with nighttime performance standards (County of San Mateo, City of South San Francisco, Town of Colma, and City of San Bruno) at sites with proposed nighttime construction. The significance thresholds for the jurisdictions vary (see Table 5.7-10 [Summary of Local Noise Regulations Pertaining to Construction]).

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

<u>Sites 2, 5, 6, and Westlake Pump Station</u>

Sites 2, 5, 6, and the Westlake Pump Station would be located in the City of Daly City. As discussed in Section 5.7.2.3 (Local Regulations), noise in Daly City that disturbs any other person beyond the confines of the property between the hours of 10:00 p.m. and 6:00 a.m. is prohibited. The Daly City noise ordinance has no specific restrictions on daytime construction. Proposed well facility and pipeline construction at Sites 2, 5, 6, and the Westlake Pump Station would not occur between 10:00 p.m. and 6:00 a.m. and therefore would not conflict with the Daly City Noise Ordinance. No well drilling is proposed at Sites 2, 5, 6, or the Westlake Pump Station. Therefore, there would be no exceedance of the local daytime or nighttime noise standards. As a result, *no impact* would occur.

Impact Conclusion: No Impact

<u>Sites 7 and 15</u>

Site 7

Site 7 would be located in the Town of Colma. As noted above in Section 5.7.2.3 (Local Regulations), Colma's noise regulations state that no person shall operate equipment in residential areas or within a radius of 500 feet therefrom that exceeds a noise level of 85 dBA measured at a distance of 25 feet from the source during the hours of 7:00 a.m. to 8:00 p.m. Monday through Friday (weekend and holiday hours of 10:00 a.m. to 6:00 p.m.), or 60 dBA at a distance of 25 feet from the source during the hours of 8:00 p.m. to 7:00 a.m. Monday through Friday (weekend and holidays hours 6:00 p.m. to 10:00 a.m.) Under Colma's noise regulations, hourly limits in non-residential areas are decided on a project-by-project basis by the Building Official. Because hourly limits have not been set by the Building Official for construction of the Project in this area, the provisions of Colma's noise regulations relating to construction in residential areas or within a radius of 500 feet therefrom are used in this analysis to be conservative.

Neither option at Site 7 would be located in a residential zone or within 500 feet of a residential zone, and therefore construction at Site 7 would not conflict with the Colma noise ordinance. As a result, any noise impacts would be *less than significant*.

Site 15

Site 15 would be located in the City of San Bruno. As presented in Table 5.7-10 (Summary of Local Noise Regulations Pertaining to Construction), the City of San Bruno sets L_{max} limits for individual pieces of equipment at 85 dBA at 100 feet during the day (i.e., 7:00 a.m. to 10:00 p.m.) and 60 dBA at 100 feet for nighttime (i.e., 10:00 p.m. to 7:00 a.m.) within any residential zone or within 500 feet of a residential zone. No construction work at the Site 15 well facility would be within any residential zones or within 500 feet of a residential zone, because the nearest residence would be located approximately 700 feet from the well facility. However, the pipeline route on Sneath Lane would be located within about 100 feet of the property line of a multi-family residence. Construction noise levels for individual pieces of equipment utilized for the Site 15 pipeline installation would be 77 dBA L_{eq}, which is below the standard for daytime (see Table 5.7-16 [Conflicts with Local Noise Ordinances during Construction]), and the pipeline would be constructed only during the daytime. Therefore, the impact of construction-related noise ordinance conflicts at Site 15 would be *less than significant*.

Impact Conclusion: Less than Significant

TABLE 5.7-16
Conflicts with Local Noise Ordinances during Construction

Site	Jurisdiction	Nearest Receptor	Approximate Distance to Property Line of Receptor (feet)	Daytime Construction (Well Drilling and Testing; Well Facility and Pipeline Construction)					Nighttime Construction (Well Drilling and Testing)	
							Construction Outside of Allowable Daytime Hours			
				Loudest Daytime Activity	Predicted Noise Level at Property Line of Receptor[a] dBA L_{max}/L_{eq}	Conflict with Ordinance? (LSM/SUM)	Would construction occur outside of allowable daytime hours? (Yes/No)	Conflict with Ordinance? (LSM/SUM)	Predicted Noise Level at Property Line of Receptor dBA L_{max}/L_{eq}	Conflict with Ordinance? (LSM/SUM)
Site 1	Daly City	Multi-family Residential	90[b]	N/A	N/A[c]		No	No	77[b]	Yes (SUM)
Site 2	Daly City	Multi-family Residential	N/A	N/A	N/A[c]		No	No	No nighttime construction.	
Site 3	San Mateo County	Single-family Residential	85	Well Drilling and Testing	The County of San Mateo has no thresholds for daytime construction.		Yes	Yes (LSM)	77	Yes (LSM)
Site 4	San Mateo County	Single-family Residential	25	Well Drilling and Testing	The County of San Mateo has no thresholds for daytime construction.		Yes	Yes (LSM)	88	Yes (SUM)
WLPS	Daly City	Multi-family Residential	N/A	N/A	N/A[c]		No	No	No nighttime construction.	
Site 5 (Consolidated Treatment at Site 6)	Daly City	Single-family Residential	N/A	N/A	N/A[c]		No	No	No nighttime construction.	
Site 6	Daly City	Multi-family Residential	N/A	N/A	N/A[c]		No	No	No nighttime construction.	
Site 7 (Consolidated Treatment at Site 6)	Colma	Cemetery	N/A	N/A	N/A		No	No	Not a noise-sensitive receptor at night.	
Site 5 (On-site Treatment)	Daly City	Single-family Residential	N/A	N/A	N/A[c]		No	No	No nighttime construction.	
Site 6	Daly City	Multi-family Residential	N/A	N/A	N/A[c]		No	No	No nighttime construction.	
Site 7 (On-site Treatment)	Colma	Cemetery	N/A	N/A	N/A[d]		No	No	Not a noise-sensitive receptor at night.	
Site 8	Colma	Cemetery	25[e]	Well Facility	91	Yes (LSM)	Yes	Yes (LSM)	Not a noise-sensitive receptor at night.	
Site 9	South San Francisco	Trailer Court	<25	Well Facility	91/89[f]	Yes (LSM)	Yes	Yes (LSM)	79	Yes (SUM)
Site 10	South San Francisco	Single-family Residential	220	Well Facility	91/74[f]	Yes (LSM)	Yes	Yes (LSM)	No nighttime construction.	

TABLE 5.7-16
Conflicts with Local Noise Ordinances during Construction

Site	Jurisdiction	Nearest Receptor	Approximate Distance to Property Line of Receptor (feet)	Daytime Construction (Well Drilling and Testing; Well Facility and Pipeline Construction)					Nighttime Construction (Well Drilling and Testing)	
				Loudest Daytime Activity	Predicted Noise Level at Property Line of Receptor[a] dBA L_{max}/L_{eq}	Conflict with Ordinance? (LSM/SUM)	Construction Outside of Allowable Daytime Hours: Would construction occur outside of allowable daytime hours? (Yes/No)	Construction Outside of Allowable Daytime Hours: Conflict with Ordinance? (LSM/SUM)	Predicted Noise Level at Property Line of Receptor dBA L_{max}/L_{eq}	Conflict with Ordinance? (LSM/SUM)
Site 11	South San Francisco	Single-family Residential	385	Well Facility	91/69[f]	Yes (LSM)	Yes	Yes (LSM)	64	Yes (LSM)
Site 12	South San Francisco	Funeral Home	<25	Well Facility	91/89[f]	Yes (LSM)	Yes	Yes (LSM)	Not a noise-sensitive receptor at night and funeral home opens at 9:00 a.m.	
		Single-family Residential	60	Well Facility	91/81[f]	Yes (LSM)	Yes	Yes (LSM)	75	Yes (LSM)
Site 13	South San Francisco	Extended Stay Hotel	25	Pipeline	91/89[f]	Yes (LSM)	Yes	Yes (LSM)	No nighttime construction.	
Site 14	San Bruno	Single-family Residential	100[g]	Well Facility	79	No	No	No	76	Yes (LSM)
Site 15	San Bruno	Multi-family Residential	100[g]	Pipeline	77	No	No	No	N/A[h]	
Site 16	Millbrae	Multi-family Residential	85	Well Drilling and Testing	Millbrae has no thresholds for daytime construction.		Yes	Yes (LSM)	77	Yes (SUM)
Site 17 (Alternate)	Colma	Cemetery	25[d]	Well Facility	93	Yes (LSM)	Yes	Yes (LSM)	Not a noise-sensitive receptor at night.	
Site 18 (Alternate)	South San Francisco	Single-family Residential	<25	Well Facility	91/93[f]	Yes (LSM)	Yes	Yes (LSM)	88	Yes (SUM)
Site 19 (Alternate)	South San Francisco	Church	<25	Pipeline	89/89[f]	No	Yes	Yes (LSM)	Not a noise-sensitive receptor at night.	
		Single-family Residential	65	Pipeline	89/80[f]	No	Yes	Yes (LSM)	80	Yes (SUM)

Notes:

(a) Approximate distance from construction activity center or pipeline installation to nearby noise sensitive property line, based on aerial photo information from Google Earth ™ and using ArcGIS ™, see Table 5.7-7 (Summary of Nearby Sensitive Receptors). L_{max}/L_{eq} evaluated at the property line of the closest sensitive receptor per ordinance requirements of respective local jurisdiction.

(b) As predicted at the nearest receptor building, where a disturbance could occur, per the City of Daly City noise ordinance.

(c) Daly City does not have thresholds for daytime construction. For information regarding Project noise levels from daytime construction, see Impact NO-3 below.

(d) Neither option at Site 7 would be located in a residential zone or within 500 feet of a residential zone; therefore, construction at Site 7 would not conflict with the Colma noise ordinance.

(e) The Town of Colma standards are enforced at 25 feet from construction equipment.

(f) Predicted noise levels are displayed as "noise level at a distance of 25 feet"/ "noise level at nearest receptor property line" for sites within the City of South San Francisco.

(g) The City of San Bruno standards are enforced at 100 feet from construction equipment

(h) Site 15 nighttime construction work is not in a residential zone or within 500 feet of a residential zone.

For purposes of determining conflicts with local noise standards, cemeteries are considered a sensitive receptor, but there are no noise thresholds applicable to cemeteries.

LSM = Less than significant with mitigation

SUM = Significant and unavoidable with mitigation

N/A = Not Applicable

Sites 3, 8, 10, 11, 13, 14, and 17 (Alternate)

Site 3 would be located in unincorporated San Mateo County. The standards for the County of San Mateo are discussed in Section 5.7.2.3 (Local Regulations). As presented in Table 5.7-10 (Summary of Local Noise Regulations Pertaining to Construction), San Mateo County only exempts construction from the noise limits from the hours of 7:00 a.m. to 6:00 p.m. on weekdays, and 9:00 a.m. to 5:00 p.m. on Saturdays. Even though the Project may be exempt from noise ordinance limitations (per section 4.88.380 of the San Mateo County Noise Ordinance), this exemption from the hourly restrictions on construction would not apply to nighttime construction or on Sundays and holidays. Instead, this analysis presumes that for nighttime, Sundays, and holidays, the L_{eq} for a time-varying source (such as construction activity) representative of the maximum noise environment, that would still comply with the County ordinance exterior noise level standard, is 57 dBA (WIA 2009). Therefore, 57 dBA is presumed to be the construction noise limit at all times on Sunday and holidays. Well facility (exclusive of well drilling and pump testing) and pipeline construction at Site 3 is proposed to occur outside of hours when construction noise is exempt from ordinance noise limits (i.e., from 6:00 p.m. to 7:00 p.m. on weekdays and occasionally from 7:00 a.m. to 9:00 a.m. on Saturdays) and would thereby result in the exposure of persons to, or in the generation of, noise levels in excess of standards established in the local noise ordinance during these hours. As a result, the impact of noise from this construction outside allowable hours would be *significant*. However, implementation of Mitigation Measure M-NO-1 (Noise Control Plan) (see page 5.7-44) would limit construction of the well facility (except well drilling and pump testing) and pipeline construction to the allowable daytime hours noted above. Therefore, with implementation of Mitigation Measure M-NO-1, this portion of the noise impact at Site 3 would be reduced to *less-than-significant* levels.

For Site 3, the estimated maximum noise level resulting from well drilling and pump testing that would occur day and night would be 77 dBA L_{eq}, which is above the nighttime standard of 57 dBA L_{eq} (see Table 5.7-16 [Conflicts with Local Noise Ordinances during Construction]). However, implementation of Mitigation Measure M-NO-1 (Noise Control Plan) would require that the maximum noise level at Site 3 for well drilling and pump testing be limited to 57 dBA L_{eq}, which would not exceed the nighttime standard. Therefore, with implementation of Mitigation Measure M-NO-1 this portion of the noise impact would be reduced to *less-than-significant* levels.

Sites 8 and 17 (Alternate) would be located in the Town of Colma. As noted above in Section 5.7.2.3 (Local Regulations), Colma's noise regulations state that no person shall operate equipment in residential areas or within a radius of 500 feet therefrom that exceeds a noise level of 85 dBA measured at a distance of 25 feet from the source during the hours of 7:00 a.m. to 8:00 p.m. Monday through Friday (weekend and holiday hours of 10:00 a.m. to 6:00 p.m.), or 60 dBA at a distance of 25 feet from the source during the hours of 8:00 p.m. to 7:00 a.m. Monday through Friday (weekend and holidays hours 6:00 p.m. to 10:00 a.m.) Under Colma's noise regulations, hourly limits in non-residential areas are decided on a project-by-project basis by the Building Official. Because hourly limits would not have been set by the Town of Colma Building Official for construction of this Project in this area, the provisions of Colma's noise regulations relating to construction in residential areas or within a radius of 500 feet therefrom are used in this analysis to be conservative.

In addition, because daily construction hours would typically be between 7:00 a.m. and 7:00 p.m. Monday through Friday (and occasionally on Saturdays between the hours of 7:00 a.m. and 5:00 p.m.), construction at Sites 8 and 17 (Alternate) is proposed to occasionally occur outside of allowable hours (i.e., occasionally from 7:00 a.m. to 10:00 a.m. on Saturdays) and thereby result in the exposure of persons to, or in the generation of, noise levels in excess of standards established in the local noise ordinance during these hours. As a result, the impact of noise from construction outside allowable hours would be potentially *significant*. However, implementation of Mitigation Measure M-NO-1 (Noise Control Plan) would limit well facility (exclusive of well drilling and pump testing at Site 17 [Alternate]) and pipeline construction to the allowable daytime hours. Therefore, with implementation of Mitigation Measure M-NO-1, this impact at Sites 8 and 17 (Alternate) would be reduced to *less-than-significant* levels.

As shown in Table 5.7-16 (Conflicts with Local Noise Ordinances during Construction), estimated maximum daytime noise levels at Sites 8 and 17 (Alternate) at a distance of 25 feet would be 91 and 93 dBA L_{max}, respectively, due to well facility construction, which would exceed the daytime standard. As a result, the impact of daytime construction-related noise would be *significant*. Implementation of Mitigation Measure M-NO-1 (Noise Control Plan) would reduce daytime noise levels to 81 and 83 dBA L_{max}, respectively, which would be below the daytime standard. Therefore, with implementation of Mitigation Measure M-NO-1, the impact of daytime well facility construction would be reduced to *less-than-significant* levels.

Well drilling would not be needed at Site 8, where there is an existing test well that would be converted to a production well, but well drilling and pump testing would be needed at Site 17 (Alternate). However, the well location for Site 17 (Alternate) is 500 feet from the nearest residential receptor, so noise regulations for nighttime construction would not be applicable to this site. Nighttime construction at Site 17 (Alternate) would thus have *less-than-significant* noise impacts.

Sites 10, 11, and 13 would be located in the City of South San Francisco. As presented in Table 5.7-10 (Summary of Local Noise Regulations Pertaining to Construction), South San Francisco limits construction to the hours of 8:00 a.m. to 8:00 p.m. on weekdays, 9:00 a.m. to 8:00 p.m. on Saturdays, and 10:00 a.m. to 6:00 p.m. on Sundays and holidays. The City of South San Francisco sets L_{max} daytime limits for any single piece of equipment at 90 dBA at 25 feet from the noise source or as measured at the property line. Construction that occurs outside of the allowable hours for the various days of the week is subject to the noise level performance standards presented in Table 5.7-9 (South San Francisco Noise Level Standards). Because daily construction hours are proposed to occur outside of allowable hours (i.e., from 7:00 a.m. to 8:00 a.m. on weekdays and occasionally from 7:00 a.m. to 9:00 a.m. on Saturdays, as well as 7:00 a.m. to 10:00 a.m. on Sundays and holidays), the Project would thereby result in the exposure of persons to, or in the generation of, noise levels in excess of standards established in the local noise ordinance during these hours. As a result, the impact of noise from construction outside allowable hours would be *significant*. However, implementation of Mitigation Measure M-NO-1 (Noise Control Plan) would limit construction of the well facility (except well drilling and pump testing) and pipeline construction to the allowable daytime hours noted above. Therefore, with implementation of Mitigation Measure M-NO-1, this impact at Sites 10, 11, and 13 would be reduced to *less-than-significant* levels. No well drilling and pump testing activities are proposed at Sites 10 and 13.

At Sites 10, 11, and 13, construction noise levels during allowable hours (8:00 a.m. to 8:00 p.m. Monday through Friday and 9:00 a.m. to 8:00 p.m. on Saturdays, as well as 10:00 a.m. to 6:00 p.m. on Sundays and holidays) would be 91 dBA L_{max}, which is above the threshold of 90 dBA L_{max} at a distance of 25 feet from the loudest single piece of equipment (see Table 5.7-16 [Conflicts with Local Noise Ordinances during Construction]). As a result, the impact of noise from construction during allowable hours would be *significant*. However, implementation of Mitigation Measure M-NO-1 (Noise Control Plan) establishes a performance standard for the attenuation that would reduce construction-related noise levels by at least 5 dBA. Therefore, with implementation of Mitigation Measure M-NO-1, this impact would be reduced to *less-than-significant* levels at Sites 10, 11, and 13.

With implementation of Mitigation Measure M-NO-1 (Noise Control Plan), there would be no construction activities outside of daytime hours as defined by the City of South San Francisco, except for well drilling at Site 11. Well drilling would require nighttime activity lasting up to seven consecutive days and subsequent pump-testing activities would last 24 to 48 hours. The estimated maximum noise levels resulting from well-drilling and pump-testing activities would be 64 dBA L_{50} at Site 11, which would exceed the nighttime standard for single-family residential (50 dBA L_{50}) by 14 dBA, and thus result in a *significant* noise impact. However, implementation of Mitigation Measure M-NO-1 establishes a performance standard for the attenuation that would reduce nighttime construction-related noise levels by at least 20 dBA (calculations on file with the San Francisco Planning Department). Therefore, with implementation of Mitigation Measure M-NO-1 this impact would be reduced to *less-than-significant* at Site 11 by limiting construction noise levels to the locally allowable limit for ongoing operational noise; i.e., even though construction at Site 11 would still be occurring outside of allowable hours for construction, the exposure of nearby noise-sensitive receptors to this noise would be reduced to the local limit for ongoing activities and thereby not result in exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance.

Site 14 would be located in the City of San Bruno. The standards for the City of San Bruno are discussed in Section 5.7.2.3 (Local Regulations). The estimated maximum noise level resulting from daytime construction measured at 100 feet would be 79 dBA L_{max} (see Table 5.7-16 [Conflicts with Local Noise Ordinances during Construction]). Therefore, construction-related noise levels at Site 14 during the day would be below the established standard (85 dBA L_{max}). The estimated maximum noise level resulting from construction at night would be 76 dBA L_{max} measured at 100 feet, which would be above the nighttime standard (60 dBA L_{max}), resulting in a *significant* noise impact. However, implementation of Mitigation Measure M-NO-1 (Noise Control Plan) would reduce the maximum noise level at Site 14 to 56 dBA L_{max}, which would be below the nighttime standard. Therefore, with implementation of Mitigation Measure M-NO-1, this impact would be reduced to *less-than-significant* levels.

Impact Conclusion: Less than Significant with Mitigation

<u>Sites 1, 4, 9, 12, 16, 18 (Alternate), and 19 (Alternate)</u>

Site 1 would be located in the City of Daly City. As discussed in Section 5.7.2.3 (Local Regulations), noise that disturbs any other person beyond the confines of the property between the hours of 10:00 p.m. and 6:00 a.m. is prohibited in Daly City. Nighttime well drilling and pump testing would be required at Site 1.

As a result, the impact of nighttime construction-related noise would be *significant*. The Project, by definition, requires nighttime construction for well drilling and testing, so no mitigation is available that would eliminate construction outside of Daly City's allowable hours. As a result, this impact would be *significant and unavoidable*, given that there is no feasible mitigation that would avoid continuous well drilling (see explanation in Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]).

Site 4 would be located in unincorporated San Mateo County. The standards for the County of San Mateo are discussed in Section 5.7.2.3 (Local Regulations). As presented in Table 5.7-10 (Summary of Local Noise Regulations Pertaining to Construction), San Mateo County exempts construction during the hours of 7:00 a.m. to 6:00 p.m. on weekdays, and 9:00 a.m. to 5:00 p.m. on Saturdays, from local noise limits. Even though the Project may be exempt from noise ordinance limitations (per section 4.88.380 of the San Mateo County Noise Ordinance), this exemption from the hourly restrictions on construction would not apply to nighttime construction or on Sundays and holidays. Instead, this analysis presumes that for nighttime, Sundays and holidays, the L_{eq} for a time-varying source (such as construction activity) representative of the maximum noise environment that would still comply with the County ordinance exterior noise level standard is 57 dBA (WIA 2009). Therefore, 57 dBA is presumed to be the construction noise limit at all times on Sunday and holidays. Well facility and pipeline construction at Site 4 is proposed to occur outside of hours when construction noise is exempt from ordinance noise limits (i.e., from 6:00 p.m. to 7:00 p.m. on weekdays and occasionally from 7:00 a.m. to 9:00 a.m. on Saturdays) and would thereby result in the exposure of persons to, or in the generation of, noise levels in excess of standards established in the local noise ordinance during these hours. As a result, the impact of noise from this construction outside allowable hours would be *significant*. Implementation of Mitigation Measure M-NO-1 (Noise Control Plan) would limit construction of well facility (exclusive of well drilling and pump testing) and pipeline construction to the allowable daytime hours. Therefore, with implementation of Mitigation Measure M-NO-1, this portion of the noise impact at Site 4 would be reduced to *less-than-significant* levels.

For Site 4, the estimated maximum noise level resulting from well drilling and pump testing that would occur day and night would be 88 dBA L_{eq}, which is above the nighttime standard (57 dBA L_{eq}) by 31 dBA (see Table 5.7-16 [Conflicts with Local Noise Ordinances during Construction]). Implementation of Mitigation Measure M-NO-1 (Noise Control Plan) would reduce the maximum noise levels at Site 4 to 68 dBA L_{eq}, which would still be above the nighttime standard. As a result, this portion of the noise impact would be *significant and unavoidable with mitigation*, given that no feasible mitigation is available to reduce noise levels further to an acceptable nighttime level, and well drilling must be continuous (see explanation in Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]).

Sites 9, 12, 18 (Alternate), and 19 (Alternate) would be located in the City of South San Francisco. As presented in Table 5.7-10 (Summary of Local Noise Regulations Pertaining to Construction), South San Francisco limits construction to the hours of 8:00 a.m. to 8:00 p.m. on weekdays, 9:00 a.m. to 8:00 p.m. on Saturdays, and 10:00 a.m. to 6:00 p.m. on Sundays and holidays. The City of South San Francisco sets L_{max} daytime limits for any single piece of equipment at 90 dBA at 25 feet from the noise source or as measured at the property line. Construction that occurs outside of the allowable hours for the various days of the week is subject to the noise level performance standards presented in Table 5.7-10. Because well-drilling and pump-testing activities lasting several days are proposed at Sites 9, 12, 18 (Alternate), and 19 (Alternate) and because daily construction hours for well facility and pipeline construction would typically be between 7:00 a.m. and 7:00 p.m. Monday through Friday (and occasionally on Saturdays between the hours of 7:00 a.m. and 5:00 p.m.), construction at Sites 9, 12, 18 (Alternate), and 19 (Alternate) would occur outside of allowable hours and thereby result in *significant* noise impacts. However, implementation of Mitigation Measures M-NO-1 (Noise Control Plan) would limit well facility (exclusive of well drilling and pump testing) and pipeline construction to the allowable daytime hours (i.e., 8:00 a.m. to 8:00 p.m. Monday through Friday and 9:00 a.m. to 8:00 p.m. on Saturdays). Therefore, with implementation of Mitigation Measure M-NO-1 (Noise Control Plan), this portion of the noise impact (i.e., for well facility and pipeline construction) at Sites 9, 12, 18 (Alternate), and 19 (Alternate) would be reduced to *less-than-significant* levels.

Construction noise levels associated with well facility construction during allowable hours (i.e., 8:00 a.m. to 8:00 p.m. Monday through Friday and 9:00 a.m. to 8:00 p.m. on Saturdays) at Sites 9, 12, and 18 (Alternate) would be 91 dBA L_{max} at a distance of 25 feet from the loudest single piece of equipment, which is above the threshold of 90 dBA L_{max} at a distance of 25 feet from the loudest single piece of equipment (see Table 5.7-16 [Conflicts with Local Noise Ordinances during Construction]). As a result, the impact of noise from construction during allowable hours would be *significant*. However, implementation of Mitigation Measure M-NO-1 (Noise Control Plan) establishes a performance standard for the attenuation that would reduce construction-related noise levels by at least 5 dBA. Therefore, with implementation of Mitigation Measure M-NO-1 construction noise levels during allowable hours (8:00 a.m. to 8:00 p.m. Monday through Friday and 9:00 a.m. to 8:00 p.m. on Saturdays) at Site 19 (Alternate) would be 89 dBA L_{max} due to pipeline installation, which is below the threshold of 90 dBA L_{max} at a distance of 25 feet from the loudest single piece of equipment, a *less-than-significant* impact.

In addition, however, well-drilling (lasting up to seven consecutive days) and subsequent pump-testing activities (lasting 24 to 48 hours) are proposed at Sites 9, 12, 18 (Alternate), and 19 (Alternate). The estimated highest L_{50} noise levels resulting from well-drilling and pump-testing activities would be 79 dBA L_{50} at Site 9, which would be above the nighttime standard for multi-family residential (55 dBA L_{50}) by 24 dBA; 75 dBA L_{50} at Site 12, which would be above the nighttime standard for single-family residential by 25 dBA; 88 dBA L_{50} at Site 18 (Alternate), which would be above the nighttime standard for single-family residential by 38 dBA; and 80 dBA L_{50} at Site 19 (Alternate), which would be above the nighttime standard for single-family residential by 30 dBA. However, even with implementation of Mitigation Measure M-NO-1 (Noise Control Plan) this impact would be *significant and unavoidable with mitigation* at Sites 9, 12, 18 (Alternate), and 19 (Alternate) where the standard before mitigation would be exceeded by more than 20 dBA (see nighttime noise levels with mitigation in Table 5.7-17 [Conflicts with Local Noise Ordinances during Nighttime Construction – Noise Levels with Mitigation Measure M-NO-1]), given that no feasible mitigation is available to reduce noise levels further to an acceptable nighttime level, and well drilling must be continuous (see explanation in Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]).

Site 16 would be located in the City of Millbrae and would be within 500 feet of a residential area. As discussed in Section 5.7.2.3 (Local Regulations), Millbrae's noise ordinance limits construction to the hours from 7:30 a.m. to 7:00 p.m. Monday through Friday, from 8:00 a.m. to 6:00 p.m. on Saturdays, and from 9:00 a.m. to 6:00 p.m. on Sundays and holidays within residential areas, unless otherwise authorized by the city. Well facility and pipeline construction at Site 16 is proposed to occur outside of allowable hours. As a result, the impact of noise from this construction outside allowable hours would be *significant*. However, implementation of Mitigation Measure M-NO-1 (Noise Control Plan) would limit well facility (excepting well drilling and pump testing) and pipeline construction to the allowable daytime hours. Therefore, with implementation of Mitigation Measure M-NO-1, this portion of the noise impact at Site 16 would be reduced to *less than significant*.

For Site 16, nighttime well drilling and pump testing would occur outside the hours allowed by the City of Millbrae. This impact would be *significant*. No feasible mitigation is available to eliminate nighttime construction, because well drilling must be continuous (see explanation in Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]). This impact would be *significant and unavoidable*.

Impact Conclusion: Significant and Unavoidable with Mitigation

Mitigation Measure M-NO-1 (Noise Control Plan) is followed by Tables 5.7-17 (Conflicts with Local Noise Ordinances during Nighttime Construction–Noise Levels with Mitigation Measure M-NO-1 [Noise Control Plan]) and 5.7-18 (Conflicts with Local Noise Ordinances during Daytime Construction – Noise Levels with Mitigation Measure M-NO-1 [Noise Control Plan]), which present whether the measures bring the impacts into compliance with the jurisdiction's noise ordinance.

Mitigation Measure M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate])[5]

The SFPUC will limit well facility and pipeline construction as follows:

- For Site 1 in Daly City, the proposed construction hours for well facility and pipeline construction (i.e., exclusive of well drilling and pump testing) fall within the locally allowable construction hours and therefore may occur as proposed;
- For Sites 3 and 4 in the County of San Mateo, well facility (exclusive of well drilling and pump testing) and pipeline construction will be limited to the hours of 7:00 a.m. to 6:00 p.m. Monday through Friday and 9:00 a.m. to 5:00 p.m. on Saturday, and shall be disallowed on Sundays and holidays;
- For Sites 9, 10, 11, 12, 13, 18 (Alternate), and 19 (Alternate) in the City of South San Francisco, well facility (exclusive of well drilling and pump testing at Sites 9, 11, 12, 18 [Alternate], and 19 [Alternate]) and pipeline construction will be limited to the hours of 8:00 a.m. to 8:00 p.m. Monday through Friday and 9:00 a.m. to 8:00 p.m. on Saturday and from 10:00 a.m. to 6:00 p.m. on holidays;
- For Sites 8 and 17 (Alternate), in the Town of Colma, well facility (exclusive of well drilling and pump testing at Site 17 [Alternate]) and pipeline construction will be limited

[5] Impact NO-1 is not significant for Sites 5 and 15, but they are included in the title of the Mitigation Measure because a Mitigation Measure M-NO-1 is required under Impact NO-3, which is discussed below.

to the hours of 7:00 a.m. to 8:00 p.m. Monday through Friday and 10:00 a.m. to 6:00 p.m. Saturday and from 10:00 a.m. to 6:00 p.m. on holidays; and

- For Site 16 in Millbrae, well facility (exclusive of well drilling and pump testing) and pipeline construction will be limited to the hours of 7:30 a.m. to 7:00 p.m. Monday through Friday, 8:00 a.m. to 6:00 p.m. on Saturdays and from 9:00 a.m. to 6:00 p.m. on holidays. The proposed construction hours (exclusive of well drilling and pump testing) from Monday to Friday fall within the locally allowable construction hours and therefore may occur as proposed.

The SFPUC will retain a qualified noise consultant to prepare a Noise Control Plan and the SFPUC will approve the Noise Control Plan and ensure that it is implemented to reduce construction noise levels at nearby noise-sensitive land uses to meet the following performance standards:

- For Sites 3 and 4, in unincorporated San Mateo County, well drilling and testing will be limited to 57 dBA L_{eq} at the property line of the nearest sensitive receptor;
- For Sites 8 and 17 (Alternate), in the Town of Colma, any single piece of construction equipment will be limited to 85 dBA L_{eq} at 25 feet during the day;
- For Sites 9, 10, 11, 12, 13, 18 (Alternate), and 19 (Alternate), exclusive of nighttime well drilling and pump testing -- in South San Francisco, daytime noise levels will be limited to 90 dBA L_{max} from 8:00 a.m. to 8:00 p.m. Monday to Friday and from 9:00 a.m. to 8:00 p.m. on Saturdays, measured at the property plane or at 25 feet from the loudest single piece of equipment;
- To the extent feasible, well drilling and pump testing at Sites 9, 11, 12, 18 (Alternate), and Sites 19 (Alternate) in South San Francisco that occurs between the hours of 8:00 p.m. and 10:00 p.m., Monday to Saturday, and from 6:00 p.m. and 10:00 p.m. on Sundays, L_{50} dBA noise levels will be limited to 60 dBA; from 10:00 p.m. to 7:00 a.m., Monday through Sunday, L_{50} dBA noise levels will be limited to 50 dBA; and from 7:00 a.m. to 8:00 a.m. Monday to Friday, from 7:00 a.m. to 9:00 a.m. on Saturdays and from 7:00 a.m. to 10:00 a.m. on Sundays and holidays, L_{50} dBA noise levels will be limited to 60 dBA; and
- For Site 14, in San Bruno, a single piece of construction equipment will be limited to 85 dBA L_{max} at 100 feet from 7:00 a.m. to 10:00 p.m. or to 60 dBA L_{max} at 100 feet from 10:00 p.m. to 7:00 a.m.

The contractor will determine the specific methods to meet the performance standards provided above. Specific measures that can be feasibly implemented to comply with these performance standards include, but are not limited to, the following:

- Best available noise control practices (including mufflers, intake silencers, ducts, engine enclosures, and acoustically attenuating shields or shrouds) shall be used for all equipment and trucks in order to minimize construction noise impacts.

- If impact equipment (e.g., jack hammers, pavement breakers, rock drills) is needed during Project construction, hydraulically or electric-powered equipment shall be used wherever feasible to avoid the noise associated with compressed-air exhaust from pneumatically powered tools. However, where use of pneumatically powered tools is unavoidable, an exhaust muffler on the compressed-air exhaust shall be used. External jackets on the tools themselves shall also be used if available and feasible.
- To the extent consistent with applicable regulations and safety considerations, operation of vehicles requiring use of back-up beepers shall be avoided near sensitive receptors during nighttime hours and/or, the work sites shall be arranged in a way that avoids the need for any reverse motions of large trucks or the sounding of any reverse motion alarms during nighttime work. If these measures are not feasible, trucks operating during the nighttime hours with reverse motion alarms must be outfitted with SAE J994 Class D alarms (ambient-adjusting, or "smart alarms" that automatically adjust the alarm to 5 dBA above the ambient near the operating equipment).
- Stationary noise sources shall be located as far from sensitive noise receptors as feasible. If they must be located near receptors, adequate muffling (with enclosures where feasible and appropriate) shall be used. Enclosure openings or venting shall face away from sensitive noise receptors.
- A designated project liaison shall be responsible for responding to noise complaints during the construction phases. The name and phone number of the liaison shall be conspicuously posted at construction areas and on all advanced notifications. This person shall take steps to resolve complaints, including periodic noise monitoring, if necessary. Results of noise monitoring shall be presented at regular Project meetings with the contractor. The liaison shall coordinate with the contractor to modify any construction activities that generate noise levels above the levels identified in the performance standards listed in this measure.
- A reporting program shall be required that documents complaints received, actions taken to resolve problems, and effectiveness of these actions.
- Locate equipment at the work area to maximize the distance to noise-sensitive receptors, and to take advantage of any shielding that may be provided by other on-site equipment.
- Operate the equipment mindful of the residential uses nearby, especially during the nighttime hours.
- Maintain respectful and orderly conduct among workers, including worker conversation noise during the nighttime hours.
- Maintain the equipment properly to minimize extraneous noise due to squeaking or rubbing machinery parts, damaged mufflers, or misfiring engines.
- Provide advance notice to nearby residents prior to starting work at each work site, with information regarding anticipated schedule, hours of operation and a Project contact person.

- Provide a minimum 24-hour advance notice to residents within 250 feet of the production well site prior to nighttime work involving drilling, drilling-related activities, pumping tests, or truck deliveries.
- Schedule work and deliveries to minimize noise-generating activities during nighttime hours at work sites (e.g., no deliveries or non-essential work).
- Utilize a temporary noise barrier placed as close to the receptor (e.g., along the residential property line) or to the work site (e.g., as close as 15 to 20 feet from the drill rig or loudest generating activity area) as possible.
- Utilize sound blankets.

TABLE 5.7-17
Conflicts with Local Noise Ordinances during Nighttime Construction – Noise Levels with Mitigation Measure M-NO-1 (Noise Control Plan)

	Nighttime Construction	
Site	**Predicted Noise Level with Mitigation** L_{max}/L_{eq}	**Remaining Conflict with Local Ordinance with Mitigation?**
Site 1	57	Yes
Site 3	57	No
Site 4	68	Yes
Site 9	59	Yes
Site 11	44	No
Site 12	55	Yes
Site 14	56	No
Site 16	57	Yes
Site 18 (Alternate)	68	Yes
Site 19 (Alternate)	60	Yes

TABLE 5.7-18
Conflicts with Local Noise Ordinances during Daytime Construction – Noise Levels with Mitigation Measure M-NO-1 (Noise Control Plan)

Site	Daytime Construction	
	Predicted Noise Level with Mitigation L_{max}/L_{eq}	Remaining Conflict with Local Ordinance with Mitigation?
Site 3	N/A	No
Site 4	N/A	No
Site 8	81	No
Site 9	81	No
Site 10	86	No
Site 11	81	No
Site 12	81	No
Site 13	86	No
Site 16	N/A	No
Site 17 (Alternate)	83	No
Site 18 (Alternate)	81	No
Site 19 (Alternate)	N/A	No

Note:
N/A = Not applicable, because mitigation only requires limits on hours of construction.

Impact NO-2: Project construction would result in excessive groundborne vibration. (Less than Significant with Mitigation)

The analysis of groundborne vibration associated with construction is based on the level of vibration generated by proposed construction equipment, as listed in Table 3-8 (Estimated Daily Worker and Construction Equipment Trips for Wells and Well Facilities Construction) in Chapter 3, Project Description. Table 5.7-4 (Vibration Levels for Construction Equipment) summarizes typical vibration levels generated by construction equipment proposed for use by the Project (FTA 2006).

A bulldozer would be used during site preparation; loaded trucks would be used to haul excess soil away after grading of sites and pipeline trenching; a drilling rig would be used to drill the production well; a compactor would be used after backfilling the pipeline trench. Because pipeline trench compaction (equivalent to a vibratory roller) would occur at each well facility site, the maximum vibration level at each site would be 0.210 in/sec PPV at a distance of 25 feet from the pipeline. As shown in Table 5.7-4 (Vibration Levels for Construction Equipment), all other activities would cause vibration levels of less than 0.1 in/sec PPV at a distance of 25 feet.

As discussed in Section 5.7.3.2 (Approach to Analysis), 0.20 in/sec PPV is the significance threshold for construction vibration that could cause damage to buildings. The maximum estimated vibration level resulting from pipeline installation (i.e., from vibratory compacting equipment) is 0.210 in/sec PPV at a distance of 25 feet. Following the recommendations in the Caltrans Guidance Manual (Caltrans 2004), pipeline construction occurring at distances of less than 27 feet from a structure could result in vibration levels approaching or possibly exceeding the damage threshold. The analysis also establishes 0.012 in/sec PPV as the significance threshold for annoyance caused by construction-related activities at night, however this threshold is considerably more conservative than the Caltrans annoyance threshold of 0.1 in/sec. Construction activities at night would be limited to drilling. The vibration level resulting from drilling is 0.089 in/sec PPV at a distance of 25 feet (Table 5.7-4 [Vibration Levels for Construction Equipment]). A maximum vibration level of 0.089 in/sec PPV at a distance of 25 feet is equivalent to 0.012 in/sec PPV level at 155 feet. The vibration source in this instance is the drill head, so the distance is actually the slant distance from the drill head to the residential structure. For example, if the residence is located 50 feet horizontally from the drilling operation, once the drilling has reached a depth of 147 feet the slant distance of 155 feet would be achieved. Alternatively, once the depth of the drilling has reached 155 feet ground level vibration would be below the threshold level everywhere.

The evaluation of impacts that follows discusses sites with less-than-significant impacts, followed by sites with significant impacts.

Nighttime Residential Annoyance Potential

<u>All Sites</u>

Residential receptors closest to Sites 1, 3, 4, 9, 12, 14, 16, 18 (Alternate), and 19 (Alternate) would be located within 155 feet of the nearest construction area where potential nighttime drilling would occur for well facility construction. Residential receptors closest to these sites could be exposed to vibration levels greater than 0.012 in/sec, thus exceeding the annoyance threshold (which is far more conservative than the Caltrans threshold of 0.1 in/sec). The annoyance threshold is consistent with the threshold used in the SFPUC WSIP Programmatic Environmental Impact Report (PEIR) and is highly conservative; vibration levels would only be expected to exceed the threshold for at most two nights until drilling is deep enough to reduce vibration levels. At all other sites, residential receptors would be located beyond 155 feet. Therefore, this temporary nighttime groundborne vibration impact would be *less than significant*.

Impact Conclusion: Less than Significant

Building Damage Potential

<u>Sites 1, 2, 5, 6, 7, 8, 9, 10, 11, 13, 14, 16, 17 (Alternate), 19 (Alternate), and Westlake Pump Station</u>

No buildings near these sites are located closer than 27 feet to the proposed pipeline trenches or to other sources of construction vibration (see Table 5.7-7 [Summary of Nearby Sensitive Receptors]). Therefore, vibration levels would be below 0.20 in/sec PPV at any nearby building and, as a result, they would also be less than the 0.25 in/sec PPV significance threshold for building damage. As a result, potential impacts from groundborne vibration would be *less than significant*.

Impact Conclusion: Less than Significant

Sites 3, 4, 12, 15, and 18 (Alternate)

At Sites 3, 4, 12, and 18 (Alternate), pipeline construction could occur closer than 25 feet to a structure. At Sites 3, 4, 12, 15, and 18 (Alternate) pipeline installation could, depending upon the final location of the trench, occur closer than 25 feet to a structure. Pipeline installation would take place adjacent to the nearest building, and vibration levels would be greater than 0.25 in/sec PPV (see Table 5.7-7 [Summary of Nearby Sensitive Receptors]), which could result in a *significant* vibration impact on the adjacent structure. However, Mitigation Measure M-NO-2 (Reduce Vibration Levels during Construction of Pipelines), requires that the construction of pipelines within 25 feet of the structures near Sites 3, 4, 12, 15, and 18 use either non-vibratory means of compaction or controlled low strength materials (CLSM) as backfill so that compaction is not necessary. Either of these pipeline construction methods would avoid significant vibration levels near the building. As a result, this groundborne vibration impact would be *less than significant with mitigation*.

Mitigation Measure M-NO-2: Reduce Vibration Levels during Construction of Pipelines (Sites 3, 4, 12, 15, and 18 [Alternate])

The SFPUC shall require that the construction contractor not use vibratory compaction equipment within 25 feet of structures adjacent to Sites 3, 4, 12, 15, and 18 (Alternate). Non-vibratory compaction or controlled low strength materials (CLSM) backfill may be used in lieu of vibratory compaction equipment at these locations.

Impact Conclusion: Less than Significant with Mitigation

Impact NO-3: Project construction would result in a substantial temporary increase in ambient noise levels. (Significant and Unavoidable with Mitigation)

Noise impacts evaluated under Impact NO-1 (temporary noise levels in excess of local standards) and Impact NO-3 (temporary increase in ambient noise levels), evaluate the same daytime and nighttime noise impacts using different thresholds and slightly different methodologies. Instead of predicting construction-related noise levels at the nearest property line and comparing them with local noise ordinance standards (as in Impact NO-1), the analysis under Impact NO-3 predicts noise levels at the nearest building for comparison with speech and sleep interference thresholds. Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction) presents noise threshold exceedances for daytime construction (well drilling and testing; well facility and pipeline construction), and Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction) presents noise threshold exceedances for nighttime construction (well drilling and testing).

TABLE 5.7-19
Exceedance of Noise Thresholds – Daytime Construction

Site	Nearest Receptor	Approximate Distance from the Construction Activity Center (not including Pipelines) (feet)[(a)]	Approximate Distance from the Nearest Proposed Pipeline (feet)[(a)]	Loudest Construction Activity Type	Construction Noise Level at Receptor dBA (L_{eq})	Speech Interference Threshold Exceeded? (LSM/SUM) 70 dBA L_{eq}
Site 1	Multi-family Residential	90	40	Well Facility and Pipeline	86	Yes (SUM)
Site 2	Multi-family Residential	325	140	Pipeline	73	No[(b)]
	Garden Village Elementary School	350	275	Pipeline	67	No[(b)]
Site 3	Single-family Residential	90	110	Well Drilling and Pump Testing	77	Yes (LSM)
	Ben Franklin Intermediate School	250	200	Well Drilling and Pump Testing	68	No
Site 4	Single-family Residential	75	<25	Well Drilling and Pump Testing	78	Yes (LSM)
	Garden Village Elementary School	425	250	Well Drilling and Pump Testing	63	No
WLPS	Multi-family Residential	75	No pipelines	Upgrade inside existing building	50	No
Site 5 (Consolidated Treatment at Site 6)	Single-family Residential	50	25	Fenced Enclosure	81	Yes (LSM)
	Single-family Residential	50	25	Pipeline	88	No[(b)]

TABLE 5.7-19
Exceedance of Noise Thresholds – Daytime Construction

Site	Nearest Receptor	Approximate Distance from the Construction Activity Center (not including Pipelines) (feet)[(a)]	Approximate Distance from the Nearest Proposed Pipeline (feet)[(a)]	Loudest Construction Activity Type	Construction Noise Level at Receptor dBA (L_{eq})	Speech Interference Threshold Exceeded? (LSM/SUM) 70 dBA L_{eq}
Site 6 (Consolidated Treatment at Site 6)	Multi-family Residential	600	370	Well Facility and Pipeline	65	No
Site 7 (Consolidated Treatment at Site 6)	No nearby sensitive receptors					
Site 5 (On-site Treatment)	Single-family Residential	50	25	Well Facility and Pipeline	91	Yes (SUM)
Site 6 (On-site Treatment)	Multi-family Residential	600	500	Well Facility and Pipeline	65	No
Site 7 (On-site Treatment)	No nearby sensitive receptors					
Site 8	Senior Care Facility	600	450	Well Facility and Pipeline	65	No
Site 9	Trailer Court	75	25	Well Facility and Pipeline	83	Yes (SUM)
Site 10	Single-family Residential	250	180	Well Facility and Pipeline	75	Yes (LSM)

TABLE 5.7-19
Exceedance of Noise Thresholds – Daytime Construction

Site	Nearest Receptor	Approximate Distance from the Construction Activity Center (not including Pipelines) (feet)[a]	Approximate Distance from the Nearest Proposed Pipeline (feet)[a]	Loudest Construction Activity Type	Construction Noise Level at Receptor dBA (L_{eq})	Speech Interference Threshold Exceeded? (LSM/SUM) 70 dBA L_{eq}
Site 11	Single-family Residential	400	315	Well Facility and Pipeline	71	Yes (LSM)
Site 12	Funeral Home	80	<25	Well Facility and Pipeline	83	Yes (SUM)
	Single-family Residential	140	80	Well Facility and Pipeline	78	Yes (LSM)
Site 13	Single-family Residential	290	105	Well Facility and Pipeline	72	Yes (LSM)
	Extended Stay Hotel	>1,000	80	Pipeline	77	N/A[b]
Site 14	Single-family Residential	100	100	Well Facility and Pipeline	81	Yes (SUM)
Site 15	Multi-family Residential	750	250	Well Facility and Pipeline	69	No
Site 16	Multi-family Residential	115	35	Well Facility and Pipeline	80	Yes (LSM)
Site 17 (Alternate)	Senior Care Facility	500	425	Well Facility and Pipeline	67	No
Site 18 (Alternate)	Single-family Residential	35	<25	Well Facility and Pipeline	92	Yes (SUM)

TABLE 5.7-19
Exceedance of Noise Thresholds – Daytime Construction

Site	Nearest Receptor	Approximate Distance from the Construction Activity Center (not including Pipelines) (feet)[(a)]	Approximate Distance from the Nearest Proposed Pipeline (feet)[(a)]	Loudest Construction Activity Type	Construction Noise Level at Receptor dBA (L_{eq})	Speech Interference Threshold Exceeded? (LSM/SUM) 70 dBA L_{eq}
Site 19 (Alternate)	Church and Preschool	50	30	Well Drilling and Pump Testing	82	Yes (LSM)
	Single-family Residential	115	80	Well Drilling and Pump Testing	75	Yes (LSM)

Notes:

(a) Approximate distance to nearby noise sensitive receptor's building or property line is based on aerial photo information taken from Google Earth™ and using ArcGIS™.

(b) Impacts from pipeline construction located away from the well facility are not included in the table in most cases, because no single receptor would be exposed to substantial pipeline installation-related construction noise for more than two weeks. Therefore, the impact would be less than significant (as explained in the Section 5.7.3.2 [Approach to Analysis]).

LSM = Less than significant with mitigation

SUM = Significant and unavoidable with mitigation

TABLE 5.7-20

Exceedance of Noise Thresholds – Nighttime Construction

Site	Nearest Receptor	Approximate Distance from the Well[(a)]	Construction Noise Level at Receptor dBA (L_{eq})[(a)]	Sleep Interference Threshold Exceeded? (LSM/SUM 50 dBA L_{eq}
Site 1	Multi-family Residential	50	77	Yes (SUM)
Site 2	Multi-family Residential and School	325 and 350	No nighttime construction	
Site 3	Single-family Residential	90	77	Yes (SUM)
	Ben Franklin Intermediate School	250	School would not be in session.	
Site 4	Single-family Residential	75	78	Yes (SUM)
	Garden Village Elementary School	425	Not a noise sensitive receptor at night	
WLPS	Multi-family Residential	<25	No nighttime construction	
Site 5 (Consolidated Treatment at Site 6)	Single-family Residential	50	No nighttime construction	
Site 6 (Consolidated Treatment at Site 6)	Multi-family Residential	555	No nighttime construction	
Site 7 (Consolidated Treatment at Site 6)	No nearby sensitive receptors			
Site 5 (On-site Treatment)	Single-family Residential	35	No nighttime construction	
Site 6 (On-site Treatment)	Multi-family Residential	555	No nighttime construction	
Site 7 (On-site Treatment)	No nearby sensitive receptors			
Site 8	Senior Care Facility	600	No nighttime construction	

TABLE 5.7-20

Exceedance of Noise Thresholds – Nighttime Construction

Site	Nearest Receptor	Approximate Distance from the Well[(a)]	Construction Noise Level at Receptor dBA (L_{eq})[(a)]	Sleep Interference Threshold Exceeded? (LSM/SUM 50 dBA L_{eq}
Site 9	Trailer Court	30	78	Yes (SUM)
Site 10	Single-family Residential	250	No nighttime construction	
Site 11	Single-family Residential	390	64	Yes (LSM)
Site 12	Funeral Home	50	Not a noise sensitive receptor at night	
	Single-family Residential	130	73	Yes (SUM)
Site 13	Single-family Residential and Hotel	260 and >1,000	No nighttime construction	
Site 14	Single-family Residential	80	76	Yes (SUM)
Site 15	Multi-family Residential	715	58	Yes (LSM)
Site 16	Multi-family Residential	115	75	Yes (SUM)
Site 17 (Alternate)	Senior Care Facility	500	62	Yes (LSM)
Site 18 (Alternate)	Single-family Residential	25	85	Yes (SUM)
Site 19 (Alternate)	Church and Preschool	80	Not a noise sensitive receptor at night	
	Single-family Residential	120	75	Yes (SUM)

Note:

(a) Approximate distance from well drilling/pumping tests to nearby noise sensitive structure, based on aerial photo information from Google Earth ™ and using ArcGIS™, see Table 5.7-7 (Summary of Nearby Sensitive Receptors). L_{eq} evaluated at the nearest structure.

LSM = Less than significant with mitigation

SUM = Significant and unavoidable with mitigation

The evaluation of impacts that follows discusses sites with less-than-significant impacts, followed by sites with significant impacts.

<u>Sites 2, 6, 7, 8, and Westlake Pump Station</u>

Site 2

Site 2 would be located at the southern end of the Lake Merced Golf Club in Daly City, shielded from the fairways by vegetation and topography (see Figure 3-12). Site 2 includes an existing test well, and no new well drilling is proposed. Additionally, the Site 2 well facility would be a fenced enclosure, and no building construction is proposed. Sensitive noise receptors that could be affected by construction at Site 2 include multi-family residences and Garden Village Elementary School, which are located approximately 140 feet to the north and 275 feet to the east, respectively, from the nearest proposed pipeline. For the analysis of potential noise impacts on the adjacent golf club, see Section 5.11, Recreation.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), pipeline and fenced enclosure construction would result in noise levels of up to 73 dBA L_{eq} at the nearest multi-family residences and 67 dBA L_{eq} at the Garden Village Elementary School, occurring over approximately one month. Therefore, the noise levels at Garden Village Elementary School and Ben Franklin Intermediate School (which is located further from construction than Garden Village) would not exceed the daytime speech interference threshold of 70 dBA L_{eq}, while the noise levels at the multi-family residences located closest to the proposed pipeline would occasionally exceed the daytime speech interference threshold.

Pipeline installation located away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed, and therefore any individual noise-sensitive receptor near Site 2 would not be exposed to substantial construction-related noise level increases for more than two weeks. In addition, fenced enclosure construction would occur over a one-month period. Construction at Site 2 would create temporary noise levels of up to 65 dBA L_{eq} at the multi-family residences and 64 dBA L_{eq} at the Garden Village Elementary School. Therefore, noise impacts from pipeline installation and construction of the fenced enclosure at Site 2 would be *less than significant*.

No nighttime construction is proposed at Site 2, so there would be no exceedance of the nighttime sleep interference threshold of 50 dBA L_{eq}. Therefore, at night, there would be *no impact* related to noise at Site 2.

Westlake Pump Station

Westlake Pump Station upgrades would occur within the fenced and paved Daly City Corporation Yard, which is bordered by a multi-family residence and the playing fields of the Benjamin Franklin Intermediate School (see Figure 3-13). Additionally, the proposed improvements would be made inside the existing building. Although the size of the improvements at the Westlake Pump Station has not yet been determined, construction noise levels inside the existing building would not be likely to exceed 85 dBA L_{eq}, given the type of equipment anticipated to be used. Typically, concrete industrial buildings similar to the existing building on the site attenuate noise levels by approximately 25 dBA L_{eq} (U.S. EPA 1974). The resulting noise at the nearest sensitive receptor would therefore be 50 dBA L_{eq} or less, which is below the speech interference threshold of 70 dBA L_{eq}. Therefore, this potential noise impact would be *less than significant*.

No nighttime construction is proposed at the Westlake Pump Station, so there would be no exceedance of the nighttime sleep interference threshold of 50 dBA L_{eq}. Therefore, at night, there would be *no impact* related to noise at the Westlake Pump Station.

Site 6

Site 6 would be located in Daly City and across D Street from, and west of, the Colma BART station and BART's railtrack extension and storage yard. To the west of Site 6 is a SamTrans park-and-ride lot; a multi-family residential complex lies to the east; and Woodlawn Memorial Park is located to the south (see Figures 3-14 and 3-16 for Consolidated Treatment at Site 6 and Figures 3-18 and 3-20 for On-Site Treatment). Site 6 includes an existing test well, and no new well drilling is proposed. Construction of a well facility building is proposed under both the Consolidated at Site 6 Treatment and On-Site Treatment options. Sensitive noise receptors that could be affected by construction at Site 6 include visitors to gravesites at Woodlawn Memorial Park, the closest of which are located approximately 325 feet south of the construction activity center, and the multi-family residences, which are located approximately 600 feet to the east of the construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well facility and pipeline construction would result in noise levels of up to 65 dBA L_{eq} at the multi-family residence, occurring over approximately 14 months. The noise levels at the multi-family residence would not exceed the daytime speech interference threshold of 70 dBA L_{eq}. Therefore, this impact would be *less than significant*.

The cemetery in the vicinity of Site 6 would not be substantially affected by noise from construction because the SFPUC would stop construction for outdoor graveside services upon request from the cemeteries In addition, noise level at the closest portion of the cemetery would be 70 dBA L_{eq}, and because this analysis assumes that cemetery visitors tend to come infrequently and therefore would be unlikely to be exposed to construction noise more than once or twice during the construction period. As a result, the impact of construction noise on the cemetery would be *less than significant*.

In addition, Site 6 would require the installation of up to 765 feet of pipeline. The nearest noise-sensitive receptors are multi-family residences located approximately 500 feet from the proposed pipeline. Since pipeline installation is proposed to progress at a rate of 300 to 600 feet per week, any one sensitive receptor along the pipeline installation route would not be exposed to substantial construction-related noise level increases for more than two weeks. Therefore, noise impacts on the closest sensitive receptors during pipeline installation at Site 6 would be *less than significant*.

No nighttime construction is proposed under either option at Site 6 so there would be no exceedance of the nighttime sleep interference threshold of 50 dBA L_{eq}. Therefore, at night, there would be *no impact* related to noise at Site 6.

Site 7 (Consolidated Treatment at Site 6)

Site 7 (Consolidated Treatment at Site 6) would be located on vacant land adjacent to Woodlawn Memorial Park in Colma (see Figures 3-14 and 3-17). The site is located next to a cemetery maintenance shed, a mausoleum (currently unused) and across Colma Boulevard from Greenlawn Cemetery. Site 7 (Consolidated Treatment at Site 6) would have a well with a fenced enclosure, but no building construction is proposed. Sensitive receptors that could be affected by the construction of Site 7 include visitors to gravesites at Woodlawn Memorial Park and Greenlawn Cemetery, the closest of which would be located in the Greenlawn Cemetery, approximately 60 feet from the proposed construction activity center.

Construction at Site 7 (Consolidated Treatment at Site 6) would include the construction of pipelines for the conveyance of water from Site 7 to Site 6 across the Woodlawn Memorial Park for treatment. The proposed pipeline route through the cemetery is approximately 1,780 feet long and based on a construction rate of 300 to 600 feet per week (see Project Description Section 3.5.1.1 [Construction Methods for Production Wells]) would take approximately three to six weeks to construct. Pipeline trenching would extend across the memorial park and would be audible to all visitors. However, the cemetery in the vicinity of Site 7 would not be substantially affected by noise from construction because the SFPUC would stop construction for outdoor graveside services upon request from the cemeteries (as described in Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]), and because this analysis assumes that cemetery visitors tend to come infrequently and therefore would be unlikely to be exposed to construction noise more than once or twice during the construction period. As a result, the impact of construction noise on the cemetery would be *less than significant*.

Other sensitive receptors (single-family residences) would be located 1,300 feet north of the well at Site 7. In addition, fenced enclosure construction would occur over a three-month period. Construction at Site 7 (Consolidated Treatment at Site 6) is 1,300 feet away from sensitive receptors and noise levels caused by construction would not be audible. Therefore, noise impacts from construction of the fenced enclosure would be *less than significant*.

Accounting for distance and ground attenuation, nighttime well drilling activities would result in noise levels at the nearest residences of up to 47 dBA L_{eq} occurring over approximately seven consecutive nights, which would not exceed the nighttime sleep interference threshold of 50 dBA L_{eq}.

Nighttime well drilling activities and pumping tests would also result in increased noise levels at nearby gravesites. However, since cemeteries are not open to visitors at night, the nighttime noise would not affect cemetery visitors.

Site 7 (On-site Treatment)

Site 7 would be located on vacant land adjacent to Woodlawn Memorial Park in Colma (see Figures 3-18 and 3-21). Site 7 (On-site Treatment) would include construction of a well facility building instead of consolidating treatment at Site 6. Sensitive receptors that could be affected by construction at Site 7 include visitors to gravesites at Woodlawn Memorial Park and Greenlawn Cemetery, the closest of which are located at the Greenlawn Cemetery, approximately 60 feet from the proposed construction activity center.

The cemetery in the vicinity of Site 7 would not be substantially affected by noise from construction (including well drilling and pump testing, as well as well facility and pipeline construction) because the SFPUC would stop construction for outdoor graveside services upon request from the cemeteries (as described in Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]), and because this analysis assumes that cemetery visitors tend to come infrequently and therefore would be unlikely to be exposed to construction noise more than once or twice during the construction period. As a result, the impact of construction noise on the cemetery would be *less than significant*.

Other sensitive receptors (single-family residences) would be located 1,300 feet north of the well. Accounting for distance and ground attenuation, nighttime well drilling activities would result in noise levels at the nearest residences of up to 47 dBA L_{eq} occurring over approximately seven consecutive nights, which would not exceed the nighttime sleep interference threshold of 50 dBA L_{eq}.

Nighttime well drilling and pumping tests would also result in increased noise levels at nearby gravesites. However, since cemeteries are not open to visitors at night, the drilling noise would not affect cemetery visitors.

Site 8

Site 8 is situated in the Town of Colma south of Serramonte Boulevard between the Kohl's Department Store rear parking area and a tall retaining wall east of a car dealership (see Figure 3-22). Site 8 includes an existing test well, and no new well drilling is proposed. Construction of a well facility building is proposed. The nearest sensitive receptors to Site 8 would be visitors at gravesites at Greenlawn Cemetery, the closest of which would be about 500 feet northwest of the construction activity center, and a senior care facility located approximately 600 feet to the southeast, on the other side of large intervening buildings.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well facility and pipeline construction would result in intermittent noise levels of up to 65 dBA L_{eq} at the senior care facility, occurring over approximately 14 months, which therefore would not exceed the daytime speech interference threshold of 70 dBA L_{eq}. As a result, this noise impact would be *less than significant*.

The cemetery in the vicinity of Site 8 would not be substantially affected by noise from construction because the SFPUC would stop construction for outdoor graveside services upon request from the cemeteries (as described in Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). In addition, noise level at the closest portion of the cemetery would be 67 dBA L_{eq} and this analysis assumes that cemetery visitors tend to come infrequently and therefore would be unlikely to be exposed to construction noise more than once or twice during the construction period. As a result, the impact of construction noise on the cemetery would be *less than significant*.

In addition, Site 8 would require the installation of approximately 450 feet of pipeline, which would occur during the daytime. The nearest sensitive receptors would be the senior care facility, located approximately 450 feet from the proposed pipeline, on the other side of large intervening buildings. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed, and therefore, the senior care facility would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no mitigation measures would be required.

No nighttime construction is proposed at Site 8, so there would be no exceedance of the nighttime sleep interference threshold of 50 dBA L_{eq}. Therefore, at night, there would be *no impact* related to noise at Site 8.

Impact Conclusion: Less than Significant

Sites 5 (Consolidated Treatment at Site 6), 10, 11, 13, 15, and 17 (Alternate)

Site 5 (Consolidated Treatment at Site 6)

Site 5 would be located adjacent to the parking lot of the former Serra Bowl bowling alley and a single-family residence fronting onto B Street in Daly City (see Figure 3-15). Proposed construction at Site 5 (Consolidated Treatment at Site 6) includes the installation of a new pipeline that would connect the well at Site 5 to treatment facilities for Sites 5, 6, and 7 that would be constructed (i.e., consolidated) at Site 6 (see Figure 3-14). The pipeline would be installed under the Serra Bowl parking lot and through the SFPUC right-of-way west of the Colma BART Station. Pipeline installation would occur approximately 25 feet from the adjacent single-family residence. Installation of the 1,120 feet of pipeline to Site 6 would occur during daytime construction. Site 5 includes an existing test well, and no new well drilling is proposed. Additionally, with consolidated treatment at Site 6, the Site 5 well facility would be in a fenced enclosure, and no building construction is proposed. Sensitive noise receptors that could be affected by construction of Site 5 (Consolidated Treatment at Site 6) include the single-family residence located approximately 25 feet from the nearest proposed pipeline.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), pipeline construction would result in noise levels of up to 88 dBA L_{eq}, which would occasionally exceed the daytime speech interference threshold of 70 dBA L_{eq} at the adjacent residence. Fenced enclosure construction would occur over a three-month period and would generate temporary noise levels of up to 81 dBA L_{eq} at a distance of 50 feet. However, implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce daytime construction-related noise levels to 70 dBA L_{eq} by requiring the SFPUC to meet a 70 dBA L_{eq} performance standard using feasible measures such as installing a temporary noise barrier (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]). This mitigated noise level would be below the daytime speech interference threshold of 70 dBA L_{eq} at the closest residence. Therefore, with implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), this noise impact would be reduced to *less-than-significant* levels.

Pipeline installation extending away from the well facility at Site 5 would progress at a rate of 300 to 600 feet per week, as proposed, and therefore the noise-sensitive receptor adjacent to Site 5 would not be exposed to substantial construction-related noise level increases for more than two weeks. Therefore, this portion of the noise impact would be *less than significant*.

No nighttime construction is proposed at Site 5 (Consolidated Treatment at Site 6), so there would be no exceedance of the nighttime sleep interference threshold of 50 dBA L_{eq}. Therefore, at night, there would be *no impact* related to noise at Site 5 (Consolidated Treatment at Site 6).

Site 10

Site 10 would be located within the SFPUC right-of-way south of Hickey Boulevard, near commercial land uses and single-family residences. Site 10 includes an existing test well, and no new well drilling is proposed. Construction of a well facility building is proposed. The nearest noise-sensitive receptors to Site 10 are the single-family residences located approximately 250 feet west of the proposed construction activity center (see Figure 3-25).

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well facility and pipeline construction would result in noise levels at nearby residences of up to 75 dBA L_{eq}, occurring over approximately 14 months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq}. Therefore, this noise impact would be *significant*. However, implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plans) would reduce daytime construction-related noise levels to 70 dBA L_{eq} by requiring the SFPUC to meet a 70 dBA L_{eq} performance standard using feasible measures such as installing a temporary noise barrier (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]). This mitigated noise level would be below the daytime speech interference threshold of 70 dBA L_{eq} at the closest residences. Therefore, with implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), this noise impact would be reduced to *less-than-significant* levels.

In addition, Site 10 would require the installation of approximately 455 feet of pipeline, which would occur during the daytime. The nearest sensitive receptors are single-family residences, located approximately 180 feet from the proposed pipeline. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

No nighttime construction is proposed at Site 10, so there would be no exceedance of the nighttime sleep interference threshold of 50 dBA L_{eq}. Therefore, at night, there would be *no impact* related to noise at Site 10.

Site 11

Site 11 would be located on vacant land adjacent to a BART ventilation structure in South San Francisco (see Figures 3-27 and 3-28). The construction zone for the well facility would be near the Centennial Way Trail, a Kaiser Medical Center garage and parking lot, and single-family residences. Site 11 would include construction of both a new production well and a well facility building. The nearest sensitive receptors to

Site 11 are the single-family residences located approximately 400 feet southwest of the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in noise levels of up to 64 dBA L_{eq} at the single family residences during a four to six week period, and well facility and pipeline construction would result in noise levels of up to 71 dBA L_{eq} at nearby residences, occurring over approximately 14 months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq}. Therefore, this noise impact would be *significant*. However, implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce daytime construction-related noise levels to 66 dBA $L_{eq,}$ by requiring the SFPUC to prepare a noise control plan and implement measures such as installing a temporary noise barrier to meet a 70 dBA L_{eq} performance standard for Impact NO-3.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well drilling activities at night would result in noise levels at the closest residences of up to 64 dBA L_{eq} occurring over approximately seven consecutive nights, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well pumping tests would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 [Construction Impacts and Mitigation Measures], would produce noise levels similar to the well drilling activity). Therefore, this impact would be *significant*. However, implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce nighttime noise levels to 49 dBA L_{eq} by requiring the SFPUC to meet a 50 dBA L_{eq} performance standard using feasible measures such as the installation of truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), which would be below the nighttime sleep interference threshold. Therefore, with the implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), this noise impact would be reduced to *less-than-significant* levels.

In addition, Site 11 would require the installation of approximately 1,315 feet of pipeline along a restricted-access driveway off Antoinette Lane, which would occur during the daytime. The nearest sensitive receptors are multi-family residences, located approximately 315 feet from the proposed pipeline. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

Site 13

Site 13 would be located adjacent to the Centennial Way Trail on SFPUC-owned land across South Spruce Avenue from Francisco Terrace Playlot and single-family residences (see Figures 3-31 and 3-32). Site 13 includes an existing test well, and no new well drilling is proposed. Construction of a well facility building is proposed. Sensitive receptors that could be affected by construction of Site 13 include single-family residences located approximately 290 feet west of the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), residences would experience well facility and pipeline construction noise levels of up to 72 dBA L_{eq} occurring over approximately 14 months, which would occasionally exceed the daytime speech interference threshold of 70 dBA L_{eq}. Therefore, this noise impact would be *significant*. However, implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce daytime construction-related noise levels to 67 dBA L_{eq} by requiring the SFPUC to meet a 70 dBA L_{eq} performance standard using feasible measures such as installing a temporary noise barrier (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]). This mitigated noise level would be below the daytime speech interference threshold of 70 dBA L_{eq}. Therefore, with implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), this impact would be reduced to *less-than-significant* levels.

In addition, Site 13 would require the installation of approximately 2,475 feet of pipeline along Spruce Avenue and Huntington Avenue, which would occur during the daytime. The nearest sensitive receptor is Stay Bridge Suites, an extended stay hotel, located approximately 80 feet southeast of the proposed pipeline. The Stay Bridge Suites are located over 1,000 feet south of the construction activity center and there would be no combined effect of pipeline installation during other daytime construction activities. Additionally, the single-family residence located approximately 105 feet from pipeline installation could temporarily be exposed to noise levels of up to 77 dBA L_{eq}. However, pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual noise-sensitive receptor would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

No nighttime construction is proposed at Site 13, so there would be no exceedance of the nighttime sleep interference threshold of 50 dBA L_{eq}. Therefore, at night, there would be *no impact* related to noise at Site 13.

Site 15

Site 15 would be located in San Bruno in the Golden Gate National Cemetery, immediately adjacent to a cemetery maintenance facility building along Sneath Lane (see Figures 3-34 and 3-36). Site 15 would include both the drilling of a new production well and construction of a new well facility building. Sensitive noise receptors that could be affected by construction of Site 15 include visitors to gravesites at the Golden Gate National Cemetery, located as close as approximately 100 feet from the construction activity center, and a multi-family residence, located approximately 750 feet southwest of the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing would result in noise levels of up to 58 dBA L_{eq} over a four to six week period at the nearest residence, and well facility and pipeline construction would result in noise levels of up to 69 dBA L_{eq} at the multi-family residence, occurring over approximately 14 months. The daytime speech interference threshold of 70 dBA L_{eq} would not be exceeded at the multi-family residence, and the noise impact there would be *less than significant*.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well-drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels at the nearest residences of up to 58 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (the well pumping tests discussed above would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 (Construction Impacts and Mitigation Measures), would produce noise levels similar to the production well installation). Therefore, the impact of nighttime construction-related noise at Site 15 on sensitive noise receptors would be *significant*. However, implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce nighttime construction-related levels to 43 dBA L_{eq} at the multi-family residence (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]) by requiring the SFPUC to meet a 50 dBA L_{eq} performance standard using feasible measures such as the installation of truck-mounted noise control blankets. Therefore, with implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), the impact of nighttime construction-related noise levels on the multi-family residence would be reduced to *less-than–significant* levels.

The cemetery in the vicinity of Site 15 would not be substantially affected by noise from construction because the SFPUC would stop construction for outdoor graveside services upon request from the cemeteries (as described in Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]), and because this analysis assumes that cemetery visitors tend to come infrequently and therefore would be unlikely to be exposed to construction noise more than once or twice during the construction period. As a result, the impact of construction noise on the cemetery would be *less than significant*.

In addition, to connect to the distribution system, approximately 935 feet of pipeline would be installed, which would occur during the daytime. The nearest sensitive receptor is the multi-family residence located approximately 250 feet from the proposed pipeline installation route. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

Nighttime well drilling activities at Site 15 would also result in increased noise levels at nearby gravesites. However, since cemeteries are not open to visitors at night, the drilling noise would not affect cemetery visitors. As a result, at night, there would be *no impact* related to noise at Site 15.

Site 17 (Alternate)

Site 17 (Alternate) would be located adjacent to Standard Plumbing Supply and Cypress Lawn Cemetery (see Figure 3-38). A portion of the construction area would be located within the SFPUC right-of-way across Collins Avenue. Site 17 (Alternate) would include construction of both a production well and a well facility building. Sensitive receptors that could be affected by construction of Site 17 (Alternate) include a senior care facility located approximately 500 feet northeast of the proposed construction activity center and visitors to gravesites at Cypress Lawn Cemetery, the closest of which would be located approximately 200 feet south of the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing would result in noise levels of up to 67 dBA at the senior care facility during a four to six week period, and well facility and pipeline construction would result in noise levels at the senior care facility of up to 67 dBA L_{eq} occurring over approximately 14 months, which would not exceed the daytime speech interference threshold of 70 dBA L_{eq}. Therefore, this noise impact would be *less than significant*.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well-drilling activities at night would result in noise levels at the senior care facility of up to 62 dBA L_{eq} occurring over approximately seven consecutive nights, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well-pumping tests would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 [Construction Impacts and Mitigation Measures], would produce noise levels similar to the production well). Therefore, this noise impact would be *significant*. However, implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce nighttime noise levels to 47 dBA L_{eq} by requiring the SFPUC to meet a 50 dBA L_{eq} performance standard using feasible measures such as the installation of truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), which would be below the nighttime sleep interference threshold. Therefore, with the implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), this noise impact would be reduced to *less-than–significant* levels.

In addition, Site 17 (Alternate) would require the installation of approximately 250 feet of pipeline, which would occur during the daytime. The nearest sensitive receptor is the senior care facility, located approximately 425 feet from the proposed pipeline. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, the senior care facility would not be exposed to substantial additional construction-related noise level increases at any one location for more than two weeks, and no additional mitigation measures would be required.

The cemetery in the vicinity of Site 17 (Alternate) would not be substantially affected by noise from construction because the SFPUC would stop construction for outdoor graveside services upon request from the cemeteries (as described in Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]), and because this analysis assumes that cemetery visitors tend to come infrequently and therefore would be unlikely to be exposed to construction noise more than once or twice during the construction period. As a result, the impact of construction noise on the cemetery would be *less than significant*.

Nighttime well drilling activities and pumping tests would also result in increased noise levels at nearby gravesites. However, since cemeteries are not open to visitors at night, the drilling noise would not affect cemetery visitors. As a result, this impact would be *less than significant*.

Impact Conclusion: Less than Significant with Mitigation

Sites 1, 3, 4, 5 (On-site Treatment), 9, 12, 14, 16, 18 (Alternate), and 19 (Alternate)

Site 1

Site 1 would be located on the northeast corner of Lake Merced Golf Club property west of I-280 and south of the Westlake Village apartment complex in Daly City (see Figure 3-11). A restroom building for the golf club is situated in the southern portion of the proposed construction area and would be demolished as part of the proposed Project. Site 1 would include construction of both a new production well and a well facility building. Sensitive noise receptors that could be affected by construction of Site 1 include the Westlake Apartment residences, the closest of which would be located approximately 90 feet north of the construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in noise levels up to 77 dBA L_{eq} during a four to six week period at the nearest residences, and well facility and pipeline construction (including demolition) would result in intermittent noise levels at the nearest residences of up to 86 dBA L_{eq} occurring over approximately 14 months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq}.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well-drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels at the nearest residences of up to 77 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well-pumping tests discussed above would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 (Construction Impacts and Mitigation Measures), would produce noise levels similar to the new production well installation). As a result, the impact of both daytime and nighttime construction-related noise would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 1 to speech interference and sleep interference thresholds respectively, where feasible, by use of feasible measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 76 dBA L_{eq} and nighttime construction-related noise levels to 57 dBA L_{eq}. However, even with the implementation of all feasible mitigation these noise levels would still exceed both the daytime speech interference threshold of 70 dBA L_{eq} for residences within 180 feet of the construction activity center and the nighttime sleep interference threshold of 50 dBA L_{eq} for residences within 200 feet of the well. As a result, this impact would be *significant and unavoidable with mitigation*, given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

In addition, Site 1 would require the installation of up to approximately 295 feet of pipeline, which would occur during the daytime. The nearest sensitive receptors would be the residences located approximately 40 feet from the proposed pipeline. Pipeline installation away from well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

Site 3

Site 3 would be located near single-family residences and within the southwest portion of a playing field at Ben Franklin Intermediate School in unincorporated Broadmoor. The Lake Merced Golf Club is northeast of the site. Site 3 would include a well facility with fenced enclosure, and no building construction is proposed. Sensitive noise receptors that could be affected by construction of Site 3 include single-family residences, located approximately 90 feet south of the construction activity center and the Benjamin Franklin Intermediate School, located approximately 250 feet northwest of the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in noise levels of up to 77 dBA L_{eq} at the nearest single-family residences and 68 dBA L_{eq} at Benjamin Franklin Intermediate School during a four to six week period, and fenced enclosure construction and pipeline construction would occur over approximately six months divided over two summers when school is not in session (for three months each summer; includes well drilling and pump testing). Because construction would be limited to two summer seasons (see Chapter 3, Section 3.5.1 [Construction Sequencing and Schedule]), noise impacts at the school would be *less than significant*, as students would not be present. However, noise levels at the single-family residences would exceed the daytime speech interference threshold of 70 dBA L_{eq}. In addition, fenced enclosure construction would occur over the two three-month summer seasons and create temporary noise levels of up to 67 dBA L_{eq} at the single-family residences which would also exceed the daytime speech interference threshold of 70 dBA L_{eq}.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels the nearest residences of up to 77 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well-pumping tests would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 (Construction Impacts and Mitigation Measures), would produce noise levels similar to the new well installation). As a result, the impact of both daytime and nighttime construction-related noise at Site 3 on sensitive receptors would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 3 to speech interference and sleep interference thresholds respectively, where feasible, by use of feasible measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 57 dBA L_{eq} and nighttime construction-related noise levels to 57 dBA L_{eq}, at the nearest single-family residences. These mitigated noise levels would be below the daytime speech interference threshold of 70 dBA L_{eq}. Therefore, with implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), the daytime construction noise impact would be reduced to *less-than–significant* levels. However, the mitigated nighttime noise levels at the residences within approximately 190 feet of the well would still exceed the nighttime sleep interference threshold of 50 dBA L_{eq} by up to 7 dBA L_{eq}. As a result, this impact would be *significant and unavoidable with mitigation* given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

In addition, Site 3 would require the installation of approximately 845 feet of pipeline, which would occur during the daytime. The nearest sensitive receptors would be residences, located approximately 110 feet from the proposed pipeline. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required. Therefore, noise impacts from pipeline installation would be *less than significant*.

Site 4

Site 4 would be located at the Garden Village Elementary School playing field and adjacent to the backyards of residences that front onto 87th Street in unincorporated Broadmoor (see Figure 3-12). The Site 4 well facility would have a fenced enclosure, and no building construction is proposed. Noise-sensitive receptors that could be affected by construction of Site 4 include the adjacent single-family residences, located approximately 75 feet south of the proposed construction activity center, and the Garden Village Elementary School, located approximately 425 feet northeast of the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in noise levels of up to 78 dBA L_{eq} at the nearest single-family residences and 63 dBA L_{eq} at Garden Village Elementary School, occurring over a four to six week period, and fenced enclosure construction and pipeline construction would occur over approximately three months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq} at the single-family residences. However, the daytime speech interference threshold would not be exceeded at Garden Village Elementary School, given that the school is 425 feet from the site of well installation.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), nighttime well drilling activities would result in noise levels at the nearest residences of up to 78 dBA L_{eq} occurring over approximately seven consecutive nights, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well pumping tests would be performed sequentially to the final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 (Construction Impacts and Mitigation Measures), would generate noise levels similar to the new well installation). As a result, the impact of both daytime and nighttime construction-related noise at Site 4 on sensitive receptors would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 4 to speech interference and sleep interference thresholds respectively, where feasible, by use of feasible measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 58 dBA L_{eq} and nighttime construction-related noise levels to 58 dBA L_{eq}. at the single-family residences. This mitigated noise level would be below the daytime speech interference threshold of 70 dBA L_{eq}. Therefore, with implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), the daytime construction noise impact at the affected single-family residences would be reduced to *less-than-significant* levels.

However, the nighttime noise levels at the residences within approximately 190 feet of the well would still exceed the nighttime sleep interference threshold of 50 dBA L_{eq} by up to 8 dBA L_{eq}. As a result, this impact would be *significant and unavoidable with mitigation* given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

In addition, Site 4 would require the installation of approximately 1,000 feet of pipeline, which would occur during the daytime. The nearest sensitive receptors are residences, located less than 25 feet from the proposed pipeline. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required. Therefore, noise impacts from pipeline installation would be *less than significant*.

Nighttime well drilling activities and well pumping tests would also result in increased noise levels at Garden Village Elementary School. However, since the school is not open at night, the drilling noise would not affect the learning environment of the school. As a result, this impact would be *less than significant*.

Site 5 (On-site Treatment)

Site 5 would be located adjacent to the parking lot of the former Serra Bowl bowling alley and a single-family residence fronting onto B Street in Colma (see Figure 3-19). Site 5 (On-site Treatment) would include construction of a well facility building. Site 5 has an existing test well, and no new well drilling is proposed. Sensitive receptors that could be affected by construction of Site 5 (On-site Treatment) include the single-family residence located approximately 50 feet from the proposed construction activity center. As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), construction activities for well facility and pipeline construction would result in noise levels of up to 91 dBA L_{eq} at the single-family residence, occurring over approximately 14 months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq} at this single-family residence. Therefore, the impact of daytime construction-related noise at Site 5 (On-site Treatment) on sensitive receptors would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce daytime construction-related noise levels to 81 dBA L_{eq} (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]) at the single-family residence. However, this noise level would still exceed the daytime speech interference threshold of 70 dBA L_{eq}. As a result, this impact would remain s*ignificant and unavoidable with mitigation*.

The proposed Project includes an option for Site 5 to be constructed with consolidated treatment at Site 6, which is the SFPUC's preferred option, and if implemented, this option would avoid the significant noise impacts that would result from the 14-month construction of a well facility building at Site 5. Construction of Site 5 (Consolidated Treatment at Site 6) instead of Site 5 (On-site Treatment) would result in a *less-than-significant* noise impact, because consolidated treatment would require only a four-month construction duration for a fenced enclosure at Site 5, which would have a *less-than-significant* noise impact relative to speech interference, instead of a 14-month construction duration if a well facility building were constructed (see evaluation of Site 5 [Consolidated Treatment at Site 6], above). However, given that the SFPUC is currently uncertain of the feasibility of installing a pipeline between Sites 5 and 6 (due to the potential for unforeseen constraints that may render this option infeasible), as preferred (See Chapter 3, Project Description, Section 3.4.3 [Facility Sites]), the SFPUC maintains as part of its project proposal the option of constructing on-site treatment at Site 5, which would only be built if consolidating treatment at Site 6 is infeasible. Therefore, if this option were implemented, it would result in *significant and unavoidable* impacts even with all feasible mitigation applied at the site.

No nighttime construction is proposed at Site 5 (On-site Treatment), so there would be no exceedance of the nighttime sleep interference threshold of 50 dBA L_{eq}. Therefore, at night, there would be *no impact* related to noise at Site 5.

Construction at Site 5 (On-site Treatment) includes pipeline construction of up to approximately 645 feet of pipeline, which would occur during the daytime. The nearest sensitive receptor is a nearby residence, located approximately 25 feet from the proposed pipeline. Pipeline installation at the well facility would proceed in combination with construction of the well facility. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, the residence on B Street would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

Site 9

Site 9 would be on SFPUC-owned land east of El Camino in South San Francisco and located southeast of the Treasure Island Trailer Court, outside of the existing improved area of the trailer court (see Figures 3-23 and 3-24). Other nearby land uses include single-family residences to the east and commercial uses to the south. Site 9 would include both the drilling of a new production well and the construction of a new well facility building. Sensitive noise receptors that could be affected by construction of Site 9 include trailers at the Treasure Island Trailer Court, the closest of which would be located approximately 75 feet from the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in up to 78 dBA L_{eq} at nearby residences during a four to six week period, and well facility and pipeline construction would result in noise levels measured at the exterior of the nearest residences of up to 83 dBA L_{eq} occurring over approximately 14 months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq}.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels at the nearest residences of up to 78 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} at this location (well pumping tests discussed above would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 [Construction Impacts and Mitigation Measures], would generate noise levels similar to the new production well installation). Therefore, the impact of both daytime and nighttime construction-related noise would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 9 to speech interference and sleep interference thresholds respectively, where feasible, by use of measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 73 dBA L_{eq} and nighttime construction-related noise levels to 58 dBA L_{eq} at the nearest single family residence.

However, these noise levels would still exceed both the daytime speech interference threshold of 70 dBA L_{eq} and the nighttime sleep interference threshold of 50 dBA L_{eq}. As a result, this impact would be *significant and unavoidable with mitigation* given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

In addition, Site 9 would require the installation of approximately 600 feet of pipeline, which would occur during the daytime. The nearest sensitive receptors are mobile-home residences, located approximately 25 feet from the proposed pipeline. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any one residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

In addition, construction traffic would use the San Mateo County Flood Control District's access road from Mission Road to the site. This access road is adjacent to a row of trailers at the Treasure Island Trailer Court. The evaluation of the noise from construction traffic along this road is discussed below in Impact NO-4, regarding construction-hauling routes.

Site 12

Site 12 would be located adjacent to the Garden Chapel Funeral Home on Southwood Drive in South San Francisco (see Figures 3-29 and 3-30). The site is partially located on the parking lot for the funeral home. Surrounding land uses include commercial and single-family residential. Site 12 would include both the drilling of a new production well and construction of a new well facility building. Sensitive receptors that could be affected by construction of Site 12 include the Garden Chapel Funeral Home, located approximately 80 feet from the construction activity center, and single-family residences, the closest of which would be located approximately 140 feet from the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in noise levels up to 73 dBA L_{eq} at the nearest residences and 82 dBA L_{eq} at the funeral home within a four to six week period, and well facility and pipeline construction would result in noise levels of up to 83 dBA L_{eq} at the funeral home and 78 dBA L_{eq} at the nearest residences, occurring over approximately 14 months, which would both exceed the daytime speech interference threshold of 70 dBA L_{eq}.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels at the nearest residences of up to 73 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well pumping tests would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 [Construction Impacts and Mitigation Measures], would generate noise levels similar to the new production well installation). Therefore, the impact of both daytime and nighttime construction-related noise at Site 12 on sensitive receptors would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 12 to speech interference and sleep interference thresholds respectively, where feasible, by use of measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 68 dBA L_{eq} and nighttime construction-related noise levels to 53 dBA L_{eq} at the nearest single-family residences; whereas implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) would reduce daytime construction-related noise levels at the funeral home to 73 dBA L_{eq} (see Table 5.7-21). However, these noise levels would still exceed both the daytime speech interference threshold of 70 dBA L_{eq} at the funeral home and the nighttime sleep interference threshold of 50 dBA L_{eq} within approximately 190 feet of the construction activity center at the single-family residences. As a result, this impact would be *significant and unavoidable with mitigation* given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

In addition, Site 12 would require the installation of approximately 1,635 feet of pipeline along El Camino Real, which would occur during the daytime and would take approximately three to six weeks to complete. The nearest sensitive receptor would be the funeral home, located less than 25 feet from proposed pipeline installation; and single-family residences are located as close as approximately 80 feet from the proposed pipeline installation route. Pipeline installation is proposed to progress at a rate of 300 to 600 feet per week, as proposed. Therefore, the funeral home and any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

Nighttime well drilling activities and pumping tests would also result in increased noise levels at the funeral home. However, since the funeral home is not generally open to visitors at night and impacts would only occur for approximately seven days for well drilling and up to 48 hours subsequently for pump testing, the drilling noise would not substantially affect this noise receptor. As a result, this nighttime noise impact would be *less than significant* at the funeral home.

Site 14

Site 14 would be located in San Bruno on an existing SFPUC right-of-way at the northern boundary of the Golden Gate National Cemetery, in proximity to gravesites and homes that face onto Greenwood Drive (see Figures 3-34 and 3-35). Site 14 would include both the drilling of a new production well and the construction of a new well facility building. Demolition of the existing pump station, tank, and well near Site 14 may also occur. Sensitive receptors that could be affected by construction of Site 14 include visitors to gravesites at the Golden Gate National Cemetery, located as close as approximately 25 feet from the construction activity center, and single-family residences to the west and north that face onto Greenwood Drive, located approximately 100 feet from the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in noise levels of up to 76 dBA L_{eq} at the nearest residences during a four to six week period, and well facility and pipeline construction (including demolition) would result in noise levels of up to 81 dBA L_{eq} at the single-family residences, occurring over approximately 14 months or less. These noise levels at the single-family residences would exceed the daytime speech interference threshold of 70 dBA L_{eq}, which would be a *significant* noise impact.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well-drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels at the nearest residences of up to 76 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well-pumping tests discussed above would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 [Construction Impacts and Mitigation Measures], would generate noise levels similar to the production well drilling). Therefore, the impact of both daytime and nighttime construction-related noise at Site 14 on sensitive noise receptors would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 14 to speech interference and sleep interference thresholds respectively, where feasible, by use of measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 71 dBA L_{eq} and nighttime construction-related levels to 56 dBA L_{eq} at single-family residences. However, these noise levels would still exceed both the daytime speech interference threshold of 70 dBA L_{eq} within approximately 110 feet of the construction activity center and the nighttime sleep interference threshold of 50 dBA L_{eq} within approximately 190 feet of the well at the single-family residences. As a result, this impact would be *significant and unavoidable with mitigation* given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

The proposed Project also includes the installation of approximately 2,895 feet of pipeline associated with Site 14, which would occur less than 25 feet away from the nearest gravesites. Pipeline installation would take five to 10 weeks to complete. The cemetery surrounding Site 14 would not be substantially affected by noise from construction because the SFPUC would stop construction for outdoor graveside services upon request from the cemeteries (as described in Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]), and because this analysis assumes that cemetery visitors tend to come infrequently and therefore would be unlikely to be exposed to construction noise more than once or twice during the construction period. As a result, the impact of construction noise on the cemetery would be *less than significant*. In addition, the nearest noise-sensitive receptor is the multi-family residence located approximately 250 feet southwest of the proposed pipeline installation route. Pipeline installation away from the well facility would progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual sensitive noise receptor would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

Nighttime well drilling activities and pumping tests at Site 14 would also result in increased noise levels at nearby gravesites. However, since cemeteries are not open to visitors at night, the drilling noise would not affect cemetery visitors. As a result, this portion of the noise impact would be *less than significant*.

Site 16

Site 16 would be located in Millbrae on SFPUC-owned land that is currently occupied by an Orchard Supply Hardware store for parking and storage (see Figure 3-37). The site is located between El Camino Real and the Caltrain right-of-way. Site 16 would include both the drilling of a new production well and the construction of a new well facility building. Sensitive receptors that could be affected by construction of Site 16 include a multi-family residence located approximately 115 feet south of the proposed construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in noise levels of up to 75 dBA at the nearest multi-family residence over a four to six week period, and well facility and pipeline construction would result in noise levels of up to 80 dBA L_{eq} at the nearest residences, occurring over approximately 14 months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq}.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels at the nearest residences of up to 75 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well pumping tests discussed above would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 [Construction Impacts and Mitigation Measures], would produce noise levels similar to the new production well installation). Therefore, the impact of both daytime and nighttime construction-related noise at Site 16 on noise-sensitive receptors would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 16 to speech interference and sleep interference thresholds respectively, where feasible, by use of measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 70 dBA L_{eq} and nighttime construction-related noise levels to 55 dBA L_{eq} at the multi-family residence. Therefore, with implementation of Mitigation

Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), the impact of daytime construction-related noise levels on the multi-family residence would be reduced to *less-than-significant* levels. However, nighttime construction-related noise levels would still exceed the nighttime sleep interference threshold of 50 dBA L_{eq} up to a distance of approximately 190 feet from the well. As a result, this impact would be *significant and unavoidable with mitigation* given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

In addition, Site 16 would require the installation of up to approximately 1,095 feet of pipeline, which would occur during the daytime. The nearest sensitive receptors would be at a multi-family residence, located approximately 35 feet from the proposed pipeline installation route. Additionally, the multi-family residence located approximately 35 feet from pipeline installation could temporarily be exposed to substantial noise levels. However, pipeline installation is proposed to progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, resulting in a *less-than-significant* noise impact for this portion of the Project, and no additional mitigation measures would be required.

Site 18 (Alternate)

Site 18 (Alternate) would be in South San Francisco on land located south of Alta Loma Drive in a single-family residential neighborhood. Site 18 (Alternate) would include both the drilling of a new production well and construction of a new well facility building. Sensitive receptors that could be affected by construction of Site 18 (Alternate) include single-family residences, one of which is located approximately 35 feet from the proposed construction activity center (see Figure 3-39).

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and testing, would result in noise levels of up to 85 dBA L_{eq} at the nearest residences over a four to six week period, and well facility and pipeline construction would result in noise levels measured at the exterior of the nearest residences of up to 92 dBA L_{eq} occurring over approximately 14 months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq}.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels at the nearest residences of up to 85 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} at this location (well pumping tests discussed above would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 [Construction Impacts and Mitigation Measures] would generate noise levels similar to the new production well drilling). Therefore, the impact of both daytime and nighttime construction-related noise at Site 18 (Alternate) on sensitive receptors would be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 18 (Alternate) to speech interference and sleep interference thresholds respectively, where feasible, by use of measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 82 dBA L_{eq} and nighttime construction-related noise levels to 65 dBA L_{eq}. However, these noise levels would still exceed both the daytime speech interference threshold of 70 dBA L_{eq} and the nighttime sleep interference threshold of 50 dBA L_{eq}. As a result, this impact would be *significant and unavoidable with mitigation* given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

In addition, Site 18 (Alternate) would require the installation of approximately 425 feet of pipeline, which would occur during the daytime. The nearest sensitive receptors are the residences, located less than 25 feet from the proposed pipeline installation route. Pipeline installation is proposed to progress at a rate of 300 to 600 feet per week, as proposed. Therefore, any individual residence would not be exposed to substantial additional construction-related noise level increases for more than two weeks, and no additional mitigation measures would be required.

Site 19 (Alternate)

Site 19 (Alternate) would be located in South San Francisco behind the Our Redeemer's Lutheran Church (which also operates a preschool at this location), and behind nearby single-family and multi-family residences (see Figure 3-40). This area is across Southwood Drive from the Garden Chapel Funeral Home where Site 12 would also have to be developed if Site 19 (Alternate) is selected. Site 19 (Alternate) would involve construction of a new production well with a fenced enclosure, but no building construction is proposed. Sensitive receptors that could be affected by construction at Site 19 (Alternate) include the Our Redeemer's Lutheran Church and its preschool, located approximately 50 feet from the construction activity center, single-family residences located approximately 115 feet from the proposed construction activity center, and multi-family residences located approximately 150 feet from the construction activity center.

As presented in Table 5.7-19 (Exceedance of Noise Thresholds – Daytime Construction), well installation, which includes site development, well drilling and pump testing, would result in noise levels of up to 82 dBA L_{eq} at the church and preschool and 75 dBA L_{eq} at the nearest residence over a four to six week period, and fenced enclosure construction and pipeline construction would occur over approximately four months, which would exceed the daytime speech interference threshold of 70 dBA L_{eq} at both receptors.

As presented in Table 5.7-20 (Exceedance of Noise Thresholds – Nighttime Construction), well drilling activities at night, occurring over approximately seven consecutive nights, would result in noise levels at the nearest residences of up to 75 dBA L_{eq}, which would exceed the nighttime sleep interference threshold of 50 dBA L_{eq} (well pumping tests discussed above would be performed sequentially to final well development for a continuous period of 12 to 48 hours and, as noted in Section 5.7.3.4 [Construction Impacts and Mitigation Measures], would generate noise levels similar to those associated with the new production well drilling). Therefore, the impact of both daytime and nighttime construction-related noise at Site 19 (Alternate) on sensitive receptors would be *significant*. Implementation of Mitigation Measures

M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), which limit daytime and nighttime noise levels at Site 19 (Alternate) to speech interference and sleep interference thresholds respectively, where feasible, by use of measures such as installing temporary noise barriers and truck-mounted noise control blankets (see Table 5.7-21 [Exceedance of Noise Thresholds during Construction – Mitigated Noise Level]), would reduce daytime construction-related noise levels to 55 dBA L_{eq} and nighttime construction-related noise levels to 55 dBA L_{eq} at the nearest single-family residences and to 62 dBA L_{eq} at the church and preschool. Therefore, with implementation Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan), the impact of daytime construction-related noise levels would be reduced to *less-than-significant* levels. However, nighttime construction-related noise levels would still exceed the nighttime sleep interference threshold of 50 dBA L_{eq} at single-family residences within approximately 190 feet from the well. As a result, this impact would be *significant and unavoidable with mitigation* given that even with all feasible mitigation, as discussed above, the Project would still result in a substantial temporary increase in ambient noise levels in the project vicinity above levels existing without the project.

In addition, Site 19 (Alternate) would use the same pipeline route along El Camino Real for connecting to the distribution system as would need to be installed for Site 12, discussed above. The only difference would be the 225 feet of pipelines extending from Site 19 (Alternate) to the middle of Southwood Drive. As a result, the noise impacts of pipeline installation associated with Site 19 (Alternate) would not result in any additional impacts that would be substantially different than those discussed under Site 12, which would be *less than significant*. Therefore, noise impacts from pipeline installation of the fenced enclosure would be *less than significant*.

Nighttime well-drilling activities and pumping tests would also result in increased noise levels at the church. However, since the church and preschool are assumed not to be generally open to visitors at night and nighttime construction activities would be limited to approximately one week for the well drilling and up to 48 hours for the pump testing, the drilling noise would not substantially affect this receptor. As a result, this portion of the noise impact would be *less than significant*.

Impact Conclusion: Significant and Unavoidable with Mitigation

Mitigation Measure M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate])

(See Impact NO-1 for a description)

Mitigation Measure M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate])

In addition to the requirements of Mitigation Measure M-NO-1 (Noise Control Plan) under Impact NO-1, the SFPUC will require that its construction contractor prepare and implement an Expanded Noise Control Plan to further reduce construction noise levels at nearby noise-sensitive land uses. Construction noise shall not exceed the following performance standards as measured at the exterior of the closest sensitive receptor: If noise measurements are not permitted at the exterior of the sensitive receptor's location, the SFPUC shall take noise measurements and then estimate the noise level at the sensitive receptor by adjusting for the attenuation across the additional distance. If there is any conflict between Mitigation Measure M-NO-1 (Noise Control Plan) and Mitigation Measure M-NO-3 (Expanded Noise Control Plan), the most stringent requirement would be applicable.

- 70 dBA L_{eq} between the hours of 7:00 a.m. and 10:00 p.m., Monday through Friday at residences, senior care and religious facilities, and schools.

- 50 dBA L_{eq} at residential type buildings during normal sleeping hours, which are considered to be 10:00 p.m. to 7:00 a.m.

The contractor will determine the specific methods to meet the performance standards given above. Specific measures that can be feasibly implemented to comply with these performance standards include, but are not limited to, those listed in Mitigation Measure M-NO-1 (Noise Control Plan) under Impact NO-1.

For Sites 1, 3, 4, 9, 12, 14, 16, 18 (Alternate), and 19 (Alternate), the SFPUC shall offer hotel vouchers to residents who are subject to noise levels from well drilling and testing that exceed the performance standard of 50 dBA L_{eq} at the exterior of the residence for the period of the well drilling and pump testing that will occur during the nighttime hours.

TABLE 5.7-21

Exceedance of Noise Thresholds during Construction – Mitigated Noise Level

Site	Nearest Receptor	Daytime Construction			Nighttime Construction		
		Mitigation Measure No.	Predicted Noise Level at Receptor Building with Mitigation	Speech Interference Threshold Exceeded with Mitigation? 70 dBA L_{eq}	Mitigation Measure No.	Predicted Noise Level at Receptor Building with Mitigation	Sleep Interference Threshold Exceeded with Mitigation? 50 dBA L_{eq}
Site 1	Multi-family Residential	1 and 3	76	Yes	1 and 3	57	Yes
Site 3	Single-family Residential	1 and 3	57	No	1 and 3	57	Yes
Site 4	Single-family Residential	1 and 3	58	No	1 and 3	58	Yes
Site 5 (Consolidated Treatment)	Single-family Residential	1 and 3	70	No	No nighttime construction		
Site 5 (On-site Treatment)	Single-family Residential	1 and 3	81	Yes	No nighttime construction		
Site 9	Trailer Court	1 and 3	73	Yes	1 and 3	58	Yes
Site 10	Single-family Residential	1 and 3	70	No	No nighttime construction		
Site 11	Single-family Residential	1 and 3	66	No	1 and 3	49	No

TABLE 5.7-21

Exceedance of Noise Thresholds during Construction – Mitigated Noise Level

Site	Nearest Receptor	Daytime Construction			Nighttime Construction		
		Mitigation Measure No.	**Predicted Noise Level at Receptor Building with Mitigation**	**Speech Interference Threshold Exceeded with Mitigation? 70 dBA L_{eq}**	**Mitigation Measure No.**	**Predicted Noise Level at Receptor Building with Mitigation**	**Sleep Interference Threshold Exceeded with Mitigation? 50 dBA L_{eq}**
Site 12	Funeral Home	1 and 3	73	Yes	Not a noise sensitive receptor at night.		
	Single-family Residential	1 and 3	68	No	1 and 3	53	Yes
Site 13	Single-family Residential	1 and 3	67	No	No nighttime construction		
Site 14	Single-family Residential	1 and 3	71	Yes	1 and 3	56	Yes
Site 15	Multi-family Residential	None required	N/A	N/A	1 and 3	43	No
Site 16	Multi-family Residential	1 and 3	70	No	1 and 3	55	Yes
Site 17 (Alternate)	Senior Care Facility	None required	N/A	N/A	1 and 3	47	No
Site 18 (Alternate)	Single-family Residential	1 and 3	82	Yes	1 and 3	65	Yes
Site 19 (Alternate)	Church and preschool	1 and 3	62	No	Not a noise sensitive receptor at night.		
	Single-family Residential	1 and 3	55	No	1 and 3	55	Yes

Impact NO-4: Project construction would not result in a substantial temporary increase in ambient noise levels along construction haul routes. (Less than Significant)

All Sites

Haul truck, and material and equipment delivery truck volumes associated with the Project would vary from day to day, with the highest volumes generally occurring during the removal of well cuttings or during the overlap of facility construction and pipeline installation (see Table 5.5-6 [Maximum Daily Construction Vehicle Round Trip Generation during the Highest Volume Construction Phase] in Section 5.6, Transportation and Circulation for the maximum truck trips per day). Calculations made for the worst-case hour assume that all workers would arrive at or leave each site in separate autos or light-duty trucks during a typical hour containing truck trips. It should be noted that autos and light-duty truck traffic noise did not make a measurable contribution to the Project-related traffic noise as calculated for this report (calculations on file with the San Francisco Planning Department). The sites are proposed to be constructed in various clusters, as explained in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule). The truck traffic for each site was added together for when they are to be in the same general location. Estimated Project-related traffic noise levels along haul routes associated with construction at each facility site are listed in Table 5.7-22 (Summary of Noise Effects from Construction Truck Traffic). The haul truck noise impact is considered on an hourly basis. Hourly average noise levels generated by haul truck traffic are estimated to range between 52 and 59 dBA L_{eq} at 50 feet from the roadway centerline, depending on truck volumes generated.

Typical daytime noise levels measured in the baseline survey (see Table 5.7-8 [Summary of Measured Noise Levels at Representative Sites - April and October 2009]) ranged from 55 – 70 dBA L_{eq}. Estimated noise levels resulting from haul trucks are typical of these baseline noise levels from traffic along area roadways. In addition, all estimated noise levels would fall below the daytime speech interference thresholds. Therefore, because estimated noise levels from truck trips would fall below the daytime speech interference thresholds, and haul truck noise would fall within the range of existing baseline noise levels along roadways serving the sites, noise impacts from temporary disturbance from noise along construction haul routes at all sites would be *less than significant*.

Impact Conclusion: Less than Significant

TABLE 5.7-22
Summary of Noise Effects from Construction Truck Traffic

Site	General Location	Maximum Daily Trips[a]	Maximum Noise Level at 50 feet from Roadway Centerline dBA L_{eq}[b]
Site 1	Poncetta Drive	26	55
Site 2	Park Plaza Drive	10	52
Site 3 and 4	Park Plaza Drive	40	59
Westlake Pump Station	Coronado Avenue	9	52
Site 5	B Street Hill Street	9	52
Site 6	Hill Street D Street	27	55
Site 7	Colma Blvd	15	56
Site 8	Serramonte Blvd	27	55
Site 9	Mission Road	24	55 [b]
Site 10	Camaritas Avenue	28	55
Site 11	Antoinette Lane	24	52
Site 12	Southwood Drive	26	55
Site 13	South Spruce Avenue Huntington Avenue	24	52
Site 14	Sneath Lane	26	59
Site 15	Sneath Lane	24	59
Site 16	El Camino Real (State Hwy 82) Hemlock Avenue	24	52
Site 17 (Alt)	Collins Avenue	26	55
Site 18 (Alt)	Alta Loma Drive	26	55
Site 19(Alt)	Southwood Drive	15	55

Note:

(a) Maximum Daily Trips were taken from maximum daily trips as shown in Table 5.6-6 (Maximum Daily Construction Vehicle Round Trip Generation during the Highest Volume Construction Phase) in Section 5.6, Transportation and Circulation.

(b) Access Road centerline assumed to be 25 feet from trailers.

5.7.3.5 Operational Impacts and Mitigation Measures

Impact NO-5: Operation of the Project would result in exposure of people to noise levels in excess of local noise standards or result in a substantial permanent increase in ambient noise levels in the Project vicinity. (Less than Significant with Mitigation)

Operational noise from the well facilities would result primarily from running the well pump. Associated piping and smaller ancillary valves, gauges, pumps, and compressors would also contribute minimally to overall noise generation. Minor traffic noise would result from maintenance trips to each site at a maximum of two trips per day.

As described in Chapter 3, Section 3.4 (Proposed Project), four well station types are included in the Project: 1) well with fenced enclosure; 2) well with a building; 3) well with a treatment building; and 3) well with a treatment and filtration building. Each proposed well with fenced enclosure site has been designed to have a submersible pump to minimize noise (see Section 3.4.2.3 [Well Pumps]). At locations with submersible pumps, the pumps would be installed below grade and submersed in water (see schematic drawing in Figure 3-10 [Typical Well Profile for Submersible Motor Driven Pump]), and would therefore not have perceptible noise generated aboveground[6].

For sites with building enclosures, the buildings would be constructed of board-formed concrete and metal panels. Where the building's air system is connected to the outside air for intake and exhaust, acoustical louvers would be installed to help reduce noise produced inside the building from reaching the exterior of the building. The building would also include noise reducing features such as standard weatherproofed steel doors and roofing materials with sound-reducing qualities. A limited amount of sound absorbing material would be included inside the well buildings to minimize an interior increase in noise levels due to sound reflections off hard room surfaces (see Section 3.4.2.2 [Well Facility Types]).

Electrical pump noise is a function of the size and speed of the motor. The electrical demand of the pumps in kilovolt amperes (kVA) is provided in Table 3-6 (Electrical Energy Demand for Facility Sites during Dry Years) in Chapter 3, Project Description. The pumps would range in size from 84 kVA to 168 kVA. Noise level generation from these pumps is calculated to be 92 to 93 dBA measured at a distance of three feet (Hoover & Keith 1981).

Given the assumptions stated in Section 5.7.3.2 (Approach to Analysis), noise levels were calculated at each noise-sensitive receiver location and compared to the threshold levels established in local standards and for potential speech or sleep interference. Where the standard is in terms of the hourly average noise level during the daytime or the nighttime, the lower of the two thresholds is used. Where the local standard is in terms of CNEL or L_{dn} the equivalent hourly L_{eq} for 24-hour continuous noise is used. The results of the analysis are shown in Table 5.7-23 (Conflicts with Local Noise Standards – Operation); and in Table 5.7-24 (Exceedance of Noise Thresholds – Operation).

[6] The sound of the submersible pumps is inaudible above ground, because sound from the pump would be attenuated due to the distance below the ground surface, as well as the dampening effect of the water. The impedance of water is thousands of times greater than air, so noise does not travel through water to any great extent (Au and Hastings 2008).

TABLE 5.7-23
Conflicts with Local Noise Standards - Operation

Site	Jurisdiction	Nearest Receptor	Approximate Distance to the Receptor Property Line (feet)[(a)]	Most Restrictive Threshold Applicable to the Receptor	Predicted Noise Level at Receptor L_{eq}	Conflict with Ordinance? (LSM/SUM)[(b)]
Site 1	Daly City	Multi-family Residential	30	58	60	Yes (LSM)
Site 2	Daly City	Multi-family Residential and School	320 and 150	Submersible pump would not increase ambient noise levels		
Site 3	Unincorporated San Mateo County	Single-family Residential and School	85 and Within	Submersible pump would not increase ambient noise levels		
Site 4	Unincorporated San Mateo County	Single-family Residential and School	25 and 100	Submersible pump would not increase ambient noise levels		
WLPS	Daly City	Multi-family Residential	< 25	53	[(c)]	Yes (LSM)
Site 5 (Consolidated Treatment at Site 6)	Daly City	Single-family Residential	40	Submersible pump would not increase ambient noise levels		
Site 6 (Consolidated Treatment at Site 6)	Colma	Cemetery	200	58	48	No
		Multi-family Residential	455	53	37	No
Site 7 (Consolidated Treatment at Site 6)	Colma	Cemetery	30	Submersible pump would not increase ambient noise levels		
Site 5 (On-site Treatment)	Daly City	Single-family Residential	25	53	62	Yes (LSM)

TABLE 5.7-23
Conflicts with Local Noise Standards - Operation

Site	Jurisdiction	Nearest Receptor	Approximate Distance to the Receptor Property Line (feet)[(a)]	Most Restrictive Threshold Applicable to the Receptor	Predicted Noise Level at Receptor L_{eq}	Conflict with Ordinance? (LSM/SUM)[(b)]
Site 6 (On-site Treatment)	Colma	Cemetery	200	58	48	No
		Multi-family Residential	455	53	37	No
Site 7 (On-site Treatment)	Colma	Cemetery	< 25	58	64	Yes (LSM)
Site 8	Colma	Cemetery	445	58	37	No
Site 9	South San Francisco	Trailer Court	25	50	62	Yes (LSM)
Site 10	South San Francisco	Single-family Residential	220	50	43	No
Site 11	South San Francisco	Single-family Residential[(d)]	375	50	38	No
Site 12	South San Francisco	Funeral Home	20	65	64	No
		Single-family Residential	90	50	51	Yes (LSM)
Site 13	South San Francisco	Single-family Residential	210	50	44	No
		Extended Stay Hotel	>1,000	50	< 30	No
Site 14	San Bruno	Single-family Residential	25	Submersible pump would not increase ambient noise levels		

TABLE 5.7-23
Conflicts with Local Noise Standards - Operation

Site	Jurisdiction	Nearest Receptor	Approximate Distance to the Receptor Property Line (feet)[(a)]	Most Restrictive Threshold Applicable to the Receptor	Predicted Noise Level at Receptor L_{eq}	Conflict with Ordinance? (LSM/SUM)[(b)]
Site 15	San Bruno	Multi-family Residential	665	Submersible pump would not increase ambient noise levels		
Site 16	Millbrae	Multi-family Residential	85	54	51	No
Site 17 (Alternate)	Colma	Cemetery	130	58	48	No
Site 18 (Alternate)	South San Francisco	Single-family Residential	< 25	50	64	Yes (LSM)
Site 19 (Alternate)	South San Francisco	Church/preschool and Single-family Residential	45 and 65	Submersible pump would not increase ambient noise levels		

Notes:

(a) Approximate distance from well or well facility to nearby noise sensitive property line, based on aerial photo information from Google Earth ™, see Table 5.7-7 (Summary of Nearby Sensitive Receptors). L_{eq} evaluated at the property line of the closest sensitive receptor per ordinance requirements of respective local jurisdiction.

(b) LSM = less than significant with mitigation
SUM = significant and unavoidable with mitigation

(c) The size and exact location of proposed new equipment is not known at this time. Therefore, the impact of operational noise from the Westlake Pump Station would be potentially significant.

TABLE 5.7-24

Exceedance of Noise Thresholds – Operation

Site	Nearest Receptor	Approximate Distance from the Well or Well Facility (feet)[a]	Predicted Noise Level at Receptor Building	Speech Interference Threshold Exceeded? (LSM/SUM)[b] 70 dBA L_{eq}	Sleep Interference Threshold Exceeded? (LSM/SUM)[b] 50 dBA L_{eq}
Site 1	Multi-family Residential	50	56	No	Yes (LSM)
Site 2	Multi-family Residential and school	325 and 350	Submersible pump would not increase ambient noise levels		
Site 3	Single-family Residential and school	90 and 250	Submersible pump would not increase ambient noise levels		
Site 4	Single-family Residential and school	75 and 425	Submersible pump would not increase ambient noise levels		
WLPS	Multi-family Residential	<25	[c]	Yes (LSM)	Yes (LSM)
Site 5 (Consolidated Treatment at Site 6)	Single-family Residential	50	Submersible pump would not increase ambient noise levels		
Site 6 (Consolidated Treatment at Site 6)	Multi-family Residential	555	35	No	No
Site 7 (Consolidated Treatment at Site 6)	No nearby sensitive receptors[d]				
Site 5 (On-site Treatment)	Single-family Residential	35	59	No	Yes (LSM)
Site 6 (On-site Treatment)	Multi-family Residential	555	35	No	No

TABLE 5.7-24

Exceedance of Noise Thresholds – Operation

Site	Nearest Receptor	Approximate Distance from the Well or Well Facility (feet)[a]	Predicted Noise Level at Receptor Building	Speech Interference Threshold Exceeded? (LSM/SUM)[b] 70 dBA L_{eq}	Sleep Interference Threshold Exceeded? (LSM/SUM)[b] 50 dBA L_{eq}
Site 7 (On-site Treatment)	No nearby sensitive receptors[d]				
Site 8	Senior Care Facility	600	34	No	No
Site 9	Trailer Court	30	60	No	Yes (LSM)
Site 10	Single-family Residential	250	42	No	No
Site 11	Single-family Residential	390	38	No	No
Site 12	Funeral Home	50	56	No	Not a noise sensitive receptor at night
	Single-family Residential	130	48	No	No
Site 13	Single-family Residential	260	42	No	No
	Extended Stay Hotel	>1,000	<30	No	No
Site 14	Single-family Residential	<25	Submersible pump would not increase ambient noise levels		
Site 15	Multi-family Residential	715	Submersible pump would not increase ambient noise levels		

TABLE 5.7-24

Exceedance of Noise Thresholds – Operation

Site	Nearest Receptor	Approximate Distance from the Well or Well Facility (feet)[a]	Predicted Noise Level at Receptor Building	Speech Interference Threshold Exceeded? (LSM/SUM)[b] 70 dBA L_{eq}	Sleep Interference Threshold Exceeded? (LSM/SUM)[b] 50 dBA L_{eq}
Site 16	Multi-family Residential	115	49	No	No
Site 17 (Alternate)	Senior Care Facility	500	36	No	No
Site 18 (Alternate)	Single-family Residential	25	62	No	Yes (LSM)
Site 19 (Alternate)	Church/preschool and Single-family Residential	80 and 120	Submersible pump would not increase ambient noise levels		

Notes:

(a) Approximate distance from the well or well facility to the nearby noise sensitive structure based on aerial photo information from Google Earth™ and Arc GIS™; see Table 5.7-7 (Summary of Nearby Sensitive Receptors). L_{eq} evaluated at the nearest structure.

(b) LSM = less than significant with mitigation, SUM = significant and unavoidable with mitigation

(c) The size and exact location of proposed new equipment is not known at this time. Therefore, the impact of operational noise from the Westlake Pump Station would be potentially significant.

(d) For purposes of determining conflicts with local noise standards, cemeteries are considered a sensitive receptor, but this analysis does not otherwise apply analytical noise thresholds to cemeteries.

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

Sites 2, 3, 4, 5 (Consolidated Treatment at Site 6), 7 (Consolidated Treatment at Site 6), 14, 15, and 19 (Alternate)

Well facilities at these sites would have a submersible pump. Submersible pumps are underground and would not result in measurable noise above ground due to the attenuation provided by the water column. The above ground equipment would consist of a weatherproof control panel that would not be a source of noise given that control panels do not generate noise. Therefore, *no impact* would occur at these well facilities relative to conflicts with local noise ordinances or relative to the speech and sleep interference thresholds.

Impact Conclusion: No Impact

Sites 6, 8, 10, 11, 13, 16, and 17 (Alternate)

As identified in Table 5.7-23 (Conflicts with Local Noise Standards – Operation) and Table 5.7-24 (Exceedance of Noise Thresholds – Operation), noise levels during well operation at these sites would result in noise levels below the thresholds based on the applicable local noise ordinance for the jurisdiction in which the site is located and below the speech and sleep interference thresholds. As a result, the impact would be *less than significant*.

Impact Conclusion: Less than Significant

Sites 1, 5 (On-site Treatment), 7 (On-site Treatment), 9, 12, 18 (Alternate), and the Westlake Pump Station

Site 1

Site 1 would be located in Daly City in the northeast corner of the Lake Merced Golf Club (see Figure 3-11) adjacent to multi-family residences. As identified in Table 5.7-23 (Conflicts with Local Noise Standards – Operation), noise levels during well operation would result in 60 dBA L_{eq} at the property line of the multi-family residences for which the Daly City General Plan recommends a threshold of 58 dBA L_{eq}. As identified in Table 5.7-24 (Exceedance of Noise Thresholds – Operation), noise levels during well operation at Site 1 would result in 56 dBA L_{eq} at the exterior of the multi-family residences, which would exceed the sleep interference threshold of 50 dBA L_{eq}. Therefore, this noise impact would be *significant*. However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce this impact to *less than significant* by requiring that the final design of the well facility meet the performance standard of 50 dBA L_{eq}, by incorporating such measures as additional sound insulation and weatherstripping.

Site 5 (On-site Treatment)

Site 5 would be located in Daly City on B Street (see Figures 3-18 and 3-19) adjacent to a single-family residence. As identified in Table 5.7-23 (Conflicts with Local Noise Standards – Operation), noise levels during well operation would result in 62 dBA L_{eq} at the property line of the multi-family residences for which the Daly City General Plan recommends a threshold of 53 dBA L_{eq}. As identified in Table 5.7-24 (Exceedance of Noise Thresholds – Operation), noise levels during well operation at Site 5 (On-site Treatment) would result in 59 dBA L_{eq} at the exterior of the single-family residence, which would exceed the sleep interference threshold of 50 dBA L_{eq}. Therefore, this noise impact would be *significant*. However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce this impact to *less than significant* by requiring that the final design of the well facility meet the performance standard of 50 dBA L_{eq}, by incorporating such measures as additional sound insulation and weatherstripping.

Site 7 (On-site Treatment)

Site 7 (On-site Treatment) would be located in Colma adjacent to the Woodlawn Memorial Park (see Figures 3-18 and 3-21). As identified in Table 5.7-23 (Conflicts with Local Noise Standards – Operation), noise levels during well operation would result in 64 dBA L_{eq} at the property line of the cemetery for which the Colma General Plan recommends a threshold of 58 dBA L_{eq}. Therefore, this noise impact would be *significant*. Operational noise levels would not exceed speech or sleep interference thresholds, as there are no residences nearby, and this analysis does not apply these thresholds to cemeteries since noise sensitive receptors are not constantly present at cemeteries (unlike at residences). However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce this impact to *less than significant* by requiring that the final design of the well facility meet the performance standard of 58 dBA L_{eq}, by incorporating such measures as additional sound insulation and weatherstripping.

Site 9

Site 9 would be located in South San Francisco east of El Camino Real (see Figures 3-23 and 3-24) adjacent to a BART ventilation structure. As identified in Table 5.7-23 (Conflicts with Local Noise Standards – Operation), noise levels during well operation would result in 62 dBA L_{eq} at the property line of the multi-family residences for which the South San Francisco Municipal Code identifies a threshold of 50 dBA L_{eq}. As identified in Table 5.7-24 (Exceedance of Noise Thresholds – Operation), noise levels during well operation at Site 9 would result in 60 dBA L_{eq} at the exterior of nearby single-family residences, which would exceed the sleep interference threshold of 50 dBA L_{eq}. Therefore, this noise impact would be *significant*. However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce this impact to *less than significant* by requiring that the final design of the well facility meet the performance standard of 50 dBA L_{eq}, by incorporating such measures as additional sound insulation and weatherstripping.

Site 12

Site 12 would be located in South San Francisco on Southwood Drive (see Figures 3-29 and 3-30) adjacent to a funeral home and single-family residences. As identified in Table 5.7-23 (Conflicts with Local Noise Standards – Operation), noise levels during well operation would result in 51 dBA L_{eq} at the property line of the single-family residences for which the South San Francisco Municipal Code identifies a threshold of 50 dBA L_{eq}, and noise levels would result in 64 dBA L_{eq} at the property line of the funeral home for which the South San Francisco Municipal Code identified a threshold of 65 dBA L_{eq}. Therefore, this noise impact would be *significant* (operational noise levels would not exceed the speech and sleep interference thresholds; see Table 5.7-23). However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce this impact to *less than significant* by requiring that the final design of the well facility meet the performance standard of 50 dBA L_{eq}, by incorporating such measures as additional sound insulation and weatherstripping.

Site 18 (Alternate)

Site 18 (Alternate) would be located in South San Francisco on Alta Loma Drive (see Figure 3-39) adjacent to single-family residences. As identified in Table 5.7-23 (Conflicts with Local Noise Standards – Operation), noise levels during well operation would result in 64 dBA L_{eq} at the property line of the closest single-family residence for which the South San Francisco municipal Code identifies a threshold of 50 dBA L_{eq}. As identified in Table 5.7-24 (Exceedance of Noise Thresholds – Operation), noise levels during well operation at Site 18 (Alternate) would result in 62 dBA L_{eq} at the exterior of the multi-family residences, which would exceed the sleep interference threshold of 50 dBA L_{eq}. Therefore, this noise impact would be *significant*. However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce this impact to *less than significant* by requiring that the final design of the well facility meet the performance standard of 50 dBA L_{eq}, by incorporating such measures as additional sound insulation and weatherstripping.

Westlake Pump Station

The Westlake Pump Station would be located in Daly City (see Figure 3-13) adjacent to multi-family residences. Upgrades to the Westlake Pump Station would be necessary to serve the well facilities at Sites 2, 3, and 4. As described in Section 3.4 (Proposed Project), the proposed upgrades to this pump station include new chemical storage tanks, replaced or upgraded chemical metering pumps, a resized transformer, and up to three new booster pumps to deliver the additional water into the distribution system. The size and exact location of proposed new equipment is not known at this time. Therefore, the impact of operational noise from the Westlake Pump Station relative to the Daly City noise ordinance, as well as the speech and sleep interference thresholds would be potentially *significant*. However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce this impact to *less than significant* by requiring that the final design of the improvements at the pump station meet the performance standard of 50 dBA L_{eq}, the sleep interference threshold, by incorporating such measures as additional sound insulation and weatherstripping.

Measure M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)

The SFPUC shall incorporate noise controls that reduce noise levels from operation of the Project to meet the following performance standards:

- For Sites 1, 5 (On-site Treatment), 9, 12, 18 (Alternate), and the Westlake Pump Station, operational noise levels shall be reduced to 50 dBA L_{eq} or less.

- For Site 7 (On-site Treatment), operational noise levels shall be reduced to 58 dBA L_{eq} or less.

To meet these performance standards, noise control measures, which could include the following or other equally effective measures, will be implemented, as needed. The designs for the enclosure buildings will be reviewed by a qualified acoustical expert[7] to confirm that the following measures have been appropriately incorporated into the final design documents and that they are sufficient to achieve the stipulated performance standard for each site:

- Install sound-absorbing material on the interior ceiling and/or wall surfaces, as necessary, to control reverberant buildup within the enclosure building.
- Utilize standard construction methods to eliminate cracks and gaps at the wall-roof junction and at penetrations through the walls and roof.
- Install a gypsum board ceiling, or equivalent, to provide a sound insulating roof construction.
- Orient louvers away from sensitive receptors, where possible. Where it is not possible to orient louvers away from sensitive receivers, utilize sound attenuators or additional baffles that provide up to 20 dBA of transmission loss from inside to outside the building as needed to meet the performance standard.
- Use doors that are filled steel and fully weather-stripped.
- Do not allow unprotected ventilation openings through the building walls or roof. Control all ventilation sound transmission paths, as appropriate for the fan types and ventilation systems used.

Impact Conclusion: Less than Significant with Mitigation

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[7] Qualifications shall include the following: A) Bachelor of Science or higher degree from a qualified program in engineering, physics, or architecture offered by an accredited university or college, and five years' experience in noise control engineering and construction noise analysis. B) Demonstrated substantial and responsible experience in preparing and implementing construction and operational noise control treatments and monitoring plans, calculating construction and operational noise levels, and overseeing the implementation of construction and operational noise abatement measures.

5.7.3.6 Cumulative Impacts and Mitigation Measures

Impact C-NO-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to noise. (Significant and Unavoidable with Mitigation)

For cumulative construction-related noise and vibration impacts, the geographic scope for the analysis of cumulative impacts relative to noise (and vibration) consists of each proposed GSR facility site (including the construction area for the well, the well facility, and the pipelines), and the immediate vicinity around each of these sites.

Construction

Expose persons to, or generation of, noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies

As discussed above under Impact NO-1, during certain phases of construction, the GSR Project would include construction within jurisdictions with daytime standards (South San Francisco and San Bruno) and nighttime standards (County of San Mateo, City of South San Francisco, Town of Colma, and City of San Bruno). In some instances, proposed GSR construction would include work outside of the local jurisdictions' noise ordinance time limits within which construction is allowed. In other instances, the GSR Project's predicted daytime noise levels at certain locations would exceed the maximum daytime $L_{eq,}$ identified in local ordinances. The predicted nighttime noise levels at certain locations would also exceed the maximum nighttime L_{eq} levels identified in local ordinances. In addition, construction of the GSR Project would, in some instances, also result in a substantial temporary increase in ambient noise levels in the GSR Project vicinity above levels existing without the GSR Project.

It is assumed that several of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), particularly those projects located in the immediate vicinity, could adversely affect some of the same receptors as the GSR Project. Many of the cumulative projects listed in Table 5.1-3 would result in construction-related noise levels that may exceed local noise standards and/or may also result in a substantial temporary increase in ambient noise levels in the GSR Project vicinity above levels existing without a given cumulative project. These cumulative projects would be located in three jurisdictions:

- **Daly City.** "A" Street Well Replacement Project (cumulative project C). The continuous drilling for this well may conflict with the Daly City Municipal Code which limits noise disturbance between the hours of 10:00 p.m. and 6:00 a.m.

- **Colma.** Peninsula Pipelines Seismic Upgrade Project (PPSU) at the Colma Site (cumulative project D-1) and Holy Cross Cemetery Expansion Project (cumulative project E). Construction at cumulative project D-1 may conflict with the Colma Municipal Code, but construction at cumulative project E would be located far enough away from residences that it likely would not conflict with the Town's Municipal Code.

- **South San Francisco.** Mission & McLellan Project (cumulative project F), PPSU Project at the South San Francisco Site (cumulative project D-2), the California Water Service Company (Cal Water) Well Replacement SSF1-25 Project (cumulative project G), the PG&E Transmission Pipeline Replacement Project (cumulative project H), and the Centennial Village Project (cumulative project I). Continuous drilling and testing for the Cal Water Well Replacement SSF1-25 Project and construction noise for the other projects may conflict with the South San Francisco Municipal Code, which regulates the maximum noise level for individual pieces of equipment.

The cumulative projects listed above are in proximity to Sites 5, 8, 9, 11, 12, 13, 17 (Alternate), and 19 (Alternate), all of which except for Site 5 have potentially significant noise impacts during construction. Therefore, cumulative impacts related to exposure of people to noise levels in excess of standards established by local general plan or noise ordinance, or applicable standards of other agencies would be *significant*, and the GSR Project's contribution could be cumulatively considerable, given that GSR Sites 8, 9, 11, 12, 13, 17 (Alternate), and 19 (Alternate) would have *significant* construction noise impacts.

As described in Impact NO-1, in Daly City, GSR Project construction for Site 5 would have no impact. Therefore, even though cumulative projects may conflict with local noise ordinances resulting in a significant cumulative noise impact, the contribution of the GSR Project at Site 5 would not be cumulatively considerable (*less than significant)*.

In Colma, of the GSR sites that would be in close proximity to cumulative projects, GSR Project construction for Sites 8 and 17 (Alternate) would result in *significant* impacts related to conflicts with the Colma noise ordinance. Cumulative impacts could be *significant*, and the GSR Project's contribution to this impact could be considerable. However, as discussed in Impact NO-1, the GSR Project's construction impacts related to conflict with the Colma noise ordinance would be reduced to a *less-than-significant* level with implementation of Mitigation Measure M-NO-1 (Noise Control Plan) (see Impact NO-1, above, for description). Implementation of this mitigation measure would ensure that construction activities (other than well drilling and testing) would occur during allowable hours and that noise levels from construction would be reduced below the noise ordinance threshold during construction of the GSR Project. With implementation of this mitigation measure, the GSR Project's contribution to cumulative impacts related to conflict with the Colma noise ordinance would not be cumulatively considerable (*less than significant*).

In South San Francisco, of the GSR sites that would be in close proximity to cumulative projects, GSR Project construction for Sites 9, 11, 12, 13, and 19 (Alternate) would result in *significant* impacts related to conflicts with the South San Francisco Municipal Code. The South San Francisco Municipal Code regulates the noise for single pieces of construction equipment, rather than noise levels at a sensitive receptor. Given the type of construction that would be used for other projects, it is expected that all of the projects constructed in South San Francisco would be able to meet the applicable noise limit of 90 dBA for an individual piece of equipment, resulting in a less-than-significant cumulative impact. The Cal Water replacement well would be drilled within about 630 feet of GSR Site 11, and both projects are expected to require nighttime construction to enable continuous drilling and testing. Because there are multi-family residences located on Antoinette Lane between GSR Site 11 and the Cal Water well site, this would be a significant cumulative impact, and the GSR Project's contribution would be cumulatively considerable, given that nighttime noise impacts of construction at GSR Site 11 would be significant. However, with implementation of Mitigation Measure M-NO-1 (Noise Control Plan), noise levels from nighttime construction for the GSR Project would be reduced sufficiently that construction at GSR Site 11 would not exceed local noise standards. As a result, with implementation of this mitigation measure, the GSR Project's contribution to a significant cumulative noise impact in South San Francisco would not be cumulatively considerable, and the cumulative impact would be *less than significant*.

Excessive groundborne vibration

As discussed above under Impact NO-2, damage from vibration could occur if construction occurs within 27 feet of a building. There is a potential for nighttime vibration annoyance when construction is within 155 feet of a receptor. Cumulative impacts associated with daytime construction would only be expected if both the GSR Project and a cumulative project are within 27 feet a building. Cumulative effects from nighttime construction would only occur if both projects are within 155 feet of a receptor. Of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) only the PPSU Project at the Colma Site (cumulative project D-1) which overlaps with GSR Sites 8 and 17 (Alternate), has the potential for cumulative vibration impacts. However nighttime construction is not proposed at the PPSU Colma Site, and the closest receptors are 450 feet away from Site 8 and 435 feet from Site 17 (Alternate). Therefore, no cumulative impacts related to excessive groundborne vibration are anticipated (*less than significant*).

Temporary increase in ambient noise levels

Of the GSR sites in close proximity to cumulative projects, GSR Project-related daytime and nighttime construction (as discussed under Impact NO-3) would cause *less-than-significant* temporary noise impacts at Site 8 and *significant* impacts at Sites 5, 9, 11, 12, 13, 17 (Alternate), and 19 (Alternate). It is assumed that construction of some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would also result in a substantial temporary increase in ambient noise levels in the Project vicinity above levels existing without these cumulative projects. The Daly City and Cal Water well replacement projects (cumulative projects C and G) would generate nighttime construction noise, but would not be close to the proposed GSR facility sites, where nighttime drilling would occur. Two cumulative projects in particular would generate noise close to proposed GSR facility sites. Noise levels associated with construction of these projects were estimated based on typical pipeline improvement projects. Assuming that both of these cumulative pipeline projects would generate temporary noise levels similar to GSR Project pipeline installation, the PPSU Project at the Colma Site (cumulative project D-1) could generate up to 82 dBA L_{eq} at 50 feet from the construction area during the daytime. The PG&E Transmission Pipeline Replacement Project (cumulative project H) at El Camino Real and Southwood Drive could generate up to 82 dBA L_{eq} at 50 feet from the construction area during the daytime. The PPSU Project would be located on the same site as GSR Site 8 and GSR Site 17 (Alternate). The PG&E Transmission Pipeline Replacement Project would be located near GSR Sites 12 and 19 (Alternate). Given that both of these cumulative projects would be constructed during the daytime, there would be no nighttime cumulative noise impact. However, cumulative impacts related to the temporary increase in ambient noise levels would be *significant*, and the GSR Project's contribution to this cumulative impact could be cumulatively considerable, given the proximities of some of its sites to some of the cumulative projects noted, as well as the estimated dBA levels involved in the construction of all of the projects identified in this analysis. However, as discussed in Impact NO-3, the GSR Project's noise level at the senior care facility during construction of Sites 8 and/or 17 (Alternate) would be reduced by Mitigation Measure M-NO-3 (Expanded Noise Control Measures) to 65 dBA L_{eq}, which would be less than the speech interference threshold of 70 dBA L_{eq}. Therefore, with implementation of Mitigation Measure M-NO-3, the GSR Project's contribution to cumulative impacts related to noise at nearby sensitive receptors would not be cumulatively considerable (*less than significant*).

Construction of the proposed GSR facilities at Site 12 would cause *significant* temporary noise impacts by raising noise levels during the daytime up to 83 dBA L_{eq} at the funeral home on Southwood Drive. Daytime construction at Site 19 (Alternate) would increase noise levels up to 82 dBA L_{eq} at the church and preschool at El Camino Real and Southwood Drive. However, as discussed in Impact NO-3, the GSR Project's impacts on noise levels at the funeral home during construction at Site 12 would be reduced to 73 dBA L_{eq} with implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan) (see Impact NO-1 and NO-3 for the full text of the mitigation measure). Nevertheless, noise impacts from construction at Site 12, including mitigation, would result in a *significant and unavoidable* noise impact; while the GSR Project's impacts on noise levels at the church and preschool during construction at Site 19 (Alternate) would be reduced to 62 dBA L_{eq} resulting in a *less-than-significant* impact at the church and preschool, through implementation of Mitigation Measures M-NO-1 (Noise Control Plan), and M-NO-3 (Expanded Noise Control Plan). The PG&E transmission pipeline would be constructed in the El Camino Real right-of-way approximately 200 feet from the church and preschool and 90 feet from the funeral home. In the event that the PG&E Transmission Pipeline Replacement Project and GSR Sites 12 and 19 (Alternate) were constructed at the same time (which may be the case if both Sites 12 and 19 [Alternate] are selected), temporary daytime noise levels at the church and preschool would intermittently reach 78 dBA L_{eq}, a *significant* cumulative noise impact. With implementation of Mitigation Measures M-NO-1 (Noise Control Plan) and M-NO-3 (Expanded Noise Control Plan, cumulative noise levels could still result in a cumulatively *significant* temporary increase in ambient noise levels in the GSR Project vicinity above levels existing without the GSR Project, given that even with all feasible mitigation, the GSR Project would still result in a substantial temporary increase in ambient noise levels in the GSR Project vicinity above levels existing without the GSR Project. The cumulative noise impact relative to temporary noise levels would, therefore, be *significant and unavoidable*, given that no feasible mitigation is available to reduce noise levels further to reach an acceptable level, and the GSR Project's contribution to cumulative impacts related to temporary noise levels during construction would therefore be cumulatively considerable (*significant and unavoidable with mitigation*).

Operation

Expose persons to, or cause the generation of, noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies

Of the GSR sites in close proximity to cumulative projects, operation of the proposed GSR facilities at Sites 5 (On-site Treatment), 9, and 12 as proposed (i.e., without mitigation), would result in the exposure of persons to, or generation of, noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies. Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), particularly those cumulative projects that would generate operational noise and are located in close proximity to GSR sites, could generate noise levels in excess of standards established in the local general plan or noise ordinance. The cumulative projects that are in the immediate vicinity of some of the proposed GSR sites and that may also generate incremental additions to the noise environment from operations are: The San Francisco Groundwater Supply Project wells (cumulative project A1 – A6), the Daly City "A" Street Well Replacement Project (cumulative project C), the Mission & McLellan Project (cumulative project F), the Cal Water Well Replacement SSF1-25 Project (cumulative project G), and the Centennial Village Project (cumulative project I). Therefore, cumulative impacts related to noise in excess of local standards would be *significant*, and the GSR Project's contribution to this cumulative impact at Sites 5 (On-site Treatment), 9, and 12 could be cumulatively considerable, given the analysis presented above in Impact NO-5 for these locations.

However, as described in Impact NO-5, the GSR Project's operational noise impacts would be reduced to *less-than-significant* levels with implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) for GSR Sites 5 (On-site Treatment), 9, and 12. Therefore, with implementation of the mitigation measure, the GSR Project's contribution to cumulative impacts related to operational noise would not be cumulatively considerable (*less than significant*).

Substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project

Operation of the proposed GSR facilities at certain sites, as proposed (i.e., without mitigation), would generate a substantial permanent increase in ambient noise levels in the GSR Project vicinity above levels existing without the GSR Project. Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) particularly those cumulative projects located in the immediate vicinity, could generate noise levels above existing conditions. The cumulative projects that are in the immediate vicinity of some of the proposed GSR sites and that may also generate incremental additions to the noise environment from operations are: the Daly City "A" Street Well Replacement Project (cumulative project C), the Mission & McLellan Project (cumulative project F), the Cal Water Well Replacement SSF1-25 Project (cumulative project G), and the Centennial Village Project (cumulative project I). Therefore, cumulative impacts related to increased ambient noise levels would be *significant*, and the GSR Project's contribution to this cumulative impact could be cumulatively considerable at Sites 5 (On-site Treatment), 9, and 12 given the analysis presented above in Impact NO-5 for these locations.

However, as described in Impact NO-5, the GSR Project's operational noise impacts would be reduced to *less-than-significant* levels with implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) for GSR Sites 5 (On-site Treatment), 9, and 12. Therefore, with implementation of the mitigation measure, the GSR Project's contribution to cumulative impacts related to operational noise would not be cumulatively considerable (*less than significant*).

5.7.4 References

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5.8 AIR QUALITY

This section evaluates impacts on air quality resulting from temporary construction activities and the operation of well facility sites. The analysis was conducted using methodologies and assumptions recommended by the Bay Area Air Quality Management District (BAAQMD) and determined by the San Francisco Planning Department to be adequate for use in this analysis. Procedures and methods recommended by the California Air Resources Board (CARB) are also used in this study. In keeping with guidelines for CEQA air quality studies, this report describes existing air quality, potential short-term construction-related impacts, potential direct and indirect long-term emissions associated with the Project, and the impacts of these emissions on both the local and regional scale.

5.8.1 Setting

The Project area is located in San Mateo County, which is within the San Francisco Bay Area Air Basin (Air Basin). The Project area is located in a sub-region of the Air Basin referred to as the Peninsula. Ambient concentrations of air pollutants in the Project area are a product of the quantity of pollutants emitted by local sources and the atmosphere's ability to transport and dilute such emissions. Natural factors that affect air quality and pollutant transport and dilution include terrain, wind, atmospheric stability, and the presence of sunlight.

Motor vehicles are the primary source of ambient air pollution in the proposed Project study area. Other local sources of air pollution include industry, residential heating by burning wood and natural gas, and agricultural practices. Small miscellaneous sources such as lawn mowers, coffee roasters, char broilers, bakeries, dry cleaners, gasoline stations, and many other small business operations also contribute air pollutants. Air pollutant concentrations are affected by both emissions and meteorology. While meteorology tends to create short-term variations in pollutant concentrations, changes in emissions create long-term variations. Topographical and meteorological conditions are important factors in affecting local air pollutant concentrations. Meteorological effects such as wind speed, wind direction, and air temperature gradients interact with topographical features to direct the movement and dispersal of air pollutants.

5.8.1.1 Meteorology

The climate of the San Francisco Bay Area (Bay Area) is determined largely by a high-pressure system that is almost always present over the eastern Pacific Ocean. High-pressure systems are characterized by an upper layer of dry air that warms as it descends, restricting the mobility of cooler marine-influenced air near the ground surface, resulting in subsidence inversions. In the winter, the Pacific high pressure system weakens and shifts southward, allowing storms to pass through the area. Between storm cycles, inversions often develop, and local pollution levels can build up to unhealthful concentrations.

The Pacific Ocean is a dominating influence on the climate of the Peninsula. Local wind patterns are strongly influenced by terrain gaps, such as the one in San Bruno. Marine air traveling through these gaps is typically characterized by gusty winds and low clouds. Climate information from San Francisco International Airport shows that prevailing winds flow generally from the west-northwest over 50 percent of the time (CARB 1984). On average, winds are strongest in late spring and summer, with wind speeds exceeding 20 miles per hour in the afternoons. East-southeast winds are predominant in winter, but only about 25 percent of the time. Calm conditions occur less than two percent of the time annually. Typical winter temperatures in the northern portion of the Peninsula range from the 40s in the mornings to the mid-50s to about 60 degrees during the afternoons. Typically, summer temperatures range from the 50s in morning to the 60s and 70s in the afternoon. The coldest weather is typically in December and January, while the warmest temperatures generally occur June through October. Rainfall in the area averages about 20 inches per year and is confined primarily to the wet season from late October to early May. Except for occasional light drizzles from thick marine stratus clouds, summers are almost completely dry.

Strong sunlight during late spring through summer into early fall provides a catalyst for ozone precursor pollutants to react in the atmosphere and form elevated levels of ground level ozone. Thus, the highest annual ambient ozone-smog levels typically occur from May to October. In winter, periods of stagnant air (calm or very low wind speeds) can occur, especially between Pacific storm systems. This stagnation can allow respirable and fine particulate matter levels to build up to unhealthful levels, especially when fireplaces are being heavily used (e.g., year-end holidays).

5.8.1.2 Ambient Air Quality

Air pollutant levels are typically described in terms of "concentrations," which refers to the amount of pollutant material per volumetric unit of air. Concentrations are measured in parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$). The federal and California Clean Air Acts have established ambient air quality standards for different pollutants. National Ambient Air Quality Standards (NAAQS) were established by the federal Clean Air Act for six criteria pollutants including carbon monoxide (CO), ozone, nitrogen dioxide (NO_2), small particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide and lead. Pollutants regulated under the California Clean Air Act are similar to those regulated under the federal Clean Air Act. In many cases, the California Ambient Air Quality Standards (CAAQS) are more stringent than the corresponding federal standards and incorporate additional standards for sulfates, hydrogen sulfide, vinyl chloride, and visibility-reducing particles. Both the U.S. Environmental Protection Agency (U.S. EPA) and the CARB review ambient air quality standards on a regular basis and make necessary adjustments in response to updated scientific information. Ambient air quality standards are shown in Table 5.8-1 (Relevant California and National Ambient Air Quality Standards). In addition, the U.S. EPA has identified over 100 other contaminants as hazardous air pollutants. The CARB has identified contaminants that can cause cancer or other health effects as toxic air contaminants.

TABLE 5.8-1
Relevant California and National Ambient Air Quality Standards

Pollutant	Averaging Time	California Standards	California Attainment Status	National Standards	National Attainment Status
Ozone	8-hour	0.070 ppm (137 μg/m³)	Nonattainment	0.075 ppm (147μg/m³)	Nonattainment
	1-hour	0.09 ppm (180 μg/m³)	Nonattainment	None	—
Carbon Monoxide	1-hour	20 ppm (23 mg/m³)	Attainment	35 ppm (40 mg/m³)	Attainment
	8-hour	9.0 ppm (10 mg/m³)	Attainment	9 ppm (10 mg/m³)	Attainment
Nitrogen Dioxide	1-hour	0.18 ppm (339 μg/m³)	Attainment	0.100 ppm (188 μg/m³)	Unclassified
	Annual	0.030 ppm (57 μg/m³)	Status not reported	0.053 ppm (100 μg/m³)	Attainment
Sulfur Dioxide	1-hour	0.25 ppm (655 μg/m³)	Attainment	0.075 ppm (196 μg/m³)	Attainment
	24-hour	0.04 ppm (105 μg/m³)	Attainment	0.14 ppm (365 μg/m³)	Attainment
	Annual	None	—	0.03 ppm (56 μg/m³)	Attainment
Respirable Particulate Matter (PM_{10})	24-hour	50 μg/m³	Nonattainment	150 μg/m³	Unclassified
	Annual	20 μg/m³	Nonattainment	None	—
Fine Particulate Matter ($PM_{2.5}$)	24-hour	None	—	35 μg/m³	Nonattainment
	Annual	12 μg/m³	Nonattainment	15 μg/m³	Attainment

Source: BAAQMD 2012

Notes:
ppm = parts per million
mg/m3 = milligrams per cubic meter
μg/m3 = micrograms per cubic meter

Ozone

Ground-level ozone is the principal component of smog. Ozone is not directly emitted into the atmosphere, but instead forms through a photochemical reaction of reactive organic gases (ROG) and nitrogen oxides, which are known as ozone precursors. Ozone levels are highest from late spring through autumn when precursor emissions are high and meteorological conditions are warm and stagnant. Motor vehicles create the majority of ROG and NO_X emissions in the Peninsula sub-region. Exposure to levels of ozone above current ambient air quality standards can lead to human health effects such as lung inflammation and tissue damage and impaired lung functioning. Ozone exposure is also associated with symptoms such as coughing, chest tightness, shortness of breath, and the worsening of asthma symptoms (BAAQMD 2011a). The greatest risk for harmful health effects belongs to outdoor workers, athletes, children, and others who spend greater amounts of time outdoors during periods of high ozone or $PM_{2.5}$ levels (e.g., "Spare the Air" days). Elevated ozone levels can reduce crop and timber yields, as well as damage native plants. Ozone can also damage materials such as rubber, fabrics, and plastics. In April 2005, the CARB approved a new 8-hour standard of 0.07 ppm and retained the 1-hour ozone standard of 0.09 ppm after an extensive review of the scientific literature. Evidence from the reviewed studies indicates that significant harmful health effects could occur among both adults and children if exposed to levels above these standards.

Suspended and Inhalable Particulate Matter (PM_{10} and $PM_{2.5}$)

Particulate matter (PM) is a complex mixture of tiny particles that consists of dry solid fragments, solid cores with liquid coatings, and small droplets of liquid. These particles vary greatly in shape, size, and chemical composition, and can be made up of many different materials such as metals, soot, soil, and dust. Particles 10 microns or less in diameter are defined as "respirable particulate matter" or "PM_{10}." Fine particles are 2.5 microns or less in diameter ($PM_{2.5}$) and, while also respirable, can contribute significantly to regional haze and reduction of visibility. Inhalable particulates come from smoke, dust, aerosols, and metallic oxides. Although particulates are found naturally in the air, most particulate matter found in the study area is emitted either directly or indirectly by motor vehicles, industry, construction, agricultural activities, and wind erosion of disturbed areas. Most $PM_{2.5}$ is comprised of combustion products such as smoke. Extended exposure to PM can increase the risk of chronic respiratory disease (BAAQMD 2011a). PM exposure is also associated with increased risk of premature deaths, especially in the elderly and people with pre-existing cardiopulmonary disease. In children, studies have shown associations between PM exposure and reduced lung function and increased respiratory symptoms and illnesses. Besides reducing visibility, the acidic portion of PM (e.g., nitrates or sulfates) can harm crops, forests, and aquatic and other ecosystems. In June 2002, the CARB adopted new ambient air quality standards for PM_{10} and $PM_{2.5}$, resulting from an extensive review of the health-based scientific literature. The U.S. EPA adopted a more stringent 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$ in September 2006, replacing the older standard of 65 $\mu g/m^3$ (BAAQMD 2012).

Nitrogen Dioxide (NO_2)

Nitrogen dioxide is an essential ingredient in the formation of ground-level ozone pollution. NO_2 is one of the nitrogen oxides (NO_X) emitted from high-temperature combustion processes, such as those occurring in trucks, cars, and power plants. Home heaters and gas stoves also produce NO_2 in indoor settings. Besides causing adverse health effects, NO_2 is responsible for the visibility reducing reddish-brown tinge seen in smoggy air in California. NO_2 is a reactive, oxidizing gas capable of damaging cells lining the respiratory tract. Studies suggest that NO_2 exposure can increase the risk of acute and chronic respiratory disease (BAAQMD 2011a). Due to potential health effects at or near the current air quality standard, the CARB recently revised the State ambient air quality standard for NO_2 (BAAQMD 2012). The U.S. EPA recently adopted a new 1-hour NO_2 standard of 0.10 ppm. As shown in Table 5.8-2 (Highest

Measured Air Pollutant Concentrations), levels measured in the Project vicinity are below the most up-to-date standards.

Carbon Monoxide (CO)

Carbon monoxide is a non-reactive pollutant that is toxic, invisible, and odorless. It is formed by the incomplete combustion of fuels. The largest sources of CO emissions are motor vehicles, wood stoves, and fireplaces. Unlike ozone, CO is directly emitted to the atmosphere. The highest CO concentrations occur during the nighttime and early mornings in late fall and winter. CO levels are strongly influenced by meteorological factors such as wind speed and atmospheric stability. The health threat from elevated ambient levels of CO is most serious for those who suffer from heart disease, like angina, clogged arteries, or congestive heart failure. For a person with heart disease, a single exposure to CO at relatively low levels may cause chest pain and reduce that person's ability to exercise; repeated exposures may contribute to other cardiovascular effects. High levels of CO can affect even healthy people. People who breathe high levels of CO can develop vision problems, reduced ability to work or learn, reduced manual dexterity and difficulty performing complex tasks. At extremely high levels, CO is poisonous and can cause death. As shown in Table 5.8-2 (Highest Measured Air Pollutant Concentrations), CO levels measured in the Bay Area are well below the health-based standards.

Sulfur Dioxide (SO_2)

Sulfur dioxide is a colorless gas with a strong odor. It can damage materials through acid deposition. It is produced by the combustion of sulfur-containing fuels, such as oil and coal. Refineries, chemical plants, and pulp mills are the primary industrial sources of sulfur dioxide emissions. Sulfur dioxide concentrations in the Bay Area are well below the ambient standards. Adverse health effects associated with exposure to high levels of sulfur dioxide include irritation of lung tissue, as well as increased risk of acute and chronic respiratory illness (BAAQMD 2011a).

Lead

Lead occurs in the atmosphere as particulate matter. It was primarily emitted by gasoline-powered motor vehicles, although the use of lead in fuel has been virtually eliminated. As a result, levels in the Bay Area have dropped dramatically. Lead concentrations in the Bay Area are well below the ambient standards.

5.8.1.3 Toxic Air Contaminants

Toxic Air Contaminants (TACs) are a broad class of compounds known to cause morbidity or mortality (usually because they cause cancer or serious illness) and include, but are not limited to, the criteria air pollutants listed above. TACs are found in ambient air, especially in urban areas, and are caused by industry, agriculture, fuel combustion, and commercial operations (e.g., dry cleaners). TACs are typically found in low concentrations, even near their source (e.g., diesel particulate matter near a freeway). Because chronic exposure can result in adverse health effects, TACs are regulated at the regional, State and federal level. The identification, regulation, and monitoring of TACs is relatively new compared to that for criteria air pollutants that have established ambient air quality standards. TACs are regulated or evaluated on the basis of risk to human health rather than comparison to an ambient air quality standard or emission-based threshold.

Diesel Exhaust

Diesel exhaust is the predominant TAC in urban air with the potential to cause cancer. It is estimated to represent about two-thirds of the cancer risk from TACs (based on the statewide average). According to the CARB, diesel exhaust is a complex mixture of gases, vapors, and fine particles. This complexity makes the evaluation of health effects of diesel exhaust a complex scientific issue. Some of the chemicals in diesel exhaust, such as benzene and formaldehyde, have been previously identified as TACs by the CARB, and are listed as carcinogens either under the State's Proposition 65 or under the federal Hazardous Air Pollutants programs. California has adopted a comprehensive diesel risk reduction program. The U.S. EPA and the CARB have adopted low-sulfur diesel fuel standards in 2006 that reduce diesel particulate matter substantially. The CARB recently adopted new regulations requiring the retrofit and/or replacement of construction equipment, on-highway diesel trucks, and diesel buses in order to lower $PM_{2.5}$ emissions and reduce statewide cancer risk from diesel exhaust.

Wood Smoke

In cooler weather, smoke from residential wood combustion can be a primary source of PM_{10} and $PM_{2.5}$. Highly localized particulate matter concentrations can result when cold stagnant air traps smoke near the ground, and with no wind, the pollution can persist for many hours. Wood smoke also contains TACs, (often referred to generally as polycyclic aromatic hydrocarbons). Wood smoke particulate matter can carry these TACs on their surface, and transport them deep into the lungs. Wood smoke is also an irritant and is implicated in worsening asthma and other chronic lung problems. The BAAQMD recently adopted rules to regulate wood smoke emissions from residential fireplaces. Essentially, new open fire places that burn wood are prohibited, and burning of wood in non-compliance fireplaces is prohibited on days (and nights) that BAAQMD declares as "Spare the Air" days.

5.8.1.4 Existing Pollution Levels

Ambient air quality is affected by the rate and concentration of pollutant emissions and meteorological conditions. Factors such as wind speed, atmospheric stability, and mixing height all affect the atmosphere's ability to mix and disperse pollutants. Long-term variations in air quality typically result from changes in emissions, while short-term variations result from changes in atmospheric conditions. Measured air pollutant data indicate that PM_{10} and $PM_{2.5}$ are the air pollutants of greatest concern. In recent years, ground-level ozone concentrations exceeded State and federal standards during 2010.

5.8.1.5 Measured Pollutant Concentrations

The air quality monitoring stations in San Francisco (10 Arkansas Street) and San Mateo County (in Redwood City at 897 Barron Avenue) are considered generally representative of air quality in the Project area, because they are the closest monitoring stations to the Project area. The San Francisco station is closest to the Project. Ambient air pollution data typically receives great scrutiny and quality assurance testing, so final data lags about one year behind the current calendar year. The highest local air pollutant levels measured over the past five years (2007 to 2011) are reported in Table 5.8-2 (Highest Measured Air Pollutant Concentrations). State and federal air quality standards are presented in Table 5.8-1 (Relevant California and National Ambient Air Quality Standards).

TABLE 5.8-2
Highest Measured Air Pollutant Concentrations

Pollutant	Average Time	Measured Air Pollutant Levels				
		2007	2008	2009	2010	2011
San Francisco						
Ozone	8-Hour	0.049 ppm	0.066 ppm	0.056 ppm	0.051 ppm	0.054 ppm
	1-Hour	0.06 ppm	0.082 ppm	0.072 ppm	0.079 ppm	0.07 ppm
Carbon Monoxide (CO)	8-Hour	1.6 ppm	2.29 ppm	2.86 ppm	1.37 ppm	1.2 ppm
Nitrogen Dioxide (NO_2)	1-Hour	0.069 ppm	0.062 ppm	0.059 ppm	0.093 ppm	0.093 ppm
	Annual	0.016 ppm	0.016 ppm	0.015 ppm	0.013 ppm	0.014 ppm
Respirable Particulate Matter (PM_{10})	24-Hour	**70 μg/m³**	41 μg/m³	36 μg/m³	40 μg/m³	46 μg/m³
	Annual	**22 μg/m³**	**22 μg/m³**	19 μg/m³	19 μg/m³	20 μg/m³
Fine Particulate Matter ($PM_{2.5}$)	24-Hour	**45 μg/m³**	29μg/m³	**36 μg/m³**	**45 μg/m³**	**48 μg/m³**
	Annual	9 μg/m³	12 μg/m³	NA	11 μg/m³	10 μg/m³
Redwood City						
Ozone	8-Hour	0.07 ppm	0.07 ppm	0.063 ppm	**0.077 ppm**	0.061 ppm
	1-Hour	0.077 ppm	0.082 ppm	0.087 ppm	**0.113 ppm**	0.076 ppm
Carbon Monoxide (CO)	8-Hour	2.33 ppm	1.86 ppm	1.76 ppm	1.72 ppm	1.67 ppm
Nitrogen Dioxide (NO_2)	1-Hour	0.057 ppm	0.069 ppm	0.056 ppm	0.053 ppm	0.056 ppm
	Annual	0.013 ppm	0.014 ppm	0.012 ppm	0.012 ppm	0.012 ppm
Respirable Particulate Matter (PM_{10})	24-Hour	**56 μg/m³**	41 μg/m³	INA	INA	INA
	Annual	20 μg/m³	**21 μg/m³**	INA	INA	INA
Fine Particulate Matter ($PM_{2.5}$)	24-Hour	**45 μg/m³**	28 μg/m³	32 μg/m³	**37 μg/m³**	**40 μg/m³**
	Annual	8 μg/m³	11 μg/m³	9 μg/m³	8 μg/m³	9 μg/m³

Source: BAAQMD 2013

Notes:

ppm = parts per million and μg/m³ = micrograms per cubic meter
Values reported in **bold** exceed ambient air quality standard
INA = information not available.

In general, air quality in and around San Francisco is good due to the fairly good ventilation provided by the nearly persistent sea breeze regime. The State and national ambient air quality standards for ozone were exceeded during 2010 at the Redwood City monitoring station, but not in San Francisco. The national PM_{10} standards were not exceeded during that period at either station, but exceedances of the 24-hour State standard were measured on two sampling days in San Francisco and on one sampling day in Redwood City. Exceedances of the national $PM_{2.5}$ 24-hour standard were measured on 11 sampling days in San Francisco and three sampling days in Redwood City during the five-year period. Note that PM_{10} and $PM_{2.5}$ are sampled once every six days. All other criteria pollutants are not measured because the area has a long history of compliance with those air quality standards or there is a lack of emission sources. The highest carbon monoxide concentrations measured in San Francisco and Redwood City have been well below the national and State ambient standards. However, since automobile emissions are the primary source of carbon monoxide, the highest concentrations would typically be found away from monitoring stations, near congested roadways that carry large volumes of traffic. These are referred to as "hot spots." Other criteria pollutants, such as nitrogen dioxide, sulfur dioxide, and lead, are typically found at low levels at the two monitoring stations. These pollutants should not pose a major air pollution concern in the Project area.

5.8.1.6 Attainment Status

Areas that do not violate ambient air quality standards are considered to have attained the standard. Violations of ambient air quality standards are based on air pollutant monitoring data and are judged for each air pollutant, using the most recent three years of monitoring data. The Bay Area as a whole does not meet State or national ambient air quality standards for ground level ozone and $PM_{2.5}$, nor does it meet the State standard for PM_{10} (see Table 5.8-1 [Relevant California and National Ambient Air Quality Standards]).

Under the federal Clean Air Act, the U.S. EPA has classified the region as a marginal nonattainment area for the 8-hour ozone standard. The U.S. EPA required the region to attain the standard by 2007. While the U.S. EPA has since determined that the Bay Area has met this standard, it also required BAAQMD to submit a formal redesignation request and maintenance plan before removing the marginal nonattainment designation. However, BAAQMD did not request a redesignation under the older standard, because in May 2008, the U.S. EPA lowered the 8-hour ozone standard from 0.08 to 0.075 ppm, which was finalized in September 2011. The U.S. EPA finalized area designations for the 2008 8-hour ozone standard in April and designated the Bay Area as Marginal nonattainment. The State will have to submit plans (i.e., State Implementation Plan [SIP]) to attain the new standards for areas designated as in nonattainment, including the Bay Area.

The U.S. EPA formally designated the entire Bay Area as nonattainment for the $PM_{2.5}$ standard in December 2009 based on $PM_{2.5}$ monitoring data for the three-year period 2006-2008. However, Bay Area $PM_{2.5}$ levels have declined in the past several years. Monitoring data for the 2008-2010 period and for the 2009-2011 period show that the Bay Area met the 24-hour national $PM_{2.5}$ standard during these periods. Based on the Bay Area $PM_{2.5}$ monitoring data for years 2008-2010, on December 8, 2011 CARB submitted a "clean data finding" request to the U.S. EPA on behalf of the Bay Area. If the clean data finding request is approved, then U.S. EPA guidelines provide that the region can fulfill federal $PM_{2.5}$ SIP requirements either by preparing a "clean data" SIP submittal or a "Redesignation request and $PM_{2.5}$ maintenance plan." Because peak $PM_{2.5}$ levels can vary from year to year based on natural short-term changes in weather conditions, BAAQMD believes that it would be premature to submit a redesignation request and $PM_{2.5}$ maintenance plan at this time. Therefore, BAAQMD is currently preparing a "clean data" SIP to address the required elements that include an emission inventory for primary $PM_{2.5}$, as well as precursors to secondary PM formation; and amendments to BAAQMD's New Source Review (NSR) regulation to address $PM_{2.5}$.

The Bay Area has met the CO standards for over a decade and is classified as an attainment maintenance area by the U.S. EPA. The U.S. EPA grades the region as unclassified for all other air pollutants, which include PM_{10}.

California's ambient air quality standards are more stringent than the national ambient air quality standards. At the State level, the region is considered a serious nonattainment area for ground level ozone and a nonattainment area for PM_{10} and $PM_{2.5}$. The region is required to adopt plans on a triennial basis that show progress towards meeting the State ozone standard. The area is considered an attainment area or unclassified for all other pollutants.

5.8.1.7 Sensitive Receptors

Sensitive receptors are people who are particularly susceptible to the adverse effects of air pollution. The CARB has identified the following people who are most likely to be affected by air pollution: children, the elderly, the acutely ill, and the chronically ill, especially those with cardio-respiratory diseases. Residential areas are also considered sensitive receptors to air pollution because residents (including children and the elderly) tend to be at home for extended periods of time, resulting in sustained exposure to any pollutants present. Other sensitive receptors include retirement facilities, day care facilities, hospitals, and schools. There are multiple sensitive receptors within the Project vicinity (see Appendix 2 of the GSR Air Quality Technical Report [Illingworth & Rodkin 2012], included as Appendix E of this EIR).

5.8.2 Regulatory Framework

5.8.2.1 Federal and State Regulations

The federal Clean Air Act of 1977 (CAA) governs air quality in the United States. In addition to being subject to federal requirements, air quality in California is also governed by more stringent regulations under the California Clean Air Act. At the federal level, the U.S. EPA administers the Clean Air Act. The California Clean Air Act is administered by the CARB and by the Air Quality Management Districts at the regional and local levels. The BAAQMD regulates air quality at the regional level, which includes San Francisco and San Mateo County.

Federal Clean Air Act

The U.S. EPA is responsible for enforcing the federal CAA. The U.S. EPA is also responsible for establishing the NAAQS. The NAAQS are required under the CAA and subsequent amendments. The

U.S. EPA regulates emission sources that are under the exclusive authority of the federal government, such as aircraft, ships, and certain types of locomotives. The U.S. EPA has jurisdiction over emission sources outside State waters (e.g., beyond the outer continental shelf) and establishes various emission standards, including those for vehicles sold in states other than California. Automobiles sold in California must meet the stricter emission standards established by the CARB.

California Clean Air Act and California Air Resources Board

In California, the CARB, which is part of the California Environmental Protection Agency, is responsible for meeting the State requirements of the federal Clean Air Act, administering the California Clean Air Act, and establishing the CAAQS. The California Clean Air Act, as amended in 1992, requires all air districts in the State to endeavor to achieve and maintain the CAAQS. The CARB regulates mobile air pollution sources, such as motor vehicles. It is responsible for setting emission standards for vehicles sold in California and for other emission sources, such as consumer products and certain off-road equipment. The CARB established passenger vehicle fuel specifications, which became effective in March 1996. It oversees the functions of local air pollution control districts and air quality management districts, which in turn administer air quality activities at the regional and county level.

5.8.2.2 Regional and Local Regulations

Bay Area Air Quality Management District

The BAAQMD is the regional agency responsible for air quality regulation within the San Francisco Bay Area Air Basin (Air Basin), regulating air quality through planning and review activities (i.e., permitting activities). The BAAQMD has permit authority over most types of stationary emission sources and can require stationary sources to obtain permits, impose emission limits, set fuel or material specifications, or establish operational limits to reduce air emissions. The BAAQMD regulates new or expanding stationary sources of toxic air contaminants.

The BAAQMD's responsibilities include operating an air quality monitoring network as well as awarding grants to reduce motor vehicle emissions, conducting public education campaigns, and many other activities. The BAAQMD has jurisdiction over most of the nine-county Bay Area, including the proposed well facility sites.

To protect public health, BAAQMD has adopted plans to achieve ambient air quality standards. BAAQMD must continuously monitor its progress in implementing attainment plans and must periodically report to the CARB and the U.S. EPA. It must also periodically revise its attainment plans to reflect new conditions and requirements.

In 1991, the BAAQMD, Metropolitan Transportation Commission (MTC) and Association of Bay Area Governments (ABAG) prepared the *Bay Area 1991 Clean Air Plan*. This air quality plan addresses the California Clean Air Act. Updates are developed approximately every three years. The plans are meant to demonstrate progress toward meeting the more stringent 1-hour ozone CAAQS. In 2010, BAAQMD adopted the *Bay Area 2010 Clean Air Plan* (2010 Clean Air Plan) (BAAQMD 2010b). This Clean Air Plan updates the most recent ozone plan, the 2005 Ozone Strategy. Unlike previous Bay Area Clean Air Plans, the 2010 Clean Air Plan is a multi-pollutant air quality plan addressing four categories of air pollutants:

- Ground-level ozone and the key ozone precursor pollutants (reactive organic gases and NO_X), as required by State law.
- Particulate matter, primarily $PM_{2.5}$, as well as the precursors to secondary $PM_{2.5}$.[1]
- Toxic air contaminants.
- Greenhouse gases.

While the 2010 Clean Air Plan addresses State requirements, it will also provide the basis for developing future control plans to meet federal requirements (i.e., NAAQS) for ozone and $PM_{2.5}$. The region is required to prepare a federally enforceable plan to meet the NAAQS for $PM_{2.5}$. In addition, U.S. EPA is likely to adopt a more stringent NAAQS for ozone. These new standards will likely trigger new planning requirements for the Bay Area and more stringent federally enforceable control measures. As of January 2013, this planning process is ongoing.

While previous Clean Air Plans have relied upon a combination of stationary and transportation control measures, the 2010 Clean Air Plan adds two new types of control measures: (1) Land Use and Local Impact Measures, and (2) Energy and Climate Measures. These types of measures would indirectly reduce air pollutant and greenhouse gas emissions through reductions in vehicle use and energy usage. In addition, the plan includes Further Study Measures, which will be evaluated as potential control measures.

The 2010 Clean Air Plan proposes expanded implementation of transportation control measures (TCMs) and includes public outreach programs designed to educate the public about air pollution in the Bay Area and promote individual behavior changes that improve air quality. New measures in the 2010 Clean Air Plan are aimed at helping guide land use policies that would indirectly reduce air pollutant emissions. Some of these measures or programs rely on local governments for implementation. The clean air planning efforts for ozone also will reduce PM_{10} and $PM_{2.5}$, as a substantial amount of particulate matter comes from combustion emissions such as vehicle exhaust. Conversely, strategies to reduce ozone precursor emissions will reduce secondary formation of $PM_{2.5}$ and PM_{10}.

In addition, California's Senate Bill 656 (SB 656, Sher, 2003) that amended Section 39614 of the Health and Safety Code, required further action by the CARB and air districts to reduce public exposure to PM_{10} and $PM_{2.5}$. Efforts identified by BAAQMD in response to SB 656 are primarily targeting reductions in wood smoke emissions, adoption of new rules to further reduce NO_X and particulate matter from internal combustion engines, and reductions in particulate matter from commercial charbroiling activities.

[1] PM is both directly emitted (referred to as direct PM or primary PM) and also formed in the atmosphere through reactions among different pollutants (this is referred to as indirect or secondary PM).

5.8.3 Impacts and Mitigation Measures

5.8.3.1 *Significance Criteria*

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on air quality if it were to:

- Conflict with or obstruct implementation of the applicable air quality plan.
- Violate any air quality standard or contribute substantially to an existing or projected air quality violation.
- Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is in non-attainment under an applicable federal, State, or regional ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).
- Expose sensitive receptors to substantial pollutant concentrations.
- Create objectionable odors affecting a substantial number of people.

5.8.3.2 *Approach to Analysis*

The air quality impact analysis considers construction and operational impacts associated with the proposed Project. The analysis evaluates construction of 19 potential well facility sites; however, a maximum of 16 well facilities would ultimately be operated as part of the Project. Construction equipment, trucks, worker vehicles, and ground-disturbing activities associated with the Project would generate emissions of criteria pollutants and precursors.

The GSR Air Quality Technical Report was prepared to evaluate air quality impacts associated with construction and operation of the Project (Illingworth & Rodkin 2012) (see Appendix E [GSR Final Air Quality Technical Report]). This technical report is consistent with the San Francisco Planning Department, Environmental Planning Division's requirements for air quality assessments and the BAAQMD Guidelines for assessing and mitigating air quality impacts. Based on a writ of mandate issued by the Alameda County Superior Court, the significance thresholds adopted by the BAAQMD have been set aside and are no longer in effect. As a result, the BAAQMD is no longer recommending the 2011 thresholds be used to measure a project's significant air quality impacts. Instead, the BAAQMD suggests that lead agencies use the 1999 CEQA thresholds to make determinations regarding the significance of an individual project's air quality impacts (BAAQMD 1999). However, the Planning Department has determined that Appendix D of the 2011 *BAAQMD CEQA Air Quality Guidelines*, in combination with BAAQMD's Revised Draft Options and Justification Report, provide substantial evidence to support the BAAQMD recommended thresholds and, therefore, has determined they are appropriate for use in this CEQA analysis (BAAQMD 2009).

The BAAQMD guidelines indicate that the significance of a project's impact should be evaluated based on the effectiveness of proposed measures to reduce construction-related emissions (e.g., whether control measures are implemented as part of construction). If appropriate, mitigation measures are implemented for each project to control PM_{10} and $PM_{2.5}$ emissions. Table 5.8-3 (Air Quality Significance Thresholds), summarizes the air quality thresholds of significance, followed by a discussion of each threshold.

TABLE 5.8-3
Air Quality Significance Thresholds

Pollutant	Construction Thresholds	Operational Thresholds	
	Average Daily Emissions (lbs./day)	Average Daily Emissions (lbs./day)	Annual Average Emissions (tons/year)
Criteria Air Pollutants			
ROG	54	54	10
NO_x	54	54	10
PM_{10}	82	82	15
$PM_{2.5}$	54	54	10
CO	Not Applicable	9.0 ppm (8-hour average) or 20.0 ppm (1-hour average)	
Fugitive Dust	Construction Dust Ordinance or other Best Management Practices	Not Applicable	
Health Risks and Hazards for New Sources			
Excess Cancer Risk	10 per one million	10 per one million	
Chronic or Acute Hazard Index	1.0	1.0	
Incremental annual average $PM_{2.5}$	0.3 μg/m³	0.3 μg/m³	
Health Risks and Hazards for Sensitive Receptors (Cumulative from all sources within 1,000 foot zone of influence) and Cumulative Thresholds for New Sources			
Excess Cancer Risk	100 per one million		
Chronic Hazard Index	10.0		
Annual Average $PM_{2.5}$	0.8 μg/m³		

Sources: BAAQMD 2011a; BAAQMD 2009

Ozone Precursors

As discussed previously, the Bay Area is currently designated as in non-attainment for ozone and particulate matter (PM_{10} and $PM_{2.5}$). Ozone is a secondary air pollutant produced in the atmosphere through a complex series of photochemical reactions involving ROG and NO_x. The BAAQMD is the primary regulatory agency in the Bay Area charged with ensuring that the region attains applicable federal and State ambient air quality standards. The potential for a project to result in a cumulatively considerable net increase in criteria air pollutants, which may contribute to an existing or projected air quality violation, is based on the State and federal Clean Air Acts emissions limits for stationary sources.

The federal NSR program was created by the federal CAA to ensure that stationary sources of air pollution are constructed in a manner that is consistent with attainment of federal health based ambient air quality standards. Similarly, to ensure that new stationary sources do not cause or contribute to a violation of an air quality standard, BAAQMD Regulation 2, Rule 2 requires that any new source that emits criteria air pollutants above a specified emissions limit must offset those emissions. For ozone precursors, ROG and NO_x, the offset emissions level is an annual average of 10 tons per year (or 54 pounds per day) (BAAQMD 2009). These represent emissions levels under which new sources are not anticipated to contribute to an air quality violation or result in a considerable net increase in criteria air pollutants.

Although this regulation applies to new or modified stationary sources, construction projects result in ROG and NO_x emissions as a result of increases in vehicle trips, architectural coatings, and construction activities. Therefore, the above thresholds can be applied to the construction and operational phases of land use projects, and those projects that result in emissions below these thresholds would not be considered as contributing to an existing or projected air quality violation or resulting in a considerable net increase in ROG and NO_x emissions. Because construction activities are temporary in nature, only the average daily thresholds are applicable to construction phase emissions.

Particulate Matter (PM_{10} and $PM_{2.5}$)

The BAAQMD has not established an offset limit for $PM_{2.5}$ and the current federal Prevention of Significant Deterioration (PSD) offset limit of 100 tons per year for PM_{10} is too high and would not be an appropriate significance threshold for the Air Basin considering the nonattainment status for PM_{10}. However, the emissions limits provided for in the federal NSR that apply to stationary sources that emit criteria air pollutants in areas that are currently designated as in nonattainment is an appropriate significance threshold. For PM_{10} and $PM_{2.5}$, the emissions limits under NSR are 15 tons per year (82 lbs. per day) and 10 tons per year (54 lbs. per day), respectively. These emissions limits represent levels at which a source is not expected to have an impact on air quality (BAAQMD 2009). Similar to ozone precursor thresholds identified above, land use development projects typically result in particulate matter emissions as a result of increases in vehicle trips, space heating and natural gas combustion, landscape maintenance, and construction activities. Therefore, the above thresholds can be applied to the construction and operational phases of a land use project. Those projects that result in emissions below the NSR emissions limits would not be considered as contributing to an existing or projected air quality violation or resulting in a considerable net increase in PM_{10} and $PM_{2.5}$ emissions. Because construction activities are temporary in nature, only the average daily thresholds are applicable to construction-phase emissions.

Other Criteria Pollutants

Regional concentrations of CO in the Bay Area have not exceeded the CAAQS in the past 11 years and SO_2 concentrations have never exceeded the standards. The primary source of CO impacts from land use projects is vehicle traffic. Construction-related SO_2 emissions represent a negligible portion of the total basin-wide emissions and construction-related CO emissions represent less than five percent of the Bay Area total basin-wide CO emissions (BAAQMD 2009). As discussed previously, the Bay Area is designated as in attainment for both CO and SO_2. Furthermore, the BAAQMD has demonstrated that in order to exceed the California ambient air quality standard of 9.0 ppm (8-hour average) or 20.0 ppm (1-hour average) for CO, project traffic in addition to existing traffic would need to exceed 44,000 vehicles per hour at affected intersections (or 24,000 vehicles per hour where vertical and/or horizontal mixing is limited) (BAAQMD 2011a). Operation of the Project is estimated to add one vehicle per day during a Take Year. Therefore, given the Bay Area's attainment status and the limited CO and SO_2 emissions that could result, construction of projects such as the proposed Project would not result in a cumulatively considerable net increase in CO or SO_2, and quantitative analysis is therefore not required.

Fugitive Dust

Fugitive dust emissions are typically generated during construction phases. Studies have shown that the application of best management practices (BMPs) at construction sites significantly controls fugitive dust (Western Regional Air Partnership 2006). Individual measures have been shown to reduce fugitive dust by anywhere from 30 percent to 90 percent (BAAQMD 2009). The BAAQMD has identified a number of BMPs to control fugitive dust emissions from construction activities (BAAQMD 2011a). Such measures include site watering, treatment or covering of exposed surfaces, prevention of dirt track out on to public roadways, maintenance of equipment, and public noticing.

Health Risks and Hazards from New or Modified Sources

Construction activities typically require the use of heavy-duty diesel vehicles and equipment, which emit diesel particulate matter (DPM). CARB identified DPM as a TAC in 1998, based on evidence demonstrating cancer effects in humans (CARB 1998). The exhaust from diesel engines includes hundreds of different gaseous and particulate components, many of which are toxic. Mobile sources such as trucks and buses are among the primary sources of diesel emissions, and concentrations of DPM are higher near heavily traveled highways. Other sources of health risks and hazards include: gas stations, stationary diesel engines (i.e., backup generators), dry cleaners, crematories, spray booths, diesel-fueled locomotives, major ports, rail yards, airports, oil refineries, power plants, and cement plants (BAAQMD 2011b). Land use projects that require a substantial amount of heavy-duty diesel vehicles and equipment, as well as projects that require stationary sources, such as a diesel backup generator, would result in emissions of DPM and possibly other TACs that may affect nearby sensitive receptors. Construction-phase TACs, however, would be temporary, and current health risk modeling methodologies are associated with longer-term exposure periods of 9, 40, and 70 years, which do not correlate well with the temporary and highly variable nature of construction activities, resulting in difficulties with producing accurate modeling results (BAAQMD 2009). Nevertheless, DPM is a known TAC and therefore, appropriate thresholds are identified to ensure that a project does not expose sensitive receptors to substantial pollutant concentrations.

Similar to the criteria pollutant thresholds identified above, the BAAQMD Regulation 2, Rule 5, sets cancer risk limits for new and modified sources of TACs at the maximally exposed individual (MEI). In addition to cancer risk, some TACs pose non-carcinogenic chronic and acute health hazards. Acute and chronic non-cancer health hazards are expressed in terms of a hazard index, or HI, which is a ratio of the TAC concentration to a reference exposure level (REL), a level below which no adverse health effects are expected, even for sensitive individuals (BAAQMD 2011a). In accordance with Regulation 2, Rule 5, the BAAQMD Air Pollution Control Officer shall deny any permit to operate a source that results in an increased cancer risk of 10 per million or an increase chronic or acute Hazard Index of 1.0 at the MEI. This threshold is designed to ensure that the source does not contribute to a cumulatively significant health risk impact (BAAQMD 2011a).

In addition, particulate matter, primarily associated with mobile sources (vehicular emissions) is strongly associated with mortality, respiratory diseases, and impairment of lung development in children, and can contribute to hospitalization for cardiopulmonary disease. Based on toxicological and epidemiological research, smaller particles and those associated with traffic appear more closely related to health effects (San Francisco Department of Public Health 2008). Therefore, estimates of $PM_{2.5}$ emissions from a new source can be used to approximate broader potential adverse health effects. The U.S. EPA has proposed a Significant Impact Level (SIL) for $PM_{2.5}$. For developed urban areas, including much of San Francisco, the U.S. EPA has proposed a SIL of between 0.3 $\mu g/m^3$ to 0.8 $\mu g/m^3$. The SIL represents the level of incremental $PM_{2.5}$ emissions that represents a significant contribution to regional non-attainment (BAAQMD 2011a). The BAAQMD has determined that on balance the annual average $PM_{2.5}$ threshold of 0.3 $\mu g/m^3$ will afford the same health protections as required by San Francisco's Health Code Article 38 (BAAQMD 2011a). Therefore, the lower range of the U.S. EPA recommended SIL of 0.3 $\mu g/m^3$ is an appropriate threshold for determining the significance of a source's $PM_{2.5}$ impact.

In determining the potential distance that emissions from a new source (construction sources or operational sources) may affect nearby sensitive receptors, a summary of research findings in the CARB's *Land Use Compatibility Handbook* suggests that air pollutants from high volume roadways are substantially reduced or can even be indistinguishable from upwind background concentrations at a distance of 1,000 feet downwind from sources such as freeways and large distribution centers (BAAQMD 2011a). Given the scientific data on dispersion of TACs from a source, the BAAQMD recommends assessing impacts of sources of TACs on nearby receptors within a 1,000-foot radius (BAAQMD 2011a). This radius is also consistent with the CARB's *Land Use Compatibility Handbook* and Health and Safety Code Section 42301.6 (Notice for Possible Source Near School) (BAAQMD 2011a).

In summary, potential health risks and hazards from new sources on existing or proposed sensitive receptors are assessed within a 1,000-foot zone of influence and risks and hazards from new sources that exceed any of the following thresholds at the MEI are determined to be significant: excess cancer risk of 10 per one million, chronic or acute Hazard Index of 1.0, and annual average $PM_{2.5}$ increase of 0.3 $\mu g/m^3$.

Cumulative Air Quality Impacts

Regional air quality impacts are, by their very nature, cumulative impacts. Emissions from past, present, and future projects contribute to adverse regional air quality impacts on a cumulative basis. No single project by itself would be sufficient in size to result in nonattainment of ambient air quality standards. Instead, a project's individual emissions contribute to existing cumulative adverse air quality impacts (BAAQMD 2011a). As described above, the project-level thresholds for criteria air pollutants are based on levels by which new sources are not anticipated to contribute to an air quality violation or result in a considerable net increase in criteria air pollutants. Therefore, if a project's emissions are below the project-level thresholds, the project would not be considered to result in a considerable contribution to cumulative regional air quality impacts.

With respect to localized health risks and hazards, as described above, the significance thresholds for sensitive receptors represent a cumulative impact analysis, as this analysis considers all potential sources that may result in adverse health impacts within a receptor's zone of influence. Similarly, new sources that contribute to health risks and hazards at nearby sensitive receptors that exceed these cumulative thresholds would result in a significant health risk and hazards impact to existing sensitive receptors (BAAQMD 2010a).

Consistency with Applicable Air Quality Plan

As discussed previously, the BAAQMD has published the 2010 Clean Air Plan, representing the most current applicable air quality plan for the Air Basin. Consistency with this plan is the basis for determining whether the proposed Project would conflict with or obstruct implementation of an applicable air quality plan.

Construction Impacts

Air quality impacts from construction are assessed with respect to whether or not the Project would result in a cumulatively considerable net increase of nonattainment pollutants or their precursors as measured against thresholds which were established by the BAAQMD and which the Planning Department has determined are adequate for use in this analysis, as discussed above in Section 5.8.3.2 (Approach to Analysis).

On-site construction period air pollutants were modeled using the latest version of the California Emissions Estimator Model, CalEEMod (Version 2011.1.1). The mobile emissions during construction, which include haul truck trips, vendor or delivery truck trips and worker trips, were computed using the EMFAC2011 model developed by the CARB. The on-site construction modeling was based on the construction equipment inventories and schedule provided by the SFPUC. A new production well would be installed at each site, except for the Westlake Pump Station and Sites 2, 5, 6, 8, 10, and 13, where test wells currently exist (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]). Either a well station building or a fenced enclosure would be constructed at each site. In addition, pipelines would be installed to connect the well stations to the existing distribution system. Interior upgrades at the Westlake Pump Station were not modeled because there would be very little use of diesel-powered equipment, so health risk impacts would be negligible. As discussed in Chapter 3, Project Description, Section 3.5.1 (Construction Sequencing and Schedule), total construction time for a production well and building is estimated to last 16 months; emissions were calculated based on the duration of specific types of activities within that overall construction period. Emissions associated with each component of the construction activities were computed as follows:

- Well drilling/well construction anticipated to last 30 days,
- Construction of well facility building anticipated to last 240 days,
- Construction of fenced enclosure (for well facility sites that would not have buildings) anticipated to last 60 days of which 40 would have equipment operation, and
- Pipelines anticipated to be constructed at a rate of 120 feet per day.

For sites with well facility buildings, the largest construction scenario was assumed and applied to each site on which a building is proposed, because this phase of construction would have the highest emissions. For Sites 5, 6, and 7, a well facility building was assumed at each site, because this configuration would have the highest emissions. Pipeline construction was based on an assumption that 120 feet of pipeline could be constructed in an average work day, because the majority of the pipeline is in soil where minimal obstructions are anticipated.

Model input assumptions are based on the type and quantity of equipment, projected average daily usage (in hours), and size (in terms of horsepower). Where horsepower was unknown, the CalEEMod model default value for that type of equipment was assumed. CalEEMod only computes annual emissions in tons per year or maximum daily emissions in pounds per day. Since some of the construction phases would have relatively low emissions, predicting annual emissions was found to be problematic, because CalEEMod only predicts emissions in tons with accuracy to one significant decimal point. For $PM_{2.5}$ emissions, which are used for the health risk analysis, this would introduce a large error in the predicted emissions. To avoid this type of error, average daily emissions for an entire construction phase (e.g., construction of well facility building) were predicted by inputting the usage of each piece of construction equipment with average hours per day based on the entire construction duration. For example, a grader would be operated for approximately four hours on one day during the site preparation sub-phase of production well installation, but was modeled as operating for 0.1 hours per Phase Day (four hours divided by 30 days) to account for the average amount of time it would be operated over the course of the entire 30-day phase. As a result, average daily construction period emissions from the off-road equipment operating at each site were computed.

Construction equipment assumptions in the CalEEMod model were adjusted to account for the CARB overestimation of emissions. The model is based on older load factor assumptions. The CARB adjusted construction fleet emissions by reducing the load factors used in their OFFROAD2007 model by 33 percent. Since CalEEMod is also based on the same OFFROAD2007 model, the load factors in the model for this Project were also reduced by 33 percent.

Mobile-source emissions were computed using the CARB EMFAC2011 model that computes emissions from on-road vehicles. The emissions from haul truck tips were assumed to be all heavy-duty trucks. Vendor and delivery truck trips were computed assuming a mix of 50 percent heavy-duty trucks and 50 percent medium-duty trucks. Worker trips were assumed to be 50 percent light-duty automobiles and 50 percent light-duty trucks. Vehicle trips were assumed to be the default trip lengths used in CalEEMod, which are 12.4 miles for worker trips, 7.3 miles for vendor truck trips, and 20 miles for heavy-duty truck trips. Emissions for 10 minutes of idling were applied to each truck roundtrip, which would include five minutes for each trip.

Operation and Maintenance Impacts

Operation of the Project would involve the operation and maintenance of pumps. These pumps would be operated by electricity. The Project would also include provisions for portable drive-up emergency generators to power the pumps, during a Take Year, in the event of a power outage. Operation of the Project was analyzed qualitatively based on these intermittent and infrequent proposed operational activities which would only occur during a Take Year and a power outage. The intermittent operation of the emergency generators would result in very low emissions, with no potential to cause significant air quality impacts.

Areas of No Project Impact

Operation of the Project would not result in impacts related to conflicts with an applicable air quality plan. The following criterion is, therefore, not discussed further in this section relative to Project operation.

Conflict with or obstruct implementation of applicable air quality plans. Project operation and maintenance activities would result in emissions well below the BAAQMD thresholds for criteria air pollutants and would not expose sensitive receptors to substantial levels of air pollutants (see Impacts AQ-5, AQ-6 and C-AQ-1). As a result, Project operation would not conflict with the *Bay Area 2010 Clean Air Plan*, nor would it obstruct implementation of the 2010 Clean Air Plan.

5.8.3.3 Summary of Impact Analysis

Table 5.8-4 (Summary of Impacts – Air Quality), provides a summary of potential air quality impacts from the Project.

TABLE 5.8-4
Summary of Impacts – Air Quality

Facility Sites	Construction				Operations			Cumulative
	Impact AQ-1: Construction of the Project would not conflict with or obstruct implementation of applicable air quality plans.	**Impact AQ-2: Emissions generated during construction activities would violate air quality standards and would contribute substantially to an existing air quality violation.**	**Impact AQ-3: Project construction would expose sensitive receptors to substantial pollutant concentrations.**	**Impact AQ-4: Project construction activities would not create objectionable odors affecting a substantial number of people.**	**Impact AQ-5: Project operations would not violate air quality standards or contribute substantially to an existing air quality violation.**	**Impact AQ-6: Project operations would not expose sensitive receptors to substantial pollutant concentrations.**	**Impact AQ-7: Project operations would not create objectionable odors affecting a substantial number of people.**	**Impact C-AQ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality.**
Site 1	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 2	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 3	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 4	LS	LSM	LS	LS	LS	LS	LS	LSM
Westlake Pump Station	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 5 (Consolidated Treatment at Site 6)	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 5 (On-Site Treatment)	LS	LSM	LSM	LS	LS	LS	LS	LSM
Site 6	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 7 (Consolidated Treatment and On-site options)	LS	LSM	LS	LS	LS	LS	LS	LSM

TABLE 5.8-4
Summary of Impacts – Air Quality

Facility Sites	Construction				Operations			Cumulative
	Impact AQ-1: Construction of the Project would not conflict with or obstruct implementation of applicable air quality plans.	Impact AQ-2: Emissions generated during construction activities would violate air quality standards and would contribute substantially to an existing air quality violation.	Impact AQ-3: Project construction would expose sensitive receptors to substantial pollutant concentrations.	Impact AQ-4: Project construction activities would not create objectionable odors affecting a substantial number of people.	Impact AQ-5: Project operations would not violate air quality standards or contribute substantially to an existing air quality violation.	Impact AQ-6: Project operations would not expose sensitive receptors to substantial pollutant concentrations.	Impact AQ-7: Project operations would not create objectionable odors affecting a substantial number of people.	Impact C-AQ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality.
Site 8	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 9	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 10	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 11	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 12	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 13	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 14	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 15	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 16	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 17 (Alternate)	LS	LSM	LS	LS	LS	LS	LS	LSM

TABLE 5.8-4
Summary of Impacts – Air Quality

Facility Sites	Construction				Operations			Cumulative
	Impact AQ-1: Construction of the Project would not conflict with or obstruct implementation of applicable air quality plans.	Impact AQ-2: Emissions generated during construction activities would violate air quality standards and would contribute substantially to an existing air quality violation.	Impact AQ-3: Project construction would expose sensitive receptors to substantial pollutant concentrations.	Impact AQ-4: Project construction activities would not create objectionable odors affecting a substantial number of people.	Impact AQ-5: Project operations would not violate air quality standards or contribute substantially to an existing air quality violation.	Impact AQ-6: Project operations would not expose sensitive receptors to substantial pollutant concentrations.	Impact AQ-7: Project operations would not create objectionable odors affecting a substantial number of people.	Impact C-AQ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality.
Site 18 (Alternate)	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 19 (Alternate)	LS	LSM	LS	LS	LS	LS	LS	LSM

Notes:
LS = Less than Significant
LSM = Less than Significant with Mitigation

5.8.3.4 Construction Impacts and Mitigation Measures

Impact AQ-1: Construction of the Project would not conflict with or obstruct implementation of applicable air quality plans. (Less than Significant)

<u>All Sites</u>

The Project would not conflict with or obstruct the BAAQMD's *Bay Area 2010 Clean Air Plan*, the most recently adopted regional air quality plan that pertains to the Project (BAAQMD 2010b). The 2010 Clean Air Plan provides a comprehensive plan to improve Bay Area air quality and protecting public health.

The Clean Air Plan contains 55 control measures under the following categories: stationary-source measures, mobile-source measures, transportation control measures, land use, and local impact measures and energy and climate measures. Many of these control measures require action on the part of the BAAQMD, CARB, or local communities, and are not directly related to the actions undertaken by an individual infrastructure project. For example, the first mobile source control measure listed in the Plan is MSM A-1 Promote Clean, Fuel-Efficient Light and Medium-Duty Vehicles. Under this control measure the BAAQMD would provide incentives for the purchase of low emission vehicles, target high-mileage vehicles for fleet turnover, initiate demonstration projects for renewable fuels and projects for GHG efficient vehicle and PM emissions, encourage federal participation, and continue public outreach and education of efficient driving habitats and vehicle maintenance. While the Project could benefit from these actions, in no way would it prevent the BAAQMD from implementing these actions as none directly apply to the Project. The comparison provided between MSM A-1 and the Project would be similar for the remaining 54 control measures.

The activities associated with Project construction and operation would not conflict with or obstruct implementation of the long-term air quality planning goals of the 2010 Clean Air Plan due to the short-term nature of the construction emissions. Because construction of the proposed Project would not conflict with or obstruct implementation of the 2010 Clean Air Plan, the impact would be *less than significant*.

Impact Conclusion: Less than Significant

Impact AQ-2: Emissions generated during construction activities would violate air quality standards and would contribute substantially to an existing air quality violation. (Less than Significant with Mitigation)

<u>All Sites</u>

Construction of all well facility sites would generate fugitive dust (including PM_{10} and $PM_{2.5}$) and other criteria pollutants, primarily as a result of a variety of construction activities, including excavation, grading, demolition, vehicle travel on paved and unpaved surfaces, and vehicle exhaust. With respect to construction-related emissions, PM_{10} is the pollutant of greatest concern to BAAQMD. Construction-related emissions could cause substantial increases in localized concentrations of PM_{10} and could affect compliance with PM_{10} ambient air quality standards on a regional basis. Particulate emissions from construction activities could also lead to adverse health effects and nuisance concerns (e.g., reduced visibility and soiling of exposed surfaces).

In addition, combustion emissions from construction equipment and vehicles (i.e., heavy equipment and delivery/haul trucks, worker commute vehicles, air compressors, and generators) would be generated during Project construction. Emissions from construction worker commute trips would be minor compared to the emissions generated by construction equipment (e.g., diesel-powered drilling equipment). Nevertheless, total criteria pollutant emissions of ROG and NO_x from these emission sources would incrementally add to regional atmospheric loading of ozone precursors during Project construction.

Table 5.8-5 (Estimated Total Criteria Air Pollutant Construction Emissions), shows criteria air pollutant emissions associated with construction of each facility site and the total for the construction of 19 wells and the Westlake Pump Station.

TABLE 5.8-5
Estimated Total Criteria Air Pollutant Construction Emissions (in pounds)

Facility Site	ROG	NO_x	PM_{10}	$PM_{2.5}$
Site 1	205	1,511	81	73
Site 2	15	107	7	6
Site 3	57	419	22	20
Site 4	62	434	23	21
Westlake Pump Station	5	26	4	1
Site 5 (On-Site Treatment)[a]	176	1,291	77	66
Site 6 (On-Site Treatment) [a]	172	1,266	76	65
Site 7 (On-Site Treatment) [a]	220	1,593	88	79
Site 8	165	1,228	73	62
Site 9	207	1,522	82	74
Site 10	165	1,229	73	62
Site 11	212	1,549	85	76
Site 12	214	1,564	86	77
Site 13	179	1,308	79	68
Site 14	223	1,616	90	81
Site 15	209	1,534	83	75
Site 16	211	1,540	84	75
Site 17 (Alternate)	204	1,506	81	73
Site 18 (Alternate)	206	1,516	82	74
Site 19 (Alternate)	66	451	25	22

TABLE 5.8-5
Estimated Total Criteria Air Pollutant Construction Emissions (in pounds)

Facility Site	ROG	NO_x	PM_{10}	$PM_{2.5}$
Total (pounds)	3,174	23,211	1,301	1,150
Average Daily Emissions (pounds per day)	7.6	55.3	3.1	2.7
Threshold (pounds per day)	54	54	82	54
Exceed Threshold?	No	Yes	No	No

Source: Illingworth & Rodkin 2012

Notes:

(a) Worst-case scenario for Sites 5, 6 and 7 assumes on-site treatment, longest proposed pipeline to water connection, and highest potential trip generation. For this reason, the consolidated treatment Scenario F at Site 6 is not presented.

The emissions are reported as total emissions for each site in pounds, and average daily emissions are computed for the entire Project construction period, assumed to be 420 days. Construction days were calculated based on 20 construction days over 21 months. Detailed emissions computations and assumptions along with CalEEMod modeling output are contained in Appendix 3 of the GSR Air Quality Technical Report (Illingworth & Rodkin 2012), provided as Appendix E.

Average daily emissions are compared against the daily criteria air pollutant emission significance thresholds. As indicated in Table 5.8-5 (Estimated Total Criteria Air Pollutant Construction Emissions), construction emissions of ROG, PM_{10} and $PM_{2.5}$ would be below the significance thresholds. NO_x emissions would be below the significance threshold if 16 well facilities, plus the Westlake Pump Station modification, were constructed, but would exceed the significance threshold if it were necessary to construct more than 16 well facility sites, plus the Westlake Pump Station modification. However, Mitigation Measure M-AQ-2b (NO_x Reduction during Construction of Alternate Sites) would reduce this air quality impact to *less than significant* by reducing construction-period NO_x emissions at the alternate sites by 20 percent. If only 16 well facilities, plus the Westlake Pump Station modification, were constructed, the NO_x emissions would not exceed the significance threshold and no mitigation measures would be required. Construction-period NO_x emissions at the alternate sites were recomputed assuming that all on-site off-road construction equipment would have emissions that are 20 percent lower than the current fleet-wide average assumed in the CalEEMod model. With this mitigation measure, construction of all 19 wells plus the Westlake Pump Station modifications would result in daily NO_x emissions of 53.7 pounds per day on average over the 420-day construction period, which is below the significance threshold and would, therefore, be *less than significant with mitigation*.

Table 5.8-5 (Estimated Total Criteria Air Pollutant Construction Emissions) does not include emissions for fugitive dust, which is treated separately under the BAAQMD CEQA Air Quality Guidelines. Application of Best Management Practices for minimizing dust emissions that are identified in the BAAQMD CEQA Air Quality Guidelines would minimize those impacts to a less-than-significant level. Since the Project does not include the BAAQMD Best Management Practices for minimizing dust emissions due to Project construction, this impact would be significant. However, implementation of Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures) would reduce this impact on air quality to a less-than-significant level.

Mitigation Measure M-AQ-2a: BAAQMD Basic Construction Measures (All Sites)

The SFPUC shall post one or more publicly visible signs with the telephone number and person to contact at the SFPUC with complaints related to excessive dust or vehicle idling. This person shall respond to complaints and, if necessary, take corrective action within 48 hours. The telephone number and person to contact at the BAAQMD's Compliance and Enforcement Division shall also be provided on the sign(s) in the event that the complainant also wished to contact the applicable air district.

In addition, to limit dust, criteria pollutants, and precursor emissions associated with Project construction, the following BAAQMD-recommended Basic Construction Measures shall be included in all construction contract specifications for the proposed Project:

- All exposed surfaces (e.g., parking areas, staging areas, soil piles, graded areas and unpaved access roads) shall be watered two times per day;
- All haul trucks transporting soil, sand, or other loose material off-site shall be covered;
- All visible mud or dirt tracked-out onto adjacent public roads shall be removed using wet power vacuum street sweepers at least once per day. The use of dry power sweeping shall be prohibited;
- All vehicle speeds on unpaved areas shall be limited to 15 miles per hour;
- All paving shall be completed as soon as possible after pipeline replacement work is finished;
- Idling times shall be minimized either by shutting equipment off when not in use or reducing the maximum idling time to five minutes (as required by the California airborne toxics control measure Title 13, Section 2485 of California Code of Regulations). Clear signage shall be provided for construction workers at all access points; and
- All construction equipment shall be maintained and properly tuned in accordance with manufacturer's specifications. All equipment shall be checked by a certified mechanic and determined to be running in proper condition prior to operation.

Mitigation Measure M-AQ-2b: NO_x Reduction during Construction of Alternate Sites

If one to three wells at Sites 1 through 16 are drilled but found to be unusable for any reason, and one to three well facilities are therefore constructed at alternate sites, the SFPUC shall reduce NO_x emissions by 20 percent during construction at the alternate site or sites. To meet this performance standard, the SFPUC shall develop and implement a plan demonstrating that the off-road equipment (i.e., equipment rated at more than 50 horsepower that is owned or leased by the contractor or subcontractors) to be used in constructing the wells and facilities at the alternate sites would achieve a fleet-wide average of 20 percent NO_x reduction compared to the most recent CARB fleet average. Acceptable options for reducing emissions include the use of late model engines (i.e., meeting U.S. EPA Tier 3 standards or later), low-emission diesel products, alternative fuels that have lower NO_x emissions, engine retrofit technology, after-treatment products, add-on devices, and/or other options as such become available.

Impact Conclusion: Less than Significant with Mitigation

Impact AQ-3: Project construction would expose sensitive receptors to substantial pollutant concentrations. (Less than Significant with Mitigation)

Construction activities associated with the Project would require the use of heavy-duty diesel vehicles and equipment that emit diesel particulate matter (DPM) as $PM_{2.5}$, which is a TAC identified by the CARB as causing cancer. In addition, the organic gas components of DPM can pose non-cancer hazards. To address such potential health risk impacts, estimated emissions data from the proposed construction activities were input to a dispersion model that computes DPM/$PM_{2.5}$ and organic compound concentrations at receptors. Refer to Section 5.8.3.3 (Summary of Impact Analysis), above and the GSR Air Quality Technical Report for information regarding the methodology for computing both cancer and non-cancer health risks (Illingworth & Rodkin 2012) (Appendix E, [GSR Final Air Quality Technical Report]).

The health risk associated with 19 well facility sites was estimated by calculating risk at groups of well facility sites in close proximity. Some proposed well facility sites are separated sufficiently from other proposed sites such that they would not have additive effects together; whereas the opposite is also true (i.e., the potential effects from some well facility sites would overlap with the effects from other sites). Therefore, those well facility sites that would have overlapping 1,000-foot zone of influences were grouped and modeled together, with an MEI for each group of modeled sites identified. Nine modeling groups were evaluated as follows, with Group 3 modeled under two different scenarios:

Group 1: Facility Site 1
Group 2: Facility Sites 2, 3, and 4
Group 3: Facility Sites 5, 6, and 7 (On-site Treatment)
Group 3: Facility Sites 5, 6, and 7 (Consolidated Treatment at Site 6)
Group 4: Facility Site 8 and Site 17 (Alternate)
Group 5: Facility Sites 9 and 10, and Site 18 (Alternate)
Group 6: Facility Sites 11 and 12, and Site 19 (Alternate)
Group 7: Facility Site 13
Group 8: Facility Sites 14 and 15
Group 9: Facility Site 16

MEIs were identified for each geographic group of sites. The MEI for the group with the highest risk is the MEI for the Project as a whole. The MEI with the highest risk and the only one that exceeds a threshold is a single family residence at Group 3, which includes Sites 5, 6, and 7 with the On-site Treatment option.

The excess cancer risk hazard index for acute or chronic exposures (whichever is highest), and the highest $PM_{2.5}$ concentrations for each of the geographic groups of sites are shown in Table 5.8-6 (Project Cancer Risks, Non-cancer Hazard Indices, and $PM_{2.5}$ Concentrations). The results shown in Table 5.8-6 apply to the MEI for each group. Results that exceed the applicable thresholds are highlighted in Table 5.8-6.

TABLE 5.8-6
Project Cancer Risks, Non-cancer Hazard Indices, and $PM_{2.5}$ Concentrations

Site Modeling Group	Lifetime Excess Cancer Risk (per million)	Non-cancer Acute or Chronic Hazard Index[a]	$PM_{2.5}$ Concentration (μg/m³)
Project Thresholds	10	1.00	0.3
Group 1: Site 1	2.41	0.48	0.02
Group 2: Sites 2, 3, and 4	1.51	0.72	0.02
Group 3: Sites 5, 6, and 7 (Consolidated Treatment at Site 6)	1.31	0.11	0.01
Group 3: Sites 5, 6, and 7 (On-site Treatment)	**10.74**	0.22	0.08
Group 4: Facility Site 8 and Site 17 (Alternate)	1.05	0.18	0.01
Group 5: Facility Sites 9 and 10	5.87	0.33	0.05
Group 5: Sites 9 and 10, and Site 18 (Alternate)	9.55	0.53	0.08
Group 6: Sites 11 and 12, and Site 19 (Alternate)	7.88	0.46	0.07
Group 7: Site 13	1.34	0.14	0.01
Group 8: Sites 14 and 15	3.37	0.54	0.03
Group 9: Site 16	7.60	0.37	0.06

Source: Illingworth & Rodkin 2012

Notes:
(a) Highest of acute or chronic Hazard Index shown

As indicated in Table 5.8-6 (Project Cancer Risks, Non-cancer Hazard Indices, and $PM_{2.5}$ Concentrations) the excess cancer risk at the MEI for each geographic group caused by construction of the Project is estimated to range from 1.05 to 10.74. The highest value is estimated to be 10.74, which would exceed the BAAQMD threshold of 10 in a million, at Group 3 for Sites 5, 6, and 7 for the On-site Treatment option. No other groups would exceed the threshold. Because construction of Group 3 (Sites 5, 6, 7 with On-site Treatment) would have the highest risk, the MEI for Group 3 (Sites 5, 6, 7 with On-site Treatment) would also be the MEI for the Project as a whole. Because the construction of Group 3 (Sites 5, 6, 7 with On-site Treatment) could exceed the BAAQMD threshold, this air quality impact would be *significant*. However, implementation of Mitigation Measure M-AQ-3 (Construction Health Risk Mitigation) would reduce this impact to *less than significant* by requiring the use of equipment that generate fewer emissions of TACs. Construction emissions for Group 3 (with On-site Treatment) were recomputed assuming that all on-site off-road construction equipment that is larger than 50 horsepower for construction of the well facility building at Site 5 would have diesel engines that meet the minimum mitigation requirements. This would reduce $PM_{2.5}$ emissions identified in Table 5.8-6 by greater than 50 percent. As a result, excess cancer risk was recomputed to be less than 5.39 per million for Group 3 (Sites 5, 6, 7 with On-site Treatment) (Illingworth & Rodkin 2012). The resulting cancer risks with mitigation would be below the significance thresholds and would, therefore, be *less than significant*.

As also indicated in Table 5.8-6 (Project Cancer Risks, Non-cancer Hazard Indices, and $PM_{2.5}$ Concentrations), the Hazard Index, which evaluates non-cancer health risks, is estimated to range from

0.11 to 0.72, which would be less than the significance threshold of 1.00. The annual $PM_{2.5}$ concentrations are estimated to range from 0.01 to 0.07 μg/m^{3,} which would be less than the significance threshold of 0.3 μg/m^3.

> ***Mitigation Measure M-AQ-3: Construction Health Risk Mitigation (Site 5 On-site Treatment)***
> The SFPUC shall require the construction contractor to utilize, during the construction of Site 5 (On-site Treatment), off-road equipment (more than 50 horsepower) with late model engines meeting U.S. EPA Tier 4 (Interim), or utilize a combination of Tier 2 or Tier 3 engines with add-on devices that consist of level 3 diesel particulate filters.

Impact Conclusion: Less than Significant with Mitigation

Impact AQ-4: Project construction activities would not create objectionable odors affecting a substantial number of people. (Less than Significant)

<u>All Sites</u>

While construction activities may cause localized odors (e.g., diesel operation) on a temporary basis, these are not anticipated to be objectionable beyond the construction boundaries such that they would result in formal odor complaints, given that the activities are intermittent and temporary. Therefore, given that construction of the project would not generate objectionable odors that could affect a substantial number of people this impact would be *less than significant*.

Impact Conclusion: Less than Significant

5.8.3.5 Operational Impacts and Mitigation Measures

Impact AQ-5: Project operations would not violate air quality standards or contribute substantially to an existing air quality violation. (Less than Significant)

<u>All Sites</u>

The SFPUC and Partner Agencies would operate 16 new well facilities with an annual average pumping capacity of 7.2 million gallons per day (equivalent to 8,100 acre-feet per year) to provide a supplemental dry-year water supply. During dry-year conditions and Hold Periods, Partner Agencies would also pump from their own existing wells up to annual average rates consistent with the pumping limitations expressed in the Project's Operating Agreement. During wet or normal years, weekly or monthly exercising of the Project production wells for one- to four-hour periods would be required to ensure that the facilities remain operational. Operators may fine-tune the exercise schedule according to the characteristics of individual wells.

In addition, the Project well facilities would be powered by electricity. All well facilities would have provisions for a drive-up portable generator connection, so that in the event of a power failure the well pumps could continue to run in a dry year or be used as a temporary alternate water supply (in a normal or wet year). The portable diesel generators would be trailer-mounted models with built-in sound reduction and spill containment features. The SFPUC or the Partner Agencies would utilize existing generators and would not acquire new generators for this Project.

Project operation and maintenance activities would result in less than one vehicle trip to each site per day during a dry year and less than one vehicle trip per week during a wet or normal year. This level of activity would result in emissions well below the BAAQMD thresholds. The portable generators would only operate during periods of power outages when facility operations are vital. This would be rare and, therefore, the generators would not result in significant air quality impacts. Portable diesel engines are required to meet CARB standards (California Code of Regulations, Section 93116 of Title 17). As a result, Project operation would result in a *less-than-significant* air quality impact because it would not violate air quality standards nor contribute substantially to an existing air quality violation.

Impact Conclusion: Less than Significant

Impact AQ-6: Project operations would not expose sensitive receptors to substantial pollutant concentrations. (Less than Significant)

<u>All Sites</u>

As described under Impact AQ-5, operational pollutant emissions would be quite small, and are therefore not anticipated to cause localized emissions that would lead to significant excess cancer risk, significant acute or chronic hazards or annual $PM_{2.5}$ concentrations. Therefore, such potential air quality impacts attributable to the Project would be *less than significant*.

Impact Conclusion: Less than Significant

Impact AQ-7: Project operations would not create objectionable odors affecting a substantial number of people. (Less than Significant)

<u>All Sites</u>

Operation of the Project would not cause objectionable odors that could affect a substantial number of people, because the Project wells would run on electrical power (no direct emissions) and chemicals used for water treatment would be stored in the well facility buildings. In addition, water treatment facilities are not typically a source of odor complaints and are not listed by BAAQMD as a potential odor source (BAAQMD 2011a). Therefore, since there is no odor potential during operation of the Project, this air quality impact would be *less than significant*.

Impact Conclusion: Less than Significant

5.8.3.6 Cumulative Air Quality Impacts

Impact C-AQ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality. (Less than Significant with Mitigation)

The geographic scope for the analysis of potential cumulative air quality impacts is the overall region in which the facilities are being constructed within the San Francisco Bay Area Air Basin. Projects throughout this region could have adverse effects on the same sensitive receptors. Refer to Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis) in Section 5.1, Overview, for the location of the cumulative projects.

Construction-related Criteria Pollutant Emissions

The significance thresholds used to address pollutant emissions associated with project construction represent the levels at which a project's individual emissions of criteria pollutants and precursors would result in a cumulatively considerable contribution to the San Francisco Bay Area Air Basin's existing air quality violations. As indicated in Table 5.8-5 (Estimated Total Criteria Air Pollutant Construction Emissions) above, construction-related criteria pollutant and precursor emissions associated with the Project would exceed the BAAQMD significance threshold for NO_x if all sites, including alternate sites, were constructed. The Project would also generate fugitive dust emissions during construction. Since the Project does not include the BAAQMD Best Management Practices for minimizing dust emissions due to Project construction, this impact would be *significant*. As a result, the Project's contribution to this cumulative impact would be cumulatively considerable (*significant*). However, implementation of Mitigation Measures M-AQ-2a: BAAQMD Basic Construction Measures and M-AQ-2b (NO_x Reduction during Construction of Alternate Sites) would reduce fugitive dust emissions and NO_x emissions to less-than-cumulatively considerable (*less than significant*) levels by requiring measures to minimize dust emissions, and by requiring the construction contractors to use newer equipment or retrofitted equipment that would create fewer emissions of NO_x. Construction emissions of other criteria air pollutants (i.e., ROG, PM_{10} and $PM_{2.5}$) would be below the significance thresholds (see Table 5.8-5). As a result, cumulative air quality impacts would be *less than significant with mitigation*.

Construction-related Health Risks

To address cumulative impacts on sensitive receptors due to TAC emissions during Project construction, potential health risks and hazards were assessed from TAC sources, including the Project, that are located within 1,000 feet of the Project MEI. Cumulative sources were identified using the BAAQMD database and include busy roadways and stationary sources. In addition, Daly City plans to replace or upgrade the existing "A" Street Well (cumulative project C). Construction of the Daly City well project is assumed for the purposes of this analysis to have TAC emissions similar to construction of a GSR production well[2].

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[2] Although included in the analysis in this EIR, the cumulative project C, the Daly City "A" Street Well Replacement Project, was not included in the analysis in the Air Quality Technical Report as the information was made available after completion of the Air Quality Technical Report.

Table 5.8-7 (Cumulative Cancer Risks, Non-cancer Hazard Indices, and $PM_{2.5}$ Concentrations Calculated at the Project MEI), shows the cumulative risk, hazard indices, and annual $PM_{2.5}$ concentrations for construction at the MEI. As discussed above, the Project MEI would be at Group 3 (Sites 5, 6, 7 with On-site Treatment). The cumulative excess cancer risk to the Project MEI would be 30.24 in one million, which is below the cumulative significance threshold of 100 in one million. The cumulative Hazard Index for the Project MEI at Group 3 (Sites 5, 6, 7 with On-site Treatment) is predicted to be 0.40, which is below the cumulative significance threshold of 10.0. The cumulative annual $PM_{2.5}$ concentration for the Project MEI at Group 3 (Sites 5, 6, 7 with On-site Treatment) is predicted to be 0.34 μg/m^3, which is below the cumulative significance threshold of 0.8 μg/m^3. The cumulative impacts relative to health risk from construction would, therefore, be *less than significant*.

TABLE 5.8-7
Cumulative Cancer Risks, Non-cancer Hazard Indices, and PM2.5 Concentrations Calculated at Project MEI

Site Modeling Group	Cumulative TAC Source Analyzed	Lifetime Excess Cancer Risk (per million)	Non-cancer Acute or Chronic Hazard Index[(a)]	$PM_{2.5}$ Concentration (μg/m^3)
Cumulative Thresholds		100	10.00	0.8
Project MEI (located at Group 3: Sites 5, 6, and 7 with On-site Treatment)				
Project risk		10.74	0.22	0.08
Cumulative source - roadway	I-280	7.74	0.01	0.13
Cumulative source - roadway	Junipero Serra Blvd.	1.84	0.02	0.05
Cumulative source - roadway	San Pedro Rd.	1.04	0.02	0.05
Cumulative source - roadway	Washington St	0.96	0.02	0.02
Cumulative stationary source[(b)]	Plant G9309	0.29	0.00	0.00
Cumulative stationary source[(b)]	Plant 14102	6.32	0.00	0.00
Cumulative project C (Daly City "A" Street Well Replacement)	Construction	1.31	0.11	0.01
Cumulative risk		30.24	0.40	0.34

Source: Illingworth & Rodkin 2012

Notes:
(a) The acute or chronic hazard index is reported, whichever is higher.
(b) Stationary sources are identified by their BAAQMD Plant ID.

Operations-related Emissions

The significance thresholds applicable to operational emissions represent the levels at which a project's individual emissions of criteria pollutants and precursors would result in a cumulatively considerable contribution to the San Francisco Bay Area Air Basin's existing air quality violations. The proposed Project is anticipated to have very small emissions, because on average, it would generate about one vehicle trip per day and not cause any other routine emissions. As a result, operational emissions would not exceed the significance thresholds, and, therefore, cumulative impacts relative to operational emissions would be *less than significant*.

5.8.4 References

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5.9 GREENHOUSE GAS EMISSIONS

This section addresses greenhouse gas (GHG) emissions that could result from implementation of the proposed Project. Construction-related and operational GHG emissions are evaluated quantitatively and then compared to the 2011 *CEQA Air Quality Guidelines* of the Bay Area Air Quality Management District (BAAQMD) (BAAQMD 2011). GHGs and their contribution to climate change are a global issue, and this analysis qualitatively assesses the Project's consistency with local and statewide GHG reduction policies.

5.9.1 Setting

5.9.1.1 GHGs and Climate Change

Gases that trap heat in the atmosphere are referred to as GHGs because they capture heat radiated from the sun as it is reflected back into the atmosphere, much like a greenhouse. The accumulation of GHGs has been implicated as the driving force for global climate change. The primary GHGs are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), ozone (O_3), and water vapor (H_2O).[1]

While GHGs in the atmosphere are naturally occurring, the emission rate of CO_2, CH_4, and N_2O has been accelerated by human activities. Emissions of CO_2 are largely by-products of fossil fuel combustion, whereas CH_4 results from off-gassing associated with agricultural practices and landfills. Other GHGs include hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, which are generated during certain industrial processes. GHGs are typically reported in "carbon-dioxide-equivalent" measures (CO_2e).

There is international scientific consensus that human-caused increases in GHGs have and will continue to contribute to climate change. Potential climate change impacts in California may include, but are not limited to: a decrease in snowpack; sea level rise; and a greater number of extreme heat days per year, high ozone days, large forest fires, and drought years. Secondary effects are likely to include impacts on agriculture, changes in disease vectors, and changes in habitat and biodiversity (California Environmental Protection Agency 2006).

5.9.1.2 GHG Emissions Summary

The California Air Resources Board (CARB) estimated that in 2009 California produced about 457 million metric tons of CO_2e (MMT CO_2e). The transportation sector was the highest source at 38 percent of the State's total GHG emissions, followed by electricity generation (both in-state and out-of-state) at 23 percent and industrial sources at 18 percent. Commercial and residential fuel use (primarily for heating) accounted for nine percent of the State's total GHG emissions (CARB 2011).

[1] Ozone that is not directly emitted, but formed from other gases in the troposphere (the lowest level of the earth's atmosphere), also contributes to the retention of heat.

In the San Francisco Bay Area (Bay Area), fossil fuel consumption in the transportation sector (e.g., on-road motor vehicles, off-highway mobile sources, and aircraft), and the industrial and commercial sectors are the two largest sources of GHG emissions, each accounting for approximately 36 percent of the Bay Area's 95.8 MMT CO_2e emitted in 2007. Electricity generation accounted for approximately 16 percent of the Bay Area's GHG emissions, followed by residential fuel usage at seven percent, off-road equipment at three percent, and agriculture at one percent (BAAQMD 2010a).

5.9.2 Regulatory Framework

5.9.2.1 Federal Regulations

There are no federal regulations or requirements pertaining to GHG emissions that apply to the Project.

5.9.2.2 State Regulations

Global Warming Solutions Act (Assembly Bill 32)

In 2006, the California legislature passed the Global Warming Solutions Act, or Assembly Bill 32 (AB 32) (California Health and Safety Code Division 25.5, Sections 38500 et seq.). AB 32 requires the CARB to design and implement emission limits, regulations, and other feasible and cost effective measures to ensure that statewide GHG emissions will be reduced to 1990 levels by 2020.

California Climate Change Scoping Plan

In December 2008, pursuant to AB 32, the CARB adopted the California Climate Change Scoping Plan, which outlines measures to attain the 2020 GHG reduction limits. To meet these goals, California must reduce its GHG emissions by 30 percent below projected 2020 business-as-usual emissions levels, or about 15 percent from current levels (CARB 2010). The Scoping Plan estimates a reduction of 174 MMT CO_2e (about 191 million U.S. tons) from the transportation, energy, agriculture, forestry, and high global warming potential gas sectors. The CARB has identified an implementation timeline for the GHG reduction strategies in the Scoping Plan (CARB 2011). Some of these measures may require new legislation to implement, some will require subsidies, some already have been developed, and some will require additional effort to evaluate and quantify. Additionally, some emission reduction strategies may require environmental review under CEQA or the National Environmental Policy Act (NEPA).

AB 32 also anticipates that local government actions will result in reduced GHG emissions. The CARB has identified a GHG reduction target of 15 percent from current levels for local governments, noting that successful plan implementation relies on the authority of local governments to plan, zone, approve, and permit land development to accommodate population growth and the changing needs of their jurisdictions.

5.9.2.3 Local Regulations

Bay Area Air Quality Management District CEQA Guidelines

The BAAQMD is the primary agency responsible for air quality regulation in the nine-county San Francisco Bay Area Air Basin. As part of its role in air quality regulation, BAAQMD prepared CEQA Air Quality Guidelines to assist lead agencies in evaluating air quality impacts. In May 2011, BAAQMD adopted revised CEQA air quality thresholds of significance and issued revised guidelines superseding the 1999 air quality guidelines. The 2011 *CEQA Air Quality Guidelines* provided CEQA thresholds of significance for operational GHG emissions for the first time. GHG operational thresholds for land use projects are: compliance with a Qualified GHG Reduction Strategy; or 1,100 metric tons (MT) of CO_2 equivalent (CO_2e) per year; or 4.6 MT CO_2e per service population (residents plus employees) per year. No construction thresholds for GHG emissions are provided. The BAAQMD recommends the significance of GHG construction-related emission impacts be determined in relation to meeting AB 32 GHG reduction targets. The BAAQMD further recommends and encourages lead agencies to incorporate best management practices (BMPs) to reduce GHG emissions during construction, as feasible and applicable (BAAQMD 2011).

Based on a decision by the Alameda County Superior Court, these thresholds have been set aside and are no longer in effect. In a ruling dated February 14, 2012, Alameda County Superior Court Judge Frank Roesch found that in adopting updated significance thresholds for air quality impacts, the BAAQMD violated CEQA by not first studying the potential environmental impacts of its new rules, and then required they be rescinded pending compliance with CEQA (California Building Industry Association v. BAAQMD 2012). However, the San Francisco Planning Department has determined that Appendix D of the BAAQMD *CEQA Air Quality Guidelines*, in combination with BAAQMD's Revised Draft Options and Justification Report (BAAQMD 2009), provide substantial evidence to support the BAAQMD recommended thresholds and, therefore, has determined that they are appropriate for use in this CEQA analysis. Therefore, the analysis in this section applies the numeric thresholds of significance from the 2011 *CEQA Air Quality Guidelines* discussed above.

The San Francisco Planning Department submitted to BAAQMD a draft of the City and County of San Francisco's (CCSF) *Strategies to Address Greenhouse Gas Emissions in San Francisco*, which presents a comprehensive assessment of policies, programs, and ordinances that collectively represent San Francisco's Qualified GHG Reduction Strategy (San Francisco Planning Department 2010). The BAAQMD responded stating the strategy met the criteria for a qualified greenhouse gas reduction strategy as described in the District's *CEQA Air Quality Guidelines* (BAAQMD 2010b). However, because the Project is located outside the CCSF's geographic boundaries, the Qualified GHG Reduction Strategy has not been applied to assess the Project's impact on GHG emissions.

San Francisco Greenhouse Gas Reduction Ordinance

In May 2008, the CCSF adopted an ordinance amending the San Francisco Environment Code to: establish GHG emissions targets and departmental action plans; authorize the San Francisco Department of the Environment to coordinate efforts to meet these targets; and make environmental findings. The

Greenhouse Gas Reduction Ordinance establishes the following GHG emissions reduction limits and the target dates by which to achieve them:

- Reduce GHG emissions by 25 percent below 1990 levels by 2017.
- Reduce GHG emissions by 40 percent below 1990 levels by 2025.
- Reduce GHG emissions by 80 percent below 1990 levels by 2050.

The ordinance also directs CCSF departments to prepare climate action plans that assess GHG emissions associated with their activities and with the activities they regulate, as well as to report the results of those assessments to the San Francisco Department of the Environment.

SFPUC Climate Action Plan

In 2009, pursuant to San Francisco's Greenhouse Gas Reduction Ordinance, the San Francisco Public Utilities Commission (SFPUC) presented a departmental climate action plan focused on energy efficiency and renewable energy programs that help to reduce GHG emissions. The total energy savings potential for all SFPUC facilities is estimated to be 11.8 million kilowatt-hours (kWh) of electricity. A number of SFPUC energy efficiency and renewable energy generation projects have already been implemented, with many more in the planning, design, or construction phases (San Francisco Planning Department 2010).

The SFPUC manages and implements energy-efficiency projects in municipal buildings and facilities and provides energy-efficiency services, such as energy audits, and design and construction management. Energy-efficiency technologies are commonly applied to: lighting; heating, ventilation, and air conditioning (HVAC); facility pumps and motors; and electrical controls. As of 2007, the SFPUC estimated that the energy-efficiency improvement projects had resulted in a reduction in CO_2 emissions of approximately 11,000 MT per year (San Francisco Planning Department 2010).

The SFPUC currently operates over two megawatts (MW) of solar electric photovoltaic projects throughout San Francisco that collectively generate over two million kWh of clean renewable electricity annually. A large-scale solar electric photovoltaic project planned for Sunset Reservoir is expected to produce an additional five MW of solar energy. Other potential opportunities for large scale solar projects are being considered for the SFPUC Tesla Portal facility in San Joaquin County, as well as for SFPUC water supply facilities in the Sunol Valley. In addition, the SFPUC has installed wind-monitoring equipment at sites in and around the Bay Area and the Sierra Nevada to evaluate the potential for wind power development (San Francisco Planning Department 2010). SFPUC projects that reduce electrical energy consumption and/or generate renewable energy help to reduce GHG emissions associated with SFPUC facility operations.

San Francisco's Electricity Resource Plan

San Francisco's 2011 Updated Electricity Resource Plan presents the City-wide plan to help San Francisco achieve its goal of generating all of its energy needs from renewable and zero-GHG electric energy sources by 2030 (SFPUC 2011a). The updated plan proposes three broad strategies to reduce GHG emissions from electricity:

- Empower San Francisco citizens and businesses to cost-effectively reduce GHG emissions associated with their own electric energy usage;
- Increase the amount of zero-GHG electricity supplied to the City's customers from the wholesale energy market; and
- Continue and expand the SFPUC electric service to guarantee reliable, reasonably-priced, and environmentally sensitive service to its customers.

San Francisco's 2011 Updated Electricity Resource Plan includes recommendations for implementation of each of these strategies.

5.9.3 Impacts and Mitigation Measures

5.9.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on greenhouse gases if it were to:

- Generate GHG emissions, either directly or indirectly, that may have a significant impact on the environment.
- Conflict with any applicable plan, policy, or regulation adopted for the purpose of reducing emissions of GHGs.

5.9.3.2 Approach to Analysis

The analysis of GHG emissions considers construction-related and operational impacts associated with the Project. Construction is conservatively assumed to occur at all 19 sites, while operation is assumed to occur at 16 sites. Pursuant to Section 15064.4 of the CEQA Guidelines, the significance of the Project's GHG emissions has been determined based on the thresholds of significance as discussed in Section 5.9.2.3 (Local Regulations) above, and on whether the Project's emissions would exceed levels outlined in any applicable GHG reduction plans, policies, or regulations.

The thresholds of significance include a threshold for operational GHG emissions, but none for construction-related GHG emissions (BAAQMD 2011). Therefore, the impact analysis for construction compares the total GHG emissions that would be generated during Project construction to BAAQMD operational significance thresholds. This comparison is shown in two ways: first, comparing the annual construction emissions to the threshold and; second, by averaging construction emissions over the lifespan of the Project. The life of the Project is estimated at 45 years.[2] The operational GHG threshold of significance that applies to the Project is 1,100 MT of CO_2e per year.

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[2] The SFPUC provided an estimate of Project life of 50 years (SFPUC 2012b); a slightly shorter lifetime of 45 years has been used in this analysis to provide a conservative estimate of Project life.

There are two types of GHG emissions that would occur due to construction activities: direct and indirect. Direct GHG emissions are those emissions that occur from implementation of the Project and are directly associated with construction activities. These include the combustion of fossil fuels in mobile equipment, such as off-road construction equipment, on-road haul trucks, and on-road worker vehicles. Indirect GHG emissions are releases from sources that are not directly associated with the Project, such as from the purchase of electricity to operate any electrical equipment for Project construction. The methodology used to evaluate construction-related GHG emissions is summarized below.

Construction-related GHG Emissions Sources

Off-road Construction Equipment

On-site construction period emissions were modeled using the latest version of the California Emissions Estimator Model, or CalEEMod (Version 2011.1.1, July 2012). Construction equipment assumptions in CalEEMod were adjusted to account for the CARB overestimation of emissions, in that the model is based on older load factor assumptions. CARB adjusted construction fleet emissions by reducing the load factors used in their OFFROAD2007 model by 33 percent. Because CalEEMod is also based on the same OFFROAD model, the load factors in the model for this Project were also reduced by 33 percent.

Regarding indirect GHG emissions, although construction sites are expected to be connected to the local electric grid system, construction of the Project would not rely on electricity-powered equipment. Therefore, construction-related GHG emissions are not estimated.

On-road Haul Trucks, Vendors, and Worker Trips

The mobile emissions during construction, which include haul truck trips, vendor or delivery truck trips, and worker trips, were computed using the EMFAC2011 model developed by CARB. A total of 210 haul truck trips was assumed in the calculations using soil import/export amounts (in cubic yards) and assuming a 20-cubic yard capacity haul truck as indicated in Chapter 3, Project Description, Section 3.5.2 (Construction Area, Site Preparation, Excavation, and Spoil Handling). The emissions from haul truck trips were assumed to be all heavy-duty trucks as classified by CARB EMFAC 2007. Vendor and delivery truck trips were computed assuming a mix of 50 percent heavy-duty trucks and 50 percent medium-duty trucks. Worker trips were assumed to be 50 percent light-duty automobiles and 50 percent light-duty trucks. Trucks were assumed to idle on-site for 10 minutes. Vehicle trips were assumed to be the default trip lengths used in CalEEMod, which are 12.4 miles for worker trips, 7.3 miles for vendor truck trips and 20 miles for heavy heavy-duty truck trips. Emissions for five minutes of idling were applied to each one-way haul truck for a total of 10 minutes per roundtrip.

Areas of No Project Impact

The Project would not result in impacts related to conflicts with applicable plans and policies related to emissions of greenhouse gases. The following criterion is not discussed further in this section.

Conflict with an applicable plan, policy, or regulation adopted for the purpose of reducing the emissions of greenhouse gases. The Project would not be in conflict with any adopted GHG reduction plan, policy or regulation. For the purposes of this discussion, the applicable adopted plans are the State Scoping Plan, the San Francisco Greenhouse Gas Reduction Ordinance and the San Francisco Electricity Resource Plan. As noted above, the CCSF's Strategies to Address Greenhouse Gas Emissions are not being applied to assess the Project's GHG emissions impacts because the Project is located outside of the geographical boundaries of the CCSF.

The Project would not conflict with the State strategies or the local government operation reduction goals identified in the Scoping Plan, nor the San Francisco Greenhouse Gas Reduction Ordinance. The SFPUC actively contributes to and facilitates the City's strategy to reduce GHG emissions 10 percent below its 1990 levels by the end of 2012 (SFPUC 2012a). The Greenhouse Gas Reduction Ordinance establishes a reduction target of 25 percent below 1990 levels by 2017. Both these reduction goals are more aggressive than the Scoping Plan recommended reduction goal for local by governments of 15 percent below 2008 levels by 2020. Further, as indicated in Chapter 3, Project Description, Section 3.7 (Greenhouse Gas Reduction Actions), the SFPUC has established GHG reduction actions that would be included in the construction specifications for the Project. The GHG reduction actions would be implemented as part of the Project and include requiring construction contractors to maintain tire pressure in construction vehicles and the SFPUC to consult with the SFPUC Power Enterprise's Energy Efficiency Group to incorporate all applicable energy efficiency measures in the project design. This is consistent with the both the tire inflation and green building measures identified in the Scoping Plan and the SFPUC strategies to reduce GHG emissions under the San Francisco Greenhouse Gas Reduction Ordinance.

The Project would not conflict with the San Francisco Electricity Resource Plan. As noted in Section 5.9.1 (Setting), the Plan has three broad strategies for dealing with reducing GHG emissions of residents and businesses: empowering residents and businesses to cost-effectively reduce their own GHG emissions; increasing the zero-GHG electricity supply; and guaranteeing reliable, reasonably priced, and environmentally sensitive service to its customers. The Project would develop groundwater wells and associated facilities, and would not interfere with the SFPUC's ability to implement GHG strategies in the community, purchase or construct zero-GHG electricity supply, or service its customers.

For these reasons, the Project would not conflict with an applicable plan, policy, or regulation adopted to reduce emissions of greenhouse gases.

5.9.3.3 Summary of Impacts

Table 5.9-1 (Summary of Impacts – Greenhouse Gas Emissions), provides a summary of potential greenhouse gas impacts from the Project.

TABLE 5.9-1
Summary of Impacts – Greenhouse Gas Emissions

Construction	Operation	Cumulative
Impact GG-1: Project construction would generate GHG emissions, but not at levels that would have a significant impact on the environment.	**Impact GG-2: Project operations would generate GHG emissions, but not at levels that would result in a significant impact on the environment.**	**Impact C-GG: The proposed Project would not result in a cumulatively considerable contribution to GHG emissions.**
LS All Sites	LS All Sites	LS All Sites

Note:
LS = Less than Significant Impact

5.9.3.4 Construction Impacts and Mitigation Measures

Impact GG-1: Project construction would generate GHG emissions, but not at levels that would have a significant impact on the environment. (Less than Significant)

<u>All Sites</u>

Project construction activities are estimated to occur for approximately 21 months (June 2014 to February 2016). As shown in Table 5.9-2 (Project Construction GHG Emissions), construction of the Project would emit from 817 to 1,084 MT of CO_2 annually and a total of 1,901 MT of CO_2. Because the BAAQMD CEQA Guidelines do not contain significance thresholds for GHG emissions for construction, this analysis apportions GHG emissions from construction over the lifetime of the Project. The life of the Project is estimated at 45 years. Apportioning the construction emissions over the lifetime of the Project would result in emissions of 42 MT of CO_2 per year.

TABLE 5.9-2
Project Construction GHG Emissions (Sites 1-19 [Alternate] and Westlake Pump Station)

Construction Emission Source	Year 1 CO_2 (Metric Tons)	Year 2 CO_2 (Metric Tons)
Construction equipment	936	706
Haul trucks	71	53
Worker commute	77	58
Total annual construction emissions	**1,084**	**817**
Total construction emissions	**1,901 MT**	
Total construction emissions apportioned over the 45 years of the Project lifetime	**42 MT per year**	

Annual construction emissions, as well as emissions apportioned over the 45 years of the Project life, would result in emissions of approximately 42 MT per year, which is far less than the 1,100-MT per year operational threshold of significance.

In addition, the SFPUC would require construction contractors to implement GHG reduction actions, as noted in Chapter 3, Project Description, Section 3.7 (Greenhouse Gas Reduction Actions). This includes maintaining tire inflation to manufacturers' inflation specifications and implementing a construction worker education program.

Because construction emissions would be far below the operational threshold of 1,100 MT per year (both for each year of construction and apportioned over the life of the Project) and the Project incorporates greenhouse gas reduction strategies, construction-period greenhouse gas emissions would be *less than significant*.

Although no mitigation is necessary to reduce GHG emissions from Project construction, implementation of Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures), as described under Impact AQ-2a in Section 5.8, Air Quality, would also serve to reduce construction-related GHG emissions. Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures) includes idling restrictions specified in Title 13 of the California Code of Regulations, Section 2485.

Impact Conclusion: Less than Significant

5.9.3.5 Operational Impacts and Mitigation Measures

Impact GG-2: Project operations would generate GHG emissions, but not at levels that would result in a significant impact on the environment. (Less than Significant)

All Sites

The Project would use a small amount of fuel for worker trips to perform routine equipment checks at each well facility site. Worker trips are anticipated to be once per week during normal and wet years and daily during dry years when wells are operating (i.e., Take Years). However, these maintenance trips would be made by existing employees in existing SFPUC fleet vehicles, and any increase in GHG emissions would be small.

Indirect operation-related GHG emissions include the use of electricity for operation of the Project well facilities and pump station upgrade, operation of the Partner Agency wells to the extent they operate differently under the Project from their existing operation, and operation of the regional water system to the extent it provides additional surface water to the Partner Agencies during normal and wet years to facilitate the increase in storage of groundwater. As indicated in Appendix I (Calculations for GSR Energy Use Impacts), the collective energy demand of the Project would consist of operation of new well facilities and the Westlake Pump Station (increase of four million kWh), operation of the Partner Agencies' wells (decrease of four million kWh), and operation of the regional water system (no change). Therefore, overall, the change in electricity use as a result of the Project would be negligible. Furthermore, the electricity required to supply the new well facilities would be supplied by the SFPUC Power Enterprise from facilities at Hetch Hetchy. Generation of this electricity does not cause GHG emissions because the power is generated from hydroelectric facilities (SFPUC 2011b).

As explained in Section 5.9.3.2 (Approach to Analysis), and in Impact GG-1 above, construction-period GHG emissions are apportioned over the life of the Project and then compared to the operational threshold of 1,100 MT per year to determine significance. Construction emissions from the Project would be 42 MT per year. Even with the addition of construction-period GHG emissions to the operational GHG emissions, annual GHG emissions would still be less than the operational threshold of 1,100 MT of CO_2e per year (see Table 5.9-2 [Project Construction GHG Emissions]).

In addition, as noted in Chapter 3, Project Description, Section 3.7 (Greenhouse Gas Reduction Actions), WSIP projects that include construction of new buildings would be coordinated with the SFPUC Power Enterprise's Energy Efficiency Group to incorporate all applicable energy efficiency measures into the Project design. Projects with building components will attempt to maximize energy efficiency by exceeding Title 24 minimum requirements by at least 20 percent. Projects with building components will attempt to meet or exceed LEED Silver certification as required by the City's Green Building Ordinance.

Therefore, the Project's operational GHG emissions would be *less than significant*.

Impact Conclusion: Less than Significant

5.9.3.6 *Cumulative Impacts and Mitigation Measures*

Impact C-GG: The proposed Project would not result in a cumulatively considerable contribution to GHG emissions. (Less than Significant)

Because GHG emissions affect global climate change, the evaluation of GHG emissions is inherently a cumulative impact issue. Because it is not feasible to evaluate GHG emissions impacts based on all of the cumulative projects that may affect global climate change, the geographic scope for the analysis of cumulative GHG emission impacts includes the San Francisco Bay Area Air Basin, as well as the State as a whole.

GHG Emissions during Project Construction

As discussed above under Impact GG-1, the BAAQMD has not established a threshold of significance for construction-related GHG emissions. It is estimated that construction activities associated with the GSR Project would generate up to 1,084 MT of CO_2e in the peak 12-month construction period in 2014 and 2015. Total GHG emissions from construction activity of 1,901 MT of CO_2e apportioned over a minimum 45-year lifespan of the Project would be approximately 42 MT of CO_2e per year. Peak-year construction emissions of 1,084 MT of CO_2e would represent approximately 0.0002 percent of total annual GHG emissions for the State and approximately 0.001 percent of total annual GHG emissions for the Bay Area. Thus, while the cumulative impact of regional and statewide GHG emissions is *significant*, the contribution of GHG emission from the Project would be extremely small in terms of both the statewide and Bay Area annual GHG emissions. In addition, construction-related GHG emissions would be temporary in nature and limited to the 21-month construction period. Therefore, the GSR Project's contribution to GHG emissions during construction would not be cumulatively considerable (*less than significant*).

Although no mitigation would be necessary to reduce GHG emissions from Project construction, the SFPUC would implement GHG reduction actions and would divert the majority of construction-related wastes from landfills. Further, implementation of Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures), would also serve to reduce GHG emissions during construction.

GHG Emissions during Project Operations

Given the global nature of climate change, cumulative GHG emissions are considered a significant impact. At the project level, the BAAQMD CEQA Guidelines established 1,100 MT of CO_2e per year as the individual project operational threshold. Because the BAAQMD's threshold of significance for operational GHG emissions represents the level that would not substantially conflict with the goal of reducing statewide GHG emissions – which in turn are aimed at stabilizing global climate change (BAAQMD 2011) – GHG emissions below this threshold are not considered cumulatively considerable.

Operation of the GSR Project would not cause an increase in GHG emissions, because the Partner Agency wells would use less electricity from Pacific Gas and Electric Company (PG&E) over the long-term, and the new GSR wells would use clean electricity from the SFPUC Power Enterprise. Even with the construction emissions apportioned to the first 45 years of Project operation, GHG emissions would not exceed the 1,100 MT per year threshold of significance. Because the GSR Project's operational GHG emissions would be less than the threshold of 1,100 MT of CO_2e, the GSR Project's contribution to cumulative GHG emissions and associated climate change impacts would not be cumulatively considerable (*less than significant*).

5.9.4 References

Bay Area Air Quality Management District (BAAQMD). 2009. *Revised Draft Options and Justification Report, California Environmental Quality Act Thresholds of Significance.*

BAAQMD. 2010a. *Source Inventory of Bay Area Greenhouse Gas Emissions*. February.

BAAQMD. 2010b. Personal Communication, Jean Roggenkamp, October 28, 2010.

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California Air Resources Board (CARB). 2010. *California's Climate Plan: Fact Sheet*. September 25.

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California Building Industry Association v. Bay Area Air Quality Management District. 2012. *Proposed Statement of Decision. Case No. RG10-548693. Superior Court of the State of California in and for the County of Alameda*.

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San Francisco Planning Department. 2010. *Strategies to Address Greenhouse Gas Emissions in San Francisco*. November.

San Francisco Public Utilities Commission (SFPUC). 2011a. *San Francisco's 2011 Updated Electricity Resource Plan, Achieving San Francisco's Vision for Greenhouse Gas Free Electricity*. March.

SFPUC. 2011b. Personal communication, Greg Bartow, December 21, 2011.

SFPUC. 2012a. *Climate Action Plan Annual Report to Mayor's Climate Team*. April.

SFPUC. 2012b. Personal communication, Robin Cort, July 6, 2012.

5.10 WIND AND SHADOW

This section analyzes potential impacts related to wind and shadow that could occur during construction and operation of the Project, as well as the potential for Project implementation to adversely affect existing wind and shadow patterns.

5.10.1 Setting

The Project would be located in northern San Mateo County as shown on Figure 2-1 (Project Vicinity Map), in Chapter 2, Introduction and Background. The study area for potential impacts related to wind and shadow is the individual well facility site and the areas nearby. The Project would be located within the cities of Daly City, South San Francisco, San Bruno, and Millbrae, the Town of Colma, and unincorporated San Mateo County (Broadmoor). These jurisdictions are within the Peninsula climatological subregion, as identified by the Bay Area Air Quality Management District (BAAQMD). Winds on the Peninsula are generally influenced by the Pacific Ocean and the Santa Cruz Mountains. Two physical gaps in the Santa Cruz Mountains are found on the Peninsula; the Project would be located in proximity to the San Bruno Gap. Because this gap is oriented in the same northwest to southeast direction as the prevailing winds, and because the elevations along the gap are less than 200 feet above mean sea level, marine air easily penetrates through to San Francisco Bay. Annual average wind speeds range from five to 10 miles per hour (mph) throughout the Peninsula, with higher wind speeds usually found along the Pacific Coast. Winds on the eastern side of the Peninsula are often higher in certain areas, such as near the San Bruno Gap (BAAQMD 2011). Due to the limited presence of tall buildings (generally higher than 40 feet as defined by the San Francisco Planning Code [San Francisco 1985]) in the study area, natural wind and shadow patterns are largely unaffected by man-made structures.

5.10.2 Regulatory Framework

No federal, State or local regulations governing wind or shadow would apply to the Project. Although City and County of San Francisco (CCSF) regulations govern wind and shadow effects within the boundaries of San Francisco, these local regulations do not apply to the Project because it would be outside the city limits. Nevertheless, an overview of CCSF wind and shadow regulations is provided for informational purposes.

5.10.2.1 Wind

The San Francisco Planning Code establishes wind comfort and wind hazard criteria for use in evaluating new development in four areas of San Francisco: the C-3 Downtown Commercial Districts; the Van Ness Avenue Special Use District; the Folsom–Main Residential/Commercial Special Use District; and the

Downtown Residential District.[1] As the Project would not be located in any of these areas, the wind comfort and wind hazard criteria established in the Planning Code do not apply to the Project.

5.10.2.2 Shadow

San Francisco General Plan

The *Recreation and Open Space Element* of the *San Francisco General Plan* (San Francisco 2009) includes the following policy related to potential solar access or shading impacts:

> *Policy 1.6*: Preserve sunlight in public open spaces

The policy promotes solar access and states that shadows created by new development can critically diminish the utility of public open spaces. It states that properties under the jurisdiction of the Recreation and Park Department or designated for acquisition are protected by the Planning Code, which restricts the issuance of building permits authorizing construction of any structure exceeding 40 feet in height that would shade these properties from between one hour after sunrise to one hour before sunset, unless it is determined that the impact on the use of the space would be insignificant. Policy 1.6 further states that:

> A number of other open spaces designated in this Element or elsewhere in the General Plan are under the jurisdiction of other public agencies, or are privately owned and therefore not protected by the Planning Code amendments. Planning Code protections that limit the shading should be extended to other public open spaces, such as the San Francisco Redevelopment Agency parks and some Bay Area Rapid Transit (BART) plazas, such as the New Montgomery station. The CCSF should conduct a thorough study to assess the extent of these spaces and the feasibility of protecting them during the hours of their most intensive use.

The Project would not be located on San Francisco Recreation and Park Department property or located next to other open spaces in the CCSF. Therefore, this policy does not apply to the Project.

San Francisco Planning Code

Planning Code Section 295, adopted in 1985 pursuant to voter approval of Proposition K (also known as the Sunlight Ordinance), prohibits the issuance of building permits for structures over 40 feet in height that would cast shade or shadow on property under the jurisdiction of, or designated to be acquired by, the Recreation and Park Commission. The statute applies to the time of day beginning one hour after sunrise and ending one hour before sunset at any time of year, unless the Planning Commission

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[1]The San Francisco Planning Code provides that any new building or addition located in these areas of the City that would cause wind speeds to exceed the hazard level of 26-mph equivalent for more than one hour of any year must be modified to meet this criterion. (The 26-mph standard, as defined in the Planning Code, accounts for short-term three-minute-averaged wind observations at 36 mph as equivalent to the frequency of an hourly-averaged wind speed of 26 mph. Winds over 34 mph make it difficult for a person to maintain balance and gusts can blow a person over). For CEQA purposes, the San Francisco Planning Department generally refers to the wind hazard criterion to determine the significance of wind effects related to new development in the City.

determines that the shade or shadow would have an insignificant adverse impact on the use of such property (San Francisco 1985).

The Project would be located on the Peninsula, outside of the San Francisco city limits. No parks or open spaces are within the Project or vicinity that are under the jurisdiction of the San Francisco Recreation and Park Department (refer to Section 5.11, Recreation). Therefore, the Project would not be subject to review under Planning Code Section 295.

5.10.3 Impacts and Mitigation Measures

5.10.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on wind and shadow if it were to:

- Alter wind in a manner that substantially affects public areas.
- Create new shadow in a manner that substantially affects outdoor recreation facilities or other public areas.

5.10.3.2 Approach to Analysis

Due to the nature of the Project, no impacts would occur related to the impact criteria listed above for the reasons described below:

Alter Wind in a Manner that Substantially Affects Public Areas. While the Project would include construction of new structures to house well facilities (up to 15.5 feet above finished grade and up to 103 feet long), the size and height of the structures would be similar to, or less than, other buildings in the study area. Due to their smaller height and size, new well facility structures would not alter wind patterns to the degree that they would adversely affect surrounding public areas. Therefore, the criterion related to altering wind in a manner that would substantially affect public areas is not applicable to the Project and is not discussed further.

Create New Shadow in a Manner that Substantially Affects Outdoor Recreation Facilities or Other Public Areas. The proposed Project does not include any features that would substantially affect shadow patterns. Although numerous public areas exist near well facility sites, the low elevation of the proposed new well facility buildings (approximately 15.5 feet above finished grade) at the various well facility sites would not be high enough to result in substantial shadowing that would affect off-site outdoor recreational facilities or the enjoyment or use of other public areas. Therefore, the criterion related to creating new shadow that would substantially affect outdoor recreational facilities or other public areas is not applicable to the proposed Project and is not discussed further.

5.10.3.3 Construction and Operational Impacts and Mitigation Measures

As discussed above, implementation of the proposed Project would not result in impacts related to wind and shadow. Therefore, no mitigation measures related to this resource topic are required.

5.10.3.4 Cumulative Impacts and Mitigation Measures

Because the GSR Project would not result in Project-specific impacts related to wind or shadow, implementation of the Project would not contribute to any such cumulative impacts.

5.10.4 References

Bay Area Air Quality Management District (BAAQMD). 2011. *California Environmental Quality Act Air Quality Guidelines.* May.

San Francisco, City and County of. 1985. *San Francisco Planning Code Article 2.5: Height and Bulk Districts, Section 295 Height Restrictions on Structures Shadowing Property Under the Jurisdiction of the Recreation and Park Commission.* January.

San Francisco, City and County of. 2009. *San Francisco General Plan, Recreation and Open Space Element.*

5.11 RECREATION

This section provides an overview of the recreational resources in the vicinity of the Project and evaluates the potential impacts of construction and operation on these recreational resources. Recreational resources addressed in this section include parks, trails (i.e., pedestrian and bicycle paths), a golf club, and school athletic fields. This section also evaluates potential effects of GSR Project pumping on the recreational facilities and activities at Lake Merced. Potential impacts on bicycle paths are also addressed in Section 5.6, Transportation and Circulation, from the perspective of bicycle and pedestrian network performance. Impacts on irrigated golf clubs due to changes in the availability of groundwater are evaluated in Section 5.16, Hydrology and Water Quality.

5.11.1 Setting

The proposed Project would be located in northern San Mateo County as shown on Figure 2-1 (Project Vicinity Map) in Chapter 2, Introduction and Background. The study area for potential impacts related to recreation includes the individual facility sites and areas nearby. The study area also includes Lake Merced and the facilities used for lake-based activities, as well as upland recreational areas such as trails and picnic tables surrounding the lake. Lake Merced is included in the study area because GSR pumping could alter lake levels and result in changes to recreational resources at and surrounding the lake. Well facilities would be constructed and operated as part of the Project at locations in the cities of Daly City, South San Francisco, San Bruno, and Millbrae, the Town of Colma, and unincorporated San Mateo County. Table 5.11-1 (Recreational Resources near GSR Facility Sites) lists the recreational resources located at or near the well facility sites.

TABLE 5.11-1
Recreational Resources near GSR Facility Sites

<table>
<tr><th>Jurisdiction</th><th>Recreational Resource</th><th>Proximity to Project Facility Sites[a]</th></tr>
<tr><td>City of San Francisco</td><td>Lake Merced (see Figure 5.11-1)</td><td>Site 1 would be located approximately one mile southeast of Lake Merced.</td></tr>
<tr><td rowspan="4">Daly City</td><td rowspan="4">Lake Merced Golf Club
(see Figures 3-11, 3-12, and 5.11-1)</td><td>Site 1 would be located in the northeast portion of the golf club property approximately 50 feet northeast of playing surfaces.</td></tr>
<tr><td>Site 2 would be approximately 60 feet west of playing surfaces.</td></tr>
<tr><td>Site 3 would be approximately 525 feet west of playing surfaces. Pipelines would be installed within 275 feet of playing surfaces.</td></tr>
<tr><td>Site 4 would be approximately 450 feet south of playing surfaces. Pipelines would be installed within 65 feet of playing surfaces.</td></tr>
</table>

TABLE 5.11-1
Recreational Resources near GSR Facility Sites

Jurisdiction	Recreational Resource	Proximity to Project Facility Sites[a]
Broadmoor, in unincorporated San Mateo County	Ben Franklin Intermediate School (see Figures 3-12, 3-13, and 5-11.1)	Site 2 would be located approximately 60 feet away from the athletic field, across Park Plaza Drive.
		Site 3 would be located at the southeast corner of the school's athletic field. Pipelines would be located underneath the field and running track.
		Site 4 would be located approximately 100 feet southeast of the school's athletic field, across Park Plaza Drive; the well facility would be approximately 220 feet from the field. A pipeline would be located approximately 60 feet from the field across Park Plaza Drive.
		Westlake Pump Station is adjacent to the school's secondary athletic field.
	Garden Village Elementary School (see Figures 3-12, 3-13, and Figure 5.11-1)	Site 2 would be approximately 30 feet north of the school's athletic field; the well facility would be 125 feet away from the field.
		Site 3 would be approximately 330 feet west of the school's athletic field, across Park Plaza Drive.
		Site 4 well facility would be adjacent to the school's athletic field, and pipelines would run along the western edge of the field.
South San Francisco	South San Francisco Centennial Way Trail (See Figures 3-27, 3-28, 3-31, 3-32, and 5.11-2)	Site 11 would be approximately 75 feet west of the trail. The well facility would be approximately 230 feet west of the trail.
		Site 13 would be approximately 50 feet west of the trail. The well facility would be approximately 70 feet west of the trail.
	Francisco Terrace Playlot (See Figures 3-31, 3-32, and 5.11-2)	Site 13 would be approximately 50 feet southeast of the park, across South Spruce Avenue. The well facility would be approximately 160 feet west of the park.

Notes:

(a) Distances were measured in GIS from the edge of the construction area boundary to the boundary of the recreational resource (e.g., athletic field, trail, etc.).

5.11.1.1 Description of Recreational Resources

Recreational resources are illustrated on Figures 5.11-1 (Recreational Resources (North]) and 5.11-2 (Recreational Resources [South]).

City of San Francisco

Lake Merced is a 300-acre freshwater lake within a larger 614-acre Lake Merced area tract in southwest San Francisco. The lake and surrounding open space area are under the jurisdiction of the SFPUC, but managed by the San Francisco Recreation and Parks Department (SFRPD). Lake Merced is composed of four individual, but connected, water bodies (North Lake, South Lake, East Lake, and Impound Lake) and is located approximately one mile northwest of GSR Site 1, as shown on Figure 5.11-1 (Recreational Resources [North]). Lake Merced discharges to the Vista Grande Drainage Canal at a spillway located near the midpoint of the southwest bank of South Lake; this spillway limits the level of the lake to no more than 13 feet City Datum[1].

Lake Merced supports numerous recreational activities, including boating, fishing, bird and nature watching, picnicking, trail activities, and bicycling. Several special events are hosted at the lake annually, including competitive boating races (e.g., dragon boating), and walks around the perimeter of the lake. Competitive and public leisure boating occurs at North Lake and South Lake (SFPUC 2011).

Fishing primarily occurs from the lake shorelines and fishing piers, and occasionally from boats; Lake Merced has four fishing piers – two on North Lake and two on South Lake (SFPUC 2011). The Lake Merced trail system consists of the paved perimeter trail and a series of unpaved nature trails that extend from the perimeter trail down to, or along, the shoreline of all four individual lakes. Lake Merced is not widely used for picnicking; however, limited picnic facilities are available near North Lake, South Lake, and Impound Lakes (SFPUC 2011). Beach access points are located adjacent to the picnicking areas on the North Lake, South Lake, and Impound Lake.

City of Daly City

The Lake Merced Golf Club is an 18-hole, private golf club located in northwest Daly City. Site 1 would be located within the northeast corner of this golf club. Sites 2, 3, and 4 would be located between 60 feet and 525 feet from the southwest corner of the golf club property, as shown on Figure 3-12 in Chapter 3, Project Description.

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[1] City Datum is a measurement system that has been used at Lake Merced since at least 1926 and is used throughout this document for Lake Merced water levels. The City Datum does not represent the depth of the lake. An elevation of 0 feet City Datum is equal to 11.37 feet above mean sea level (NAVD 88) and 8.57 NGVD 29. Since mean sea level is equivalent to 0 feet NGVD 29, a lake level of -8.57 City Datum is equal to mean sea level, and negative lake elevations above this level are not below mean sea level.

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Recreational Resources (North)

Legend

- Proposed Well
- Existing Test Well
- Westlake Pump Station
- Recreational Resources in the Project Area

0 500 1,000 2,000
Scale Feet
1 " = 2,000 '

Regional Groundwater Storage and Recovery Project

Figure 5.11-1

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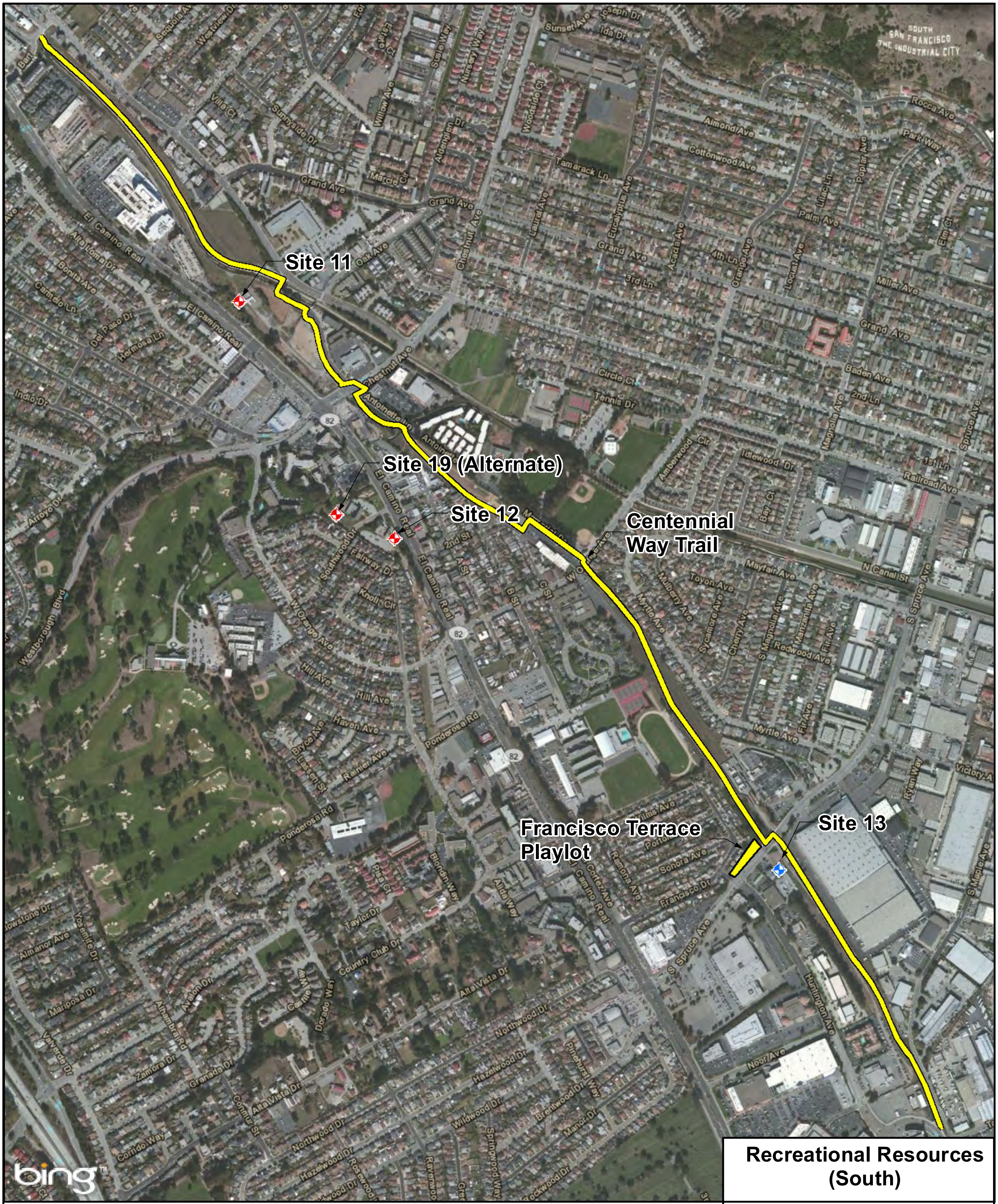

Recreational Resources (South)

Legend

- Proposed Well
- Existing Test Well
- Recreational Resources in the Project Area

0 500 1,000
Scale Feet
1" = 1,000'

N

Regional Groundwater Storage and Recovery Project

Figure 5.11-2

Broadmoor (Unincorporated San Mateo County)

Garden Village Elementary School and Ben Franklin Intermediate School are located in the northern section of Broadmoor, south of the Lake Merced Golf Club. Both schools have athletic fields that are used both for school and non-school recreational activities.

Garden Village Elementary School athletic field is about three acres in area and is located along the east side of Park Plaza Drive. The construction area for Sites 2 and 4 would be located adjacent to the school's athletic field, with a pipeline route traversing the southern edge of the field. The construction area of Site 3 would be located across Park Plaza Drive from the field.

The Ben Franklin Intermediate School athletic field is also about three acres in area and is located along the west side of Park Plaza Drive. The school's athletic fields can host a variety of recreational activities including softball, baseball, soccer, and track and field. The construction area of Site 3 would be within the school's athletic field. The construction area of Sites 2 and 4 would be across Park Plaza Drive from the field.

City of South San Francisco

The City of South San Francisco's Centennial Way Trail connects the South San Francisco Bay Area Rapid Transit (BART) station to the San Bruno BART station mostly along the BART right-of-way. The trail is a linear park that is also classified as a Class I bicycle and pedestrian path[2], together with several plazas, interpretive panels, benches, and a dog run. The construction area for Site 11 would be located approximately 75 to 230 feet west of the trail, as it passes the site. The construction area for Site 13 would be located about one mile south of Site 11 and approximately 50 feet west of the trail and a small plaza with interpretive panels.

Francisco Terrace Playlot is located on the western side of South Spruce Avenue, between Terrace Drive and Centennial Way Trail. The playlot has a basketball court and a play area with a play structure and other play equipment. The construction area for Site 13 would be located approximately 50 feet southeast of the playlot, across South Spruce Avenue.

5.11.2 Regulatory Framework

5.11.2.1 Federal

No federal regulations regarding recreation are applicable to the Project.

[2] Class I bicycle facilities are exclusive rights-of-way that are physically separated from motorists (South San Francisco 1999).

5.11.2.2 State

The Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan), prepared by the San Francisco Bay Regional Water Quality Control Board (RWQCB), identifies the beneficial uses of surface waters and groundwater within its region (RWQCB 2011). The RWQCB is responsible for protecting the beneficial uses of San Francisco Bay Area water resources, including Lake Merced. The Basin Plan was last revised on December 31, 2011 (RWQCB 2011). Existing beneficial uses of Lake Merced relevant to recreation identified in the Basin Plan include commercial sport and fishing, body contact recreation (e.g., swimming, wading, and fishing), and non-contact recreation (e.g., rowing). However, due to the Lake's function as an emergency water source for San Francisco (see Section 5.17, Hazards and Hazardous Materials), swimming is not permitted in Lake Merced (SFPUC 2011).

5.11.2.3 Local

Daly City General Plan

The Daly City General Plan Noise Element (Daly City 1989) specifies policies related to operational-related noise levels that are specifically applicable to golf clubs. Policy 1.2 requires use of the State Office of Noise Control Guidelines to assess development. The acceptable noise levels near golf clubs are a Community Noise Equivalent Level (CNEL) of 75 dBA (equivalent to approximately 68 dBA L_{eq}) (Daly City 1989) (see Section 5.7, Noise and Vibration for a definition of terms and further analysis of noise impacts).

Western Shoreline Area Plan

The Western Shoreline Area Plan, which is part of the San Francisco General Plan, is the City and County of San Francisco's (CCSF's) plan for the Local Coastal Zone established by the California Coastal Commission (San Francisco 1988). Policies related to Lake Merced include preserving recreational facilities, passive activities, playgrounds, and vistas of the Lake Merced area; maintaining a recreational pathway around the lake for multiple use; and only allowing activities that will not adversely affect the lake's water quality as a standby reservoir for emergency use.

Significant Natural Resource Areas Management Plan

The SFRPD is currently completing a Significant Natural Resource Areas Management Plan (SNRAMP) for designated significant natural areas in the CCSF. The purpose of the management plan is to establish a maintenance and preservation program related to the protection and enhancement of natural resource values. The SNRAMP itself has not been finalized and adopted; however, the process of developing the SNRAMP began in 1995, with the preparation of a staff report on the SNRAMP. The staff report set forth general objectives, policies, and management actions to guide development of the SNRAMP and the protection and enhancement of natural areas under CCSF's jurisdiction. General policies and management actions presented in the staff report relevant to recreational resources at Lake Merced include: developing nature programs to promote educational and recreational value of resources; and developing guidelines for pathways and interpretive trails/signs (SFRPD 1995).

5.11.3 Impacts and Mitigation Measures

5.11.3.1 Significance Criteria

For purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant impact on recreation if it were to:

- Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facilities would occur or be accelerated.
- Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment.
- Physically degrade existing recreational resources.

5.11.3.2 Approach to Analysis

This analysis assesses recreation impacts associated with the implementation of the proposed Project. Local planning documents, site visits, and maps were reviewed to identify the recreational resources in the Project area that, because of their proximity, could be affected by the proposed Project. Additionally, groundwater modeling was used to model Lake Merced water levels and surface area both under existing conditions and with the GSR Project and, under cumulative conditions, to determine potential impacts to recreational resources resulting from changing water levels. The approach to analysis for impacts to recreation at Lake Merced is described in detail below, under "Potential Effects at Lake Merced".

The significance criteria listed above were then used to assess potential impacts on each recreational resource in the study area, including direct impacts on recreational facilities during Project construction, including pipelines. With regard to the last criterion, the analysis considers that physical degradation of existing resources could occur if the Project were to:

- Remove or damage existing recreational resources directly;
- Disrupt access to existing recreation facilities; or
- Cause environmental impacts that would result in deterioration of the quality of the recreational experience.

To determine the potential for construction activities to cause an effect on recreation, the proposed construction areas were compared to locations of identified recreational resources and facilities. In addition, impact findings in other relevant sections of the EIR were reviewed for relevance to recreational resources. The impact findings of Section 5.2, Land Use; 5.3, Aesthetics; 5.6, Transportation and Circulation; 5.7, Noise and Vibration; and 5.8, Air Quality were reviewed to determine potential air quality effects from construction-related dust and construction equipment exhaust; noise effects from the operation of construction equipment and permanent well facilities; visual effects from the presence of construction equipment and staging and permanent operation of well facilities; and traffic effects from construction-related roadway detours and/or closures. To determine the potential effect of operation and maintenance of the proposed Project on Lake Merced, impact findings from Section 5.16, Hydrology and Water Quality were reviewed, as described below.

Potential Effects at Lake Merced

Impacts on recreation would be significant if groundwater pumping were to result in physical deterioration of recreational facilities or resources at Lake Merced, which is hydraulically connected to the underlying groundwater basin. As described in Section 5.1, Overview, Section 5.1.6 (Groundwater Modeling Overview), groundwater level changes were modeled to project groundwater levels and other parameters for three scenarios: modeled existing conditions, conditions with the proposed GSR Project, and the cumulative conditions. For each scenario, groundwater conditions were modeled for a 47-year hydrologic sequence based upon historical hydrologic years (1958 to 2005) using the pumping assumptions listed in Table 5.1-2 (Model Input – Pumping Assumptions for Modeling Scenarios). As also discussed in Section 5.1.6 (Groundwater Modeling Overview), the groundwater modeling was supplemented by lake level modeling for Lake Merced for the same period.

To determine the potential for impacts on recreation at Lake Merced, the fluctuation of lake water levels, estimated over the 47-year modeling period, was incorporated into a geographic information system (GIS), along with lake topography, bathymetry, and slope. A GIS-based analysis was then conducted to estimate lake depth and surface area for: 1) the monthly minimum water levels for the modeled existing conditions, Project conditions, and cumulative conditions, and 2) the monthly maximum water levels for the modeled existing conditions, Project conditions, and cumulative conditions. The minimum and maximum water levels were evaluated to show the range of impacts that could occur from the Project. These conditions represent the extremes and are meant to illustrate the range of potential impacts. Therefore, mean monthly water levels are also provided in Table 5.11-4 (Lake Merced Acreage and Depth under Modeled Existing Conditions and Project Conditions) to provide context. The GIS-based analysis estimated lake depth and surface area for monthly minimum and maximum water levels to determine whether the lake itself, which is a recreational resource, would be physically degraded; or, whether nearby recreational resources and facilities, such as docks, trails and picnic areas, would be physically degraded as a result of Project operations.

As discussed in Section 5.1.6 (Groundwater Modeling Overview), under pumping conditions with the Project, hydrologic parameters such as temperature and rainfall would not occur exactly as modeled, and the response to pumping would depend on actual hydrological conditions taking place at that time and in the not-too-distant past. In addition, at water levels of approximately 5 feet City Datum and above, all of the individual lakes are hydraulically connected. At water levels of approximately 5 feet City Datum and below, the individual lakes are hydrologically independent, in which case lake levels tend to decrease progressively from north to south; i.e., North and East lakes would have higher levels than South Lake, and South Lake would be higher than Impound Lake (Kennedy/Jenks 2012a). The GIS-based analysis cannot determine this level of detail because sufficient information about the comparative rate of decline between the lakes is not available. Hence, the GIS-based analysis applies one constant rate of decline across all of the lakes, and the modeled lake levels should be considered representative of relative changes in lake levels in response to groundwater pumping.

Areas of No Project Impact

Due to the nature of the proposed Project (potable water infrastructure), there would be no impacts related to increased use of recreational facilities or the construction or expansion of recreational facilities, as this type of project does not create additional demand for or cause additional use of such facilities. These criteria are not discussed further in this section for the following reasons:

Increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facilities would occur or be accelerated. The Project would not increase the use of existing recreational facilities. The Project is a groundwater storage and recovery system that would not, independently and separately from its contribution as part of the overall Water System Improvement Program (WSIP), deliver any additional amounts of water or generate new residential or employee population (discussed further in Chapter 6, Other CEQA Issues, Section 6.1 [Growth Inducement]) beyond that analyzed for the WSIP in the WSIP Program Environmental Impact Report (PEIR). Because the Project would not increase the existing population or housing supply of the Project area over and above its contribution to the WSIP, no increased use of parks and other recreational resources would occur at a Project-specific level that would result in physical deterioration or accelerated deterioration of existing recreational resources.

Include recreational facilities or require the construction or expansion of recreational facilities that might have an adverse physical effect on the environment. The Project does not propose any recreational facilities and would not require construction or expansion of recreational resources that might have an adverse physical effect on the environment.

Impair access to recreational resources near the facility sites during operation of the Project. Operation of the facility sites would not cause long-term access conflicts with established recreational facilities, because the Project would not permanently close roadways or otherwise change access to recreational resources. Lake Merced impacts are discussed separately under Impact RE-6.

Remove or damage recreational resources, or deteriorate the quality of the recreational experience at Lake Merced during construction. The GSR Project does not include any construction activities at or near Lake Merced. Therefore there would be no impact to Lake Merced from Project construction.

5.11.3.3 Summary of Impacts

Tables 5.11-2 and 5.11-3 provide summaries of potential recreational impacts from the Project. Table 5.11-2 (Summary of Impacts on Recreational Resources) provides a summary of construction and operational impacts on recreational resources near the facility sites. Table 5.11-3 (Summary of Impacts on Recreational Resources at Lake Merced) provides a summary of Project operational impacts on Lake Merced. Lake Merced impacts are presented in a separate table since these impacts are related to the proposed Project as a whole and not associated with an individual proposed well facility site or group of sites.

TABLE 5.11-2
Summary of Impacts on Recreational Resources

	Construction			Operations		Cumulative
Sites	**Impact RE-1: The Project would not remove or damage existing recreational resources during construction.**	**Impact RE-2: The Project would deteriorate the quality of the recreational experience during construction.**	**Impact RE-3: The Project would not impair access to recreational resources during construction.**	**Impact RE-4: The Project would not damage recreational resources during operation.**	**Impact RE-5: The Project would not deteriorate the quality of the recreational experience during operation.**	**Impact C-RE-1: Construction and operation of the proposed Project would not result in significant cumulative impacts on recreational resources.**
Site 1	LS	LSM	NI	NI	LS	NI
Site 2	NI	LSM	LS	NI	NI	NI
Site 3	LS	LS	LS	LS	LS	NI
Site 4	LS	LSM	LS	NI	NI	NI
Westlake Pump Station	NI	NI	NI	NI	NI	NI
Site 5 (Consolidated Treatment and On-site options)	NI	NI	NI	NI	NI	NI
Site 6	NI	NI	NI	NI	NI	NI
Site 7 (Consolidated Treatment and On-site options)	NI	NI	NI	NI	NI	NI
Site 8	NI	NI	NI	NI	NI	NI
Site 9	NI	NI	NI	NI	NI	NI
Site 10	NI	NI	NI	NI	NI	NI
Site 11	NI	LS	LS	NI	LS	LS

TABLE 5.11-2
Summary of Impacts on Recreational Resources

	Construction			Operations		Cumulative
Sites	**Impact RE-1: The Project would not remove or damage existing recreational resources during construction.**	**Impact RE-2: The Project would deteriorate the quality of the recreational experience during construction.**	**Impact RE-3: The Project would not impair access to recreational resources during construction.**	**Impact RE-4: The Project would not damage recreational resources during operation.**	**Impact RE-5: The Project would not deteriorate the quality of the recreational experience during operation.**	**Impact C-RE-1: Construction and operation of the proposed Project would not result in significant cumulative impacts on recreational resources.**
Site 12	NI	NI	NI	NI	NI	NI
Site 13	NI	LS	LS	NI	LS	LS
Site 14	NI	NI	NI	NI	NI	NI
Site 15	NI	NI	NI	NI	NI	NI
Site 16	NI	NI	NI	NI	NI	NI
Site 17 (Alternate)	NI	NI	NI	NI	NI	NI
Site 18 (Alternate)	NI	NI	NI	NI	NI	NI
Site 19 (Alternate)	NI	NI	NI	NI	NI	NI

Notes:

NI = No Impact

LS = Less than Significant Impact

LSM = Less than Significant with Mitigation

TABLE 5.11-3
Summary of Impacts on Recreational Resources at Lake Merced

Impact	Significance Level
Impact RE-6: Operation of the Project would not remove or damage recreational resources, impair access to, or deteriorate the quality of the recreational experience at Lake Merced.	LS
Impact C-RE-2: Operation of the Project would not result in significant cumulative impacts on recreational resources at Lake Merced.	LS

Notes:
LS = Less than Significant Impact

5.11.3.4 Construction Impacts and Mitigation Measures

Impact RE-1: The Project would not remove or damage existing recreational resources during construction. (Less than Significant)

Temporary impacts on established recreational facilities and resources could result if construction activities were to overlap geographically with existing recreational resources. The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 2, 5 through 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

Project construction activities at these sites would not remove or damage recreational resources, because none of the construction areas for these facility sites contain recreational resources. Therefore, *no impact* on recreational resources in terms of their damage or removal during construction would occur.

Impact Conclusion: No Impact

<u>Sites 1, 3, and 4</u>

Site 1

Site 1 would be located within the Lake Merced Golf Club (see Figure 3-11 in Chapter 3, Project Description and Figure 5.11-1). The construction area would be located within the northeast portion of the golf club property, approximately 50 feet away from playing surfaces (i.e., fairway and green) at Hole #4. The site would be located on land that is not within the area of play and that does not provide access to other playing areas at the course. An existing restroom within the construction area is proposed to be demolished during construction activities. The SFPUC would financially compensate the golf club for the loss of the restroom (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). Additionally, demolition of the restroom and construction of the well facility would not substantially damage this recreational resource, and the impact on the environment would therefore be *less than significant*, given that the remainder of this facility would remain unaffected.

Site 3

Site 3 would be located within the Ben Franklin Intermediate School athletic field on the eastern portion of the campus as shown on Figure 3-12 in Chapter 3, Project Description and on Figure 5.11-1. The well facility would be located behind a baseball backstop and the pipelines would be located within the athletic field and along the running track. Construction access to the well facility site would be along a path on the north edge of the field and along the track on the west edge of the field. Construction at Site 3, which would include well drilling, construction of a fenced enclosure, and pipeline installation, would occur during two three-month summer construction seasons. Therefore, when the neighboring schools are not in session, the entire athletic field would be closed and inaccessible to recreationists. As described in Chapter 3, Project Description, Section 3.4.3 (Facility Sites), the SFPUC would notify the Jefferson Elementary School District (School District) of construction activities in advance to enable the School District to relocate recreational activities to nearby recreational resources during construction (Jefferson Elementary School District 2013). Several similar athletic fields exist less than one mile from Site 3 (e.g., Westlake Park, Westmoor High School, and Marjorie Tobias, Pauline Brown, and Westlake elementary schools). Therefore, because the SFPUC would notify the School District of construction activities, and because this analysis presumes that recreation activities could be temporarily relocated to other nearby athletic fields, impacts on the environment due to the temporary closure of the athletic field would be *less than significant*. However, if the five locations within one mile of Site 3 cannot fully accommodate the temporary displacement of recreational activities from the Ben Franklin Intermediate School athletic field over two summers when there would be construction at Site 3, the resulting impact on this recreational resource would still be *less than significant*, given the number of other similar recreational resources in the vicinity beyond one mile from Site 3 to which such recreational activities could be temporarily relocated until the area around Site 3 is restored and the field becomes useable .

As described in Chapter 3, Project Description, Section 3.4.3 (Facility Sites), at the end of the first construction season, the SFPUC would restore the site to at least its general pre-existing conditions for school use during the intervening school year (approximately nine months). Restoration would involve replacing turf immediately following completion of the pipeline installation in the center of the field, and replacing the backstop and repaving and restriping the track and generally restoring the construction area to a clean and safe condition. Therefore, because the athletic field would be restored to a clean and safe condition in between construction seasons and after construction is complete, the temporary construction-related impact on the environment would be *less than significant.*

Site 4

Site 4 would be located on and adjacent to the athletic field at Garden Village Elementary School (see Figure 3-12 in Chapter 3, Project Description and Figure 5.11-1). The fenced enclosure for the well facility would be located at the top of a small slope about 20 feet in elevation overlooking the school's athletic field; well drilling and construction would occur at this location over a period of six months (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). The construction area includes both the top of the slope and a small portion of the athletic field (about 2,500 square feet out of approximately 132,000 square feet [three acres]) including a backstop; this portion of the athletic field, including the backstop, would be closed to recreational use for approximately six months. The water connection pipeline installation would occur within the edge of the athletic field along Park Plaza Drive. The width of the pipeline construction area within the athletic field would range from 12 to 18 feet; this portion of the athletic field would be closed to recreational use for a period of approximately six to eight weeks. As proposed, Project pipelines would be installed at a rate of 300 to 600 feet of pipeline per week; therefore, construction of this pipeline across the athletic field would take approximately one to two weeks to complete (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). The turf would be restored to its general pre-construction condition following construction (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]), and recreational use could resume in the restored area approximately three weeks after restoration activities occur. The existing baseball backstop would be temporarily relocated during construction and returned to its original location after construction is complete (see Chapter 3, Project Description, Section [3.4.3 Facility Sites]). Although construction would occur during the school year, the athletic field is large enough so that recreational use could continue in the portion of the field unaffected by construction, and therefore, the temporary construction-related impact on the environment would be *less than significant.*

Impact Conclusion: Less than Significant

Impact RE-2: The Project would deteriorate the quality of the recreational experience during construction. (Less than Significant with Mitigation)

Temporary impacts on established recreational facilities and resources could result if construction activities were to deteriorate the quality of the recreational experience through visual disruption, construction-related noise, or dust/exhaust emissions at or in proximity to recreational resources during times when they are being utilized. The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

<u>Sites 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

These sites would not be located near an existing recreational resource, except for the Westlake Pump Station. The Westlake Pump Station upgrade would be located on a parcel that is adjacent to an athletic field at the Ben Franklin Intermediate School, but facility upgrades at the Westlake Pump Station would be within the existing buildings at this site, and no ground-disturbing construction would occur. Therefore, because these facility sites are not located near an existing recreational resource, and construction at the Westlake Pump Station would occur inside existing buildings, Project construction activities would not affect the quality of the recreational experience at these sites. As a result, *no impact* on recreational resources, in terms of a potential deterioration of the quality of recreational experience, would occur.

Impact Conclusion: No Impact

<u>Sites 3, 11, and 13</u>

Site 3

Site 3 would be located approximately 600 feet from the Lake Merced Golf Club playing surfaces, across Park Plaza Drive (see Figure 3-12 in Chapter 3, Project Description). However, Site 3 pipeline installation would occur approximately 275 feet west of the Lake Merced Golf Club playing surface. Construction activities would occur during two three-month summer periods and would cause a minor increase in noise levels and dust/exhaust emissions in the vicinity of the playing surfaces (see Impact NO-3 in Section 5.7, Noise and Impact AQ-3 in Section 5.8, Air Quality). The golf course playing surface is about 20 feet in elevation higher than the proposed well facility site, and the area between the well facility site and the golf course includes a roadway, and a large number of trees and shrubs that provide substantial screening between the well facility site and the golf course playing surface. The vegetation and difference in elevation would limit recreationists' exposure to temporary dust/exhaust emissions, and noise from construction activities at the site. The site is not visible to recreationists at the golf club (see Section 5.3.1.3 [Individual Project Well Facility Sites]). Therefore, construction at Site 3 would not substantially deteriorate the quality of recreational experience at the golf club and the impact would be *less than significant*.

Site 3 would be located on the Ben Franklin Intermediate School athletic field. Project construction at Site 3 would not impact the quality of recreational experience at the athletic field, because no construction activities would occur during the school year; therefore, recreationists would not be exposed to construction-related visual, noise, or dust impacts and *no impact* would occur. During the athletic field closure, recreational activities could be relocated to other similar athletic fields in the area. However, this would not substantially deteriorate the quality of the recreational experience at other athletic fields, because there are a number of other similar recreational resources in the vicinity of Site 3 that could accommodate the relocated recreational activities. The School District develops the schedule for District school recreational facilities in August of each year (Jefferson Elementary School District 2013). As stated in Chapter 3, Project Description, Section 3.4.3 (Facility Sites) the School District would be notified a minimum of nine months prior to construction at Site 3, which would allow for the School District to plan for field closure. As a result, impacts to recreationists related to the Ben Franklin Intermediate School athletic field closure would be *less than significant*.

Site 3 would be located approximately 330 feet west of the Garden Village Elementary School athletic field. The well facility fenced enclosure at Site 3 would be separated from the athletic field by Park Plaza Drive and, partially, by a vegetated hillside topped by a single-family residence. Site 3 construction activities would be visible from some portions of the Garden Village athletic field and would also cause a minor increase in noise and dust/exhaust emissions at the athletic field (see Impact NO-3 in Section 5.7, Noise and Vibration and Impact AQ-3 in Section 5.8, Air Quality). In general, the recreational uses of the athletic field are sports-related and active and, therefore presumed by this analysis to not be overly sensitive to noise or visual disruption. Additionally, the intervening distance, trees, and hillside would prevent the exposure of recreationists to substantial temporary construction-related dust, exhaust, and noise generated at Site 3. As a result, impacts from Site 3 construction on the quality of recreational experience at the Garden Village Elementary School athletic field would be *less than significant*.

Also, noise and air quality mitigation measures would be implemented during construction of Site 3 to mitigate construction-related noise, dust, and exhaust impacts on nearby sensitive receptors such as single-family residences and school buildings. Implementation of these mitigation measures would also reduce noise levels and dust/exhaust emissions at the school athletic fields and golf club that are adjacent to this site (see mitigation measures in Impact NO-1 in Section 5.7, Noise and Vibration and Impact AQ-2 in Section 5.8, Air Quality).

Site 11

Site 11 would be located from 75 to 230 feet west of the South San Francisco Centennial Way Trail as it passes by the site (see Figures 3-27 and 3-28 in Chapter 3, Project Description and Figure 5.11-2). Pedestrians and bicyclists use the trail, which – by its nature – is primarily intended for non-stationary activities. Well drilling and construction of the well facility building would be located behind the BART ventilation structure and last for approximately 16 months (see Chapter 3, Project Description Section 3.5.1 [Construction Sequencing and Schedule]). Pipeline construction would approach within 75 feet of the trail and occur over approximately three to five weeks (including both pipeline installation and restoration of the surface). Construction-related impacts on the quality of the recreational experience for those who use the portion of the trail nearest to Site 11 would be limited to an approximately 800-foot stretch. Visual effects of construction on trail users would be minor, because the area already contains infrastructure associated with the BART system (which would presumably lower expectations for the quality of the recreational experience at this location) and most of the construction would be visually blocked from the trail by the existing BART ventilation structure. Project construction would sporadically increase noise levels at the trail. Also, construction activities would emit dust and engine exhaust in the area of the trail (see Sections 5.7, Noise and Vibration and 5.8, Air Quality). However, due to the temporary nature of the construction activities near this short segment of trail and the continuous movement of recreationists along the trail, these impacts on the quality of the recreational experience would be *less than significant.*

Additionally, noise and air quality mitigation measures would be implemented during construction of Site 11 to mitigate construction-related noise, dust and exhaust impacts to nearby sensitive receptors such as single-family residences. Implementation of these mitigation measures would also reduce noise levels and dust/exhaust emissions at the trail (see mitigation measures in Impact NO-1 in Section 5.7, Noise and Vibration and Impact AQ-2 in Section 5.8, Air Quality for more detail).

Site 13

Site 13 would be located approximately 50 feet west of the South San Francisco Centennial Way Trail and approximately 35 feet from the interpretive panels beside the trail (see Figures 3-31 and 3-32 in Chapter 3, Project Description and Figure 5.11-2). Construction-related impacts on the quality of recreational experience of those who use the portion of the trail nearest Site 13 would be limited to an approximate 250-foot stretch. Construction near the trail (i.e., well facility building and paved areas) is expected to last for 14 months (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). Project construction would cause sporadic increases in noise levels and dust/exhaust emissions at the trail and would be visible to trail users.

The recreational experience of a trail visitor using the bench would be affected by construction activities; however, such recreationalists could temporarily relocate to another portion of the trail if construction activities adversely impact their recreational experience. Similarly, other trail users may decide to utilize other trail segments in the area to avoid any of the Project's temporary impacts on recreational experience near Site 13. Therefore, given the linear nature of the trail and the temporary nature of construction, recreationalists would not have to experience a substantial deterioration of the quality of recreational experience (due to construction-related noise, dust, and exhaust emissions, or views of the construction site) for more than a few minutes as they pass the construction area.

Site 13 is also located across South Spruce Avenue from Francisco Terrace Playlot; the site's construction area is approximately 50 feet east of the park. The park contains basketball courts, a play structure, and other play equipment and is partially screened from the street with trees. Construction at Site 13 is expected to last for 14 months (see Chapter 3, Project Description Section 3.5.1 [Construction Sequencing and Schedule]). The Site 13 construction area would be partially visible by those who use the park, even though the existing trees block some views of the site; however, park users are not considered sensitive to views of construction activities, equipment and materials because the viewshed does not play a primary role in the quality of these recreational experiences. Project construction would cause sporadic increases in noise levels at the park. Dust and exhaust emissions from construction would not be substantial, because most ground disturbing activities would be located about 150 to 200 feet away across South Spruce Avenue. The quality of recreational experience at the park would deteriorate only slightly during Site 13 construction, because any exposure to dust, exhaust emissions, or increased noise levels would be limited (due to the distance from construction activities) and temporary in duration. Moreover, park users could relocate to other park resources in the area to avoid the Project's impacts. Similar recreational resources are available within a mile or less (e.g., Bayshore Circle Park, Herman Park, Orange Park, Orange Memorial Park, and South San Francisco High School). As a result, potential impacts related to the degradation of recreational resources, in terms of the quality of recreational experience, near these two sites would be *less than significant*.

Additionally, noise and air quality mitigation measures would be implemented during construction of Site 13 to mitigate construction-related noise, dust, and exhaust impacts to nearby sensitive receptors such as single-family residences. Implementation of these mitigation measures would also reduce noise levels and dust/exhaust emissions at the trail and playlot (see mitigation measures in Impact NO-1 in Section 5.7, Noise and Vibration and Impact AQ-2 in Section 5.8, Air Quality for more detail).

Impact Conclusion: Less than Significant

<u>Sites 1, 2, and 4</u>

Site 1

Site 1 would be located within the Lake Merced Golf Club (see Figure 3-11 in Chapter 3, Project Description). The construction area would be located within the northeast portion of the golf club property, approximately 50 feet away from Hole #4 and within 1,000 feet of six other playing holes used by golfers. The duration of construction is expected to be 16 months (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). The site is located on previously disturbed land that is at a higher elevation than the adjacent fairway and is not used for golfing. Site 1 would be partially separated from the fairway by existing trees and vegetation.

Substantial noise levels would occur sporadically during the 16-month construction duration. However, significant construction-related noise impacts would be limited to Hole #4 and the six other playing holes within 1,000 feet of the construction site; noise levels would decrease as golfers move away from the construction area. Therefore, because the increased noise level would be temporary and limited to one geographic area of the golf club, construction-related noise levels would have a *less-than-significant* impact on the quality of the recreational experience at the Lake Merced Golf Club.

Additionally, Mitigation Measure NO-1 (Noise Control Plan) would be implemented during construction of Site 1 to mitigate construction-related noise to nearby sensitive receptors such as single-family residences. (See mitigation measures in Impact NO-1 in Section 5.7, Noise and Vibration).

Construction would temporarily increase dust and engine exhaust emissions, and result in temporary but significant air quality impacts near Site 1 (see Section 5.8, Air Quality for detailed analysis), which would also be a temporary yet *significant* impact on the recreational experience at this location. However, Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures) is required to reduce this air quality impact to less-than-significant levels and would also serve to mitigate the temporary yet significant impact on the recreational experience at this location to *less-than-significant* levels by requiring dust control measures and equipment and vehicle best management practices per BAAQMD Guidelines. This mitigation measure would reduce dust and emission during construction and the impact on the quality of the recreational experience at the golf club would be reduced to *less-than-significant.*

Mitigation Measure M-AQ-2a: BAAQMD Basic Construction Measures (All Sites)
(See Impact AQ-2 in Section 5.8, Air Quality for a description)

Impacts on the visual quality of the golf club as it relates to the quality of the recreational experience would not be substantial. Golfers would have a partially obstructed view of the construction site during the 16-month construction period, since the well facility would be located on a vegetated hillside above the golf links. The apartment complex located north of the golf links provides a developed backdrop when the site is viewed from the fairway. Therefore, construction at Site 1 would not detract from the visual quality of the golfing experience, and the temporary impact on recreational experience at this location would be *less than significant.*

The Project also proposes the demolition of the existing golf club restroom, which is located within the proposed construction area for Site 1. The Lake Merced Golf Club operates and maintains the restroom for golfers. An additional restroom facility for the golfers is located at the club house which is approximately a third of a mile south of the existing restroom. The SFPUC would financially compensate the golf club for the loss of the restroom (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). Because the impacts from construction on recreation at this site would be temporary, and because there would be another restroom available to golfers at the Lake Merced Golf Club, the impact of the restroom demolition at Site 1 on the quality of the recreational experience at this location would be *less than significant*.

Site 2

Site 2 would be located adjacent to the Lake Merced Golf Club (see Figure 3-12 in Chapter 3, Project Description and Figure 5.11-1) and construction activities would occur about 60 feet away from the golf course playing surface. Construction at the site would include conversion of a test well, construction of a fenced enclosure, and installation of pipelines, and would take approximately one month to complete (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). Construction activities would temporarily increase noise levels and would generate dust and exhaust emissions in the vicinity of the playing surfaces. The golf course playing surface is about 20 feet higher in elevation than the proposed well facility site, and the area between the well facility site and the golf course includes a large number of trees and shrubs, which provide substantial screening between the well facility site and the golf course. In addition to the short construction duration of one month, the vegetation and difference in elevation would substantially limit recreationists' exposure to views of construction activities, and would also limit golfers' exposure to the temporary dust/exhaust emissions and noise from construction activities at the site. Therefore, the impact on the quality of recreational experience at the golf club would be *less than significant*.

Site 2 would also be located adjacent to the athletic field at Garden Village Elementary School and across Park Plaza Drive from the athletic field at Ben Franklin Intermediate School (see Figure 3-12 in Chapter 3, Project Description). Construction at Site 2 would occur during a one-month construction time period when schools may be in session. Construction at Site 2 is proposed to occur between 7:00 a.m. and 7:00 p.m. during weekdays and occasionally on Saturdays between 7:00 a.m. and 5:00 p.m., depending on construction needs (see Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]). Construction activities would be visible from and would increase noise and dust/exhaust emissions levels at the Garden Village Elementary School athletic field, and, to a lesser degree, at the Ben Franklin Intermediate School athletic field. The fields at both schools are used during the school day for school recreational activities and after school hours for non-school recreational activities, such as youth sports. In general, the recreational uses of the fields are sports related and active and, therefore, are presumed by this analysis to not be overly sensitive to visual or noise disruption from construction activities. Golfers would pass near the construction area as they golf on the links closest Site 2 and they would not linger near the construction area. For these reasons, and because impacts would be temporary, the impact on the quality of recreational experience at both the Garden Village Elementary School athletic field, the Ben Franklin Intermediate School athletic field, and the Lake Merced Golf Club due to one month of increased noise levels and view of construction activities would be *less than significant*.

In addition, construction of Site 2 would generate dust and exhaust emissions during the one-month construction duration. Site 2 construction activities would occur across the street, and approximately 60 feet away from the edge of the Ben Franklin Intermediate School athletic field. Because of the physical separation and distance, temporary air quality impacts on the recreational experience at Ben Franklin Intermediate School would be *less than significant.* However, because construction would occur immediately adjacent to the Garden Village Elementary School athletic field and because there are no natural buffers to reduce the effects of dust and exhaust emissions at the field, impacts to air quality at Garden Village Elementary School would be *significant* (see Section 5.8, Air Quality for detailed analysis), which would also be a temporary yet *significant* impact on recreational experience at this location. Implementation of Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures) is required to reduce this air quality impact *less-than-significant* levels and would also serve to mitigate the temporary yet *significant* impact on the recreational experience at this location. With implementation of dust control measures and equipment and vehicle best management practices, the impact on the quality of the recreational experience would be reduced to *less than significant.*

Mitigation Measure M-AQ-2a: BAAQMD Basic Construction Measures (All Sites)
(See Section Impact AQ-2 in 5.8, Air Quality for a description)

Site 4

Site 4 would be located approximately 560 feet south of the Lake Merced Golf Club playing surfaces (see Figure 3-12 in Chapter 3, Project Description). However, the Site 4 water connection pipeline would be installed within 65 feet of the golf course playing surface. Based on an installation rate of 300 to 600 feet per week, as proposed, the water connection pipeline would take approximately one to two weeks to complete (see discussion of pipeline construction schedule under Impact RE-1 for Site 4), while well facility construction would occur over approximately six months. Construction activities at Site 4 would not be visible from the golf course playing surface, but may temporarily increase noise and dust/emission exhaust levels near the golf club during construction of the pipeline. Nevertheless, the existing trees and shrubs at the edge of the golf course playing surface and the higher elevation of the golf course would limit recreationists' exposure to temporary construction-related dust, exhaust, and noise from Site 4 construction activities. Therefore, due to the temporary nature of construction and the natural vegetative screening, construction at Site 4 would not substantially deteriorate the quality of recreational experience at the golf club.

Site 4 would be located approximately 220 feet from the athletic field at Ben Franklin Intermediate School. However, pipeline construction for Site 4 would occur along the eastern side of Park Plaza Drive approximately 60 feet from the athletic field. Construction at Site 4 would occur during a six-month period when school would be in session, although storm drain and water connection pipeline installation along Park Plaza Drive would be only two to four weeks, based on a pipeline installation rate of 300 to 600 feet per week (see discussion under Impact RE-1 regarding Site 4). Only the Site 4 pipeline construction along Park Plaza Drive would be visible from this athletic field, because the well facility fenced enclosure at Site 4 would be separated from the athletic field by Park Plaza Drive and a vegetated hillside topped with a single-family residence. This physical separation would also substantially reduce recreationists' exposure to dust and exhaust emissions generated during construction. In general, the recreational uses of the athletic field are sports-related and active and, therefore, are presumed by this analysis to not be overly sensitive to noise or visual disruption. While construction activities would temporarily increase noise levels and dust/exhaust emissions at the athletic field due to the temporary nature of construction, the intervening road, and the vegetative screening, construction at Site 4 would not substantially deteriorate the quality of recreational experience at the Ben Franklin Intermediate School athletic field and such impacts at this location would therefore be *less than significant*.

Site 4 would be located on and adjacent to the athletic field at the Garden Village Elementary School. The fenced enclosure for the well facility would be located at the top of a slope about 20 feet in elevation overlooking the school's athletic field; well drilling and construction would occur here over a period of six months. The construction area includes both the hilltop of the slope (i.e., at street level) and a small portion of the athletic field (about 2,500 square feet). Pipeline installation would occur within the edge of the athletic field along Park Plaza Drive during a period of approximately one to two weeks, based on a pipeline installation rate of 300 to 600 feet per week, as proposed (see discussion under Impact RE-1 for Site 4).

Construction at this site would be scheduled to occur during the school year between 7:00 a.m. and 7:00 p.m. during weekdays and occasionally on Saturdays between 7:00 a.m. and 5:00 p.m., depending on construction needs (see Chapter 3, Project Description, Section 3.5.3.1 [Construction Hours]). Construction activities would be visible and cause increased noise levels as well as and dust and engine exhaust emissions at the Garden Village Elementary School athletic field.

As stated previously, the recreational uses of the field are sports-related and active and, therefore, not overly sensitive to visual and noise disruption from construction activities. For this reason, the visibility of construction activities and the temporary increase in noise levels during construction activities would have *less-than-significant* impacts on the quality of the recreational experience at the Garden Village Elementary School athletic field.

However, because pipeline construction would occur immediately adjacent to the Garden Village Elementary School athletic field, and because there are no natural buffers to reduce the effects of dust and exhaust emissions at the field, this air quality impact would be *significant* (see Section 5.8, Air Quality for detailed analysis), which would also be a temporary yet *significant* impact on recreational experience at this location. Nevertheless, implementation of Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures) is required to reduce this air quality impact to *less-than-significant* levels and would also serve to mitigate the temporary yet *significant* impact on the recreational experience at this location. With implementation of the dust control measures and equipment and vehicle best management practices, the impact on the quality of the recreational experience would be reduced to *less than significant*.

Mitigation Measure M-AQ-2a: BAAQMD Basic Construction Measures (All Sites)
(See Impact AQ-2 in Section 5.8, Air Quality, for a description)

Impact Conclusion: Less than Significant with Mitigation

Impact RE-3: The Project would not impair access to recreational resources during construction. (Less than Significant)

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 1, 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

Project construction at Sites 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 17 (Alternate), 18 (Alternate), and 19 (Alternate) would not be located near an existing recreational resource. Construction at Site 1 would not alter access to the Lake Merced Golf Club, because golfers access the Golf Club from Junipero Serra Boulevard, whereas access to Site 1 would be from Poncetta Drive. Poncetta Drive would remain open during construction (see Section 5.6, Transportation and Circulation). Although the Westlake Pump Station is on a parcel that is located adjacent to an athletic field at the Ben Franklin Intermediate School, construction activities at the Pump Station would not block roads or paths providing access to school athletic fields. Therefore, construction at these sites would have *no impact* on access to recreational resources.

Impact Conclusion: No Impact

<u>Sites 2, 3, 4, 11, and 13</u>

Site 2

Construction at Site 2 would not alter access to the Ben Franklin Intermediate School or Garden Village Elementary School athletic fields during construction. The Lake Merced Golf Club maintenance road could be temporarily blocked by construction of the Site 2 well facility and the installation of the water connection pipelines for Sites 2 and 4, as shown on Figure 3-12 in Chapter 3, Project Description. Golf club maintenance vehicles on the maintenance road may be subject to some delays while construction equipment enters and exits the site, and while pipeline is being installed across the road. Construction across the maintenance road could be completed within one day, assuming installation of pipelines at a rate of approximately 300 to 600 feet per week (see Section 3.5.1 [Construction Sequencing and Schedule]). However, the impact on recreation would be *less than significant* because construction at Site 2 would not interfere with access by golfers, and the delays to maintenance vehicles would be temporary, occurring occasionally during the one-month construction duration.

Site 3

Site 3 would not affect access to the Garden Village Elementary School athletic field and *no impact* would occur.

The Ben Franklin Intermediate School athletic field would be closed during construction of Site 3, for two three-month construction periods during summer months. Site 3 would not alter access to Garden Village Elementary School athletic field during construction. During the athletic field closure, recreationists could be relocated to other similar athletic fields in the area. Additionally, as stated in Chapter 3, Project

Description, Section 3.4.3 (Facility Sites) the School District would be notified a minimum of nine months prior to construction at Site 3, which would allow for the School District to plan for field closure. Therefore, because there are a number of other nearby recreational facilities that could accommodate recreationists during field closure, and because the School District would be notified at least nine months in advance of construction such that the District could plan for field closure, impacts as they relate to access to recreational resources would be *less than significant*.

Site 4

Site 4 would be located on and adjacent to the Garden Village Elementary School athletic field, and the water connection pipeline would be located along the western edge of the field. During the two to four weeks estimated by this analysis for pipeline construction, the western portion of the field would be closed to recreationists, including the entryway from Park Plaza Drive to the playground at the interior of the school grounds. However, the field and playground would still be available to recreationists via Village Lane.

As discussed in Section 5.6, Transportation and Circulation, construction of pipelines would require temporary closure of an approximately 350-foot stretch of the parking and northbound travel lane of Park Plaza Drive from the northern end of 87th Street. The temporary closure along Park Plaza Drive would last up to one week, assuming installation of pipelines at a rate of approximately 300 to 600 feet per week, as proposed. Partial closure would allow for controlled traffic through the intersection during construction. However, despite these partial roadway and parking closures, recreationists would still be able to park in the remaining parking spaces along Park Plaza Drive, and travel to the athletic field via Park Plaza Drive and other roadways.

Thus, due to the short duration of construction, the availability of other parking spaces, and because the field and playground would still be accessible via alternate points, the impact on access to this recreation facility would be *less than significant*.

Site 11

Site 11 would be located in South San Francisco east of El Camino Real, north of its intersection with Arroyo Drive. Site 11 would also be adjacent to an existing BART ventilation structure property, from which access to the site would be provided. An existing access road from Antoinette Lane off of Chestnut Avenue to the south would be used during construction. The existing access road intersects with the Centennial Way Trail. During construction, traffic would increase along the access road, thus increasing traffic intersecting with the trail. However, construction activities would not require closure of any portion of the Centennial Way Trail at Site 11. Thus, the impact on access to this recreational resource from Site 11 construction activities would be *less than significant*.

Site 13

Site 13 would be located approximately 50 feet west of Centennial Way Trail. The trail would remain open during construction at the site. A signaled crosswalk across South Spruce Avenue provides access to the trail at this location. Site 13 would also be located approximately 50 feet east of Francisco Terrace

Playlot, located across South Spruce Avenue. The playlot is accessible from a signaled crosswalk at the intersection of Terrace Drive and South Spruce Avenue and the public sidewalk near the access to the Centennial Way Trail. Construction traffic may increase the overall traffic along South Spruce Avenue, adjacent to the trail and playlot. Additionally, construction activities would result in temporary lane closures along South Spruce Avenue and Huntington Avenue (see Section 5.6, Transportation and Circulation); however, construction activities would not alter access to either the trail or park. Thus, the impact on access to these recreation facilities would be *less than significant*.

Impact Conclusion: Less than Significant

5.11.3.5 Operational Impacts and Mitigation Measures

Impact RE-4: The Project would not damage recreational resources during operation. (Less than Significant)

Impacts on irrigated recreational land uses (i.e., golf clubs) due to changes in the availability of groundwater are evaluated in Impact HY-6 in Section 5.16, Hydrology and Water Quality. Impacts on recreational uses of Lake Merced due to effects of Project pumping on lake levels are discussed in Impact HY-9 in Section 5.16, Hydrology and Water Quality. The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 1, 2, 4 through 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

Operational activities at these facilities would not directly degrade or damage recreational resources because these well facilities would not be located on a recreational resource (see Figures 3-11 to 3-40 in Chapter 3, Project Description). While Site 1 would be located on golf club property, it is not located on the golf links. Although some of these sites would be located near recreational resources, none of the resources would be affected. As a result, *no impact* on recreational resources through operation of these sites would occur.

Impact Conclusion: No Impact

<u>Site 3</u>

The well facility at Site 3 would be located at the southwest corner of the Ben Franklin Intermediate School athletic field behind a baseball backstop with access provided by the same asphalt road and running track used for site access during construction. Although the driveway would occasionally be used by maintenance vehicles, it would also be possible for maintenance staff to park on the street and walk to the well site. The Project proposes restoration of the athletic field to its general pre-construction condition after construction is completed. Restoration would involve replacing turf immediately following completion of the pipeline installation in the center of the field; replacing turf at the staging area behind the backstop at the end of the construction; and replacing and relocating the backstop, and repaving and restriping the track after each construction season, and restoring the site to a clean and safe condition for full school use (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). Recreational use of the turf could resume about three weeks after replacement. Use of the running track could occur immediately following restoration. Relocation of the backstop and footpath would provide for the continued use of the area for recreational purposes.

Therefore, because the athletic field would be restored to a clean and safe condition after construction is completed, and between construction seasons, and because the school's backstop and footpath would be relocated as part of the Project, the full use of the recreational resources would be restored following construction at Site 3. The impact on this recreational resource during operation would therefore be *less than significant*.

Impact Conclusion: Less than Significant

Impact RE-5: The Project would not deteriorate the quality of the recreational experience during operation. (Less than Significant)

Operational impacts on established recreational facilities and resources could result if Project operations were to physically degrade an existing recreational resource by causing a deterioration of the quality of the recreational experience (e.g., a permanent visual disruption or ongoing operational noise). The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 2, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

Sites 5, 6, 7, 8, 9, 10, 12, 14, 15, 16, 17 (Alternate), 18 (Alternate), and 19 (Alternate) would not be located near existing recreational resources. Therefore, the quality of recreational experience at existing recreational resources would not be affected by operation of these sites. As a result, *no impact* on recreation would occur through operation of these sites.

Sites 2, 4, and the Westlake Pump Station would be located near Ben Franklin Intermediate School and Garden Village Elementary School athletic fields. Although Sites 2 and 4 would be located near these recreational resources, operational noise from the well facilities would be indiscernible to recreationists at recreational resources nearby because these sites would be equipped with submersible well pumps and would not have perceptible noise generated aboveground (see Section 5.7, Noise and Vibration). Recreationists at these fields are not considered sensitive to views of the well facilities because the viewshed is presumed by this analysis to not play a primary role in the quality of the recreational experience at this location.

Operation and maintenance of Project well facilities would require access for well exercising either weekly or monthly (i.e., one hour per week, or a single four-hour period each month). Each well station would also be visited daily at times when wells are operating (i.e., dry years) for routine equipment checks, lasting approximately 30 minutes. Permanent access to Site 2 would be facilitated by an existing golf club maintenance road. This road is not used by golfers or other recreationists, and therefore operation and maintenance would not interfere with the recreational experience at the golf club or recreationists at the school athletic fields and *no impact* would occur. Permanent access to Site 4 would be from Park Plaza Drive. Operation and maintenance of Site 4 would not deteriorate the quality of the recreational experience at the school athletic fields because it would not disrupt or impair recreational activities at these recreational resources, and *no impact* would occur.

Equipment upgrades at the Westlake Pump Station would occur inside the existing building, and the Westlake Pump Station would continue to be accessed via the existing access road off of Coronado Avenue (see Figure 3-13), and would not significantly alter the operations of the facility such that it would result in the deterioration of the recreational experience of those using the Ben Franklin Intermediate school secondary athletic field. As a result, *no impact* on recreational resources near these sites, in terms of a potential deterioration of the quality of recreational experience, would occur.

Impact Conclusion: No Impact

<u>Sites 1, 3, 11, and 13</u>

Site 1

Site 1 would be located in the northeastern corner of the Lake Merced Golf Club, a privately owned golf club. The proposed well facility building would replace an existing restroom on the site. The well facility would be located above the golf links and golfers would have a relatively unobstructed view of the well facility. However, intervening vegetation would likely grow to sufficient height to provide visual screening. The existing apartment complex adjacent to the golf club provides a developed backdrop when the proposed well facility site is viewed from the links, and therefore the visual impact from operation of Site 1 would be less than significant (see Impact AES-3 in Section 5.3, Aesthetics). Maintenance and operation would occur either weekly or monthly, and the site would be accessed via Poncetta Drive (see Figure 3-11). Each well station would also be visited daily at times when wells are operating (i.e., dry years) for routine equipment checks, lasting approximately 30 minutes. Maintenance and operation of the well facility would not disrupt recreational activities at the golf club, and therefore there would be *no impact* from operation and maintenance activities.

As discussed in Impact NO-5 in Section 5.7, Noise and Vibration, operation of the well facility at Site 1 would generate perceptible operational noise. However, as discussed in Impact RE-2, noise levels experienced by golfers would be limited geographically to the portion of the golf links nearest to the well facility; perceptible noise levels would decrease as golfers continue down the links away from the well facility. Therefore, given the non-stationary nature of this recreational activity, and that the noise would be limited to one geographic area of the golf links, impacts on the recreational experience at the Lake Merced Golf Club as it relates to operational noise would be *less than significant*.

Site 3

Sites 3 would be located in the southwest corner of the Ben Franklin Intermediate School athletic field. Operational noise from the well facility would be indiscernible to recreationists at recreational resources nearby because the site would be equipped with a submersible well pump and would not have perceptible noise generated aboveground (see Impact NO-5 in Section 5.7, Noise and Vibration). Recreationists at this field are not considered sensitive to views of the well facility because the viewshed is presumed by this analysis to not play a primary role in the quality of the recreational experience at this location. Permanent access to Site 3 would follow the route shown on Figure 3-12 from Park Plaza Drive along the path at the northern edge of the athletic field and along the running track at Ben Franklin School, and would occur either one hour per week, or for four hours once a month. As described in Chapter 3, Project Description, Section 3.4.3 (Facility Sites), the SFPUC would coordinate site access for operation and maintenance with the Jefferson Elementary School District to minimize potential disruptions to recreationists. Therefore, impacts on the recreational experience at this location would be *less than significant*.

Site 11

The well facility at Site 11 would be located about 230 feet west of the South San Francisco Centennial Way Trail. Operation and maintenance of Project well facilities would require access for well exercising either weekly or monthly (i.e., one hour per week, or a single four-hour period each month). Each well station would also be visited daily at times when wells are operating (i.e., dry years) for routine equipment checks, lasting approximately 30 minutes. Access would occur via an existing access road, as shown on Figure 3-27. Ongoing site access would not interfere with trail users, and therefore would not disrupt or otherwise affect the quality of the recreational experience at the Centennial Way Trail. The well facility building would be located behind the existing BART ventilation structure, would be visible from only short sections of the trail, and would also be separated by existing trees. Because of this, visual impacts on the Centennial Way Trail would be *less than significant* (see Impact AES-3 in Section 5.3, Aesthetics). Also because of the distance and the intervening BART structure and trees, any increased noise levels in the vicinity of the trail from operation of the well facility would not be substantial (see Impact NO-5 in Section 5.7, Noise and Vibration). Additionally, as discussed in Impact RE-3, the trail is primarily used for non-stationary activities. Because of the distance of the well facility to the trail, intervening structure and vegetation, and the nature of the recreational experience at the trail, operation of the Site 11 well facility would not substantially affect the quality of the recreational experience from Centennial Way Trail. As a result, the impact on recreation at this site would be *less than significant*.

Site 13

The well facility at Site 13 would be located approximately 70 feet from the Centennial Way Trail and approximately 160 feet from the Francisco Terrace Playlot located on the opposite side of South Spruce Avenue. Operation and maintenance of Project well facilities would require access for well exercising either weekly or monthly (i.e., one hour per week, or a single four-hour period each month). Each well station would also be visited daily at times when wells are operating (i.e., dry years) for routine equipment checks, lasting approximately 30 minutes. Access would occur from a driveway off of South Spruce Avenue for ongoing maintenance and operation (see Figure 3-32). The access driveway is located away from the Centennial Way Trail, and would not interfere with trail users. The well facility building would be visible from both the trail and Francisco Terrace Playlot. However, the site would include landscape planting, and the building would be consistent with other industrial and commercial uses that dominate the viewsheds in this area, therefore visual impacts would be less than significant (see Impact AES-3 in Section 5.3, Aesthetics), and the impact on the quality of the recreational experience would be *less-than-significant*.

Operation of the well facility at Site 13 would generate noise (see Impact NO-5 in Section 5.7, Noise and Vibration). However, as discussed in Section 5.7, Noise and Vibration, 5.7.1.1 (Characteristics of Noise), active parks and playgrounds are not considered sensitive receptors because the levels of background noise are elevated due to active recreational uses. Open space or outdoor recreation areas that are used for passive recreational activities, such as picnicking, would be noise-sensitive uses if the noise environment is considered to contribute to the recreational experience. The Francisco Terrace Playlot is separated from the well facility by South Spruce Avenue, a four-lane road, and existing trees. Because of this distance, and because active playgrounds are not considered by this analysis to be sensitive to noise, such impacts on the recreational experience at the Francisco Terrace Playlot would be *less than significant.* The primary function of Centennial Way Trail is for non-stationary recreation. Existing benches are located across from the well facility; however, they are located across South Spruce Avenue and do not represent the primary function of the trail. Therefore, noise impacts on the recreational experience at Centennial Way Trail would be *less than significant*. As a result, the impact on quality of recreational experience at this site would be *less than significant*.

Impact Conclusion: Less than Significant

Impact RE-6: Operation of the Project would not remove or damage recreational resources, impair access to, or deteriorate the quality of the recreational experience at Lake Merced. (Less than Significant)

Lake Merced Water Levels under Modeled Existing Conditions and Project Conditions

The analysis presented below comes from information generated in the groundwater modeling. The groundwater modeling is discussed in detail in Section 5.1, Overview, Section 5.1.6 (Groundwater Modeling Overview).

Figure 5.16-12 (Simulated Lake Merced Levels Relative to Modeled Existing Conditions) shows the estimated Lake Merced water levels) over the 47-year simulation period under modeled existing conditions. The modeled existing conditions respond directly to the assumed hydrologic sequence and existing groundwater practices described in Section 5.1.6 (Groundwater Modeling Overview). Lake levels are predicted to increase during years one to four in response to simulated above-average precipitation periods, followed by a predicted decline in lake levels in years 4 through 16 to a low of 1.5 feet City Datum during a simulated dry period. From years 16 to 36, lake levels are predicted to fluctuate with climatic conditions, but are also predicted to show an overall increasing trend and rise to over 11 feet City Datum. During the design drought[3] in years 36 to 44, the estimated lake levels decline sharply to -0.8 feet City Datum, then recover to about 5 feet City Datum. Over the simulation period, the estimated mean monthly lake level is predicted to be 6.3 feet City Datum. The estimated lake levels are predicted to be below 5 feet City Datum for 33 percent of the simulation period.

[3] See Section 5.1.6.1 (Westside Basin Groundwater Model) in Section 5.1, Overview, for discussion of the Westside Basin Groundwater Model, including a definition of the design drought.

Figure 5.16-12 in Section 5.16, Hydrology and Water Quality also shows the estimated Lake Merced water levels over the 47-year simulation period under Project conditions. For the first two years of the simulation, the estimated Lake Merced water levels are expected to be similar to the modeled existing conditions, but then rise rapidly from approximately 9 feet City Datum to approximately 11 feet City Datum by year 10 as a result of predicted higher groundwater levels in the Shallow Aquifer. During years 44 to the end of the simulation, after the design drought, the Project-affected lake levels are predicted to be about 4 feet below what they would be under the modeled existing conditions at the end of the simulation. The lowest estimated lake level, expected at the end of the design drought, is approximately -2 feet City Datum (compared to approximately -1.5 feet City Datum under modeled existing conditions; i.e., without the Project), which would leave approximately 4 feet of water in Impound Lake and about 9 feet of water in East Lake. The estimated mean monthly lake level is predicted to be 9.1 feet City Datum. The estimated lake levels would be below 5 feet City Datum for 14 percent of the simulation period, whereas the estimated lake levels would be below 5 feet City Datum for 33 percent of the simulation period under the modeled existing conditions.

The estimated size and depth of the four individual lakes are provided in Table 5.11-4 (Lake Merced Acreage and Depth under Modeled Existing Conditions and Project Conditions) for monthly minimum, mean, and maximum lake levels under modeled existing conditions and Project conditions.

TABLE 5.11-4
Lake Merced Acreage and Depth under Modeled Existing Conditions and Project Conditions

	Acreage and Depth under Modeled Existing Conditions			Acreage and Depth under Project Conditions		
	At Monthly Minimum Water Level of -0.8 ft. City Datum	At Monthly Mean Water Level of 6.3 ft. City Datum	At Monthly Maximum Water Level of 12.4 ft. City Datum	At Monthly Minimum Water Level of -2.5 ft. City Datum	At Monthly Mean Water Level of 9.1 ft. City Datum	At Monthly Maximum Water Level of 13 ft. City Datum
North Lake						
Acreage (acres)	51.9	56.4	66.4	51.2	63.5	66.8
Water Depth (feet)	14.2	21.3	27.4	12.5	24.1	28
South Lake						
Acreage (acres)	159.8	171.9	202.5	157.5	196.2	203.4
Water Depth (feet)	16.2	23.3	29.4	14.5	26.1	30
East Lake						
Acreage (acres)	20.1	24.6	32.6	19.37	30.1	32.9
Water Depth (feet)	10.2	17.3	23.4	8.5	20.1	24
Impound Lake						
Acreage (acres)	9.3	16.6	22.4	8.4	20.1	22.7
Water Depth (feet)	5.2	12.3	18.4	3.5	15.1	19

Source: Kennedy/Jenks 2012b

The lake itself is a recreational resource used for boating and fishing. Boating occurs at North and South Lakes. Fishing occurs from the shoreline, fishing piers located at the North and South Lakes, and occasionally from boats (SFPUC 2011). East Lake's recreational resources include trails and pathways; it does not have fishing piers, boat docks or beach access points. Therefore, it is assumed that this lake does not support recreational fishing. In addition to in-water recreational activities, the lake also supports recreational activities at its shoreline beach access points, and upland trail, picnic, and sitting areas. The scenic quality of the lake is also a contributor to the quality of the recreational experience for all recreationists. Recreational activities that could be affected by increased water depth include boating and fishing, because increased water levels could inundate stationary docks and piers. Increased lake acreage could affect shoreline fishing, beach access, trail access, and other low-lying recreational facilities such as picnic areas, because the increased lake surface area could encroach into these shoreline and/or upland recreational resources.

The monthly maximum and minimum water levels represent the range of conditions that are predicted to occur at Lake Merced under both the modeled existing conditions and Project conditions. As shown on Table 5.11-4 (Lake Merced Acreage and Depth under Modeled Existing Conditions and Project Conditions), the estimated monthly maximum lake water level under modeled existing conditions is predicted to be 12.4 feet City Datum. Under the Project, the estimated monthly maximum lake elevation is predicted to increase slightly to 13 feet City Datum. The change would be an approximately 7-inch increase in water depth and a 0.3- to 1.1-acre increase in size at each individual lake.

However, the minor increase in water depth and surface area acreage under Project conditions would not result in a discernible difference in the availability and quality of recreational resources at Lake Merced because the change in water level would not alter access to recreational facilities nor would it render facilities unusable. The Project would not encroach upon any additional trail, beach access areas, or piers/docks that are not already affected by the fluctuations in water levels under existing conditions. The minor increase in lake depth and surface area would also have a negligible effect on the scenic quality of the lake, because it would not substantially change its appearance. Therefore, impacts on recreational resources at Lake Merced due to increased lake levels under monthly maximum Project conditions would be *less than significant*.

As shown in Table 5.11-4 (Lake Merced Acreage and Depth under Modeled Existing Conditions and Project Conditions), the monthly minimum lake elevation under modeled existing conditions is -0.8 feet City Datum. Under the Project, the estimated monthly minimum lake elevation is predicted to decrease to -2.5 feet City Datum. This translates to an approximately 1.7-foot decrease in water depth, and a 0.7- to 2.3-acre decrease in acreage at each individual lake. Decreased lake levels have the potential to affect boating and fishing because these recreational activities require sufficient water depth. As discussed in Section 5.11.2.2 (State), boating and fishing are also identified in the RWQCB's Basin Plan as beneficial uses of Lake Merced. If decreased lake surface area were to strand floating docks/piers, this would also impact fishing and boating. Decreased lake acreage also would have the potential to affect the quality of the recreational experience if decreased water levels were to affect the scenic quality of the lake.

However, the decrease in water depth and lake acreages under modeled project conditions would not substantially affect recreational resources at Lake Merced, and there would be no discernible change from modeled existing conditions. As shown on Table 5.11-4 (Lake Merced Acreage and Depth under Modeled

Existing Conditions and Project Conditions), there would be sufficient water depth during operation of the Project to support fishing and boating at North and South Lakes, with a depth of 12.5 feet and 14.5 feet, respectively. Generally, a water depth greater than 4 feet supports small craft boating, and a water depth of 6 feet supports dragon boating (DBAW 1991; International Canoe Federation 2011). There would also be sufficient acreage to support the floating and stationary docks/piers at North and South Lakes, as well as boating and rowing activities. Additionally, while the lake would experience a decrease in acreage during dry periods, the difference would not substantially change the visual appearance of the individual lakes when compared to the monthly minimum water levels under modeled existing conditions. Because existing recreational resources would be preserved, the Project would be consistent with *Western Shoreline Area Plan* policies that call for the preservation of recreational facilities in a usable condition, including passive activities, vistas, and trails/paths. Additionally, the Project would not preclude SNRAMP staff report policies to promote recreational uses and develop guidelines for pathways and interpretive trails/signs.

Therefore, impacts on recreational resources at Lake Merced due to decreased lake levels predicted under monthly minimum Project conditions would be *less than significant*.

Impact Conclusion: Less than Significant

5.11.3.6 Cumulative Impacts and Mitigation Measures

Impact C-RE-1: Construction and operation of the proposed Project would not result in significant cumulative impacts on recreational resources. (Less than Significant)

Construction

The geographic scope for the analysis of cumulative construction impacts on recreational resources consists of each proposed GSR facility site (including the construction area for the well, the well facility, and the pipelines) and the immediate vicinity around each of these sites, including the roadways that provide access to the recreational resources in and near each of the proposed GSR facility sites. Table 5.11-5 (Recreational Resources Near Proposed GSR Facility Sites and Other Cumulative Projects) identifies the recreational resources that are within the geographic scope of analysis for cumulative recreation impacts. Refer to Figures 5.11-1 (Recreational Resources [North]) and 5.11-2 (Recreational Resources [South]) for the location of recreational resources relative to the proposed GSR facility sites, and refer to Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis) in Section 5.1, Overview for the location of the cumulative projects.

TABLE 5.11-5
Recreational Resources Near Proposed GSR Facility Sites and Other Cumulative Projects

Recreational Resource	Proximity to Proposed GSR Facility Sites	Other Cumulative Projects (with Cumulative Project ID)
South San Francisco Centennial Way Trail (Class I bicycle and pedestrian path)	• GSR Site 11 construction area would be approximately 75 to 230 feet west of the trail. • GSR Site 13 construction area would be approximately 50 feet west of the trail. • GSR Sites 11 and 13 are approximately one mile from each other and would be constructed at the same time.	• Cumulative Project H: PG&E Transmission Pipeline Replacement Project would roughly parallel the Centennial Way Trail for a mile, approximately 100 to 700 feet away; the PG&E pipeline route would be approximately 250 to 650 feet from GSR Site 11.
Francisco Terrace Playlot	GSR Site 13 pipeline construction area would be approximately 50 feet south of the park, across South Spruce Avenue.	• Cumulative Project I: Centennial Village Project would be a mixed use development approximately 270 feet to the southwest across South Spruce Avenue from Francisco Terrace Playlot and approximately 160 feet from the closest pipeline construction area for GSR Site 13.

Of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), the PG&E Transmission Pipeline Replacement Project (cumulative project H) and the Centennial Village Project (cumulative project I) could generate construction-related impacts that could also affect recreational resources, as detailed below. Activities associated with these projects could occur at the same time as the construction activities proposed at GSR Sites 11 and 13 (including installation of pipelines). No other cumulative projects were identified that would be located both near GSR facility sites and recreational resources affected by the GSR Project.

Impacts on Recreational Experience

Centennial Way Trail

Construction of the PG&E Transmission Pipeline Replacement Project would generate noise, dust, and vehicle exhaust emissions near the Centennial Way Trail, which could impact the recreational experience of bicyclists and pedestrians using the trail. The PG&E transmission pipeline replacement roughly parallels the Centennial Way Trail for a mile and is approximately 250 to 650 feet from Site 11. Project construction at GSR Sites 11 and 13 would result in a *less-than-significant*, temporary increase in noise levels at Centennial Way Trail due to the use of construction equipment, lasting approximately 16 months and 14 months, respectively. Typical daily construction hours for the GSR Project would be between 7:00 a.m. and 7:00 p.m. Monday through Friday. If necessary, construction work may occasionally occur on Saturdays between the hours of 7:00 a.m. and 5:00 p.m., when the trail may have more users. Daytime construction at proposed GSR Sites 11 and 13 would also result in release of fugitive dust, resulting from soil disturbance and diesel engine exhaust emissions, which would be a *less-than-significant* Project impact on air quality (see Impact RE-2). Depending on whether and the extent to which there may be overlapping construction schedules among these projects, implementation of these projects together could result in a cumulative impact on recreational resources. However, these impacts would be temporary (only during construction) and transitory (lasting only as long as it would take for a recreationist to pass by the area of construction), and potentially-affected recreationists could avoid this area completely by heading north or south to other sections of the trail, or they could utilize alternate recreational facilities in the region (e.g., Bayshore Circle Park, Orange Memorial Park, and the South San Francisco High School athletic fields) until construction is completed. For these reasons, the potential cumulative impact on Centennial Way Trail would be *less than significant*.

Francisco Terrace Playlot

Construction of the Centennial Village Project (cumulative project I) identified in Table 5.1-3 (Projects Considered for Cumulative Impacts) would generate noise, dust, and vehicle exhaust emissions near the Francisco Terrace Playlot located at Terrace Drive and South Spruce Avenue, which could impact the recreational experience for park users.

The Centennial Village Project includes mixed use development approximately 160 feet southwest of the GSR Site 13 pipeline construction area and 270 feet southwest of the Francisco Terrace Playlot.

Project construction at GSR Site 13 would result in a *less-than-significant*, temporary increase in noise levels at Francisco Terrace Playlot due to the use of construction equipment, for approximately 14 months. Typical daily construction hours for the GSR Project would be between 7:00 a.m. and 7:00 p.m. Monday through Friday. If necessary, construction work may occasionally occur on Saturdays between the hours of 7:00 a.m. and 5:00 p.m., when the park may have more users. Daytime construction at proposed GSR Site 13 would also result in release of fugitive dust, resulting from soil disturbance and diesel engine exhaust emissions, which would be a *less-than-significant* project impact on air quality (See Impact RE-2). Depending on the extent of overlap between the construction schedules for the two projects, implementation of these projects together could result in a cumulative impact on recreational resources. However, any exposure to dust, exhaust emissions, or increased noise levels would be limited (due to the playlot's distance from the GSR Project and Centennial Village project construction activities) and temporary in duration. Moreover, potentially affected park users could avoid this area completely by utilizing alternate recreational facilities in the region (e.g., Bayshore Circle Park, Herman Park, Orange Park, Orange Memorial Park, and the South San Francisco High School athletic fields) until construction is completed. For these reasons, the potential cumulative impact on Francisco Terrace Playlot would be *less than significant*.

Disruption of Access to a Recreational Resource

Construction of the PG&E Transmission Pipeline Replacement Project (cumulative project H) may require a temporary closure of the portion of Centennial Way Trail where the pipeline crosses from Antoinette Lane to El Camino Real. However, construction of proposed GSR Site 11 near the PG&E Transmission Pipeline project would not affect access to the Centennial Way Trail. Therefore, there would be *no impact* related to cumulative construction-related impacts on access to the Centennial Way Trail.

Operations

The geographic scope for the analysis of cumulative operational impacts on recreational resources consists of the GSR study area, including the proposed GSR facility sites and the immediate vicinity around each of these sites, including the roadways that provide access to the recreational resources in and near each of the proposed GSR facility sites. Refer to Figures 5.11-1 (Recreational Resources [North]) and 5.11-2 (Recreational Resources [South]) for the location of recreational resources relative to the proposed GSR facility sites, and refer to Figure 5.1-3 (Location of Projects Considered in Cumulative Analysis) in Section 5.1, Overview for the location of the cumulative projects. Of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), the Mission & McLellan Project (cumulative project F) and the Centennial Village Project (cumulative project I) could generate operation-related impacts that could also affect recreational resources, as detailed below. No other cumulative projects were identified that would affect recreational resources in the GSR Project study area. Cumulative impacts on irrigated recreational land uses (i.e., golf clubs) due to changes in the availability of groundwater are evaluated in Impact C-HY-2 in Section 5.16, Hydrology and Water Quality.

The Mission & McLellan and Centennial Village projects are not located on or adjacent to a recreational resource in the GSR study area; therefore, they would not have permanent impacts on the recreational experience or access to recreational resources during their operation. However, these projects combined would include the development of 152 new residential units. Residents of these units could utilize recreational resources in the GSR study area, which could increase use of these resources such that physical deterioration or accelerated deterioration of these recreational resources could occur, or require construction or expansion of recreational resources. Therefore, cumulative impacts related to the potential need for expanded recreational resources could be *significant*.

However, the GSR Project would not increase the use of, or require construction or expansion of recreational resources that might have an adverse physical effect on the environment. The Project is a groundwater storage and recovery system that would not, independently and separately from its contribution as part of the overall WSIP, deliver any additional amounts of water or generate new residential or employee population (discussed further in Chapter 6, Other CEQA Issues, Section 6.1 [Growth Inducement]) beyond that analyzed for the WSIP in the WSIP PEIR. Because the Project would not increase the existing population or housing supply of the Project area over and above its contribution to the WSIP, no increased use of parks and other recreational resources would occur at a Project-specific level that would result in increased use resulting in physical deterioration or accelerated deterioration of existing recreational resources. As discussed above under Impact RE-5, operation of the Project at most sites would have no impact on the quality of existing recreational experiences, and would have a less-than-significant impact during operation of Sites 11 and 13 on Centennial Way Trail and Francisco Terrace Playlot, respectively, and under Impact RE-4, a less-than-significant impact on the athletic field at Site 3. Therefore, the GSR Project's contribution to a potentially *significant* cumulative impact on recreational resources during operation would not be cumulatively considerable (*less than significant*).

Impact C-RE-2: Operation of the Project would not result in significant cumulative impacts on recreational resources at Lake Merced. (Less than Significant)

The geographic scope for cumulative operational impacts on Lake Merced recreational resources includes the four individual lakes and the upland areas surrounding the lakes. Refer to Figures 5.11-1 (Recreational Resources [North]) and 5.11-2 (Recreational Resources [South]) for the location of recreational resources relative to the proposed GSR facility sites, and refer to Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis) in Section 5.1, Overview for the location of the cumulative projects.

As noted in greater detail in the cumulative analysis presented in Section 5.16, Hydrology and Water Quality, these include the SFPUC's proposed San Francisco Groundwater Supply (SFGW) Project (cumulative project A) and Daly City's proposed Vista Grande Drainage Basin Improvement Project (cumulative project B). The former would affect Lake Merced water surface elevations most directly through groundwater pumping and the latter through direct hydrologic input of stormwater to the Lake (Vista Grande), as well as projected pumping by Partner Agencies in the South Westside Groundwater Basin and potentially increased pumping at the Holy Cross cemetery (i.e., other existing projects). See Section 5.1, Overview, Section 5.1.6 (Groundwater Modeling Overview) for an explanation of cumulative operational scenarios considered in the modeling conducted for the proposed Project.

With operation of the GSR Project and the identified cumulative projects, the average Lake Merced water levels, according to the Westside Basin Groundwater Model, are predicted to decrease 0.3 feet over the 47-year simulation period (calculated as a monthly average). Due to stormwater inputs from the Vista Grande Drainage Basin Improvement Project (as well as in-lieu recharge from the GSR Project), water levels are predicted to be slightly higher than under the modeled existing conditions for much of the 47-year simulation period (see Figures 5.16-11 (Simulated Lake Merced Level Changes) and 5.16-12 (Simulated Lake Merced Levels Relative to Modeled Existing Conditions) in Section 5.16, Hydrology and Water Quality). However, initial pumping by the San Francisco Groundwater Project and pumping by the GSR Project during dry years are predicted to decrease Lake Merced lake levels (Kennedy/Jenks 2012a).

To examine the potential effects of recreational resources at Lake Merced, including possible inundation of trails and fishing piers, as well as water-dependent activities such as boating, rowing, and fishing, Table 5.11-6 (Lake Merced Acreage and Depth under Modeled Existing Conditions and Cumulative Conditions) presents the minimum, mean, and maximum water depths and acreages at Lake Merced for the modeled existing conditions and the cumulative conditions.

TABLE 5.11-6
Lake Merced Acreage and Depth under Modeled Existing Conditions and Cumulative Conditions

	Acreage and Depth under Modeled Existing Conditions			Acreage and Depth under Cumulative Conditions		
	At Monthly Minimum Water Level of -0.8 ft. City Datum	At Monthly Mean Water Level of 6.3 ft. City Datum	At Monthly Maximum Water Level of 12.4 ft. City Datum	At Monthly Minimum Water Level of -4.9 ft. City Datum	At Monthly Mean Water Level of 6.1 ft. City Datum	At Monthly Maximum Water Level of 9.5 ft. City Datum
North Lake						
Acreage (acres)	51.9	56.4	66.4	50.4	55.8	64
Water Depth (feet)	14.2	21.3	27.4	10.1	21.1	24.5
South Lake						
Acreage (acres)	159.8	171.9	202.5	154.3	170.6	197.4
Water Depth (feet)	16.2	23.3	29.4	12.1	23.1	26.5
East Lake						
Acreage (acres)	20.1	24.6	32.6	18.3	24.2	30.6
Water Depth (feet)	10.2	17.3	23.4	6.1	17.1	20.5
Impound Lake						
Acreage (acres)	9.3	16.6	22.4	7.2	16.4	21.2
Water Depth (feet)	5.2	12.3	18.4	1.1	12.1	15.5

Source: Kennedy/Jenks 2012b

Under cumulative conditions , the available surface area of North, South, and East Lakes is not predicted to decrease substantially as compared to modeled existing conditions, and the water depth under cumulative conditions is predicted to be sufficient to support existing boating uses in all years at North and South Lakes. Generally, a water depth greater than 4 feet supports small craft boating, and a water depth of 6 feet supports dragon boating (DBAW 1991; International Canoe Federation 2011). Further, floating and stationary docks would not be disconnected from the lake water surface.

However, under cumulative conditions, Impound Lake water levels are predicted to be substantially reduced during an extended drought compared to modeled existing conditions. While the depth and size of Impound Lake would be reduced naturally under modeled existing conditions during an extended drought, the combination of the groundwater pumping associated with the proposed Project and the San Francisco Groundwater Project, along with other ongoing groundwater pumping activities, would exacerbate the effects on Impound Lake during the years of an extended drought. This would reduce the visual quality and, therefore, the quality of the recreational experience near Impound Lake as seen from the paved trail around the lake perimeter, and from the picnic areas on John Muir Drive and Lake Merced Boulevard.

However, all four lakes, including Impound Lake, would remain accessible for recreational purposes during extended drought periods. Impound Lake supports recreational activities such as picnicking, beach access, and potentially shoreline fishing, in addition to scenic vistas. Boating does not occur at Impound Lake. Even under extended drought periods, picnic facilities and shoreline access would still be in useable condition. The existing availability of trails and beach access points at all lakes is also not predicted to change substantially under cumulative conditions.

While the visual quality at Impound Lake would be reduced during an extended drought, Lake Merced would continue to offer scenic vistas. The reduced visual quality of Impound Lake alone would not result in a significant cumulative impact on the overall physical degradation of the recreational resources because all other currently supported recreational activities would still be available to recreationists. The effects under cumulative conditions would not have permanent or ongoing impacts on recreational resources at Lake Merced, given that water levels are predicted to decline for only a temporary period of time during an extended drought under cumulative conditions, and the water level fluctuations and surface area changes would not prevent use of the lake by recreationists. Additionally, because recreation facilities would be preserved, cumulative conditions would not conflict with the Western Shoreline Plan policies to preserve passive recreational activities, pathways, and vistas in a useable condition, or preclude SNRAMP policies to promote recreational uses and develop guidelines for pathways and interpretive trails/signs. Therefore, cumulative operational impacts on recreational resources at Lake Merced would be *less than significant*.

5.11.4 References

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5.12 UTILITIES AND SERVICE SYSTEMS

This section addresses potential impacts on utilities and service systems that could occur as a result of Project implementation. Utilities and service systems discussed in this section include natural gas, telecommunications, potable water, wastewater, stormwater, and solid waste facilities. Water quality is addressed in Section 5.16, Hydrology and Water Quality, safety hazards related to underground utilities are addressed in Section 5.17, Hazards and Hazardous Materials, and potential impacts on energy resources are addressed in Section 5.18, Mineral and Energy Resources.

5.12.1 Setting

Project facilities would be constructed and operated at locations in the Town of Colma, cities of Daly City, South San Francisco, San Bruno, and Millbrae, and the community of Broadmoor in unincorporated San Mateo County. The study area for potential impacts related to public services includes individual facility sites and the service systems (i.e., infrastructure and capacity of the system) for the electricity, natural gas, telecommunications, potable water, wastewater, stormwater, and solid waste facilities that serve the facility sites. Table 5.12-1 (Utilities and Major Service Providers in the Project Area) shows utilities and major service providers in the study area.

5.12.1.1 Utilities

Electricity and Natural Gas

The San Francisco Public Utilities Commission (SFPUC) Power Enterprise provides electricity to all City and County of San Francisco (CCSF) facilities. Pacific Gas and Electric Company (PG&E) provides electricity and natural gas to most of Northern California, including the study area. It provides the SFPUC Power Enterprise with transmission and distribution services from Newark (California) to points west, pursuant to an Interconnection Agreement regulated by the Federal Energy Regulatory Commission (FERC). Under this agreement, PG&E transmits and distributes electricity to the SFPUC Power Enterprise customers and would provide power distribution services for the proposed Project.

PG&E provides natural gas to customers in the study area through a network of regional gas transmission pipelines. Transmission pipelines are generally larger and operate at a higher pressure than distribution pipelines (PG&E 2012a). PG&E transmission pipelines operate at or above 60 pounds per square inch gauge (psig). A natural gas transmission pipeline is located near GSR Site 1 immediately west of Interstate 280 (I-280) and along Hickey Boulevard immediately north of Site 10. A transmission pipeline is located along El Camino Real south of Site 11 and west of Site 12. These pipelines are considered high-priority utility lines (PG&E 2012b[1]).

[1] High priority utilities pipelines include natural gas in pipelines greater than six-inches diameter with normal operating pressures greater than 60 pounds per square inch gauge (Caltrans 1999).

TABLE 5.12-1
Utilities and Major Service Providers in the Project Area

City/County	Electricity/ Natural Gas	Telecom	Potable Water	Wastewater	Stormwater	Solid Waste
City of Daly City	PG&E	Comcast, Astound	City of Daly City	North San Mateo County Sanitation District (NSMCSD)	Daly City	Allied Waste Daly City
San Mateo County (Broadmoor)	PG&E	Comcast, Astound	California Water Service Company (Cal Water)	NSMCSD	Daly City	Allied Waste Daly City
Town of Colma	PG&E	Comcast, Astound	Cal Water	NSMCSD, South San Francisco-San Bruno Water Quality Control Plant (SSF/SB WQCP)	Town of Colma	Allied Waste Daly City
City of South San Francisco	PG&E	Astound, Comcast, AT&T	Cal Water, Westborough County Water District	SSF/SB WQCP	City of South San Francisco	South San Francisco Scavenger Company
City of San Bruno	PG&E	San Bruno Cable	City of San Bruno	SSF/SB WQCP	City of San Bruno	Recology San Bruno
City of Millbrae	PG&E	AT&T, Comcast	City of Millbrae	City of Millbrae	City of Millbrae	South San Francisco Scavenger Company

Sources: San Francisco Planning Department 2009; San Mateo County 2009; San Mateo County 2011; San Mateo County n.d.

Notes:

PG&E = Pacific Gas and Electric Company

AT&T = American Telephone and Telegraph

Telecommunications

Telecommunication services in this analysis include telephone land line, cellular telephone, cable and satellite television, and internet access. Multiple telecommunication providers serve customers in the study area including Astound, American Telephone and Telegraph (AT&T), Comcast, and San Bruno Cable.

Water Service

The cities of Daly City, San Bruno, and Millbrae provide water service to their customers. The Town of Colma and San Mateo County (Broadmoor) receive their potable water from the California Water Service Company (Cal Water). The City of South San Francisco receives its potable water from Cal Water and the Westborough County Water District (South San Francisco 1999; Colma 1999; San Mateo County 2009).

Wastewater Service

Three wastewater treatment providers exist in the study area: North San Mateo County Sanitation District (NSMCSD), the cities of South San Francisco-San Bruno, and the City of Millbrae. The NSMCSD collects, treats, and disposes of wastewater for the majority of the residents of City of Daly City (including the proposed facility sites), unincorporated community of Broadmoor, a portion of the Town of Colma (including the proposed facility sites), the Westborough County Water District in South San Francisco, and the San Francisco County Jail in San Bruno. According to the NSMCSD's National Pollutant Discharge Elimination System (NPDES) permit (CA0037737), the treatment plant has an average dry weather flow design of eight million gallons of effluent per day (mgd) and can treat up to 25 mgd during wet weather flow periods. As of 2006, the plant discharges an annual average flow of 6.85 mgd (RWQCB 2006).

The City of South San Francisco and the City of San Bruno jointly own the South San Francisco-San Bruno Water Quality Control Plant. According to the two cities' joint NPDES permit (CA0038130), the facility has a dry-weather capacity of 13 mgd and a wet-weather capacity of approximately 62 mgd (RWQCB 2003). The average dry weather flow through the plant is 9 mgd (South San Francisco 2012).

The City of Millbrae owns and operates a sewer collection system and wastewater treatment plant. In 1998, the Millbrae General Plan identified that the capacity at the treatment plant was very limited and appeared to be insufficient to handle projected flows. In 2011, the City applied for and received approval from the California State Revolving Fund for financing to upgrade the plant. According to the City's NPDES permit (CA0037532), the plant has an average dry weather flow design capacity of 3 mgd and a peak wet weather capacity of 9 mgd. As stated in the NPDES permit, the plant discharged an average dry weather flow of 2.2 mgd and an annual average flow of 2.41 mgd (five-year averages, 1995 through 1999) (RWQCB 2001).

Stormwater

Each jurisdiction within the study area manages its own stormwater system, which includes maintenance of creeks and storm drains located underneath streets. San Bruno also oversees two San Mateo County Flood Control District pump stations (San Bruno 2011).

5.12.1.2 Solid Waste

Allied Waste Daly City provides solid waste and recycling collection services in the City of Daly City, the unincorporated community of Broadmoor, and the Town of Colma. The South San Francisco Scavenger Company provides solid waste and recycling collection services in the cities of South San Francisco and Millbrae. Recology San Bruno provides solid waste and recycling collection services in the City of San Bruno (San Mateo County 2011). Solid waste that is collected in San Mateo County is directed to the Ox Mountain Sanitary Landfill in Half Moon Bay, the only operating landfill in the County. The Ox Mountain landfill has a permitted capacity of 37,900,000 cubic yards and a maximum disposal capacity of 3,598 tons per day. The remaining capacity is approximately 24,600,000 cubic yards, with approximately 28 years of site life remaining. The landfill solid waste permit lists an estimated closure date of 2018; however the permit is reviewed every five years (Republic Services 2012). The landfill accepts a variety of materials including construction and demolition materials (CalRecycle 2011).

5.12.2 Regulatory Framework

5.12.2.1 Federal

No federal regulations relative to utilities and service systems would be applicable to the Project.

5.12.2.2 State

California Public Utilities Commission

The California Constitution vests the California Public Utilities Commission (CPUC) with exclusive power and sole authority to regulate privately-owned and investor-owned public utilities. The CPUC regulates Cal Water as an investor-owned utility, but does not have jurisdiction over municipal utilities operated by the SFPUC, Daly City, and San Bruno. The CPUC has provisions that require regulated utilities to work closely with local governments and to give due consideration to their concerns.

California Integrated Waste Management Act of 1989

The *California Integrated Waste Management Act of 1989* (Public Resources Code [PRC], Division 30), enacted through Assembly Bill (AB) 939 and modified by subsequent legislation, required all California cities and counties to implement programs to reduce, recycle, and compost at least 50 percent of wastes by the year 2000 (PRC Section 41780). The Department of Resources, Recycling, and Recovery (CalRecycle), formerly known as the California Integrated Waste Management Board (CIWMB), determines compliance with this mandate to divert generated waste (which includes both disposed and diverted waste). Prior to 2007, diversion for cities and counties was calculated by establishing a "base year" waste generation rate against which future diversion was measured. In 2007, SB 1016 changed how the diversion rate is computed. SB 1016 builds on AB 939 compliance requirements by implementing a simplified measure of jurisdictions' performance by changing to a per capita disposal rate which uses only two factors: a jurisdiction's population (or in some cases employment) and its disposal as reported by disposal facilities. The per capita disposal rate approach is not determinative of jurisdiction compliance. Instead, CalRecycle uses per capita disposal as an indicator in evaluating program implementation and local jurisdiction performance (CalRecycle 2012). Jurisdictional diversion/disposal progress data for the per capital disposal rate approach is available from 2007 through 2011 from CalRecycle (CalRecycle 2013). Jurisdictional compliance status is "Awaiting Review" for the cities of San Bruno, South San Francisco, and Millbrae, the Town of Colma, and unincorporated San Mateo County for 2007 through 2011. Daly City compliance was listed as "Issued," "Active," and "Fulfilled" in 2007, 2008, and 2009, respectively; for 2010 and 2011, Daly City's compliance status is "Awaiting Review" (CalRecycle 2013).

Utility Notification Requirements

Title 8, Section 1541 of the California Code of Regulations requires excavators to determine the approximate locations of subsurface installations such as sewer, telephone, fuel, electric, and waterlines (or any other subsurface installations that may reasonably be encountered during excavation work) prior to opening an excavation. The California Government Code (Sections 4216 et seq.) requires owners and operators of underground utilities to become members of and participate in a regional notification center. According to Section 4216.1, operators of subsurface installations who are members of, participate in, and share, in the costs of a regional notification center are in compliance with this section of the code. Underground Service Alert North (USA North) receives planned excavation reports from public and private excavators and transmits those reports to all participating members of USA North that may have underground facilities at the location of excavation. At this point, members of the regional notification center will mark or stake their facilities, provide information, or give clearance to dig (USA North 2013).

5.12.2.3 Local

City of Daly City

The Daly City Municipal Code, Chapter 15.64, *Recycling and Diversion of Construction and Demolition Debris*, requires all new construction and alteration projects within Daly City with a construction value of greater than $25,000 and $15,000, respectively, to comply with the diversion requirements set forth in this code (Daly City n.d.). The code requires that at least 60 percent of waste tonnage from construction, demolition, and alteration projects be diverted from disposal through reuse or recycling. The maximum feasible amount of designated recyclable and reusable materials must be salvaged prior to demolition. Construction and demolition debris is defined as discarded materials generally considered to be not water soluble and nonhazardous in nature, including, but not limited to: steel, copper, aluminum, glass, brick, concrete, asphalt material, pipe, gypsum, wallboard, and lumber; rocks, soils, tree remains, trees, and other vegetative matter that normally results from land clearing, landscaping and development operations for a construction project; and remnants of new materials, including, but not limited to: cardboard, paper, plastic, wood, and metal scraps.

Town of Colma Ordinance No. 569

Colma adopted Ordinance No. 569 to comply with AB 939, the Integrated Waste Management Act. The ordinance requires that at least 50 percent of the waste tonnage from any demolition project where the waste includes concrete and asphalt, (or 15 percent where there is no concrete and/or asphalt) be recycled and/or reused to meet the terms and conditions of the ordinance. In addition to demolition, new construction, remodeling, and re-roofing of homes requires 50 percent recycling of waste tonnage (Colma n.d.).

City of South San Francisco General Plan

The South San Francisco General Plan (1999) includes a goal to reduce the generation of solid waste to slow the filling of local and regional landfills, in accordance with AB 939, the California Integrated Waste Management Act. Additionally, the City of South San Francisco Municipal Code, Chapter 15.60 requires the diversion of 100 percent of inert solids from landfills, and a minimum of 50 percent of the remaining construction and demolition debris (South San Francisco n.d.).

City of San Bruno Municipal Code

The San Bruno Municipal Code, Chapter 10.23, *Recycling and Diversion of Debris from Construction and Demolition*, identifies salvage, diversion, and reporting requirements for waste disposal (San Bruno n.d.). The code contains salvage requirements to recover the maximum feasible amount of salvageable designated recyclable and reusable materials prior to demolition. The code also requires a 50 percent diversion rate for construction and demolition debris from commercial and residential buildings.

City of Millbrae Recycling and Waste Prevention Program

Millbrae operates a Recycling and Waste Prevention Program. The program was formed in 1994 to comply with AB 939, and to help meet the State-mandated goal to reduce the amount of garbage placed in landfills by 50 percent by the end of the 2000. Since 1999, Millbrae has achieved the 50 percent requirement (Millbrae 2013). Millbrae requires 50 percent recycling of all waste generated for a project by weight, with at least 25 percent achieved through reuse and recycling of materials other than source-separated dirt, concrete, and asphalt (San Mateo County 2012).

San Mateo County Integrated Waste Management Ordinance

In compliance with AB 939, San Mateo County adopted an Integrated Waste Management Ordinance in 2002 to reduce construction and demolition debris (County of San Mateo Chapter 4.105 Recycling and Diversion of Debris from Construction and Demolition) (San Mateo County 2002). This ordinance requires that: (a) 100 percent of inert solids (i.e., asphalt, concrete, rock, stone, brick, sand, soil, and fines), and at least 50 percent of the remaining construction and demolition debris be diverted from local landfills, and (b) the project proponent develop and submit a Waste Management Plan that includes at least the following:

- Salvaging all or part of structures where practicable;
- Having 100 percent of inert solids be reused or recycled at approved facilities; and
- Source separating non-inert materials, such as cardboard and paper, wood, metals, green waste, new gypsum wallboard, tile, porcelain fixtures, and other easily recycled materials, and directing them to recycling facilities approved by the County and taking the remainder (but no more than 50 percent by weight or yardage) to a facility for disposal or taking all mixed construction and demolition debris to an approved facility.

5.12.3 Impacts and Mitigation Measures

5.12.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on utilities and service systems if it were to:

- Disrupt operation of, or require relocation of, regional, or local utilities.
- Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board (RWQCB).
- Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.
- Require or result in the construction of new stormwater drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.
- Have insufficient water supply available to serve the Project from existing entitlements and resources, or require new or expanded water supply resources or entitlements.
- Result in a determination by the wastewater treatment provider that would serve the Project that it has inadequate capacity to serve the Project's projected demand in addition to the provider's existing commitments.
- Be served by a landfill with insufficient permitted capacity to accommodate the Project's solid waste disposal needs.
- Result in non-compliance with federal, State, and local statutes and regulations related to solid waste.

5.12.3.2 Approach to Analysis

The primary focus of this analysis is on temporary utility disruption during construction, as well as analysis of adequate utility capacity to accommodate Project operations. Local utilities were contacted and planning documents reviewed to identify the utility companies serving the facility sites, to identify the utilities that could be affected by the proposed Project, and to determine whether the existing utilities have capacity to serve the Project.

During construction, short-term temporary disruption of utility service could occur if existing utilities were accidentally damaged during Project-related construction activities. Additionally, electricity connections would be needed to supply temporary power for construction and permanent power to operate the well facilities at all well facility sites. Construction- and operation-related fuel and energy use are addressed in Section 5.18, Mineral and Energy Resources. This analysis also addresses the potential temporary construction-related and permanent operational-related impacts on wastewater and stormwater facilities since components of the Project require discharge water to be sent to these facilities. The impact on utilities and service systems would be significant if new or expanded facilities would be required beyond those included in the Project, the construction of which could result in an environmental impact.

This analysis also identifies potential impacts related to landfill capacity resulting from the disposal of construction waste, as well as the ability of local jurisdictions to comply with federal, State, and local landfill statutes. The analysis evaluates the potential effects of landfill disposal with respect to the available capacity of local landfills and local jurisdictions' ability to comply with solid waste diversion rates.

Areas of No Project Impact

The analysis of impacts on utilities and service systems typically evaluates whether existing utilities and services systems are adequate to serve a proposed project, or whether they require expansion or new construction to accommodate the proposed project and, if so, whether construction of the new or expanded utilities and/or service systems could have an adverse impact on the environment. The GSR Project differs from typical development projects, because the Project is a utility (water supply and treatment) project designed to increase water supply during dry years.

Due to the nature of the proposed Project, there would be no construction or operational impacts related to one of the above-listed significance criteria; therefore, the criterion is not discussed further in this section for the following reasons:

Have insufficient water supply available to serve the Project from existing entitlements and resources, or require new or expanded water supply resources or entitlements. During construction of each well facility, groundwater pumped at the site would be used to flush the treatment facilities and new pipelines to meet disinfection requirements and water quality regulations. During operation, 14 of the facility sites (well sites that include buildings) would have a sink for use when maintenance personnel visit the site – weekly during normal and wet years or daily during dry years. Water for use at the sink would be supplied from a small potable water supply line (similar to a residential connection); the demand would be less than 100 gallons per year for each site on average (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]). No other water use is needed or proposed. Use of the groundwater during construction and operations is so small that it would have a negligible effect on the ability of the Project to supply water and would not have any effect on existing water supply sources. Therefore, the significance criterion related to sufficient water supply is not applicable to construction or operation of the Project and is not discussed further.

In addition, no construction or operational impacts on natural gas or telecommunications systems would occur. Neither construction nor operation of the Project would use natural gas. Construction of the Project may require one telephone line at each facility site. Operation of the Project would also require one telephone line at each facility site for the Supervisory Control and Data Acquisition (SCADA) system (see Chapter 3, Project Description, Section 3.4.2.6 [Site SCADA Systems]). Provision of 17 telephone lines from Comcast, Astound, AT&T, and/or San Bruno Cable would not exceed the capacity of these systems, because each system operates in an urban area with the capacity for additional lines.

As described below, there would be no operational impacts related to three additional significance criteria. Therefore, the following significance criteria are not addressed further in this impact analysis in the context of Project operation; they are, however, addressed in the context of Project construction:

Disrupt operation of or require relocation of regional or local utilities during Project operations. Once operational, the Project would not disturb existing utilities or require additional relocation of utilities. Maintenance activities would occur on-site and would not require additional subsurface construction that could disrupt existing utilities systems. Therefore, the significance criterion related to disruption or relocation of regional or local utilities is not applicable to operation of the Project and is not discussed further.

Be served by a landfill with insufficient permitted capacity to accommodate the Project's solid waste disposal needs during Project operation. Upon completion of construction, the Project would not generate solid waste requiring disposal. Therefore, the significance criterion related to landfill capacity is not applicable to operation of the Project and is not discussed further.

Result in non-compliance with federal, State, and local statutes and regulations related to solid waste during Project operation. As mentioned above, upon completion of construction, the Project would not generate solid waste requiring disposal. Therefore, the significance criterion related to compliance with solid waste regulations is not applicable to operation of the Project and is not discussed further.

5.12.3.3 Summary of Impacts

Table 5.12-2 (Summary of Impacts – Utilities and Service Systems) summarizes impacts on utilities and service systems from the Project.

TABLE 5.12-2
Summary of Impacts – Utilities and Service Systems

Construction				Operations	Cumulative
Impact UT-1: Project construction could result in potential damage to or temporary disruption of existing utilities during construction.	**Impact UT-2: Project construction would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects.**	**Impact UT-3: Project construction would not result in adverse effects on solid waste landfill capacity.**	**Impact UT-4: Project construction could result in a substantial adverse effect related to compliance with federal, State, and local statutes and regulations pertaining to solid waste.**	**Impact UT-5: Project operation would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects.**	**C-UT-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to utilities and service systems.**
LSM All Sites	LS All Sites	LS All Sites	LSM All Sites	LS All Sites	LSM All Sites

Notes:

LS = Less than Significant Impact

LSM = Less than Significant Impact with Mitigation

5.12.3.4 Construction Impacts and Mitigation Measures

Impact UT-1: Project construction could result in potential damage to or temporary disruption of existing utilities during construction. (Less than Significant with Mitigation)

All Sites

Construction activities for the proposed Project could result in unintentional damage or interference with existing water, sewer, storm drain, natural gas, electricity, and/or telecommunication lines and, in some cases, could require that existing lines be permanently relocated, potentially causing a temporary disruption in service. Numerous utility lines of varying sizes are located at or near the facility sites and the proposed pipeline routes would cross existing utilities at several locations. While the Project does not propose to relocate utilities owned and operated by other utility companies, it is possible that relocation would be necessary once the locations and characteristics of existing utilities are confirmed. Table 5.12-3 (Preliminary List of Known Utilities within Construction Area at Facility Sites) presents a preliminary list of known utilities within the construction area of each facility site. Additional utilities may be identified during the construction planning and notification process.

TABLE 5.12-3
Preliminary List of Known Utilities Within Construction Area at Facility Sites

Site	Potentially Affected Utilities
Site 1	PG&E overhead electric lines, PG&E natural gas transmission line
Site 2	Daly City sanitary sewer, storm drain, and water line; overhead PG&E electric lines; SFPUC water transmission pipeline
Site 3	Daly City sanitary sewer, storm drain, and water line; overhead PG&E electric line
Site 4	Daly City sanitary sewer, storm drain, and water line; overhead PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Westlake Pump Station	Daly City storm drain and water line; overhead PG&E electric line
Site 5	Daly City sanitary sewer, storm drain, and water line; overhead PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 6	Daly City sanitary sewer and storm drain; overhead PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 7	Daly City sanitary sewer; Colma storm drain; overhead PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 8	Daly City sanitary sewer; Colma storm drain; underground PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 9	Daly City sanitary sewer; South San Francisco storm drain; overhead PG&E electric line; SFPUC water transmission pipeline
Site 10	South San Francisco sanitary sewer and storm drain; overhead PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 11	South San Francisco sanitary sewer; South San Francisco storm drain; underground PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 12	South San Francisco sanitary sewer and storm drain; overhead PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 13	South San Francisco sanitary sewer and storm drain; overhead PG&E electric line; Cal Water waterline
Site 14	San Bruno sanitary sewer and storm drain; overhead PG&E electric line; SFPUC water transmission pipeline
Site 15	San Bruno sanitary sewer and storm drain; underground PG&E Gas Electric; SFPUC water transmission pipeline
Site 16	Millbrae sanitary sewer and storm drain; PG&E overhead electric line; SFPUC water transmission pipeline; PG&E gas line
Site 17 (Alternate)	Daly City sanitary sewer; Colma storm drain; underground PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 18 (Alternate)	South San Francisco sanitary sewer and storm drain; overhead PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline
Site 19 (Alternate)	South San Francisco sanitary sewer and storm drain; overhead PG&E electric line; SFPUC water transmission pipeline; Cal Water waterline, PG&E gas line

Note: Potentially affected utilities are those utilities within the construction area shown in Figures 3-11 to 3-40.

It is expected that construction at each facility site would occur over a 16-month period for facility sites that include a well facility building and during a three-month period for wells that have only a fenced facility (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). Project pipeline construction would generally progress at a rate of 300 to 600 feet per week, including excavation, disconnection of affected utilities, pipeline replacement, utility reconnection and backfill of construction trenches (see Chapter 3, Project Description, Section 3.5.1 [Construction Sequencing and Schedule]). However, utility connections that extend perpendicularly from a site across a roadway may take more time to install, given the potential to encounter additional utilities and the need to maintain roadway circulation; in such cases, these connections may take up to one week for installation of a single connection, and up to two weeks for connections of two or more utilities within the same area.

Impacts on existing utilities within the construction area of the well facility site could occur during construction. Site preparation, foundation construction, and utility connections would have the potential for disrupting existing utilities based on the excavation needed for construction. The open-cut construction method for pipeline installation would also have the potential for disrupting existing utilities from excavation activities near utilities. Accidental rupture of, or damage to, such utility lines during Project construction could temporarily disrupt utility services and may pose a safety risk for construction workers. Due to the potential for encountering unanticipated utilities in the vicinity of the facility sites, potential damage to, relocation of and service disruption of these utilities could occur, which could result in *significant* impacts. However, these impacts would be reduced to *less-than-significant* levels with implementation of Mitigation Measures M-UT-1a through M-UT-1i as discussed below.

Mitigation Measure M-UT-1a: Confirm Utility Line Information (All Sites)

Prior to excavation and/or other ground-disturbing construction activities, the SFPUC or its contractor(s) shall locate overhead and underground utility lines, such as natural gas, electricity, sewer, telephone, and waterlines, that may be encountered during excavation work. Pursuant to State law, the SFPUC or its contractor(s) shall notify USA North. Information regarding the size and location of existing utilities shall be confirmed before excavation and other ground-disturbing activities commence. These utilities shall be highlighted on all construction drawings. Utilities may be located by customary techniques such as geophysical methods and hand excavation.

Mitigation Measure M-UT-1b: Safeguard Employees from Potential Accidents Related to Underground Utilities (All Sites)

While any excavation is open, the SFPUC or its contractor(s) shall protect, support, or remove underground utilities as necessary to safeguard employees. As part of contractor specifications, the contractor(s) shall be required to provide updates on planned excavations for the upcoming week and to specify when construction will occur near any high-priority utility lines that are identified. At the beginning of each week when this work will take place, the SFPUC construction managers shall conduct meetings with contractor staff, as required by the California Occupational Safety and Health Administration (CalOSHA), to record all protective and avoidance measures regarding such excavations.

Mitigation Measure M-UT-1c: Notify Local Fire Departments (All Sites)

In the event that construction activities result in damage to high-priority utility lines, including leaks or suspected leaks, the SFPUC or its contractor(s) shall immediately notify local fire departments to protect worker and public safety.

Mitigation Measure M-UT-1d: Emergency Response Plan (All Sites)

Prior to commencing construction activities, the SFPUC shall develop an emergency response plan that outlines procedures to follow in the event of a leak or explosion resulting from a utility rupture. The emergency response plan shall identify the names and phone numbers of PG&E staff who would be available 24 hours per day in the event of damage or rupture of the high-pressure PG&E natural gas pipelines. The plan shall also detail emergency response protocols including notification, inspection, and evacuation procedures; any equipment and vendors necessary to respond to an emergency, such as an alarm system; and routine inspection guidelines.

Mitigation Measure M-UT-1e: Advance Notification (All Sites)

The SFPUC or its contractor(s) shall notify all affected utility service providers in advance of Project excavation and/or other ground-disturbing activities. The SFPUC or its contractor(s) shall make arrangements with these entities regarding the protection, relocation, or temporary disconnection of services prior to the start of excavation and other ground-disturbing activities. The SFPUC or its contractor(s) shall coordinate with the appropriate utility service providers to ensure advance notification to residents, owners, and businesses in the Project area of a potential utility service disruption two to four days in advance of construction. The notification shall provide information about the timing and duration of the potential service disruption.

Mitigation Measure M-UT-1f: Protection of Other Utilities during Construction (All Sites)

Detailed specifications shall be prepared as part of the design plans to include procedures for the excavation, support and fill of areas around subsurface utilities, cables, and pipes. If it is not feasible to avoid an overhead utility line during construction, the SFPUC or its contractor(s) shall coordinate with the affected utility owner to either temporarily or permanently support the line, to de-energize the line while temporarily supporting the overhead line, or to temporarily re-route the line.

Mitigation Measure M-UT-1g: Ensure Prompt Reconnection of Utilities (All Sites)

The SFPUC or its contractor(s) shall promptly notify utility providers to reconnect any disconnected utility lines as soon as it is safe to do so.

Mitigation Measure M-UT-1h: Avoidance of Utilities Constructed or Modified by Other SFPUC Projects (All Sites)

The final construction drawings for the Project shall reflect any changes in utility locations, as well as the locations of any new utilities installed during construction of other SFPUC projects in San Mateo County whose disturbance areas overlap with the Project area.

Mitigation Measure M-UT-1i: Coordinate Final Construction Plans with Affected Utilities (All Sites)

The SFPUC or its contractor(s) shall coordinate final construction plans and specifications with affected utility providers.

Implementation of Mitigation Measure M-UT-1a (Confirm Utility Line Information), Mitigation Measure M-UT-1b (Safeguard Employees from Potential Accidents Related to Underground Utilities), Mitigation Measure M-UT-1c (Notify Local Fire Departments), Mitigation Measure M-UT-1d (Emergency Response Plan), Mitigation Measure M-UT-1e (Advance Notification), Mitigation Measure M-UT-1f (Protection of Other Utilities during Construction), Mitigation Measure M-UT-1g (Ensure Prompt Reconnection of Utilities), Mitigation Measure M-UT-1h (Avoidance of Utilities Constructed or Modified by Other SFPUC Projects), and Mitigation Measure M-UT-1i (Coordinate Final Construction Plans with Affected Utilities) would adequately mitigate potential impacts related to the potential disruption and relocation of utility operations or accidental damage to existing utilities by requiring that the SFPUC and/or its contractor(s) identify the potentially affected lines in advance, coordinate with utility service providers to minimize the risk of damage to existing utility lines, protect lines in place to the extent possible or temporarily re-route lines if necessary, and take special precautions when working near high-priority utility lines (e.g., gas transmission lines). Therefore, this impact would be *less than significant with mitigation.*

Impact Conclusion: Less than Significant with Mitigation

Impact UT-2: Project construction would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects. (Less than Significant)

<u>All Sites</u>

The data used in this analysis of Impact UT-2 are presented in Chapter 3, Project Description, Sections 3.5.1.1 (Construction Methods for Production Wells) and 3.5.1.4 (Dewatering and Other Potential Discharges).

After well drilling is complete, each new well would undergo well development and pumping tests which produce up to approximately three million gallons of water that must be disposed. Well development and pump testing would occur over the course of approximately 150 hours (about six days) for each well, resulting in an average disposal need of 0.5 mgd. Water from the well development and testing would be discharged to a storm drain and/or sanitary sewer. Clean groundwater discharges to storm drains would be acceptable, as they would be exempt under The San Francisco Bay Region Municipal Regional Stormwater NPDES Permit (NPDES Permit CAS612008, Section C.15.a.[i][7]) (RWQCB 2011). Due to the anticipated quality of the groundwater that would be discharged from the pump tests, permits from the San Francisco Bay RWQCB are not anticipated (SFPUC 2011).

Before being placed into service, the new pipelines at all sites, including either the proposed pipeline or the alternate pipeline, would be flushed using groundwater and disinfected to meet water quality regulations. The new treatment facilities would be flushed and disinfected similarly at those sites with treatment facilities. All water used for flushing would come from the new wells and would be either dechlorinated and sent to the storm drain or, if not dechlorinated, sent via the nearest sanitary sewer to local wastewater treatment plants for processing. This process would be a one-time event at each facility site and only occur just prior to starting up operation of the proposed facilities. Construction impacts on the sanitary sewer and storm drain systems are discussed below.

Sanitary Sewer Collection System and Wastewater Treatment Plant Capacity

If discharge water from well development, pumping tests and flushing[2] were sent to a sanitary sewer, water from Sites 1, 2, 3, 4, 5, 6, 7, 8, and 17 (Alternate) would be sent to the North San Mateo County Sanitation District (NSMCSD). Water from Sites 9, 10, 11, 12, 13, 14, 15, 18 (Alternate), and 19 (Alternate) would be sent to the South San Francisco–San Bruno Water Quality Control Plant (SSF-SB WQCP). Water from Site 16 would be sent to the Millbrae Wastewater Treatment Plant.

Well installation would be phased, resulting in a maximum of four wells to be constructed simultaneously within either the NSMCSD or SSF-SB WQCP collection area.[3] Development and testing of four wells simultaneously would result in the discharge of a maximum of 2.0 mgd[4] of groundwater for approximately six days to any of the treatment facilities. The Millbrae Wastewater Treatment Plant or storm drain system would receive a maximum of 0.5 mgd with construction of the well at Site 16. Temporary flows of this size would be within the capacity of the wastewater treatment plants, which have substantial excess capacity designed for wet weather flow periods.

Water volumes used for flushing the six-inch and eight-inch diameter pipe sizes would be sent to sanitary sewer pipelines of equal or greater diameter. The available capacity of the sanitary sewer systems is variable, but if necessary, the groundwater discharge would be pumped to portable storage tanks and then released to the sanitary sewer such that the discharge rate would not exceed the capacity of any individual sanitary sewer conveyance line (see Chapter 3, Project Description, Section 3.5.1.1 [Construction Methods for Production Wells]).

Therefore, the temporary discharge of groundwater from well development, pump testing, and flushing would be accommodated by the existing sanitary sewer collection system and the wastewater treatment plant, and the Project would not exceed the capacity of these systems.

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[2] No discharges from well development, pumping tests, and flushing are expected from Sites 2, 5, 6, 8, 10, and 13 because at these sites, existing test wells would be converted to production wells and no pumping or flushing would be required.

[3] Sites 1, 3, 4, and 7 in the NSMCSD collection area would be constructed in Construction Cluster A. Sites 12, 14, 15, and 19 (Alternate) in the SSF-SB WQCP collection area could be constructed together in Construction Cluster B. Site 18 (Alternate) in the NSMCSD collection area, and Sites 9 and 11 in the SSF-SB WQCP collection area would be constructed together in Construction Cluster C. Site 16 is the only site within the Millbrae Wastewater Treatment Plant collection area, and would be constructed as part of Cluster B. The remaining well facility sites have existing wells and would not require well installation as part of the Project.

[4] Development and pump testing would occur over the course of approximately 150 hours for each well resulting in an average of approximately 0.5 mgd per well. Four wells producing approximately 0.5 mgd would result in a total of approximately 2.0 mgd.

Storm Drain Capacity

If discharge water from flushing and well development and pumping test were sent to a storm drain, the water would be sent to the closest storm drain system, each of which is owned and maintained by the local jurisdiction: the cities of Daly City, South San Francisco, San Bruno, and Millbrae; the Town of Colma; and San Mateo County.

The peak discharge rate during well development (lasting for a few hours) would be approximately 800 gallons per minute (gpm) and the typical discharge rate would be closer to 500 gpm. The capacity of most storm drain systems is over 1,000 gpm. In addition, the SFPUC would notify the above wastewater and stormwater agencies in advance of the discharge, regardless of season, so that discharge methods (i.e., direct discharge or holding in portable storage tanks) appropriate to the available capacity can be applied (see Chapter 3, Project Description, Section 3.5.1.1 [Construction Methods for Production Wells]). At any given time, the capacity of storm drain systems is variable and the existing capacity used by other dischargers is unknown. However, given the Project's construction discharge rate, and because the SFPUC would control the rate of discharge (if needed), and notify the appropriate agencies before discharge occurs, the temporary discharge of groundwater from well development, pump testing, and flushing would be accommodated by the existing storm drain system, and the Project would not exceed the capacity of these systems.

Impact Conclusion

Therefore, because the storm drain systems could accommodate the groundwater discharge, because the SFPUC would control the rate of discharge to the sanitary sewer system and notify appropriate agencies before discharge occurs, and because the local wastewater treatment plants would have adequate capacity to treat these flows, potential impacts related to exceeding the capacity of wastewater or stormwater systems such that new facilities would be required would be *less than significant*.

Impact Conclusion: Less than Significant

Impact UT-3: Project construction would not result in adverse effects on solid waste landfill capacity. (Less than Significant)

All Sites

Construction of the Project would result in the generation of waste materials, primarily soils excavated from pipeline trenches and from the foundations for building construction, with some quantities of waste material generated from well excavation. Materials excavated during well facility construction and pipeline installation could be used as backfill around the facilities. Remaining soil would be hauled off site for recycling or disposal at appropriate facilities. Other waste generated on the sites would primarily consist of vegetation, including trees, which would be hauled off site for recycling or disposal. Other waste sources would be construction debris and possibly demolition debris from Sites 1 and 14. The Project would require off-site disposal of solid waste at the nearby Ox Mountain Sanitary Landfill.

The quantities of solid waste that would be disposed of at landfills cannot be specifically calculated at this time. However, the largest potential source of solid waste would be the excavated soil. As indicated in

Chapter 3, Project Description, Table 3-10 (Construction Soil Material Haul Amounts and Anticipated Haul Truck Trips), the estimated amount of excavated soils would be approximately 3,365 cubic yards (calculated assuming some excavated soil would be used on-site as backfill for pipeline trenches and at foundations; see Table 3-10). The Ox Mountain Sanitary Landfill has a remaining capacity of approximately 24,600,000 cubic yards. Assuming all 3,365 cubic yards (which is conservative given the 50 percent diversion rate requirements of AB 939) were disposed of at the Ox Mountain Sanitary Landfill, the remaining landfill capacity would not be substantially affected (Republic Services 2012). Because the Project would be served by a landfill with more than sufficient permitted capacity to accommodate the Project's solid waste disposal needs during construction, potential impacts on the environment related to the need for additional landfill capacity would, therefore, be *less than significant*.

Impact Conclusion: Less than Significant

Impact UT-4: Project construction could result in a substantial adverse effect related to compliance with federal, State, and local statutes and regulations pertaining to solid waste. (Less than Significant with Mitigation)

All Sites

Project construction would result in the generation of waste materials, including construction debris from all sites, demolition materials from Sites 1 and 14 (potentially), and excavated spoil from all sites. Construction waste materials would be hauled off site for recycling or disposal. As described in Section 5.12.2 (Regulatory Framework), the jurisdictions in the Project area have local regulations pertaining to the disposal of solid waste. AB 939 (as modified by subsequent legislation) requires California cities and counties to implement programs to reduce, recycle, and compost at least 50 percent of waste.

Construction waste materials generated by the Project could make it difficult for the jurisdictions to achieve diversion goals in compliance with AB 939 and other local regulations. Because specific quantification of waste volumes and identification of the sources have not been possible at this time, it is unknown whether the Project's diversion rate from local landfills would be consistent with local jurisdictional diversion and solid waste disposal requirements. Therefore, this impact is considered *significant.* However, implementation of Mitigation Measure M-UT-4 (Waste Management Plan) would mitigate this impact to *less-than-significant* levels by requiring the construction contractor to prepare and implement a waste management plan, as detailed below.

Mitigation Measure M-UT-4: Waste Management Plan (All Sites)

The SFPUC shall require the construction contractor(s) to prepare a Waste Management Plan identifying the types of debris that would be generated by the Project and how all waste streams would be handled within each jurisdiction. In accordance with the priorities of AB 939, the plan shall emphasize source reduction measures followed by recycling and composting methods to reduce the amount of waste being disposed of in landfills. The plan shall include actions to divert waste with disposal in a landfill in accordance with local ordinance requirements as follows:

Daly City (Sites 1, 2, 5, 6, and the Westlake Pump Station)

For sites within Daly City, at least 60 percent of waste tonnage from construction and demolition shall be diverted from disposal through reuse or recycling. The maximum feasible amount of designated recyclable and reusable materials shall be salvaged prior to demolition. Construction and demolition debris is defined as discarded materials generally considered to be not water soluble and nonhazardous in nature, including, but not limited to: steel, copper, aluminum, glass, brick, concrete, asphalt material, pipe, gypsum, wallboard, and lumber; rocks, soils, tree remains, trees, and other vegetative matter that normally results from land clearing, landscaping, and development operations for a construction project; and remnants of new materials, including, but not limited to: cardboard, paper, plastic, wood, and metal scraps.

Unincorporated San Mateo County (Sites 3, 4)

For sites within unincorporated San Mateo County, salvage all or parts of a structure where practicable; recycle or reuse 100 percent of inert solids at approved facilities; direct source separating non-inert materials (e.g., cardboard and paper, wood, metals, green waste, new gypsum wallboard, tile, porcelain fixtures, and other easily recycled materials) to recycling facilities approved by the County, the remainder (but no more than 50 percent by weight or yardage) of which shall be taken to a facility for disposal.

Colma (Sites 7, 8, and Site 17 [Alternate])

For sites within Colma, recycle 50 percent of the waste tonnage from any demolition project where the waste includes concrete and asphalt (or 15 percent where there is no concrete and/or asphalt); and recycle 50 percent of waste tonnage for new construction.

South San Francisco (Sites 9, 10, 11, 12, 13, 18 [Alternate], and 19 [Alternate])

For sites within South San Francisco, recycle 100 percent of inert solids (i.e., asphalt, concrete, rock, stone, brick, sand, soil and fines), and recycle at least 50 percent of the remaining construction and demolition debris.

San Bruno (Sites 14 and 15)

For sites within San Bruno, recover the maximum feasible amount of salvageable designated recyclable and reusable materials prior to demolition; divert 50 percent of construction and demolition debris from residential and commercial buildings.

Millbrae (Site 16)

For sites within Millbrae, recycle 50 percent of all waste generated for the Project by weight, with at least 25 percent achieved through reuse and recycling of materials other than source separated dirt, concrete, and asphalt.

The plan shall be reviewed by the SFPUC, and upon Project completion, the contractor shall submit receipts to the SFPUC documenting achievement of the stated waste reuse, recycling, and disposal goals.

Impact Conclusion: Less than Significant with Mitigation

5.12.3.5 Operational Impacts and Mitigation Measures

Impact UT-5: Project operation would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects. (Less than Significant)

All Sites

Sanitary Sewer Collection System and Wastewater Treatment Plant Capacity

As discussed in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types), Sites 5, 6, 7, 8, 9, 10, 11, 13, and 15[5] may include filtration systems to treat the extracted groundwater, in addition to other treatment systems which may be necessary at these sites. The filtration system would consist of a series of vertical pressure vessels. The backwash water from the system would connect with a pipeline to a nearby sanitary sewer. It is anticipated that filters would be backwashed, on average, once a day for five minutes at approximately 350 gpm per filter. Depending on the quantity of water being treated, the treatment facilities would have six to 16 filters, which would result in a discharge of approximately 0.01 to 0.03 mgd per well (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]). Wastewater from the backwash process would be discharged to the sanitary sewer and be treated at the NSMCSD (for Sites 5, 6, 7 and 8 totaling 0.08 mgd) and the SSF-SB WQCP (for Sites 9, 10, 11, 13, 14, and 15 totaling 0.06 mgd). The Project would also generate small sanitary sewer flows from sinks at up to 14 of the well facilities.

As discussed in Section 5.12.1.1 (Utilities), the NSMCSD has an average dry weather flow design of eight million gallons of effluent per day and can treat up to 25 mgd during the wet weather flow period. The SSF-SB WQCP has a dry-weather capacity of 13 mgd and a wet-weather capacity of approximately 62 mgd. Both treatment facilities are currently functioning at below their permitted capacity. The 0.06 to 0.08 mgd of wastewater generated from backwashing the filters, and the small addition of wastewater flow from operation of 14 sinks, would be minor compared to the existing flows of the wastewater treatment plants receiving the flows, and would not cause the treatment facilities to exceed their permitted capacity. Therefore, Project operation would not exceed the capacity of these wastewater treatment facilities or require the construction or expansion of facilities, and the impact would be *less than significant*.

Storm Drain Capacity

The SFPUC's past experience with intermittent well operations indicates that monthly exercising for four-hour periods during normal and wet years should be adequate to prevent well screen fouling (MWH et al. 2008). The well exercising would occur at a rate of approximately 300 to 600 gpm for four hours per month during normal and wet years. It is assumed that water pumped during well exercising would be the same as the well pump capacity; see Table 3-3 (Site-specific Facility Characteristics) in Chapter 3, Project Description, Section 3.8.3 (Maintenance). Groundwater pumped during exercising

[5] The Site 6 filtration system would treat water from Sites 5, 6 and 7 in the consolidated treatment at Site 6 scenario. The Site 15 filtration system would treat water from both Sites 14 and 15.

would be discharged to a local storm drain. As discussed in Impact UT-2, the capacity of most storm drain systems is over 1,000 gpm and could accommodate discharge at the rate of 300 to 600 gpm for a four-hour period. At any given time, the capacity of storm drain systems is variable, and the existing capacity used by other dischargers is unknown. However, given the scope of discharges (four hours per month during normal and wet years at a rate of 300 to 600 gpm), there would still be significant capacity left in the system to accommodate other discharges.

Impact Conclusion

Therefore, because the quantity of discharge water associated with monthly well exercising would not exceed the capacity of local storm drains or require or result in the construction of, or expansion of stormwater drainage facilities, potential impacts related to wastewater treatment facilities or stormwater drainage facilities would be *less than significant.*

Impact Conclusion: Less than Significant

5.12.3.6 Cumulative Impacts and Mitigation Measures

Impact C-UT-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to utilities and service systems. (Less than Significant with Mitigation)

The geographic scope for the analysis of cumulative impacts on utilities and service systems consists of each proposed GSR facility site (including the construction area for the well, the well facility and the pipelines), the immediate vicinity around each of these sites and the service areas of regional service/utility providers. For landfill capacity, the geographic scope includes San Mateo County, within which construction-related waste could be sent to the Ox Mountain Landfill. For compliance with solid waste statutes and regulations, the geographic area encompasses San Mateo County.

Construction

Damage to or Disruption of Existing Utilities and Relocation of Utilities

As described in Impact UT-1, the GSR Project could result in unintentional damage or interference with existing water, sewer, storm drain, natural gas, electricity, and/or telecommunication lines and, in some cases, could require that existing lines be permanently relocated, potentially causing a temporary disruption in service. Most of the projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), could also result in potential damage to existing utilities, disruption of utility services, or relocation of utilities when the new construction ties into existing utilities. In particular, the SFPUC's Peninsula Pipelines Seismic Upgrade (PPSU) Project, Colma Site (cumulative project D-1), would replace an existing water pipeline that traverses proposed GSR Site 8 with the proposed replacement pipeline to be constructed underneath the existing storm drain culvert on the site. This could result in a temporary interruption in service of the storm drain. Additional projects could contribute to the cumulative impacts related to the disruption of existing utilities; these projects include Vista Grande Basin Drainage Improvement Project (cumulative project B) near GSR Sites 1, 2, 3, and 4; Cal Water's Well Replacement

SSF1-25 Project (cumulative project G) near GSR Sites 11, 12, and 19 (Alternate); PG&E's Transmission Pipeline Replacement Project (cumulative project H) near GSR Sites 9, 11, 13, 18 (Alternate), and 19 (Alternate); and the Centennial Village Project (cumulative project I) near Site 13.

Disruption of existing utilities could occur during construction of the GSR Project and several of the cumulative projects listed above. Specifically, the GSR Project at Site 8 and the SFPUC's PPSU Project, Colma Site (cumulative project D-1) could temporarily affect the existing storm drain culvert if construction of both projects occurred at the site time. Other temporary utility disruptions could occur with construction of the other cumulative projects. Therefore, cumulative impacts related to disruption of utility operations or accidental damage to existing utilities and relocation of regional or local utilities or services system from other lapping construction of the cumulative projects would be *significant*, and the GSR Project's contribution to this cumulative impact could be cumulatively considerable, given that the GSR Project, as proposed, also has the potential to result in *significant* impacts on utilities and service systems.

However, as discussed in Impact UT-1, the GSR Project's impacts related to damage to an existing utility, disruption of service, or relocation of utilities would be reduced to a *less-than-significant* level with implementation of Mitigation Measure M-UT-1a (Confirm Utility Line Information), Mitigation Measure M-UT-1b (Safeguard Employees from Potential Accidents Related to Underground Utilities), Mitigation Measure M-UT-1c (Notify Local Fire Departments), Mitigation Measure M-UT-1d (Emergency Response Plan), Mitigation Measure M-UT-1e (Advance Notification), Mitigation Measure M-UT-1f (Protection of Other Utilities during Construction), Mitigation Measure M-UT-1g (Ensure Prompt Reconnection of Utilities), Mitigation Measure M-UT-1h (Avoidance of Utilities Constructed or Modified by Other SFPUC Projects), and Mitigation Measure M-UT-1i (Coordinate Final Construction Plans with Affected Utilities). Implementation of these mitigation measures would ensure that existing utilities are accurately located and protected during construction, and that emergency response procedures are in place to minimize potential damage during construction. With implementation of these mitigation measures, the GSR Project's contribution to cumulative impacts related to damage or disruption of existing utilities and relocation of utilities would not be cumulatively considerable (*less than significant with mitigation*).

Wastewater Treatment, Sanitary Sewer, and Storm Drain Capacity

Most of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would result in construction-related incremental additions to the local wastewater treatment plants, sanitary sewers, and storm drain systems as many of the projects require connection to the sanitary sewer and storm drain system. In particular, the Daly City "A" Street Well Replacement Project (cumulative project C) would likely require connection to the same sanitary sewer and storm drain system. Construction of the SFPUC's PPSU Project at the Colma Site (cumulative project D-1) would require discharge to the sanitary sewer and storm drain from pipeline testing.

As described in Impact UT-2, the GSR Project would have *less-than-significant* impacts on wastewater treatment, sanitary sewer, and/or storm drain capacity because GSR Project discharges would be for brief periods of time; discharges would be pumped to portable storage tanks and then released to the sanitary sewer collection system or the storm drain system, if necessary; the wastewater treatment plants have adequate additional capacity; and the wastewater and stormwater agencies would be notified in advance.

Depending on the extent of overlap between the construction schedules for the projects listed in Table 5.1-3, implementation of these projects together with the proposed GSR Project could result in a *significant* cumulative impact on wastewater treatment, sanitary sewer, and/or storm drain capacity. However, impacts on the sanitary sewer and storm drain systems would be temporary (only during construction) and brief (e.g., 48 hours for pump testing).

As described in Chapter 3, Project Description, Section 3.5.1.2 (Construction Methods for Well Facilities), the SFPUC would notify the stormwater and wastewater agencies in advance of the well testing discharge to determine the appropriate discharge method and the appropriate discharge rate for the various stormwater and wastewater agencies. If necessary, the groundwater discharge would be pumped to portable storage tanks and then released to the sanitary sewer such that the discharge rate would not exceed the capacity of the individual sanitary sewer system. With notification, the agencies would be able to account for the GSR Project's contribution to the stormwater and wastewater systems in the context of other discharges (potentially including cumulative projects C and D-1) and avoid exceeding capacity.

Because of these notification and discharge procedures, as well as the limited impact to the sanitary and storm drain systems, the GSR Project's contribution to a potential cumulative impact on wastewater treatment, sanitary sewer, or storm drain capacity from construction-related activities would not be cumulatively considerable (*less than significant*).

Landfill Capacity

Most of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would result in construction waste that would require offsite disposal at the Ox Mountain Sanitary Landfill, because most projects would create construction waste and are in the service area of that landfill.

As described in Impact UT-3, the GSR Project would have *less-than-significant* impacts on remaining capacity at the landfill, because GSR Project construction waste for the largest component of the Project's solid waste -- excavated soils -- would be 3,365 cubic yards (not accounting for the 50 percent diversion rate requirements of AB939).

The construction phase of the cumulative projects identified in Table 5.1-3, together with the proposed GSR Project, could generate substantial quantities of waste for disposal at the landfill, reducing the remaining capacity of the landfill, which was estimated in March 2012 to be 24,600,000 cubic yards. This would be a *significant* cumulative impact. However, the proposed GSR Project's contribution to the reduction of landfill capacity would not be cumulatively considerable, because the volume of solid waste generated by the Project would be very small in relation to the remaining capacity. Therefore, the GSR Project's contribution to a cumulative impact would not be cumulatively considerable (*less than significant*).

Compliance with Solid Waste Statutes and Regulations

The cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would generate construction waste and would need to comply with local solid waste diversion and disposal regulations. However, because specific quantification of waste volumes of the cumulative projects is not specifically known at this point, it is unknown whether the cumulative projects diversion rate from local landfills would be consistent with local regulations. Although construction waste volumes are expected to be relatively small, since these volumes are not quantified at this time, it is unknown whether the proposed GSR Project's management of construction waste would be consistent with the local jurisdictional diversion requirements, which has been identified as a *significant* impact above in Impact UT-4. Therefore, cumulative impacts related to compliance with solid waste statutes and regulations during construction could be *significant* and the GSR Project's contribution to this cumulative impact could be cumulatively considerable.

However, as discussed in Impact UT-4, the GSR Project's impacts related to compliance with solid waste statutes and regulations during construction would be reduced to a *less-than-significant* level with implementation of Mitigation Measure M-UT-4 (Waste Management Plan). Implementation of this mitigation measure would ensure that local regulations pertaining to disposal and diversion of solid waste would be complied with during construction of the GSR Project. With implementation of this mitigation measure, the GSR Project's contribution to cumulative impacts related to compliance with solid waste statutes and regulations during construction would not be cumulatively considerable (*less than significant with mitigation*).

Operation

Most of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would result in incremental additions to the local wastewater treatment plants, sanitary sewers, and/or storm drain systems on a permanent basis, as new housing, commercial, or industrial uses are occupied and operated.

As described in Impact UT-5, the GSR Project would have *less-than-significant* impacts on sanitary sewer and wastewater treatment capacity, because GSR Project discharges from the filter systems during dry years when the wells would be operating would be very small (0.04 mgd to be treated at the NSMCSD and 0.06 mgd at the SSF-SB WQCP plus very small flows from the sinks at up to 14 of the well facilities) compared to the available capacity of these wastewater treatment plants (approximately 1.15 mgd of unused capacity at the NSMCSD and 4.0 mgd of unused capacity at the SSF-SB WQCP). Impact UT-5 also describes that the proposed GSR wells would be exercised for approximately four hours per month during normal and wet years, which would have a *less-than-significant* impact on storm drain capacity.

The cumulative projects identified in Table 5.1-3, together with the proposed GSR Project, could generate substantial volumes of wastewater, reducing the remaining capacity of the wastewater treatment plants and reducing the available capacity in sanitary sewers and storm drains. This would be a *significant* cumulative impact. However, the proposed GSR Project's contribution to the reduction in capacity of the wastewater treatment plants, sanitary sewers, and storm drains is not cumulatively considerable, because the volume of sewer or storm drain discharge is very small in relation to the remaining capacity. As a result, the GSR Project's contribution to a cumulative impact would not be cumulatively considerable (*less than significant*).

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5.13 PUBLIC SERVICES

This section describes the existing conditions and regulatory setting for public services and evaluates impacts on public services that could occur as a result of the implementation of the proposed Project. Public services addressed in this section include law enforcement services, fire protection services, emergency services, and schools. Impacts on emergency response or access (i.e., disruption of emergency services due to access restrictions) are addressed in Section 5.6, Transportation and Circulation. Impacts on recreational facilities are addressed in Section 5.11, Recreation. Impacts on solid waste disposal facilities are addressed in Section 5.12, Utilities and Service Systems, while energy and power issues are addressed in Section 5.18, Mineral and Energy Resources.

5.13.1 Setting

Project facilities would be constructed and operated as part of the proposed Project at locations in the cities of Daly City, South San Francisco, San Bruno, Millbrae, the Town of Colma, and unincorporated San Mateo County as shown on Figure 2-1 (Project Vicinity Map) in Chapter 2, Introduction and Background. The public services study area includes the proposed facility sites and the jurisdictions that provide public services for the sites. A description of the public services in these jurisdictions is presented below.

5.13.1.1 Law Enforcement Services

Police services in the study area are provided by the Broadmoor Police Department, a special police protection district serving the unincorporated community of Broadmoor in San Mateo County and the local police departments of Daly City, Colma, South San Francisco, San Bruno, and Millbrae. The California Highway Patrol (CHP) provides law enforcement services for the State highway facilities and unincorporated county roadways throughout the study area. The Golden Gate National Cemetery (GGNC) is under the jurisdiction of the U.S. Department of Veterans Affairs (VA) Police (Federal Police), and is also served by the San Bruno Police Department (VA 2011a, 2011b). Table 5.13-1 (Law Enforcement and Fire Protection Services within the Project Area) lists each facility site's jurisdictional law enforcement agency.

TABLE 5.13-1
Law Enforcement and Fire Protection Services within the Project Area

Sites	Jurisdiction	Law Enforcement Services	Fire Protection Services
Sites 1, 2, 5, 6, Westlake Pump Station	Daly City	Daly City Police Department	North County Fire Authority
Sites 3, 4	Unincorporated San Mateo County (Broadmoor)	Broadmoor Police Department (Special Protection District)	Colma Fire Protection District
Sites 7, 8, 17 (Alternate)	Colma	Colma Police Department	Colma Fire Protection District
Sites 9, 10, 11, 12, 13, 18 (Alternate), 19 (Alternate)	South San Francisco	South San Francisco Police Department	South San Francisco Fire Department
Sites 14, 15	San Bruno	San Bruno Police Department VA Federal Police (GGNC)	San Bruno Fire Department
Site 16	Millbrae	Millbrae Police Department	Millbrae Fire Department

Sources: Broadmoor Police Department 2010; CHP 2012; Daly City 1987; Millbrae 1998; San Bruno 2009; South San Francisco 1999; VA 2011a , 2011b; NCFA n.d.; San Mateo County 1986a, 1986b; Colma 1999

5.13.1.2 Fire Protection Services

Daly City contracts for fire services from the North County Fire Authority (NCFA n.d.). The Colma Fire Protection District serves Colma and the surrounding unincorporated areas, including the unincorporated community of Broadmoor (Colma 1999). Local fire departments serve the cities of South San Francisco, San Bruno, and Millbrae. The GGNC is served by the San Bruno Fire Department (VA 2011b). Table 5.13-1 (Law Enforcement and Fire Protection Services within the Project Area) lists each jurisdiction's fire protection agency.

5.13.1.3 Emergency Services

For emergency services, San Mateo County is served by a public/private partnership of the American Medical Response (AMR), the fire protection agencies within the County and the County Health Services Department's Emergency Medical Services office (San Mateo 2010). 911 emergency medical calls are responded to by AMR and firefighter paramedics on fire engines.

Hospitals near the Project include:

- Seton Medical Center
  1900 Sullivan Avenue
  Daly City, CA 94015

- Kaiser Permanente, South San Francisco Medical Center
  1200 El Camino Real
  South San Francisco, CA 94080
- The Emmanuel Convalescent Hospital of Millbrae
  33 Mateo Avenue
  Millbrae, CA 94030
- Mills-Peninsula Medical Center
  1501 Trousdale Drive
  Burlingame, CA 94010

San Mateo Medical Center is the public hospital for San Mateo County, although it is not located within the study area.

5.13.1.4 Schools

Public elementary, middle school, and high school districts in the vicinity of facility sites that could be affected by the Project include the Jefferson Elementary School District and the South San Francisco Unified School District, which provide various services for adult and student populations with the study area.

5.13.2 Regulatory Framework

5.13.2.1 Federal

There are no federal regulations governing public services that apply to the Project.

5.13.2.2 State

There are no State regulations governing public services that apply to the Project.

5.13.2.3 Local

The Colma General Plan and the Daly City General Plan Safety Element set forth performance objectives of an average emergency response time of two to four minutes to all locations in Colma and Daly City (Colma 1999; Daly City 1994). The San Bruno General Plan establishes an implementing policy to maintain existing or better levels of police and fire service to neighborhoods in the northern and western neighborhoods (San Bruno 2009). The South San Francisco General Plan establishes a service ratio of 1.5 police officers per 1,000 residents and sets a response time goal of two to three minutes for high priority calls (South San Francisco 1999). The Millbrae General Plan requires the City to maintain adequate manpower for police and fire departments, but does not set a specific service ratio (Millbrae 1998). The San Mateo County General Plan does not have a policy related to performance objectives of public services relevant to the Project.

5.13.3 Impacts and Mitigation Measures

5.13.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on public services if it were to:

- Result in substantial adverse physical impacts associated with the provision of, or the need for, new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any public services such as fire protection, police protection, emergency services, or schools.

5.13.3.2 Approach to Analysis

Due to the nature of the proposed Project, there would be no impacts related to the following criterion for the reasons described below and, therefore, the criterion is not discussed further.

Result in substantial adverse physical impacts associated with the provision of, or the need for, new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times, or other performance objectives for any public services such as fire protection, police protection, emergency services or schools. During the proposed 21-month construction period, an average of 193 daily construction workers would be employed at the facility construction sites[1] (see Table 3-8 [Estimated Daily Worker and Construction Equipment Trips for Well Facilities Construction], in Chapter 3, Project Description, Section 3.5.1.2 [Construction Methods for Well Facilities]). It is expected that construction workers could come from any part of the San Francisco Bay Area (Bay Area). While some workers might temporarily relocate from other areas, the proposed Project would not result in a substantial increase in local populations and would not affect established service ratios for law enforcement, fire protection, emergency services, or schools. Potential incidents requiring law enforcement, fire protection, or emergency services could occur during Project construction. However, the potential temporary increase in incidents would not exceed the capacity of local law enforcement, fire protection, and emergency facilities, compared to the existing overall population and service area. Any increase in incidents as a result of Project construction would be negligible and could be accommodated by existing service providers. Construction of the proposed Project would not result in impacts related to the need for new or physically altered

[1] Table 3-8 in Chapter 3, Project Description, Section 3.5.1.2 (Construction Methods for Well Facilities), describes the typical daily construction worker trips for each Project construction component/phase and identifies the facility sites to which that phase applies. The average daily construction workers was determined by multiplying the typical daily construction worker trips for each phase by the number of facility sites to which that phase applies. Then the results for all phases were added together. A total of 193 average daily construction workers is a conservative figure, because it assumes the simultaneous construction of all phases and all facility sites. Construction of all facilities would only overlap for a portion of the 21-month construction period.

governmental facilities in order to maintain existing levels of public services; therefore, no construction-related impacts would occur.

The proposed Project would not result in a permanent increase in the local population. Operation and post-construction maintenance activities would be similar to existing maintenance activities and would not result in substantial increases in the demand for public services, including law enforcement, fire protection, emergency services, or schools. Therefore, operational impacts related to public services are not applicable.

5.13.3.3 Construction and Operational Impacts and Mitigation Measures

As described above, implementation of the proposed Project would not result in impacts related to public services. Therefore, no mitigation measures related to this resource topic are required.

5.13.3.4 Cumulative Impacts and Mitigation Measures

Because the GSR Project would not result in Project-specific impacts related to public services, implementation of the Project would not contribute to cumulative impacts.

5.13.4 References

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5.14 BIOLOGICAL RESOURCES

This section describes the biological resources present in the vicinity of the proposed Project and evaluates the potential effects of construction and operation the proposed Project on biological resources. The discussion focuses on site-specific information pertaining to special-status wildlife and plant species and other protected biological resources (e.g., trees, wetlands, streams, habitats) potentially occurring in the Project vicinity. Included is a discussion of the existing plant communities, wildlife habitats, potentially occurring special-status plant and wildlife species, and natural communities at the Project facility sites, as well as the identification of mitigation measures, as applicable.

5.14.1 Setting

5.14.1.1 Definitions

Project area refers to the area that would experience Project-related temporary or permanent effects caused by surface disturbance, tree removal, or other alterations of habitat within the Project construction area.

Study area refers to the larger area within which biological resources could be subject to effects (e.g., disturbance to wildlife from construction-related noise). The study area for the proposed Project is the facility sites and the nearby areas surrounding the sites. The study area includes areas that would experience Project-related temporary or permanent effects caused by surface disturbance, tree removal, or other alterations of habitat within the construction area. The study area also includes lands surrounding the proposed facility sites with biological resources that could be subject to the Project's effects (e.g., disturbance to wildlife from construction-related noise). Typically, the study area in relation to biological resources encompasses habitats adjacent to the work zone which could support wildlife species whose life cycles may be substantially disrupted by construction activities or project operations.

Special-status biological resources include special-status plants, animals, and natural communities, plus wetlands and other waters of the United States and State, as defined by the U.S. Army Corps of Engineers (USACE), California Department of Fish and Wildlife (CDFW)[1], and the State Water Resources Control Board (SWRCB).

A special-status natural community is a natural habitat community that receives regulatory recognition from municipal, county, State, and/or federal entities, such as the CDFW's California Natural Diversity Database (CNDDB), because it is unique in its constituent components, restricted in distribution, supported by distinctive soil conditions, and/or considered locally rare.

[1] The California Department of Fish and Wildlife (CDFW) was known as the California Department of Fish and Game (CDFG) until January 1, 2013. CDFW documents published prior to that date are cited under the former name of CDFG.

Special-status plant and animal species are defined as:

- Species listed under the federal Endangered Species Act (FESA), Marine Mammal Protection Act, California Endangered Species Act (CESA), California Fish and Game Code (CFGC), and the California Native Plant Protection Act (NPPA) as endangered, threatened, or depleted; species that are candidates or proposed for listing; or species that are designated as rare or fully protected.

- Locally rare species, which may include species that are designated as sensitive, declining, rare, locally endemic, or as having limited or restricted distribution by various federal, State, and local agencies, organizations, and watch lists. This includes species on Lists 1B and 2 of the California Native Plant Society (CNPS).

5.14.1.2 Information Sources and Methods

Nineteen potential well facility sites (16 of which are proposed for development under the proposed Project) and one pump station upgrade site in northern San Mateo County were evaluated. The area within the construction boundary for the 20 sites, including the groundwater production well, pump station, underground distribution piping (including alternate pipeline connections), utility connections, access, and construction staging areas, was assessed for impacts on existing or potentially occurring biological resources, as well as impacts on habitat in areas surrounding each site.

Information about each site is based on the following:

- A CNDDB search for the San Francisco North, San Francisco South, Montara Mountain, and San Mateo 7.5 minute USGS quadrangles (CDFG 2011e);
- An assessment of habitat types and surrounding land uses using aerial photographs[2]; and
- Reconnaissance-level field surveys conducted by a qualified biologist on April 22, 23, and 25, 2009. Follow-up surveys were conducted on May 28, 2010, March 23, 2011, and March 4, 2012.

Additional information regarding special-status plants, animals, and habitats was compiled through a review of published literature of the California Department of Fish and Game (CDFG) (CDFG 2011a, 2011b, 2011c, 2011d), the CNPS (CNPS 2011), U.S. Fish and Wildlife Service (USFWS) (USFWS 2011a), and Corelli and Chandik (Corelli and Chandik 1995). Nomenclature for common, widespread plants and animals conforms to Hickman (Hickman 1993) and CDFG (CDFG 2005), respectively; plant names have been updated to conform to the Jepson Online Interchange[3]. Nomenclature for special-status plants conforms to CDFG (CDFG 2011a). Plant community names conform to Sawyer, et al. (Sawyer et al. 2009), Sawyer and Keeler-Wolf (Sawyer and Keeler-Wolf 1995), and Cowardin, et al. (Cowardin et al. 1979). Tables of potentially occurring special-status species were prepared using the CalBiota database (CalBiota 2011).

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[2] Source: GoogleEarth, images dated between 1993 and 2010
[3] Available online at http://ucjeps.berkeley.edu/interchange.html.

As noted above, reconnaissance-level surveys were performed at each facility site by a qualified biologist. Habitat types were classified and mapped, and observed plant and wildlife species were recorded. Trees rooted within, and adjacent to, the construction area boundaries were identified, mapped, and the trunk diameters measured and recorded. A separate Biological Survey Report was prepared for the Project (Ward & Associates 2012).

5.14.1.3 Plant Communities and Wildlife Habitats

The facility sites are mostly highly disturbed, being either paved or having been previously cleared and recolonized by primarily non-native plant species. The vegetation at most of the sites that are within the San Francisco Public Utility Commission's (SFPUC) right-of-way is routinely maintained by mowing or clearing, as is required under the SFPUC Integrated Vegetation Management Policy (SFPUC 2007). Some sites (e.g., Site 3, the area between Sites 6 and 7, and Sites 12, 13, 14, and 15) are mowed and maintained[4]. Other sites are paved or disturbed and not actively maintained, such as vacant lots. Habitats recorded during the surveys include ruderal, non-native annual grassland, and anthropogenic habitats. A single plant community dominated by native species, Central Coast riparian scrub is present adjacent to Sites 1, 6, 11, and 17 (Alternate). A discussion of relevant plant communities and their associated wildlife species is presented below. Aerial views of each Project site are presented in Figures 3-11 to 3-40 in Chapter 3, Project Description. Plant communities occurring at each facility site are identified in Table 5.14-1 (Plant Communities Present within or near Facility Sites and near Lake Merced).

[4] Site 3, the area between Sites 6 and 7, and Sites 13 and 14 are within the SFPUC right-of-way. Sites 12 and 15 are not located within the SFPUC right-of-way.

TABLE 5.14-1
Plant Communities Present within or near Facility Sites and near Lake Merced

Plant Community	Locations where Community is Present
Ruderal	Sites 1, 2, 3, 4, 6, 7, 8, 9, 12, 13, 15, 16, 17 (Alternate), 18 (Alternate), and Westlake Pump Station
Non-native annual grassland	Sites 8, 9, 10, 11, 17 (Alternate), 18 (Alternate), and 19 (Alternate)
Anthropogenic herbaceous/woodland	Sites 1, 3, 4, 6, 7, 11, 12, 13, 14, 15, and Westlake Pump Station. This community is also near Sites 10, 16, and 18 (Alternate).
None (i.e., paved/developed)	Sites 1, 2, 5, 6, 8, 10, 11, 12, 13, 14, 15, 16, and Westlake Pump Station
Central coast riparian scrub	Sites 1[(a)], 6[(a)], 11, and 17 (Alternate)[(a)]
Annual grassland	Lake Merced
Central dune scrub	Lake Merced
Coast live oak woodland	Lake Merced
Coastal scrub	Lake Merced
Developed	Lake Merced
Herbaceous	Lake Merced
Non-native forest	Lake Merced
Non-native scrub	Lake Merced
Perennial grassland	Lake Merced
Arroyo willow riparian scrub	Lake Merced
Bulrush wetland	Lake Merced
Cattail wetland	Lake Merced
Giant vetch wetland	Lake Merced
Swamp knotweed wetland	Lake Merced
Rush meadow	Lake Merced

Note:

(a) Habitat is isolated and not associated with a surface tributary.

Ruderal Habitat

Ruderal communities are found in areas from which the native vegetation has been completely removed by grading, filling, or clearing and are typical of vacant lots and roadsides (Holland and Keil 1990). Ruderal habitat is not specifically described by Sawyer and Keeler-Wolf (Sawyer and Keeler-Wolf 1995) and would be classified as upland following Cowardin, et al. (Cowardin et al. 1979). Left undeveloped, such areas typically become recolonized by invasive exotic species. Scattered native species might recolonize such sites after disturbance has ceased. Ruderal sites are typically dominated by herbaceous (i.e., non-woody) species, although scattered woody shrubs and trees may also begin to appear if left undisturbed long enough.

Ruderal habitat areas occurring within the study area are mostly sparsely vegetated. Characteristic herbaceous plants commonly identified include non-native species, such as wild radish (*Raphanus sativus*), foxtail barley (*Hordeum murinum*), ripgut brome (*Bromus diandrus*), wild oats (*Avena fatua*), cut-leaved plantain (*Plantago coronopus*), sweet fennel (*Foeniculum vulgare*), Italian thistle (*Carduus pycnocephalus*), bur clover *(Medicago polymorpha*), common vetch (*Vicia sativa*), crown daisy (*Chrysanthemum coronarium*), bristly ox-tongue (*Picris echioides*), red-stemmed filaree (*Erodium cicutarium*), and Italian ryegrass (*Lolium multiflorum*), among others. In many cases, ruderal habitat at facility sites is adjacent to, and merges with, landscaped lands (see discussion of Anthropogenic Habitats below).

Wildlife species associated with ruderal habitats in urban settings could include native mammals such as California ground squirrel (*Spermophilus beecheyi*) and Botta's pocket gopher (*Thomomys bottae*). Ground nesting or foraging birds such as house finch (*Carpodacus mexicanus*) or American goldfinch (*Carduelis tristis*) are expected. Raptors (predatory birds) may forage over ruderal areas, including red-shouldered hawk (*Buteo lineatus*), red-tailed hawk (*Buteo jamaicensis*), and American kestrel (*Falco sparverius*). Depending on cover opportunities, ruderal habitat may also support a variety of reptiles, such as western fence lizard (*Sceloporus occidentalis*), northern alligator lizard (*Elgaria coerulea*), common side-blotched lizard (*Uta stansburiana*), gopher snake (*Pituophis catenifer*), ring-necked snake (*Diadophis punctatus*), and terrestrial gartersnake (*Thamnophis elegans*).

Non-native wildlife species associated with ruderal habitats include Virginia opossum (*Didelphis virginiana*), Norway rat (*Rattus norvegicus*), and a variety of mice (*Mus* spp., *Perognathus* spp.). Ground nesting or foraging birds, such as European starling (*Sturnus vulgaris*), mourning dove (*Zenaida macroura*), house sparrow (*Passer domesticus*), and feral pigeon (*Columba livia*), are expected.

Ruderal habitat was identified on Sites 1, 2, 3, 4, 6, 7, 8, 9, 12, 13, 15, 16, 17 (Alternate), and 18 (Alternate) as well as at the Westlake Pump Station (see Table 5.14-1 [Plant Communities Present within or near Facility Sites and near Lake Merced]).

Non-native Annual Grassland

Non-native annual grassland is generally found in open areas in valleys and foothills throughout coastal and interior California (Holland 1986). Non-native annual grassland conforms to the California Annual Grassland series as described in Sawyer and Keeler-Wolf (Sawyer and Keeler-Wolf 1995) and would be classified as an upland plant association, following Cowardin, et al. (Cowardin et al. 1979). Although non-native annual grasslands can be found on a variety of other soil types, they typically occur on soils consisting of fine-textured loams or clays that are somewhat poorly drained (Holland 1986). This plant association is characterized by non-native annual grasses and weedy annual and perennial forbs, primarily of Mediterranean origin, that have replaced native perennial grasslands, scrub and woodland as a result of human disturbance. Scattered native wildflowers and grasses, representing remnants of the original vegetation, may also be common.

Within the sites owned by or within the SFPUC right-of-way, non-native annual grassland is similar to ruderal habitat. It is distinguished from ruderal habitat by the density of the vegetation, which is kept short through routine mowing. Characteristic herbaceous plants commonly identified include non-native grass species such as ripgut brome, wild oats, foxtail barley, Italian ryegrass, and rattail fescue (*Vulpia myuros*), and non-native forbs such as red-stemmed filaree, bur clover, rose clover (*Trifolium hirtum*), English plantain (*Plantago lanceolata*), common dandelion (*Taraxacum officinale*), and cut-leaved geranium (*Geranium dissectum*), among others. In many cases, non-native annual grassland habitat at facility sites is adjacent to, and merges with, ruderal and anthropogenic habitats.

Wildlife species associated with non-native annual grassland are similar to those described for ruderal habitat above. Additional native mammals that may occur in the urban setting of the study area include brush rabbit (*Sylvilagus bachmani*), meadow vole (*Microtus californicus*), striped skunk (*Mephitis mephitis*), and coyote (*Canis latrans*), as well as the non-native red fox (*Vulpes vulpes*). Grasslands provide foraging habitat for a wide variety of raptors and passerines (perching birds). Native raptors that can be expected to forage over grasslands in the area include red-tailed hawk, white-tailed kite (*Elanus leucurus*), short-eared owl (*Asio flammeus*), and barn owl (*Tyto alba*). Native passerines, such as mourning dove, rock dove (*Columba livia*), Brewer's blackbird (*Euphagus cyanocephalus*), northern mockingbird (*Mimus polyglottos*), American crow (*Corvus brachyrhynchos*), and black phoebe (*Sayornis nigricans*), are common visitors and residents within the study area.

Non-native annual grassland was identified on Sites 8, 9, 10, 11, 17 (Alternate), 18 (Alternate), and 19 (Alternate) (see Table 5.14-1 [Plant Communities Present within or near Facility Sites and near Lake Merced]).

Anthropogenic Herbaceous/Woodland Habitat

Anthropogenic plant associations are those dominated by plant species introduced by humans and established or maintained by human disturbances or activities (Holland and Keil 1990). This vegetation type is not classified by Sawyer and Keeler-Wolf (Sawyer and Keeler-Wolff 1995); it is classified as an upland following Cowardin, et al. (Cowardin et al. 1979). Some of these habitats are entirely artificial, such as areas under active cultivation (e.g., row crops, orchards, vineyards, and landscaped parks and gardens). Others include areas used as rangeland or pasture, ruderal, and areas influenced by urban or suburban landscaping or plantings. On such sites, the native vegetation has typically been removed by clearing in preparation for cultivation, landscaping, or development. Cleared areas that are planted with or colonized by non-indigenous plant species can create distinct communities dominated by annual grasses and forbs, shrubs, or trees. Some of these communities are only perpetuated with direct intervention, such as supplemental irrigation, mowing or livestock grazing, while others are capable of becoming naturalized (i.e., able to persist without human involvement). In some situations, introduced non-indigenous species invade adjacent native habitats, altering the composition of the native understory or canopy, or both.

Within the study area, anthropogenic habitats include open lawns areas associated with golf clubs, school play fields, and cemeteries. They also include ornamental shrub and tree plantings belonging to maintained gardens, as well as non-maintained or abandoned landscaped areas. In many cases, screen tree plantings around the open areas are tall and dense, comprising a woodland habitat in terms of potential wildlife usage.

Within the study area, the most commonly planted, non-indigenous trees in or adjacent to the facility sites are Monterey pine (*Pinus radiata*), Monterey cypress (*Cupressus macrocarpa*), and Tasmanian blue gum (*Eucalyptus globulus*). Other ornamental trees present include Canary Island pine (*P. canariensis*), Aleppo pine (*P. halepensis*), ever-blooming acacia (*Acacia retinodes*), horsetail casuarinas (*Casuarina equisetifolia*), Peruvian pepper (*Schinus molle*), myoporum (*Myoporum laetum*), Lombardy poplar (*Populus nigra*), and Torrey pine (*P. torreyana*), among others. A variety of ornamental shrubs and vines were identified on the facility sites, including pampas grass (*Cortaderia selloana*), Himalayan blackberry (*Rubus discolor*), Boston ivy (*Parthenocissus tricuspidata*), French broom (*Genista monspessulana*), Hottentot fig (*Carpobrotus edulis*), firethorn (*Pyracantha angustifolia*), and cotoneaster (*Cotoneaster* sp.). Invasive species identified include Bermuda buttercup (*Oxalis pescaprae*), veldtgrass (*Ehrharta erecta*), English ivy (*Hedera helix*), Algerian ivy (*H. canariensis*), Cape ivy (*Delairia odorata*), fumitory (*Fumaria officinalis*), and garden nasturtium (*Tropaeolum majus*)[5].

Many native and non-native wildlife species have adapted to human activities and can persist in anthropogenic habitats such as landscaped parks and yards. Such wildlife species can utilize ornamental landscapes for shelter, foraging, and breeding. In addition, some species can tolerate the conversion of natural ecosystems to anthropogenic habitats, and most will use landscaping or structural components (rock walls, ornamental trees, landscape bushes, woodpiles, and buildings) as escape cover, roosting sites, and nesting sites. Native species that readily adapt to landscaped terrain include Canada geese (*Branta canadensis*), barn owl, Botta's pocket gopher, raccoons (*Procyon lotor*), striped skunks, and mule deer (*Odocoileus hemionus*). Certain exotic species such as European starling, house sparrow, feral pigeon, house mouse (*Mus musculus*), Norway rat, and the Virginia opossum may occur in landscaped habitats close to human habitation. Under some circumstances, exotic rodents can represent significant forage sources for native and non-native predators.

The large and tall canopies associated with some eucalyptus trees provide good nesting habitat for larger native raptors including red-tailed hawk, red-shouldered hawk, great horned owl (*Bubo virginianus*) and golden eagle (*Aquila chrysaetos*). Additionally, some common smaller native passerine and corvid species such as western scrub jay (*Aphelocoma californica*), American crow, and raven (*Corvus corax*), will also use this tree for nesting. Particularly when situated near water, eucalyptus groves provide suitable roosting habitat for such native birds as great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), and great egret (*Ardea alba*). Eucalyptus trees also provide daytime foraging opportunities for a variety of native hummingbirds (*Calypte* spp.; *Selasphorus* spp.) and native passerines such as chestnut-backed chickadee (*Poecile rufescens*) and yellow-rumped warbler (*Dendroica coronata*).

Anthropogenic habitats were identified at Sites 1, 3, 4, 6, 7, 11, 12, 13, 14, 15, and the Westlake Pump Station (see Table 5.14-1 [Plant Communities Present within or near Facility Sites and near Lake Merced]).

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[5] Although Monterey pine, Torrey pine, and Monterey cypress are native to portions of California, specimens on site are planted as ornamentals and are not locally indigenous.

Central Coast Riparian Scrub

Central Coast riparian scrub typically consists of scrubby streamside, thickets composed of any of several species of willows. This plant community occurs close to river channels and near the coast on fine-grained sand and gravel bars with a high water table. It is distributed along and at the mouths of most perennial and many intermittent streams of the South Coast Ranges, from the San Francisco Bay Area to near Point Conception (Holland 1986) is generally regarded as early seral, meaning that it typically precedes the development of other riparian woodland or forest communities in the absence of severe flooding. However, outside of riparian situations, that is, near groundwater seeps, willow-dominated scrub represents a relatively stable plant community and is not considered seral (i.e., transitional between different plant assemblages).

Within the study area, Central Coast riparian scrub consists of dense stands dominated by arroyo willow (*Salix lasiolepis*) which conforms to the Arroyo Willow Series, as described in Sawyer and Keeler-Wolf (Sawyer and Keeler-Wolf 1995). Other plant species co-occurring with willows include Himalayan blackberry, California blackberry (*Rubus ursinus*), and Algerian ivy. Central Coast riparian scrub was identified near Sites 1, 6, 11, and 17 (Alternate). The willow stands adjacent to Sites 1, 6 and 17 (Alternate) are not associated with any surface water channel and are assumed to be supported by groundwater. The Central Coast riparian scrub habitat near Site 11 is associated with surface water runoff from nearby paved areas. Central Coast riparian scrub typically provides cover and nesting habitat for a variety of bird species. A variety of native passerine species can be expected to occur and nest in this habitat, including the black phoebe, white-crowned sparrow (*Zonotrichia leucophrys*), song sparrow (*Melospiza melodia*), yellow warbler, and yellow-rumped warbler. Urban-adapted mammals expected to occur within this habitat include the native raccoon and striped skunk, as well as non-native Virginia opossum and feral cats (*Felis silvestris catus*).

Lake and Freshwater Marsh

While not part of the proposed Project footprint, Lake Merced may be affected by the Project. Lake Merced is a natural lake that has been modified from historical conditions. Lake Merced is suitable habitat for aquatic wildlife, including native species such as mallard (*Anas platyrhynchos*), American coot (*Fulica americana*), great blue heron (*Ardea herodias*), grebe (*Podiceps* spp.), egret (*Egretta* spp.), and the non-native red-eared slider (*Trachemys scripta*). Special-status species that may be present include western pond turtle (*Actinemys marmorata)*, which is known to occur in Lake Merced. California red-legged frogs were known to occur historically at Lake Merced, but the species is now considered extirpated from the lake based on a lack of recent sightings, survey results since 2000, and the presence of predators, such as bullfrogs (Jones and Stokes 2007; San Francisco Planning Department 2011).

Freshwater marsh has largely vanished from San Francisco, but there are still areas of native bulrush-cattail marsh at Lake Merced. Freshwater emergent wetland habitat is valuable for many aquatic species, including nesting songbirds. For example, there are records of native species such as marsh wren (*Cistothorus palustris*), common yellowthroat (*Geothlypis trichas*), pied-billed grebes (*Podilymbus podiceps*), and ruddy duck (*Oxyura jamaicensis*) in Lake Merced marshes (San Francisco Field Ornithologists 2003). The Lake Merced fishery does not include special-status fish species.

Plant Communities near Lake Merced

Because lake levels at Lake Merced would be affected by the Project, information regarding the plant communities near Lake Merced is provided as shown on Figure 5.14.1 (Lake Merced 2012 Vegetation Types) and Figure 5.14-2 (Lake Merced Sensitive Habitats and Species). Plant communities and habitat types at Lake Merced are described below:

Annual Grassland

Annual grassland is present north of East Lake near Sunset Circle and on the west and east sides of Impound Lake. Dominant species include non-natives such as ripgut brome (*Bromus diandrus*), wild oats (*Avena fatua*), brome fescue (*Festuca bromoides*), hare's tail grass (*Lagurus ovatus*), cut-leaved geranium (*Geranium dissectum*), broadleaf filaree (*Erodium botrys*), sheep sorrel (*Rumex acetosella*), spring vetch (*Vicia sativa*), smooth cat's ear (*Hypochaeris glabra*), and wild radish. Native herbs include Canadian horseweed (*Conyza canadensis*), beach strawberry (*Fragaria chiloensis*), and annual lupine (*Lupinus bicolor*). Scattered native shrubs are present, including coyote brush (*Baccharis pilularis*) and dune bush lupine (*Lupinus chamissonis*). Annual grassland at Lake Merced would support a similar set of wildlife species as described above for anthropogenic areas.

Central Dune Scrub

Central dune scrub is present at Impound Lake, on the north side of East Lake and on the north side of North Lake, on very sandy soils. Dune scrub vegetation is located in restoration areas where dune plants have been planted. Dune scrub at Lake Merced is characterized by a mix of dune species with varying cover, including dune bush lupine, yellow lupine (*Lupinus arboreus*), coast buckwheat (*Eriogonum latifolium*), coyote brush, coastal sagewort (*Artemisia pycnocephala*), dune knotweed (*Polygonum paronychia*), California goldenbush (*Ericameria ericoides*), and lizard-tail (*Eriophyllum staechadifolium*). Characteristic herbs include California acaena (*Acaena pinnatifida* var. *californica*), contorted sun cup (*Camissonia contorta*), beach evening primrose (*Camissonia cheiranthifolia* subsp. *cheiranthifolia*), hairy gumweed (*Grindelia hirsutula* var. *hirsutula*), and seaside fiddleneck (*Amsinckia spectabilis* var. *spectabilis*). Dune scrub is highly variable in terms of which species are dominant or co-dominant. These areas contain high plant species diversity and high native species cover. Non-native herbs present in dune scrub vegetation include ripgut brome, soft chess (*Bromus hordeaceus*), rattlesnake grass (*Briza maxima*), wild oats, hare's tail grass, little quaking grass (*Briza minor*), and sheep sorrel. Central dune scrub at Lake Merced also supports several special-status plant species, including blue coast gilia (*Gilia capitata* subsp. *chamissonis*; CNPS List 1B.1), San Francisco spineflower (*Chorizanthe cuspidata* var. *cuspidata*; CNPS 1B.2), and dune tansy (*Tanacetum camphoratum*; locally rare). Central dune scrub at Lake Merced likely supports western fence lizard, garter snakes, small rodents such as mice and voles, and a variety of birds similar to those found in anthropogenic areas, as described above.

Coast Live Oak Woodland

Coast live oak woodland is present at Lake Merced on the northwest side of East Lake. These stands are characterized by native coast live oak (*Quercus agrifolia*) trees of different sizes that form a fairly continuous to intermittent canopy. The understory supports both native shrubs and herbs, including California blackberry (*Rubus ursinus*), California coffeeberry (*Frangula californica*), poison oak (*Toxicodendron diversilobum*), California manroot, bracken fern, and miner's lettuce (*Claytonia perfoliata* ssp. *intermontana*). Non-native species include English ivy (*Hedera helix*), fine-leaved fumitory (*Fumaria parviflora*), upright veldt grass (*Ehrharta erecta*), ripgut brome, Bermuda buttercup (*Oxalis pes-caprae*), common chickweed (*Stellaria media*), and rattlesnake grass (*Briza maxima*).

Coastal Scrub

Coastal scrub at Lake Merced is made up of 14 different vegetation types classified according to their dominant species, including native California blackberry scrub, California sage scrub, poison oak scrub, and coyote brush scrub. For the purpose of this EIR analysis, these scrub types were grouped together under the broader classification of coastal scrub and mapped as such (see Figure 5.14-1 [Lake Merced 2012 Vegetation Types]). However, three scrub types were also identified as sensitive resources because the CNPS considers their dominant species to be locally significant. These sensitive scrub types at Lake Merced are canyon live oak scrub, thimbleberry scrub, and wax myrtle scrub. Coastal scrub at Lake Merced likely supports a similar set of wildlife species as described above for anthropogenic areas, central dune scrub, and annual grasslands.

Developed

Some areas near Lake Merced are developed, for example, paved roads. Although paved roads themselves generally lack habitat for wildlife, wildlife occasionally cross roads to get to nearby landscaped habitat or non-native forest. Thus, developed areas often have similar wildlife species as the anthropogenic and non-native forest communities discussed above, but with lower rates of occurrence.

Non-native Forest

As described above, the non-native forest throughout the project area, including the Lake Merced area, is primarily comprised of blue gum eucalyptus, Monterey pine, and Monterey cypress (Monterey pine and Monterey cypress are native to California but not to the San Francisco area).

Non-native Herbaceous

Areas mapped as non-native herbaceous are dominated by weedy, non-native plant species; they can be difficult to characterize and are often temporary assemblages. In areas of frequent human disturbance, the majority of wild plants are often introduced weeds rather than natives. Around Lake Merced, this vegetation type was identified adjacent to developed areas such as sidewalks, roads, the golf club, and the Pacific Rod and Gun Club. Non-native plant species typical of ruderal vegetation in this area include ripgut brome, wild oats, soft chess (*Bromus hordeaceus*), hare barley (*Hordeum murinum* ssp. *leporinum*), Italian ryegrass (*Festuca perennis*), red-stemmed filaree, wild radish, black mustard, prickly lettuce (*Lactuca serriola*), bristly ox-tongue (*Helminthotheca echioides*), cheeseweed (*Malva parviflora*), rattlesnake grass, hare's tail grass (*Lagurus ovatus*), scarlet pimpernel, miner's lettuce, everlasting cudweed (*Pseudognaphalium luteoalbum*), red sand spurrey (*Spergularia rubra*), crimson clover (*Trifolium incarnatum*), cut-leaved geranium, spring vetch, kikuyu grass (*Pennisetum* *clandestinum*), cape ivy (*Delairea odorata*), poison hemlock (*Conium maculatum*), and iceplant (*Carpobrotus edulis*).

Non-native Scrub

The non-native scrub present at Lake Merced consists of Himalayan blackberry scrub. There are four areas of Himalayan blackberry scrub at Lake Merced, three of which are in the vicinity of the Pacific Rod and Gun Club; the other is near the Lake Merced Boathouse. Native species, including California blackberry and swamp knotweed, are present at low cover. Non-native herbs in the area include sheep sorrel (*Rumex acetosella*) and ripgut brome. Himalayan blackberry scrub is fairly uncommon around the lake compared to native California blackberry scrub. Blackberries provide food and dense protective cover for a variety of birds, particularly ground nesters such as California towhee.

Perennial Grassland

There is a small patch of perennial grassland on the north shore of East Lake at the base of a steep slope adjacent to stands of blue gum forest and rush meadow. The dominant species within this grassland is Vancouver rye, which is a hybrid between the native species American dunegrass (*Elymus mollis*) and creeping wildrye (*Elymus triticoides*). Other species include the native shrub California blackberry as well as the non-natives sheep sorrel, wild radish, ripgut brome, hairy vetch (*Vicia villosa* ssp. *villosa*), spiny sowthistle (*Sonchus asper*), and Zorro fescue (*Festuca myuros*). This patch of Vancouver rye grassland is too small to support a distinct wildlife species assemblage. However, this EIR analysis considers Vancouver rye grassland to be a sensitive resource due to its local rarity.

Arroyo Willow Riparian Scrub

This vegetation community is present at Lake Merced around all of the lakes, forming dense thickets with a continuous canopy of native arroyo willow (*Salix lasiolepis*). Arroyo willow riparian scrub is typically adjacent to bulrush wetland or swamp knotweed wetland. Additional native species such as California blackberry, California bulrush (*Schoenoplectus californicus*), swamp knotweed (*Persicaria coccinea*), bracken fern (*Pteridium aquilinum* var. *pubescens*), and California manroot (*Marah fabacea*) are also present. Arroyo willow riparian scrub at Lake Merced is important habitat for migratory and resident birds, including Townsend's warbler (*Dendroica townsendi*), ruby-crowned kinglet (*Regulus calendula*), green heron (*Butorides virescens*), western kingbird (*Tyrannus verticalis*), and warbling vireo (*Vireo gilvus*).

Bulrush Wetland

Bulrush wetland is the most abundant wetland herbaceous vegetation type mapped at Lake Merced. Bulrush wetland forms an emergent, almost continuous band along the margin of the lakes, with the exception of the east side of South Lake. California bulrush is dominant, with swamp knotweed and scattered tules (*Schoenoplectus acutus* var. *occidentalis*) also present. The wildlife species using this vegetation type at Lake Merced are described above under the heading "Lake and Freshwater Marsh."

Cattail Wetland

A small cattail wetland was mapped at Lake Merced on the east side of South Lake. This wetland is near the Tournament Players Cup Harding Park on the edge of the lake in an area of standing water. The stand is dominated by the native broadleaf cattail (*Typha latifolia*), with small amounts of swamp knotweed and California bulrush.

Giant Vetch Wetland

Giant vetch wetland is present on the north and south shores of East Lake and North Lake, growing as dense stands adjacent to bulrush wetlands. Giant vetch (*Vicia gigantea*) (native) wetland occurs at the base of a steep slope covered with the native California sagebrush (*Artemisia californica*) scrub. Other native species within this vegetation community include bracken fern and California blackberry and small amounts of California bulrush, bee plant (*Scrophularia californica*), and Hooker's evening primrose (*Oenothera elata* ssp. *hookeri*). The non-natives black mustard (*Brassica nigra*) and wild radish are also present. This vegetation type may support Sierran treefrog (*Pseudacris sierra*), garter snake, and seed-eating birds such as house finch.

Swamp Knotweed Wetland

This vegetation community is abundant along the margins of the lakes making up Lake Merced, growing as emergent vegetation often interspersed with bulrush wetland. Swamp knotweed is the dominant species in this community. Natives such as California bulrush, stinging nettle (*Urtica dioica* ssp. *holosericea*), Pacific rush (*Juncus effusus* var. *pacificus*), and Pacific oenanthe (*Oenanthe sarmentosa*) are also present. Swamp knotweed also occurs in slightly elevated adjacent habitats that are moist but not inundated. This vegetation type supports similar wildlife as described above for freshwater marsh.

Rush Meadow

Rush meadow was mapped at Lake Merced on North, East, and Impound Lakes. This community is generally located on the margin of the lake just above bulrush wetland and swamp knotweed wetland. The native Baltic rush (*Juncus balticus*) is dominant in the herbaceous layer. California blackberry is also present. This vegetation type may support Sierran treefrog (*Pseudacris sierra*), garter snake, and seed-eating birds such as lesser goldfinch (*Carduelis psaltria*).

5.14.1.4 Special-status Plant Species

The laws comprising California's legal framework and authority for plant species conservation include the FESA, CESA, the NPPA, and the California Environmental Quality Act (CEQA). Special-status plants include: those listed as endangered, threatened, or rare; those listed as candidates for listing under FESA or CESA; those listed as rare under the NPPA; those meeting the definition of rare or endangered under

CEQA[6]; and those considered locally significant (CDFG 2009). Lists of special-status species are maintained by the USFWS (USFWS 2011a), CDFG (CDFG 2011a, 2011b, 2011f), and CNPS (CNPS 2011).

Based on a review of special-status plant species in San Mateo County (CDFG 2011f; CNPS 2011), the potential for occurrence of 72 special-status plant species within the study area was evaluated. No federally or State-listed plant species were identified within the construction area boundaries and none is expected to occur within the study area based on a lack of suitable habitat. None of the other special-status plant species (e.g., locally significant) is expected to occur at any of the facility sites due to the fact that no suitable habitat is present and/or because they would have been detectable during the present survey. A summary of the status, habitat affinities, reported localities in the study area, blooming period, and potential for occurrence within the study area for each of the 72 plant species and those with a low potential to occur is presented in Appendix F (Special-status Species Tables), of this EIR.

The proposed Significant Natural Resource Areas surrounding Lake Merced support two special-status plant species: San Francisco spineflower, a CNPS Rare Plant Rank 1B.2 species, and blue coast gilia, a CNPS Rare Plant Rank 1B.1 species. In addition, several locally rare species, designated as such by the Yerba Buena Chapter of the CNPS, are also found at Lake Merced. These include San Francisco wallflower (*Erysimum franciscanum*), dune tansy (*Tanacetum camphoratum*), California pipevine (*Aristolochia californica*), Wight's paintbrush (*Castilleja wightii*), Vancouver rye (*Leymus* x *vancouverensis*), wild cucumber (*Marah oreganus*), canyon live oak (*Quercus chrysolepis*), coastal black gooseberry (*Ribes divaricatum*), and thimbleberry (*Rubus parviflorus*). These species occur in areas of dune scrub or coastal scrub located at Lake Merced.

5.14.1.5 Special-status Animal Species

Based on a review of the CNDDB (CDFG 2011f), the potential for occurrence of 51 special-status animal species in the study area was evaluated. A summary of the formal status, habitat affinities, reported localities close to the facility vicinity, and potential for occurrence within the study area for each of the 51 special-status animal species is presented in Appendix F (Special-status Species Tables), of this EIR. Of the 51 species, 13 species are federally or State-listed species and none of the listed species have suitable habitat within the Project area or study area. The white-tailed kite, a fully protected species under the CFGC, may occur within the facility sites. Of the remaining non-listed, special-status species, the presence of eight other species could not be ruled out, due to the presence of suitable habitat at one or more of the facility sites. The potentially occurring species are listed in Table 5.14-2 (Special-status Animal Species Potentially Occurring within or near Facility Sites or at Lake Merced), and each species is discussed in more detail following the table.

[6] CEQA §15380(b) and (d)

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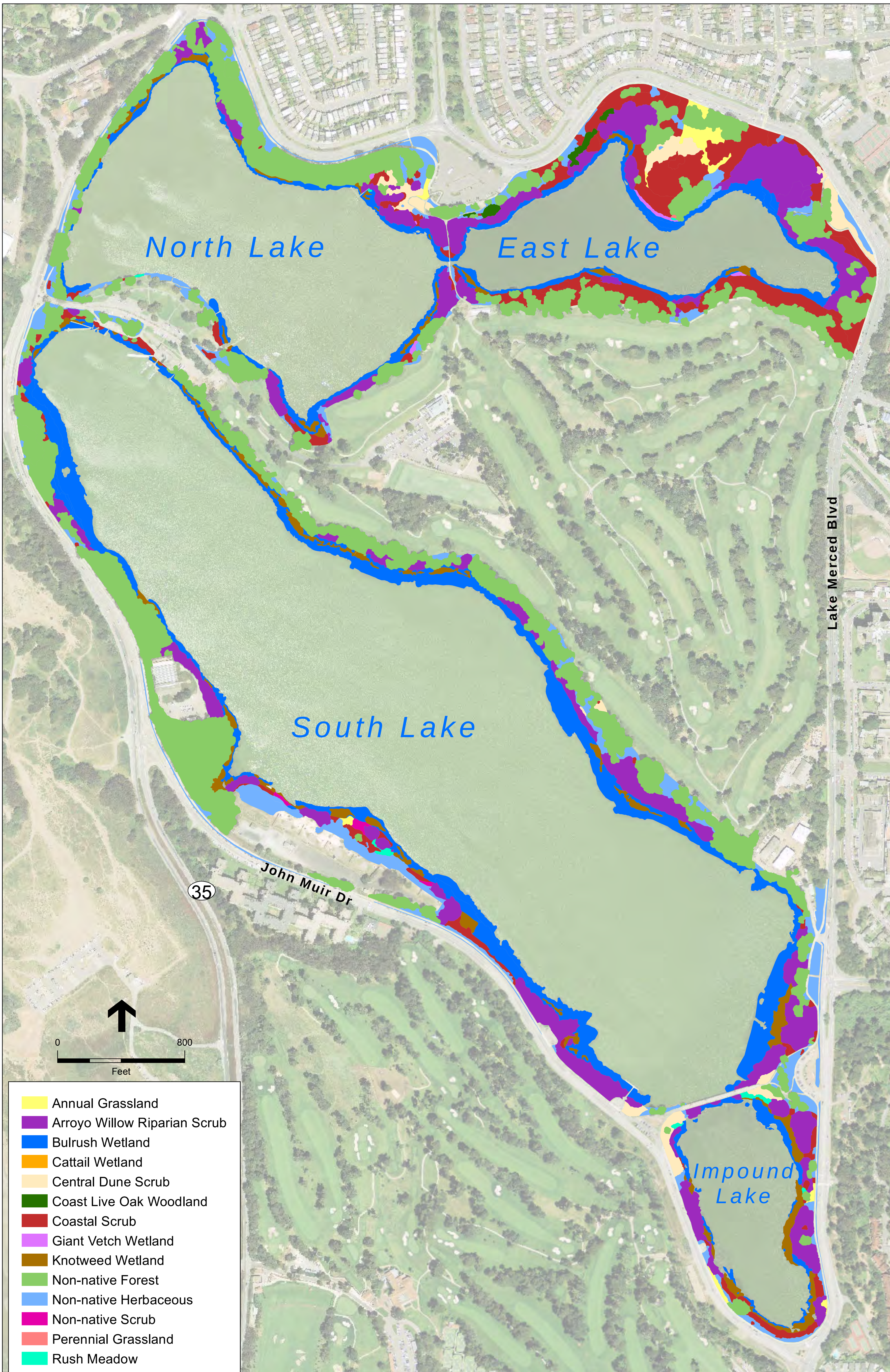

Lake Merced
2012 Vegetation

Regional Groundwater Storage and Recovery Project

Figure 5.14-1

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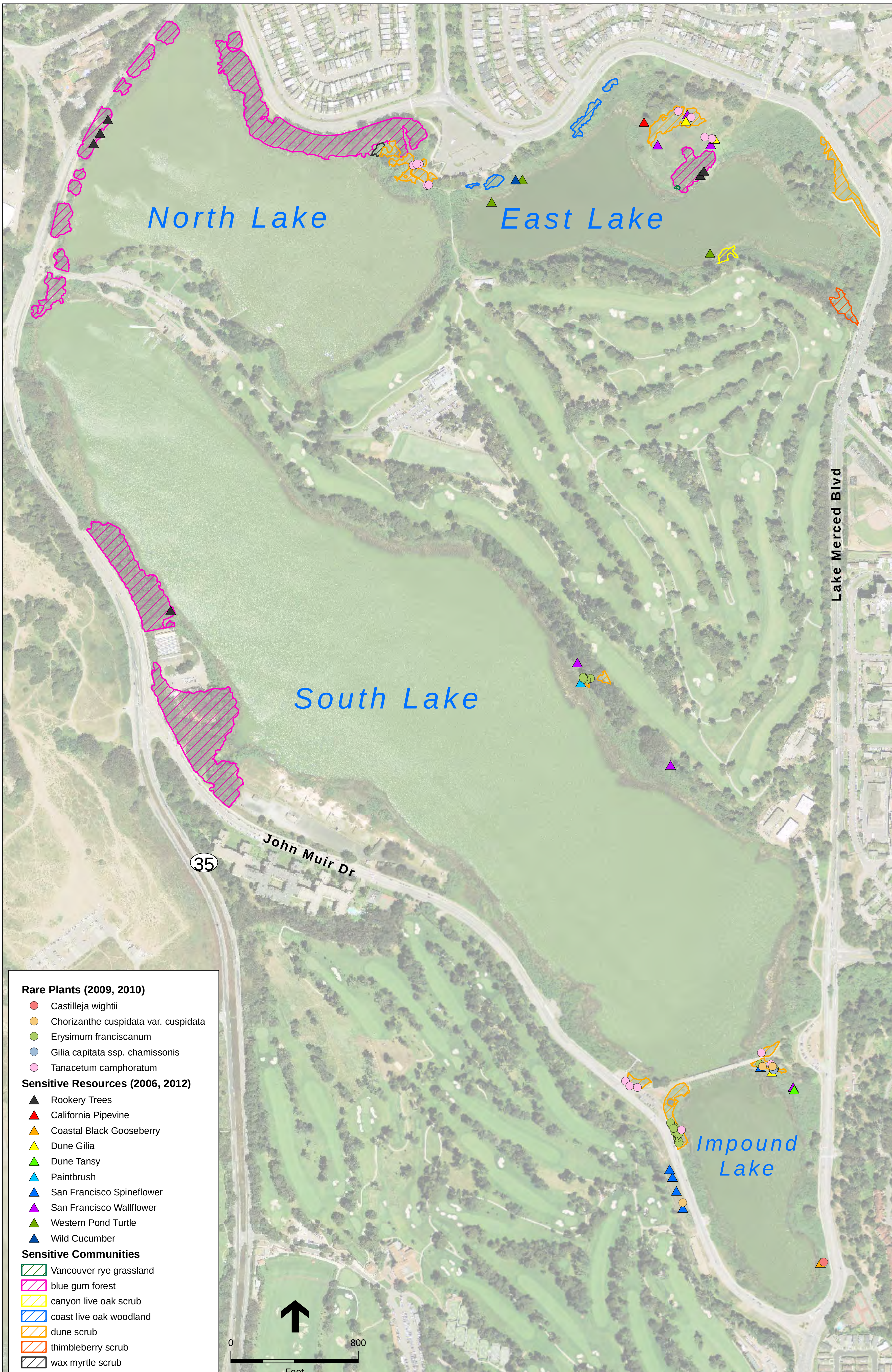

* See Figure 5.14-1 for Wetlands Locations

Lake Merced Sensitive Habitats and Species

Regional Groundwater Storage and Recovery Project

Figure 5.14-2

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TABLE 5.14-2
Special-status Animal Species Potentially Occurring within or near Facility Sites[(a)] or at Lake Merced

Common Name	Scientific Name	Location
State-listed Species		
White-tailed kite	*Elanus leucurus*	All Sites except Site 5
Other Special-status Species		
Monarch butterfly	*Danaus plexippus*	Sites 1, 3, 7, 10, and 12
Western pond turtle	*Actinemys marmorata*	Lake Merced
Oak titmouse	*Baeolophus inornatus*	All Sites except Site 5
Loggerhead shrike	*Lanius ludovicianus*	All Sites except Site 5
Allen's hummingbird	*Selasphorus sasin*	All Sites
California thrasher	*Toxostoma redivivum*	All Sites except Site 5
Migratory and special-status birds (see description below)		Lake Merced
Pallid bat	*Antrozous pallidus*	Sites 1, 3, 4, 7, 10, 11, 12, 15, 16, and Westlake Pump Station
Western red bat	*Lasiurus blossevillii*	Sites 1, 3, 4, 7, 10, 11, 12, 15, 16, Westlake Pump Station, and Lake Merced
Hoary bat	*Lasiurus cinereus*	Sites 1, 3, 4, 7, 10, 11, 12, 15, 16, and Westlake Pump Station
Yuma myotis	*Myotis yumanensis*	Lake Merced

Note:
(a) Includes facility sites with both suitable and marginally suitable habitat.

White-tailed Kite

White-tailed kite is listed by the CDFW as a fully protected bird species[7] and is protected under the Migratory Bird Treaty Act (MBTA) and the CFGC.[8] In the United States, white-tailed kites occur in California and Texas, with a separated group in Florida; the species has expanded its range into Washington and Oregon (Dunk 1995). Generally, white-tailed kites are observed in low elevation grasslands, agricultural, wetland, oak-woodland, or savannah habitats. The majority of their diet is made up of small mammals. This species nests in a wide variety of trees and, in some cases, shrubs. Nests usually consist of platforms of small sticks, leaves, weed stalks, and similar materials lined with grass, hay, or leaves. This species nests from February through August, with a peak in breeding occurring from late March through July.

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[7] CFGC §3511
[8] CFGC §3503.5

Although not observed during the reconnaissance-level survey, suitable nesting habitat for white-tailed kite is present in wooded areas with snags (i.e., dead, standing tree trunks) at or near facility sites. Specifically, nesting could occur at or near Sites 1 through 4, 6 through 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station.

Monarch Butterfly

The monarch butterfly is listed as a special animal by the CDFG (CDFG 2011c). This butterfly occupies winter roost sites along the Pacific coast from northern Mendocino County to Baja California, Mexico. Monarch butterflies begin to congregate in the fall in dense groves of trees (e.g., eucalyptus, Monterey pine, Monterey cypress) that provide shelter from prevailing winds and at sites with nectar and water sources nearby (CDFG 2011f). By February or early March, they resume their migration. Although, per the CDFW's CNDDB, there is no record of overwintering monarch butterflies in the vicinity of any of the facility sites, suitable stands of trees are present at Sites 1, 7, and 12. Suitable or marginally suitable habitat is also present adjacent to Sites 3 and 10.

Western Pond Turtle

This species—a California species of special concern—inhabits rivers, streams, natural and artificial ponds, and lakes. Adjacent terrestrial habitat is also critical for oviposition,[9] winter refuge, and dispersal. Although suitable habitat is not present within the proposed Project boundaries, this species occurs in Lake Merced (SFRPD 2006).

Oak Titmouse

The oak titmouse is listed as a special animal by the CDFG (CDFG 2011c) and is protected under the MBTA and CFGC.[10] The primary habitat for the oak titmouse includes warm, dry open woodlands typically characterized by oak or oak-pine woodlands. Nests are situated in natural or excavated cavities in trunks, primary and secondary branches, and stumps (Cicero 2000). Although not observed during the reconnaissance-level surveys, marginally suitable foraging and nesting habitat is present for oak titmouse in the wooded areas with trees and snags at or adjacent to Sites 1 through 4, 6 through 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station.

Loggerhead Shrike

Loggerhead shrike is listed as a Species of Special Concern by the CDFG (CDFG 2011c) and is protected under the MBTA and CFGC.[11] Loggerhead shrikes occur throughout California lowlands and foothills in open habitats such as grasslands, pastures with fence rows, old orchards, mowed roadsides, cemeteries, golf clubs, riparian areas and open woodlands (Yosef 1996). They are commonly observed perching on shrubs, trees, posts, fences, and utility lines. The species typically nests in densely vegetated, isolated

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[9] The process of by which certain animals lay eggs.
[10] CFGC §3503
[11] CFGC §3503

trees and shrubs and occasionally man-made structures. The nesting season ranges from February through July. Loggerhead shrikes feed on a variety of small prey including arthropods, mammals, amphibians, reptiles, and birds (Yosef 1996).

Although not observed during the reconnaissance-level surveys, marginally suitable nesting habitat for the loggerhead shrike is present in the vegetation, trees and shrubs at or adjacent to Sites 1 through 4, 6 through 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station.

Allen's Hummingbird

Allen's hummingbird is listed as a Species of Special Concern by the CDFG (CDFG 2011c) and is protected under the MBTA and CFGC.[12] It is a common summer resident (January to July) and migrant along most of the California coast. Breeding Allen's hummingbirds are most common in coastal scrub, valley foothill hardwood, and valley foothill riparian habitats, but also are common in closed-cone pine-cypress, urban, and redwood habitats. The species occurs in a variety of woodland and scrub habitats as a migrant. Although mostly coastal in migration, Allen's hummingbird is fairly common in the southern mountains in the summer and fall migrations and a few occur regularly in the Sierra Nevada.

Although not observed during the reconnaissance-level surveys, suitable nesting and foraging habitat for Allen's hummingbird is present in the trees and shrubs at or adjacent to each of the facility sites.

California Thrasher

The California thrasher is listed as a Species of Special Concern by CDFG (CDFG 2011c) and it is protected under the MBTA and CFGC.[13] This relatively common resident of foothills and lowlands occupies moderate to dense chaparral habitat and, less commonly, extensive riparian thickets, especially with blackberry patches. It nests close to the ground and feeds on invertebrates, acorns, and the seeds of forbs. California thrasher occurs across the length of California. Along the coastal fog belt north of San Francisco, it is restricted to drier sites.

Although not observed during the reconnaissance-level surveys, suitable nesting and foraging habitat for California thrasher is present in the shrubs at or adjacent to Sites 1 through 4, 6 through 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station.

Migratory and Special-status Birds

Several non-special-status migratory birds could nest in or adjacent to Lake Merced. Several raptors are known to nest in San Francisco, including red-tailed hawk (*Buteo jamaicensis*) red-shouldered hawk (*Buteo lineatus*), American kestrel (*Falco sparverius*), Cooper's hawk (*Accipiter cooperi*) and great horned owl (*Bubo virginianus*). In addition, saltmarsh common yellowthroats (*Geolthlypis trichas sinuosa*) (a former federal species of concern and current California species of special concern) are known to nest in the wetlands

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[12] CFGC §3503
[13] CFGC §3503

along the periphery of Lake Merced (CDFG 2011e), and there is a double-crested cormorant (*Phalacrocorax auritus*) rookery in trees at Lake Merced (SFRPD 2006). Additional native birds may also nest in the area. The federal Migratory Bird Treaty Act (MBTA) and CFGC protect raptors and most native migratory birds and breeding birds (see Section 5.14.2 [Regulatory Framework] below).

Bats

Of the 25 known bat species in California, 21 appear on the State's special animals list (CDFG 2011c). In general, bats are classified as non-game mammals and are afforded protection under various sections of the CFGC (§3503). They also receive protection under the California Code of Regulations (CCR)[14] and the California Public Resources Code, Division 13. Federally or State-listed bat species are protected under FESA or CESA, respectively. Impacts to any special-status bat species would be deemed significant under CEQA and must be addressed in environmental review documents.

Mature trees within the study area provide potential roosting habitat for special-status bat species. Specifically, snags, tree cavities, and deep cracks in tree bark provide nocturnal, seasonal, or maternal roosting sites for bats. In addition to natural features, many bat species have adapted to using man-made structures such as buildings and bridges. Large trees present on or near many of the facility sites, especially the Monterey cypress trees, provide potential bat roosting habitat. Three special-status species, the pallid bat, western red bat, and hoary bat, are considered to have some potential to roost on or near several of the facility sites. Specifically, these species are of concern at Sites 1, 3, 4, 7, 10, 11, 12, 15, 16, and at the Westlake Pump Station.

Pallid Bat

Pallid bat is listed as a Species of Special Concern by CDFG (CDFG 2011c). It is a locally common inhabitant of low elevations throughout California and is a year-round resident in most of its range. This mostly solitary species is most common in open, dry habitats with rocky areas for roosting, although it can be found in a wide variety of habitats including grasslands, shrublands, woodlands, and forests. Day roosts include caves, rock crevices, mines, and occasionally tree cavities. Night roosts may be more open sites, including porches and open buildings. Maternity colonies can be found from as early as April through July; maternity colonies disband between August and October. No maternity colonies have been recorded in the Project vicinity and only two records dating to the 1940s have been reported from San Mateo County (Ward & Associates 2012).

Western Red Bat

The western red bat is listed as a Species of Special Concern by CDFG (CDFG 2011c). It is locally common in some portions of California, where it ranges from Shasta County to the Mexican border, west and east of the highest mountain elevations. Roosting habitat includes forests and woodlands from sea level up through mixed conifer forests.

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[14] Title 14, §251.1, Article 20, §§ 15380 and 15382

Western red bats roost primarily in trees, often in edge habitats adjacent to streams, fields, or urban areas. Preferred roosting sites are 2 to 40 feet above the ground, covered above, open below, and located above dark groundcover. Western red bats mate in late summer and early fall, with young born late May through early July. In recent surveys, this species was one of the most commonly encountered bat species in San Francisco (Krauel 2009), especially in parks with water bodies such as lakes.

Hoary Bat

Hoary bat is listed as a special animal by the CDFG (CDFG 2011c). It is the most widespread North American bat and may be found throughout all of California. This solitary species winters in coastal and southern California. Hoary bats roost in dense foliage of medium to large trees, hidden from above, with few branches below and with dark ground cover. They mate in autumn, with young born late May through early July.

Yuma Myotis

Roosting habitat is available in tree/shrub foliage at Lake Merced. In recent surveys, this species was one of the most commonly encountered bat species in San Francisco (Krauel 2009), especially in parks with water bodies such as lakes.

5.14.1.6 Special-status Natural Communities

Special-status natural communities are defined as those that have limited distribution in the region, support special-status plant or wildlife species, or receive regulatory protection. Examples would include waters of the United States covered under Section 404 of the federal Clean Water Act (CWA) and/or waters of the State[15] covered under Section 1600 et seq., of the CFGC and the Porter-Cologne Water Quality Control Act (Water Code Sections 13000–14920). The CNDDB has ranked a number of natural communities in terms of their significance and rarity (CDFG 2010).

The only special-status natural community in the study area is the Central Coast riparian scrub habitat, discussed above under Section 5.14.1.3 (Plant Communities and Wildlife Habitat).

5.14.1.7 Wetlands and Waters

No wetlands or open waters regulated under federal or State law were identified within any of the construction areas for the facility sites during field surveys. At Site 8, a tributary to Colma Creek runs beneath a portion of the construction area in a buried culvert and is a jurisdictional water of the United States, and possibly a jurisdictional water of the State.

[15] Waters of the State are defined as "any surface water or groundwater, including saline waters, within the boundaries of the state" California Water Code Section 13050(e). These include nearly every surface or groundwater in California, or tributaries thereto, and include drainage features outside USACE jurisdiction (e.g., dry and ephemeral/seasonal stream beds and channels, etc.), isolated wetlands (e.g., vernal pools, seeps, springs and other groundwater-supplied wetlands, etc.), and natural and artificial channels.

Surface water tributaries[16] consisting of flood control channels are near Sites 9 and 11. The construction area at Site 9 is flanked by the Colma Creek Diversion Channel on the east and the San Mateo County Flood Control Channel on the west; the banks of both channels are concrete. Site 11 is approximately 190 feet from the Colma Creek Flood Control Channel at a location where the creekbed has also been concrete lined. Site 11 is also close to a small drainage that appears to originate from the Kaiser Permanente Medical Center garage and parking lot which supports a small area of Central Coast Riparian Scrub habitat. All three tributaries fall under the jurisdiction of the USACE and under the jurisdiction of the San Francisco Bay Regional Water Quality Control Board (RWQCB) and CDFW.

5.14.1.8 Trees

Many of the facility sites support mature ornamental and non-native tree species; none of the trees is locally indigenous or a remnant of a native stand. A tree inventory prepared for the Project indicates that a total of 145 trees are present within the construction area of the facility sites, with another 63 trees having canopies that overhang the construction areas that could require trimming during construction (Ward & Associates 2012). The tree species recorded at or adjacent to the proposed facility sites include: Monterey pine, Japanese black pine, Torrey pine (*Pinus torreyana*), Aleppo pine (*Pinus halepensis*), Monterey cypress (*Cupressus macrocarpa*), Italian stone pine (*Pinus pinea*), Canary Island pine (*Pinus canariensis*), spruce (*Picea sp.*), horsetail casuarinas (*Casuarina equisetifolia*), eucalyptus (*Eucalyptus sp.*), Lombardy poplar (*Populus nigra*), acacia (*Acacia sp.*), Peruvian pepper (*Schinus molle*), myoporum (*Myoporum sp*), cotoneaster (*Cotoneaster sp*), plum (*Prunus sp.*), pittosporum (*Pittosporum sp.*), Spanish bayonette (*Yucca aloifolia*), olive (*Olea sp.*), and elm (*Ulmus sp.*).

5.14.1.9 Wildlife Movement Corridors

Wildlife corridors are important for persistence of wildlife over time. These are linear habitats that naturally connect and provide passage between two or more large habitats or habitat fragments. These corridors are used by wildlife to find suitable forage, nesting and resting sites, mates, and new home ranges. In addition, wildlife corridors are used for dispersal for breeding populations, which will decrease the likelihood that subpopulations will go extinct or become locally extirpated. Even where patches of pristine habitat are fragmented, as commonly occurs with riparian vegetation, wildlife movement between populations is facilitated through habitat linkages, migration corridors, and movement corridors.

Wildlife movement includes migration (i.e., usually one direction per season), inter-population movement (i.e., long-term genetic exchange), and small travel pathways (i.e., daily movement within an animal's home range). Daily movement patterns define an animal's home range where activities such as foraging, resting, and interactions between individuals of the same species occur. Generally, longer movements by dispersing individuals connect breeding populations, permitting gene flow between these subpopulations. Corridors generally provide adequate habitat for animals to disperse until reaching an area large enough to establish home ranges. Corridors are different depending on what type of organism

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16 A stream that contributes its water to another stream or body of water.

may use it; a corridor for a butterfly or bird may be a series of "stepping stones" of suitable habitat, while a terrestrial vertebrate may need a continuous band of suitable habitat for successful movement. Habitat loss, fragmentation, and degradation resulting from a change in land use or habitat conversion can alter the use and viability of corridors.

None of the facility sites are within any significant wildlife movement corridors; however, two sites are located near surface water which may provide some marginal wildlife movement. Sites 9 and 11 are located near Colma Creek. Colma Creek has been contained in the Colma Creek Diversion Channel, flowing through a series of concrete lined channels and underground storm drains. Both sites are located near portions of the Colma Creek open channel. The short stretch of surface water near Site 9 does not provide for significant wildlife movement as the channel consists of a concrete lined open box culvert, and it provides no vegetative cover. At Site 11, although water flows through an open channel near the site, the channel does not serve as a major wildlife migration corridor as it connects only to the Kaiser Permanente Medical Center garage and parking lot.

5.14.2 Regulatory Framework

5.14.2.1 Federal

U.S. Army Corps of Engineers

Section 404 of the Clean Water Act

Proposed discharges of dredged or fill material into waters of the United States require USACE authorization under Section 404 of the CWA (33 U.S.C. 1344). Waters of the United States generally include tidal waters, lakes, ponds, rivers, streams (including intermittent streams), and wetlands (with the exception of isolated wetlands).

The USACE identifies wetlands using a "multi-parameter approach," which requires positive wetland indicators in three distinct environmental categories: hydrology, soils, and vegetation. According to the *Corps of Engineers Federal Wetlands Delineation Manual*, except in certain situations, all three parameters must be satisfied for an area to be considered a jurisdictional wetland (Environmental Laboratory 1987). The *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* is also utilized when conducting jurisdictional wetland determinations in areas identified within the boundaries of the arid west (USACE 2008). The study area falls within the arid west region (which includes most of the Central California Coast and inland) and, therefore, wetlands identified on the site were delineated using the arid west guidance and the federal manual.

Executive Order 11990, Protection of Wetlands

Executive Order 11990 provides for the protection of wetlands. The administering agency for this Order is the USACE.

U.S. Fish and Wildlife Service

Federal Endangered Species Act

The FESA of 1973 recognizes that many species of fish, wildlife, and plants are in danger of or threatened with extinction and establishes a national policy that all federal agencies should work toward conservation of these species. The Secretary of the Interior and the Secretary of Commerce are designated in FESA as responsible for identifying endangered and threatened species and their critical habitats, carrying out programs for the conservation of these species, and rendering opinions regarding the impact of proposed federal actions on endangered species. FESA also outlines what constitutes unlawful taking, importation, sale, and possession of endangered species and specifies civil and criminal penalties for unlawful activities.

Biological assessments are required under Section 7(c) of FESA if listed species or critical habitat may be present in the area affected by any major construction activity conducted by, or subject to issuance of a permit from, a federal agency as defined in Part 404.02. Under Section 7(a)(3) of FESA every federal agency is required to consult with the USFWS or National Marine Fisheries Service (NMFS) on a proposed action if the agency determines that its proposed action may affect an endangered or threatened species.

Section 9 of FESA prohibits the "take" of any fish or wildlife species listed under the FESA as endangered or threatened. Take, as defined by the FESA, means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such action." However, Section 10 allows for the "incidental take" of endangered and threatened species of wildlife by non-federal entities. Incidental take is defined by the FESA as take that is "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." Section 10(a)(2)(A) requires an applicant for an incidental take permit to submit a "conservation plan" that specifies, among other things, the impacts that are likely to result from the taking and the measures the permit applicant will undertake to minimize and mitigate such impacts. Section 10(a)(2)(B) provides statutory criteria that must be satisfied before an incidental take permit can be issued.

Migratory Bird Treaty Act

The MBTA (16 USC 703–711; 50 CFR Subchapter B), includes provisions for the protection of migratory birds, including basic prohibitions against any taking not authorized by federal regulation. The administering agency for the above authority is the USFWS. There are several migratory bird species that might use habitat potentially occurring in the study area or that could be affected by Project construction. These species include oak titmouse, white-tailed kite, loggerhead shrike, Allen's hummingbird, and California thrasher.

National Oceanic and Atmospheric Administration (NOAA)

The U.S. Congress passed the Coastal Zone Management Act (CZMA) in 1972. The CZMA, administered by the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource

Management, provides for management of the nation's coastal resources, including the Great Lakes, and balances economic development with environmental conservation.

The CZMA outlines two national programs, the National Coastal Zone Management Program and the National Estuarine Research Reserve System. The Coastal Zone Management Programs aim to balance competing land and water issues in the coastal zone, while estuarine reserves serve as field laboratories to provide a greater understanding of estuaries and how humans affect them. The overall program objectives of CZMA remain balanced to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone."

Coastal states prepare coastal management programs under the CZMA. Once the federal government approves a state's coastal management program, that state gains federal consistency-review authority. California's Coastal Management Program, federally approved in 1977, designates two coastal zone management agencies to implement the federal consistency provisions: (1) the California Coastal Commission (CCC) for all coastal areas outside San Francisco Bay; and (2) BCDC for the coastal areas along San Francisco Bay. CCC's mission is to "Protect, conserve, restore, and enhance environmental and human-based resources of the California coast and ocean for environmentally sustainable and prudent use by current and future generations."

5.14.2.2 State

California Environmental Quality Act

The laws comprising California's legal framework and authority for plant species conservation include the FESA, CESA, NPPA, and CEQA. Special-status plants include those listed as endangered, the California Native threatened, or rare or as candidates for listing under FESA[17] or CESA[18] (CDFG 2011b), those listed as rare under the NPPA[19], those that meet the definition of rare or endangered under CEQA,[20] and species considered to be locally significant[21] (CDFG 2009). Plant species routinely regarded as having special-status include plants listed by the CDFG (CDFG 2011a), as well as those found on lists 1B and 2 of the CNPS (CNPS 2011).

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[17] 50 CFR§17.12
[18] California Fish and Game Code §2050, *et seq.*
[19] California Fish and Game Code §1900, *et seq.*
[20] §15380(b) and (d)
[21] As specified under CEQA §15125(c) or CEQA Guidelines, Appendix G

Rare or endangered species are defined in the CEQA Guidelines (Section 15380) as follows:

(a) "Species" as used in this section means a species or subspecies of animal or plant or variety of plant.

(b) A species of animal or plant is:

(1) "Endangered" when its survival and reproduction in the wild are in immediate jeopardy from one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, disease, or other factors; or

(2) "Rare" when either:

(A) Although not presently threatened with extinction, the species is existing in such small numbers throughout all or a significant portion of its range that it may become endangered if its environment worsens; or

(B) The species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range and may be considered "threatened" as that term is used in the federal Endangered Species Act.

(c) A species of animal or plant shall be presumed to be rare or endangered if it is listed in:

(1) Sections 670.2 or 670.5, Title 14, California Administrative Code;

or

(2) Title 50, Code of Federal Regulations Sections 17.11 or 17.12 pursuant to the federal Endangered Species Act as rare, threatened, or endangered.

(d) A species not included in any listing identified in subsection (c) shall nevertheless be considered to be rare or endangered if the species can be shown to meet the criteria in subsection (b).

The CEQA Guidelines, under Section 15065, Mandatory Findings of Significance, also define a significant biological impact as follows (Section 15065 [a][1]):

- The project has the potential to substantially degrade the quality of the environment; substantially reduce the habitat of a fish or wildlife species; cause a fish or wildlife population to drop below self-sustaining levels; threaten to eliminate a plant or animal community; substantially reduce the number or restrict the range of an endangered, rare or threatened species.

California Coastal Act

The California Coastal Act applies to projects that result in the diking, filling, or dredging of open coastal waters, wetlands, estuaries, and lakes occurring in the coastal zone. The act limits these activities to certain types of projects (restoration projects, for example, are included among the permitted projects) and stipulates criteria under which development is permitted. Chapter 3 of the act details the coastal resources planning and management policies (Sections 30200 to 30265.5). The act also permanently established the California Coastal Commission (CCC).

The California Coastal Act includes specific policies that address issues such as shoreline public access and recreation, lower cost visitor accommodations, terrestrial and marine habitat protection, visual resources, landform alteration, agricultural lands, commercial fisheries, industrial uses, water quality, offshore oil and gas development, transportation, development design, power plants, ports, and public works. The policies of the act are the statutory standards that apply to planning and regulatory decisions made by the commission and by local governments, pursuant to the act.

Implementation of the act's policies is accomplished primarily through the preparation of local coastal programs that include land use plans. To ensure that coastal resources are effectively protected in light of changing circumstances, such as new information and changing development pressures and impacts, the CCC is required to review each certified local coastal program at least once every five years.

Coastal Act policies include:

- Coastal Act Section 30107.5 defines environmentally sensitive habitat area as:

  "any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments."

- Coastal Act Section 30240 states in part that:

  (a) Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values, and only uses dependent on such resources shall be allowed within such areas.

  (b) Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade those areas, and shall be compatible with the continuance of those habitat and recreation areas.

Within the coastal zone the CCC has authority to regulate development that would conflict with the provisions of the California Coastal Act. The coastal zone generally extends three miles seaward and about 1,000 yards inland. In order to carry out the policies of the Coastal Act, each of the 73 cities and counties in the coastal zone is required to prepare a local coastal program (LCP) for the portion of its jurisdiction within the coastal zone and to submit the program to the Commission for certification. The CCC manages protection of biological resources through a permitting process for all projects in the coastal zone. Once the CCC certifies an LCP, the local government gains authority to issue most coastal development permits (CDP). The CCC generally retains permit authority over certain specified lands (such as public trust lands or tidelands). Only the CCC can grant a coastal development permit for development in areas of its retained jurisdiction. The CCC has broad authority to regulate development in the coastal zone, and a permit is required for any project that might change the intensity of land use in the coastal zone. For example, a project that would require a building or grading permit from a city or county would also require a CDP. Other projects, such as major vegetation clearing or subdividing, may also require a CDP. The local government or the CCC reviews applications before it to determine whether the project would substantially change any existing biological resources, including wetlands, and to consider the net effects of the project on rare and endangered species.

None of the facility sites would be located within CCC jurisdiction, but the CCC has retained jurisdiction over the waters at Lake Merced, which may be affected by the Project. San Francisco's LCP is discussed further below as the *Western Shoreline Area Plan* in Section 5.14.2.3 (Local).

BCDC has jurisdiction over the open water, marshes, and mudflats of greater San Francisco Bay, including Suisun, San Pablo, Honker, Richardson, San Rafael, San Leandro, and Grizzly Bays and the Carquinez Strait, as well as the first 100 feet inland from the shoreline around San Francisco Bay. BCDC's mission statement states that BCDC "is dedicated to the protection and enhancement of San Francisco Bay and to the encouragement of the Bay's responsible use." None of the facility sites would be located within BCDC jurisdiction, and Lake Merced is not within BCDC jurisdiction.

California Department of Fish and Wildlife

California Fish and Game Code

The CDFW enforces the CFGC, which provides protection for "fully protected birds" (Section 3511), "fully protected mammals" (Section 4700), "fully protected reptiles and amphibians" (Section 5050), and "fully protected fish" (Section 5515). With the exception of permitted scientific research, no take of any fully protected species is allowed. The white-tailed kite is the only fully protected species potentially occurring in the study area.

Section 3503 of the CFGC prohibits the take, possession, or needless destruction of the nest or eggs of any bird. Subsection 3503.5 specifically prohibits the take, possession, or destruction of any birds in the orders *Falconiformes* (hawks and eagles) or *Strigiformes* (owls) and their nests. These provisions, along with the federal MBTA, essentially serve to protect nesting native birds. Non-native species, including European starling and house sparrow, are not afforded any protection under the MBTA or CFGC.

California Endangered Species Act (Fish and Game Code Sections 2050 through 2085)

The CESA includes provisions for the protection and management of species listed by the State of California as endangered or threatened or designated as candidates for such listing. The act requires consultation "to ensure that any action authorized by a State lead agency is not likely to jeopardize the continued existence of any endangered or threatened species or results in the destruction or adverse modification of habitat essential to the continued existence of the species" (Section 2053). California plants and animals declared to be endangered, threatened, or rare are listed at 14 CCR 670.2 and 14 CCR 670.5, respectively. The State prohibits the take of protected amphibians (14 CCR 41), protected reptiles (14 CCR 42), and protected furbearers (14 CCR 460). The CDFW may also authorize public agencies through permits or a memorandum of understanding to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes (Section 2081[a]). The CDFW may also authorize, by permit, the take of endangered species, threatened species, and candidate species provided specific conditions are met (Section 2081[b]).

State Species of Special Concern and Special Plants List

The CDFW maintains an informal list of *species of special concern* (Jennings and Hayes 1994; Gardali and Evens 2008; CDFG 2011a, 2011c). These are broadly defined as species that are of concern to the CDFW because of population declines and restricted distributions, and/or they are associated with habitats that are declining in California; the criteria used to define special-status species are described by the CDFG (CDFG 2009). Impacts to special-status plants and animals may be considered significant under CEQA.

Native Plant Protection Act

The CDFW administers the NPPA (Sections 1900–1913 of the CFGC). These sections allow the California Fish and Game Commission to designate rare and endangered rare plant species and to notify landowners of the presence of such species. Section 1907 of the CFGC allows the Commission to regulate the "taking, possession, propagation, transportation, exportation, importation, or sale of any endangered or rare native plants." Section 1908 further directs that "…[n]o person shall import into this State, or take, possess, or sell within this State, except as incident to the possession or sale of the real property on which the plant is growing, any native plant, or any part or product thereof, that the Commission determines to be an endangered native plant or rare native plant."

California Species Preservation Act

The California Species Preservation Act (CFGC Sections 900–903) includes provisions for the protection and enhancement of the birds, mammals, fish, amphibians, and reptiles of California. The administering agency is the CDFW.

State Water Resources Control Board and the State of California's Porter-Cologne Water Quality Control Act

The State Water Resources Control Board (SWRCB) regulates construction stormwater through SWRCB Order No. 2003-0017-DWQ, "General Waste Discharge Requirements for Dredge and Fill Discharges that Have Received State Water Quality Certification." The State's authority to regulate activities in wetlands and water at the Project facility sites resides primarily with the SWRCB, which in turn has authorized the State's nine RWQCBs, discussed below, to regulate such activities.

Regional Water Quality Control Board

Clean Water Act Section 401 Certification

Under Section 401 of the federal CWA, every applicant for a federal permit for any activity that may result in a discharge to a water body must obtain a Water Quality Certification that the proposed activity will comply with State water quality standards.

In the study area, the San Francisco Bay RWQCB would regulate construction in waters of the United States and waters of the State, including activities in wetlands, under both the CWA and the State of California's Porter-Cologne Water Quality Control Act (California Water Code, Division 7). Under the CWA, the RWQCB has regulatory authority over actions in waters of the United States, through the issuance of water quality certifications, as required by Section 401 of the CWA, which are issued in conjunction with permits issued by the USACE under Section 404 of the CWA. The RWQCB must certify that a USACE permit action meets State water quality objectives (§401 CWA, and Title 23 CCR 3830, et seq.). Activities in areas that are outside of the jurisdiction of the USACE (e.g., isolated wetlands, vernal pool, or stream banks above the ordinary high water mark) are regulated by the nine RWQCBs, under the authority of the Porter-Cologne Act, and may require the issuance of either individual or general waste discharge requirements. The California Wetlands Conservation Policy (Executive Order W-59-93) establishes a primary objective to "ensure no overall net loss … of wetlands acreage and values in California." The RWQCBs implement this policy and the Basin Plan Wetland Fill Policy, both of which require mitigation for wetland impacts.

5.14.2.3 Local

Pursuant to California Government Code Section 53090, et seq., the SFPUC, as a public utility, has intergovernmental immunity from the local building and zoning ordinances of other cities and counties when it carries out a project outside of San Francisco. Nevertheless, this section presents the local tree protection ordinances that may be applicable to assessing the potential biological resources impacts of the Project. The Project would be located within the City of Daly City, Town of Colma, City of South San Francisco, City of San Bruno, the City of Millbrae, and an unincorporated part of San Mateo County (Broadmoor). Thus, the provisions of these jurisdictions' local tree protection ordinances are discussed below.

The following sections describe these local tree protection ordinances, which are the only local ordinances specific to protecting biological resources that were identified for the municipalities in the study area.

San Mateo County

San Mateo County has both a Heritage Tree Ordinance and a Significant Tree Ordinance (San Mateo County 1977, 1990). Under the Heritage Tree Ordinance (Ordinance Number 2427, Regulation of the Removal and Trimming of Heritage Trees on Public and Private Property) a heritage tree includes any tree or grove of trees so designated by the County Board of Supervisors, or includes any of the 16 native tree species listed in Table 5.14-3 (San Mateo County Heritage Trees) of varying diameter at breast height (dbh). The ordinance regulates activities that could impact heritage trees and provides guidelines for compensating for lost heritage trees when avoidance is not feasible.

The Significant Tree Ordinance (San Mateo County Ordinance Code: Part III, Division VIII. Part III, Division VIII) prohibits removal of trees with a circumference of 38 inches or larger (which is equivalent to 12 inches dbh) without a permit.

Removal of trees protected under the Heritage Tree Ordinance and the Significant Tree Ordinance requires a permit and replacement trees.

TABLE 5.14-3
San Mateo County Heritage Trees

Bigleaf Maple (more than 36″ dbh) *Acer macrophylumm*	Douglas Fir[(a)] *Pseudotsuga menziesii*	Valley Oak (more than 48″ dbh) *Quercus lobata*
Madrone[(b)] *Arbutus menziesii*	Coast Live Oak (more than 48″ dbh) *Quercus agrifolia*	Blue Oak (more than 30″ dbh) *Quercus douglasii*
Golden Chinquapin (more than 20″ dbh) *Chrysolepis chrysophylla*	Canyon Live Oak (more than 40″ dbh) *Quercus chrysolepis*	California Bay or Laurel[(c)] *Umbellularia californica*
Santa Cruz Cypress (all) *Cupressus abramsiana*	Oregon White Oak (all) *Quercus garryana*	California Nutmeg (more than 30″ dbh) *Torreya californica*
Oregon Ash (more than 12″ dbh) *Fraxinus latifolia*	Black Oak (more than 32″ dbh) *Quercus kellogii*	Redwood[(d)] *Sequoia sempervirens*
Tan Oak (more than 48″ dbh) *Lithocarpus densiflorus*	Interior Live Oak (more than 40″ dbh) *Quercus wislizenii*	

Source: San Mateo County 1977

Notes:

(a) More than 60″ dbh east of Skyline Boulevard and north of Highway 92.
(b) Single stem or multiple stems touching each other 4′-6″; more than 48″ dbh, or clumps visibly connected above ground with basal area greater than 20 square feet measured 4′-6″ above average ground level.
(c) Single stem or multiple stems touching each other 4′-6″; more than 48″ dbh, or clumps visibly connected above ground with basal area greater than 20 square feet measured 4′-6″ above average ground level.
(d) More than 84″ dbh west of Skyline Blvd., or 72″ dbh east of Skyline Boulevard.

City of Daly City

The City of Daly City regulates the removal of trees growing upon any parkway, easement, right-of-ways or other publicly owned area (Daly City Municipal Code, Title 12: Chapter 12.40. Chapter 12.40, Urban Forestry) (Daly City 1996). Protected trees include any woody perennial plant having a single main axis or stem commonly achieving 15 feet in height. The City of Daly City has no regulations governing the removal of trees on private property.

Town of Colma

The Town of Colma requires the issuance of a permit prior to the removal or significant alteration of any tree defined as having a single stem of 12 inches or more in diameter measured four feet above the natural grade, or a multi-stemmed tree having an aggregate diameter of 40 inches or more measured four feet above the natural grade (Town of Colma Municipal Code: Subchapter Six. Subchapter Six, Tree Cutting and Removal) (Colma 2006). The City Planner can issue a permit for tree removal unless the planner finds that the tree is of such size, type, condition and location that its removal or alteration would destroy the natural beauty of the area, contribute to erosion, increase the cost of drainage systems, reduce the protection against wind, or significantly impair the privacy and quiet of a residential area. Permit conditions may include tree replacement or substitution using specimen size trees. Replacement may occur on the same property as removal unless the planner determines that an off-site location better serves the Town's objectives.

City of South San Francisco

The City of South San Francisco requires a permit for the removal or pruning of any protected tree, defined as any tree with circumference of 48 inches (≥15.2 inches in diameter) measured 4.5 feet above ground level (City of South San Francisco Municipal Code: Chapter 13.30. Chapter 13.30, Tree Preservation) (South San Francisco n.d.). Damage or removal of a protected tree requires either replacement or reimbursement to the City for replacement. The City requires replacement of protected trees at a 3:1 ratio if a 24-inch box size is used or at a 2:1 ratio if a 36-inch box is used for each protected tree removed. The Parks, Recreation, and Maintenance Department Director can waive the replacement requirement if there are sufficient trees on the site to meet the tree preservation ordinance.

City of San Bruno

The City of San Bruno requires issuance of a permit for the removal of any tree or grouping of trees meeting the definition of a "heritage tree" (City of San Bruno Municipal Code: Chapters 8.24 and 8.25. Chapter 8.25, Heritage Tree Ordinance) (San Bruno 2002). Heritage trees are defined as follows: Any native bay (*Umbellurlaria californica*), buckeye (*Aesculus species*), oak (*Quercus species*), redwood (*Sequoia sempervirens*), and pine (*Pinus radiata*) tree that has a diameter of 6 inches or more measured at 54 inches above natural grade. In addition to these tree species, a heritage tree is any tree or stand of trees that makes each dependent on the other for survival; or any other tree with a trunk diameter of 10 inches or more measured at 4.5 feet above ground level. A tree removal or pruning permit requires replacement at a minimum of two 24-inch box size trees or one 36-inch box size tree for each heritage tree removed.

City of Millbrae

The City of Millbrae regulates street trees under its Tree Protection and Urban Forestry Program (City of Millbrae Municipal Code: Chapter 8.60. Chapter 8.60, City of Millbrae Tree Protection and Urban Forestry Program) (Millbrae n.d.), which states that unless authorized by permit, no person or property owner shall plant, prune, remove, alter or undertake any other work on a street tree, defined as any wood perennial plant having a single main axis or stem commonly achieving a minimum of 10 feet in height. The City of Millbrae does not regulate trees outside of the street corridor.

City of San Francisco

Western Shoreline Area Plan

The Western Shoreline Area Plan of the San Francisco General Plan is the San Francisco plan for the Local Coastal Zone and sets forth several policies governing development in the coastal zone. Therefore, most coastal development permits are issued by the San Francisco Planning Commission. However, the CCC has retained jurisdiction over the waters at Lake Merced. In addition, coastal development permits issued for projects located within a 100-foot buffer of Lake Merced are appealable to the CCC. None of the facility sites would be located within the 100-foot buffer from Lake Merced, and none of the facility sites would be located within the area governed by the Western Shoreline Area Plan.

Objective 5 of the Plan is to "Preserve the Recreational and Natural Habitat of Lake Merced". However, there are no specific policies relevant to biological resources.

San Francisco Recreation and Parks Department Significant Natural Resources Areas Management Plan

The San Francisco Recreation and Park Department is currently completing a Significant Natural Resource Areas Management Plan (SNRAMP) for designated significant natural areas in the City and County of San Francisco (CCSF). The purpose of the management plan is to establish a maintenance and preservation program related to the protection and enhancement of natural resource values. While the SNRAMP itself has not been finalized and adopted and thus is not in effect, the process began in 1995, with the adoption of a staff report on the SNRAMP. The staff report set forth general objectives, policies, and management actions to guide development of the SNRAMP. Adopted general policies and management actions in the staff report relevant to biological resources at Lake Merced include the following:

III. General Policies and Management Actions

A. Vegetation

   a. Maintain/promote indigenous plant species; propagate native plants using seed collected from the specific site to avoid alteration of unique genetic strains of native plant species.
   b. Control/remove invasive species; remove exotic plants which adversely affect indigenous plant growth.
   c. Enhance riparian areas.
   d. Reforest and/or replant areas where appropriate to maintain diversity of indigenous plant communities.
   e. Preserve habitat which supports wildlife.

B. Water Resources

   a. Maintain/improve water quality of streams and ponds
   b. Protect riparian zones from erosion and sedimentation.
   c. Maintain drainage and erosion prevention devices along roads and service trails.
   d. Control drainage/runoff from roads.
   e. Establish and maintain tule encroachment zone around lakes.
   f. Use proper controls when using aquatic herbicide.

5.14.3 Impacts and Mitigation Measures

5.14.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Supply and Recovery Project would have a significant effect on biological resources if it were to:

- Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the CDFW or USFWS.
- Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW or USFWS.
- Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the federal CWA (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means.
- Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites.
- Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance.
- Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or State habitat conservation plan.

5.14.3.2 Approach to Analysis

The assessment of potential impacts on special-status botanical and wildlife resources, including habitat, was based on the relationship between species and habitat distribution and the locations and activities proposed for construction and operation of the proposed Project. Sources of information for determining special-status species that could occur in the study area included CNDDB, CNPS Online Inventory, and USFWS endangered and threatened species database. Field visits were conducted to determine the likelihood these species would occur at or near the facility sites and to determine the presence of wetlands, other waters, and sensitive habitats. Tree surveys were conducted. Potential impacts on special-status plants and wildlife were based on known occurrences or on the likelihood that suitable or marginally suitable habitat for special-status species would be affected. Potential impacts on sensitive habitats and other resources were based on the presence of these resources and locations of the proposed facilities. Potential conflicts with local tree protection ordinances were analyzed with reference to standards set forth in the tree ordinances for San Mateo County and municipal codes for the cities of Daly City, South San Francisco, San Bruno, and Millbrae, and the Town of Colma.

It was assumed that any biological resources located within the construction boundary for each facility site would be impacted by construction, including all 19 well facility sites and the pipeline and alternate pipeline connection for each site. Resources immediately outside the construction boundary were also evaluated on a site by site basis to determine the potential for impacts. This approach provides a conservative estimate of habitat impacts. For example, if habitat requirements of special-status species were present, the impact assessment assumed that the species was also present and that a significant adverse environmental impact could result from habitat impacts or inadvertent impacts on the species. Because impacts are primarily related to the presence or absence of resources at a site, the analysis for Sites 5, 6, and 7, which have two potential configurations, are only presented for the site. For example, the impacts of Site 5 (On-site Treatment) would be the same as for Site 5 (Consolidated Treatment at Site 6), and are discussed under Site 5. However, if there are differences in potential impacts between the two potential configurations, the impacts are discussed separately for each site.

Biological resources located near the permanent facility sites were evaluated for the potential to be affected by Project operations. The potential for special-status species or natural communities to be present near facility sites, together with the sensitivity of such species and communities to elements of Project operations were utilized to assess impacts.

Operational Impacts on Lake Merced Biological Resources

Impacts on biological resources would be significant if Project operations were to result in substantial effects on the biological resources of Lake Merced, which is hydraulically connected to the underlying groundwater basin.

As described in Section 5.16, Hydrology and Water Quality, Lake Merced water sources are primarily precipitation, limited local runoff, and groundwater inflow. Lake Merced water levels have fluctuated widely over time in response to climatic conditions, water discharges, and regional and local groundwater pumping. Water surface level (hydrologic) modeling in support of this EIR (Kennedy/Jenks 2012), including the biological resources impacts analysis, relied on historic water data to simulate water level conditions for Lake Merced over the next 47 years for the modeled existing conditions scenario, the GSR Project, and a cumulative scenario, which takes into account the effects of other projects that, should they be implemented, would play a role in influencing Lake Merced water levels (see Section 5.1, Overview, Section 5.1.6 [Groundwater Modeling Overview] for further details on the modeling).

Significance Thresholds for Influence of Changing Water Levels on Vegetation Types near Lake Merced

In large part, the mean annual water level of lake systems drives the elevational distribution of upland, wetland, and aquatic plant species around lakes and other water bodies, such as Lake Merced, primarily due to variations in adaptation to, and tolerance of, inundation. Seasonal timing, duration, water depth, and frequency of inundation are all critical factors in determining which species would persist in a given area. A rise in water levels could inundate a portion of existing wetland habitats so that they would be under water at too great a depth or for too long to persist. These newly inundated wetlands would then be converted to lacustrine habitat (i.e., open water). Some wetland habitats would persist, although their species composition could change due to the altered pattern (i.e., duration and depth) of inundation. New wetland habitats would then form within the new, higher annual fluctuation zone at elevations currently supporting upland habitats, which would be unable to persist under the new inundation regime. As groundwater levels rise, some wetlands, such as those dominated by giant vetch, may be induced or created at elevations above the new water level. Upland vegetation types would not move upslope with rising water levels, given that their distribution is not tied to water elevation, other than the fact that they can't persist in areas that are regularly inundated, and thus replacement of upland types with other upland types has no relation to water surface elevation.

To some extent, these processes are generally expected to operate in reverse as water levels recede over a period of years, but with some important differences. Under rising water level conditions, there is competition and resistance to replacement of existing vegetation types by those that dominate within the inundated or saturated zone. Under receding water levels, much of the land surface that becomes available for vegetation to occupy (with the exception of existing bulrush patches) would be newly exposed, unvegetated sediments of the former lake bottom. For instance, some upland types (such as non-native herbaceous and non-native and perennial grassland) are expected to move downslope if water levels drop substantially for long enough periods, given that receding water levels would result in the exposure of unvegetated sediment suitable for colonization by upland species at elevations of more than 1 foot above the new average annual water surface elevation.

The following describes the impact thresholds that apply to the analysis of impact on the biological resources of Lake Merced resulting from water level changes caused by the proposed Project, for the resources described in Section 5.14.1 (Setting).

Adverse Effects on Special-status Wildlife

As the only remaining large coastal lake and wetland between Pescadero to the south and Point Reyes to the north, Lake Merced provides valuable wildlife habitat, especially for birds. Many of these are special-status or otherwise protected water birds, which are discussed below relative to their nesting habitat. In addition, large eucalyptus along North and South Lake support rookeries for double crested cormorant and great blue heron and red-shouldered and red-tailed hawks nest in large trees around the lake (SFRPD 2006). This issue is discussed in detail below, under the subsection for adverse effects on wildlife nursery sites. Other special-status birds, such as Wilson's warbler, green backed heron, and black-crowned night heron nest in willow scrub around the lakes (SFRPD 2006; Murphy 1999). Impacts on willow scrub are discussed further below under the subsection for adverse effects on wetlands. Still other species protected under the CFGC, such as California towhee and Bewick's wren, nest in coastal scrub, which may also be lost in small amounts as discussed below in the next subsection.

Several special-status bird species are known to nest or have potential to nest at or near the water line at Lake Merced, including Clark's and pied-bill grebes, sora, and Virginia rail (SFPRD 2006). Additional species protected under the Migratory Bird Treaty Act and the CFGC, Section 3503, that nest in emergent vegetation at or near the water's edge include marsh wren, ruddy duck, mallard (Murphy 1999), and the California species of special concern, San Francisco common yellowthroat (Gardali and Evens 2008). Loss of emergent wetland breeding habitat for these species is discussed below under the subsection for adverse effects on wetlands. Increases in lake levels during breeding season could flood active nests. Decreases in lake levels could result in stranding of floating nests, such as those constructed by Clark's grebes. Research has shown that marsh birds are sensitive to fluctuations in water levels, especially rapid fluctuations. Thus, direct impacts on birds nesting at or near the water line would begin to occur with even small fluctuations in lake levels during the breeding season. Virginia rail and sora nest up to six inches above the water surface (Desgranges et al. 2006); marsh wren typically nest two or more feet above the water line; and Clark's grebes have been documented as abandoning their nests after a 16-inch reduction in water levels occurred over three weeks (Riensche et al. 2009).

Virginia rail (Desgranges et al. 2006) and sora (Erlich et al. 1988) nesting success would appear to be highly sensitive to water fluctuations and these can be utilized as an indicator species to determine significance thresholds. An examination of the typical nest height above water for each of these species combined with their egg incubation period of approximately 2.5 weeks[22] (Erlich et al. 1988) suggests that an increase or decrease in water level of 0.5 feet over a 2.5 week period during the nesting season would impact the reproductive success of birds nesting near the water line. Therefore, water level increases or decreases by greater than 0.5 feet over a two week period in any single nesting season (conservatively March 1 through August 15) would be considered to result in a significant impact on nesting birds.

Other special-status species documented at Lake Merced include western pond turtle sightings in East Lake and a California red-legged frog sighting in Impound Lake in 2000 (SFRPD 2006). California red-legged frog has not been observed since a single sighting in 2000 and prior to that had not been observed since the 1970's (SFPUC 2011). Based on the lack of sightings, negative protocol-survey results from 2000, and the presence of bullfrogs and largemouth bass, red-legged frog were considered extirpated from Lake Merced (SFRPD 2006; San Francisco Planning Department 2011; SFPUC 2011) and, with no evidence to the contrary, are presumed extirpated for the purposes of this analysis.

It is presumed that western pond turtle are still present in East Lake, although the presence of red-eared sliders and bullfrogs was considered a threat to the population over five years ago (SFRPD 2006) and they may have been extirpated since that time. It is unknown whether suitable western pond turtle nesting habitat is present at Lake Merced but it would be most likely to occur in dry sandy to hard soils on low gradient slopes with low, sparse vegetation (Jones and Stokes 2004). Suitable nesting sites can occur as far as 300 feet from the water line (CDFG 2000) but are typically much closer and could thus be vulnerable to inundation. Females move from aquatic sites to upland sites that are usually located above the floodplain (or in this case, above the highest average annual water level) and can lay their eggs, sometimes more than one clutch, anywhere between April and August, although most oviposition occurs in April and May. Nests must be dry (Jones and Stokes 2004) but also have a relatively high internal humidity for eggs to develop and hatch properly (CDFG 2000). Incubation can last up to three months and hatchlings typically overwinter in the nest, emerging the following spring (Jennings and Hayes 1994).

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[22]Nests that are not yet supporting eggs can be rebuilt and chicks of all the species in question are precocial, meaning they are capable of a high degree of independent activity immediately after hatching and can leave the nest and be relocated by their mother in response to fluctuations in water level.

Loss of potentially suitable turtle nesting habitat due to inundation by rising water levels would not be considered significant, since the majority of soils surrounding East and North Lakes are sandy (SFRPD 2006) and even at the maximum possible water surface elevation of 13 feet, sufficient habitat would remain to support ongoing western pond turtle reproduction. Pond turtles typically nest close to the water line but above areas prone to inundation. Since nests must be relatively dry, it would be expected that pond turtles would typically choose nest sites at least three feet above the annual high water level in any given year, so gradual increases in water surface elevations over time would not be expected to impact nesting pond turtles. Similarly, water surface elevation decreases, whether gradual or by several feet in less than a year would not impact nesting pond turtles as their nests would remain above water. However, loss of occupied nesting habitat inundated during a single year such that turtle eggs or nestlings were lost could threaten the Lake Merced western pond turtle population, if it still exists, and would therefore be considered a significant impact.

Adverse Effects on Rare Plants and Sensitive Communities

Rare plants

There are four special-status plant species documented recently at Lake Merced: San Francisco spineflower, San Francisco wallflower, blue coast gilia, and dune tansy (May & Associates 2009; Nomad Ecology 2011). In addition, there are seven plant species of local concern that occur at Lake Merced: California pipevine, Wight's paintbrush, Vancouver rye, wild cucumber, canyon live oak, coastal black gooseberry, and thimbleberry (May & Associates 2009; Nomad Ecology 2011). See Figure 5.14-2 (Lake Merced Sensitive Habitats and Species) in Section 5.14.1 [Setting] for locations of rare plants and sensitive plant communities.

None of these eleven species are federally or State listed, three are listed by CNPS, and the rest are listed by CNPS as locally rare and significant in the CCSF. Normally, only federal, State, and CNPS List 1 and 2 species are considered under CEQA. However, all eleven species noted occur in coastal dune scrub and coastal scrub habitat types, further described below, which have been severely reduced from their original extent within the CCSF.

Because special-status plants and their habitat are locally rare and thus at high risk of local extinction, impacts on rare plant habitat at Lake Merced would be considered significant under CEQA. All of these plant species occur outside the Lake Merced watershed and most are more common elsewhere throughout their range and extirpation of a local population would not pose a risk to the overall survival of the species. Given this context, some habitat loss could be acceptable and result in a-less-than significant impact under CEQA. However, due to the general lack of local habitat,, a relatively low threshold for loss is appropriate for this CEQA analysis, and impacts on special-status plant habitat would be considered significant for the purpose of this EIR if an increase in average lake levels were to result in the loss of more than 10 percent of occupied habitat, as mapped by the SFRPD (SFRPD 2006), May & Associates (May & Associates 2009), and Nomad Ecology (Nomad Ecology 2011), for one or more of the special-status or locally sensitive plants known to occur at Lake Merced.

Sensitive Communities

The following have been identified as sensitive vegetation and habitat types at Lake Merced: Central dune, thimbleberry, wax myrtle, and canyon live oak scrubs, Vancouver rye grassland (perennial grassland), fish-related habitat, wetlands (including arroyo willow riparian scrub), and blue gum eucalyptus forest. Arroyo willow riparian scrub is discussed below under wetlands and eucalyptus forest is discussed below under wildlife nursery sites.

*Central Dune Scrub***.** While there were no stands of dune scrub mapped at Lake Merced in 2002 (SFPRD 2006), restoration efforts have resulted in the establishment of over 3 acres of this vegetation type, which is rare on the San Francisco Peninsula. Dune scrub is not only locally rare, but also supports several rare plant species at Lake Merced, including San Francisco spineflower, Wight's paintbrush, dune tansy, and San Francisco wallflower and is therefore considered sensitive as rare plant habitat for the purposes of this EIR.

Locally sensitive coastal scrub types. The classification of coastal scrub at Lake Merced encompasses several different subtypes that are dominated by locally rare plant species and therefore considered sensitive natural communities for the purposes of this analysis. These subtypes include thimbleberry scrub, wax myrtle scrub, and canyon live oak scrub. These vegetation types occur in only one or two locations around Lake Merced (see Figure 5.14-2 [Lake Merced Sensitive Habitats and Species] in section 5.14.1 [Setting]) as well as in other parts of the CCSF (SFRPD 2006; CNPS 2011).

Vancouver rye grassland. This is a perennial grassland dominated by Vancouver rye, which is a hybrid between American dunegrass and creeping wild rye and thus reflective of both the dune and riparian ecological history of Lake Merced. At last report, this grassland occurred in one location on the north shore of East Lake at the base of a steep slope and adjacent to blue gum eucalyptus forest and rush meadow (Nomad Ecology 2011). Vancouver rye grassland was considered sensitive due to its local rarity by the SFRPD (SFRPD 2006) and the species is considered locally rare by CNPS. Therefore, impacts on this vegetation type would be considered significant.

Fisheries and Fish Habitat

The open waters and emergent wetlands of Lake Merced provide aquatic habitat, cover, and foraging habitat for a variety of native and non-native fish. Twenty-seven species have been collected there over the years, 18 of which are native species. Tidewater goby, a federally endangered species, are known to have occurred historically (1894) but are now presumed extirpated (CDFG 2011e). Several other species, including starry flounder, staghorn sculpin, and topsmelt, may have been present at least intermittently when Lake Merced was hydrologically connected to the ocean. At least 11 species have been introduced to the lake since 1893 and the most abundant species in recent studies were introduced largemouth bass and Sacramento blackfish (LMTF 2007). There is no spawning habitat for rainbow trout so this species must be stocked in order to maintain a fishery and stocked adults persist in the lake for only a short time. Native fishes with currently self-sustaining populations at Lake Merced include: tule perch, prickly sculpin, Sacramento blackfish, and threespine stickleback. Non-native fishes with self-sustaining populations include largemouth bass, common carp, and goldfish (LMTF 2007). There currently are no special-status fish species found in Lake Merced.

In 2004, the SFPUC retained EDAW (a San Francisco-based environmental consulting firm that is now part of AECOM) to assess the effect of water level rise on Lake Merced fisheries. EDAW's analysis anticipated that the greatest potential effect would come from reductions in littoral habitat (defined as areas with three feet or less of water around the lake perimeters) with rising lake levels, using a study baseline of 0.5 feet City Datum (EDAW 2004). The EDAW study has been reviewed by the preparers of this EIR and the study's methodology and conclusions have been determined to be adequately supported by the information presented therein. However, it was predicted that most of the loss would be in Impound Lake and much of this loss has already occurred. Decreases in littoral area were expected to impact warmwater species. But the EDAW study found that littoral area was already a very small component of the overall lake habitat, and that since there were other factors more likely to control warm water species (i.e., temperature, cover, and water clarity), this change was expected to have minimal impacts on warmwater fish population abundance, growth rates, or ability to reproduce. The EDAW study did not expect coldwater fish species to be affected by lake level increases. Water level decreases could result in increases of littoral habitat, at least to begin with, by regaining habitat lost when lake levels rose from the EDAW study baseline of 0.5 feet City Datum, and eventually, reductions in coldwater habitat through rising water temperatures, which could increase warmwater and reduce coldwater fish populations, respectively. Coldwater fish at Lake Merced are trout, which are not self-sustaining and are regularly stocked and prickly sculpin, which as of 2007 appeared to be self-sustaining (LMTF 2007). The remaining fish are warmwater species.

As described above, there are no special-status fish in Lake Merced, and the species most important for recreational purposes are regularly stocked; however, if decreased water levels were to cause fish populations to drop below levels needed to sustain the local bird populations that rely upon them—which include special-status and otherwise protected birds—the impact could potentially be significant. Population numbers for fish-eating birds as well as fish at Lake Merced are presently unknown. The Lake Merced Task Force Fish Community Study (LMTF 2007) noted that cormorants were not documented as nesting at Lake Merced prior to 1997 and that nest numbers increased from 18 in 1997 to around 200 in 2004. In 2007, 11 great blue heron and 319 double-crested cormorant nests were documented at Lake Merced and their increase in numbers may be attributable to lake level rises over low levels seen in the 1970's through the 1990's and consequent improvements in habitat (GGAS 2007). This conclusion would be speculative though, since no definitive studies have been conducted on fish population numbers or the foraging habits of fish-eating birds at Lake Merced. Nesting cormorants have been documented as flying to and from the ocean to forage while nesting at Lake Merced, which suggests that they, and presumably other fish-eating birds present at Lake Merced, do not depend exclusively on the fish available in Lake Merced (LMTF 2007). As noted above, the health of Lake Merced's fisheries is closely tied to availability of littoral habitat and water quality also plays an important role. These factors are likely the main drivers of fish abundance in Lake Merced and can be tied to the lake's beneficial uses.

The San Francisco Bay RWQCB defines several fish-related beneficial uses for Lake Merced: cold freshwater habitat, warm freshwater habitat, and fish spawning. A substantial degradation or loss of these beneficial uses, for example through significant changes in water temperature, loss of littoral habitat, or reduction in dissolved oxygen, would be considered significant. EDAW (EDAW 2004) assessed potential impacts on beneficial uses in relation to lake level rise up to 8 feet City Datum and water inputs from various potential sources and found that no effects on beneficial uses were expected. Similarly, as noted in Section 5.16, Hydrology and Water Quality, no significant correlation between lake levels and water quality has been identified in recent years, when lake levels were rising or stable. However, as also noted, and explained in greater detail, in Section 5.16, Hydrology and Water Quality, lake levels below 0 feet City Datum could result in adverse impacts on water quality through a variety of mechanisms, such as increased sedimentation due to erosion of exposed sediments or reductions in dissolved oxygen due to increased algal growth and eutrophication, and these impacts could have a substantial adverse effect on Lake Merced's beneficial uses related to fish habitat, and therefore fish populations and, indirectly, fish-eating bird populations, which, depending on the magnitude, duration, and frequency of the effect, could potentially be a significant impact.

Adverse Effects on Wetlands

As the only remaining large coastal lake and wetland between Pescadero to the south and Point Reyes to the north, Lake Merced provides valuable wildlife habitat, especially for birds. The lake's wetlands and willow riparian scrub provide wintering habitat for thousands of birds, resting and foraging habitat for fall and spring migrants, and are used as breeding and feeding habitat for nearly 50 species. The lake's wetlands also provide cover, foraging habitat, and nursery sites for warmwater fish as well as cover and foraging habitat for western pond turtle. Impacts on wetlands resulting from changing water levels could include direct wetland losses. Indirect effects due to water quality degradation at low water surface elevations are not expected to significantly affect wetland vegetation since healthy wetland vegetation has been maintained in the past at lower water levels. For example, the extent of bulrush wetlands was greater in 1996 (SFRPD 2006) and 2002 (Nomad Ecology 2011), with a mean water surface elevation of 0.5 feet City Datum, than they are today.

The slopes surrounding Lake Merced currently support approximately 27 acres of willow riparian scrub (see Table 15.4-4 [Lake Merced Vegetation Acreage: 2002, 2010, and 2012]). Since most of the willow scrub habitat at Lake Merced would also be considered jurisdictional wetlands, impacts on willow scrub are considered as part of the wetlands impact. This vegetation community is common throughout central and coastal California and as such is not always considered a sensitive natural community. However, willow scrub at Lake Merced provides high quality riparian habitat for a variety of special-status and common birds and is therefore considered sensitive by CDFW and RWQCB. In addition, the California Coastal Commission often considers willow scrub as an Environmentally Significant Habitat Area, whether or not it also has wetland status.

Lake level rise since 2002 has resulted in the conversion of a little over 1.5 acres of willow scrub to open water (see Table 15.4-4 [Lake Merced Vegetation Acreage: 2002, 2010, and 2012]) and further rise in lake levels is predicted to reduce the extent of this vegetation type. However, losses could be ameliorated somewhat through movement of willow upslope, as has also been observed since 2002 (Nomad Ecology 2011). Similarly, lake level reductions would allow willow scrub to move down slope with falling water levels.

Because habitat at Lake Merced would be considered wetlands by the USACE and/or CDFW and RWQCB (see Section 5.14-2 [Regulatory Framework]), the federal and State no-net-loss policies described in the Section 5.14-2 would reasonably be applied to the proposed Project when determining the significance of impacts on wetlands as may be caused by the Project.

Adverse Effects on Wildlife Nursery Sites

Large eucalyptus along the shores of North and South Lakes support several double crested cormorant and great blue heron rookeries, and red-shouldered and red-tailed hawks nest in large trees (eucalyptus, Monterey cypress, and pines) around all of the lakes (SFRPD 2006). Although red-shouldered and red-tailed hawks nest in parks throughout the City, heron rookeries are found only at Lake Merced and Stow Lake, with one small colony reported at the Palace of Fine Arts that may have since been extirpated (Kelly et al. 2006). In May, 2012, several rookery trees were located in the same general areas as previously mapped (SFRPD 2006) and most were approximately 1 to 5 feet above the water surface elevation, which was at or near its seasonally highest level of approximately 6.5 to 7 feet City Datum. Inundation for more than a month is expected to kill individual upland trees, which would reduce nesting substrate for herons, cormorants, and hawks. Results of the 2012 vegetation mapping update, described below, show that there are a total of 50.5 acres of non-native forest around Lake Merced, including nearly 18 acres of eucalyptus. As noted above, red-tailed and red-shouldered hawks nest in parks, open space, and some residential areas throughout the CCSF (SFFO 2003) and therefore, with relatively abundant nesting substrate available to raptors elsewhere, the loss of non-native forest at Lake Merced would not be considered significant for raptors.

Rookery trees typically die over time due to bird use and buildup of 'whitewash' on their branches. When a tree dies completely, the birds typically move their nests to an adjacent tree (USFWS 2011b) so the death of individual trees in and of itself is not considered significant. However, the distance from disturbance is typically important for nesting herons and a buffer of at least 300 feet is recommended (VFWD 2002). The rookery trees on North and South Lakes are about 80 feet and 200 feet, respectively, from busy roadways and a well-used walking trail. The third rookery, on East Lake, is more isolated and less prone to disturbance.

Since eucalyptus are an upland species, with distribution not tied to water levels, and the upper limits of most eucalyptus habitat are determined by adjacent roadways, this habitat type is not expected to move upslope with increasing water levels and would thus be permanently lost. Lake level reductions are not expected to impact rookery trees since wetlands would 'migrate' downslope along with gradually falling water levels and the trees would still be proximate to wetland and open water foraging habitat.

Predicted rises in water levels under modeled existing conditions would likely result in loss of rookery trees and other eucalyptus that provide potential alternate nesting substrate for great blue herons and cormorants below 12.4 feet City Datum. The rookery trees at South Lake would be expected to be lost with a rise in annual average water surface elevation to 7 feet City Datum but the eucalyptus stand that supports the rookery is likely large enough that the rookery could move to adjacent trees further upslope and still remain buffered from the roadway and pathways. The trees at North Lake would be inundated with a rise in annual average water surface elevation to 6.5 feet City Datum. Loss of these trees would likely require the rookery to move to a different area as there would be no buffer trees left. The rookery trees at East Lake would not be impacted as they are located at an approximate elevation of 20 feet City Datum.

Although rookeries are locally rare, there is sufficient eucalyptus forest present at Lake Merced to sustain the rookeries there should small losses of mature eucalyptus occur. In this case, there would still be sufficient trees located at sufficient distance from human disturbance to allow for the rookeries to move from one tree to another. Larger losses of eucalyptus forest could potentially result in the loss of rookery trees altogether, particularly the loss of more isolated stands, if the remaining trees were not suitable due to proximity to human disturbance. Therefore, a relatively low threshold for loss is appropriate for this CEQA analysis and a loss of 10 percent of the eucalyptus forest around Lake Merced as a result of the proposed Project would be considered significant for the purposes of this EIR.

Estimating Vegetation Response to Changes in Lake Levels

In order to determine whether Project-related impacts on biological resources could reach the thresholds defined above, vegetation responses to changes in lake levels were assessed. Building upon prior studies summarized in Section 5.14.1 (Setting), a geographic information system-based (GIS-based) vegetation map created by Nomad Ecology in 2010 was utilized as explained in the Approach to Analysis section. Using the computer program ArcGIS, ESA overlaid the 2010 vegetation data on high resolution 2010 aerial photographs and then compared the resulting imagery with existing conditions in the field. Table 5.14-4 (Lake Merced Vegetation Acreage: 2002, 2010, and 2012) presents the results of the vegetation mapping update, along with results from 2002 and 2010, for comparative purposes. See Figure 15.4-1 (Lake Merced 2012 Vegetation Types) in Section 5.14.1 (Setting) for the updated Lake Merced vegetation map.

A GIS-based analysis was then conducted to estimate vegetation response to changes in lake levels over time using the newly updated vegetation data, topography, bathymetry, slope, output from the hydrologic modeling, and 'action rules'[23] to dictate how vegetation would respond (Kennedy/Jenks 2012). For the purposes of the vegetation change analysis, the initial baseline estimates for existing vegetation acreage are those that would occur at a mean annual water surface elevation of 6 feet City Datum. This is slightly higher than the baseline 2009 water surface elevation of 5.7 feet City Datum used for the Kennedy/Jenks hydrologic modeling but was necessary in order to correspond to the topographic data, which was created at 1-foot elevation intervals. The 2012 vegetation mapping update was based on an April 2011 aerial photograph; at that time, according to historic water surface elevations data, Lake Merced water surface elevation was at about 7 feet City Datum (SFPUC 2011). The GIS-based analysis only examined vegetation at or below 13 feet City Datum, which is the existing spillway height and thus the maximum possible lake level at which vegetation changes would be expected due to changes in water level. Therefore, upland vegetation types and arroyo willow riparian scrub currently located above 13 feet City Datum, as mapped in Figure 15.14-1 (Lake Merced 2012 Vegetation Types), would remain unchanged. See Appendix J (Lake Merced Vegetation

[23] ESA biologists developed action rules for each vegetation type to estimate how vegetation would respond to increases in water surface elevation. For example, bulrush only grows in saturated soils and cannot grow if completely submerged for extended periods of time. The action rules developed for bulrush, therefore, dictate the assumption that bulrush is removed (dies) at depths greater than five feet below the water surface elevation and would establish (grow) at and up to 5 feet below the new water surface elevation.

Change Analysis Methodology), for further details on the action rules used to analyze vegetation change in response changing water surface elevations.

TABLE 5.14-4
Lake Merced Vegetation Acreage: 2002, 2010, and 2012

Vegetation Community and Cover Type	2002 (Acres; Mean Annual Water Surface Elevation: 1 foot City Datum)	2010 (Acres; Mean Annual Water Surface Elevation: 5.9 feet City Datum)	2012[(a)] (Acres)	Acreage change 2002-2012
Annual grassland	7.11	1.24	1.26	-5.85
Perennial grassland	0.49	0.01	0.01	0.48
Non-native herbaceous	17.18	12.52	11.76	-5.42
Coastal scrub	13.48	14.82	14.78	+1.30
Dune scrub	0	3.32	3.30	+3.30
Non-native scrub	0.86	0.29	0.23	-0.63
Coast live oak woodland	0.13	0.58	0.54	+0.41
Non-native forest	63.32	50.49	50.51	-12.81
Developed	188.82	197.81	198.44	+9.62
Arroyo willow riparian scrub	28.33	26.11	26.78	-1.55
Giant vetch wetland	1.13	0.29	0.25	-0.88
Rush meadow	0.71	0.20	0.32	-0.39
Swamp knotweed wetland	6.93	8.97	6.42	-0.51
Cattail wetland	0.03	0.01	0.01	-0.02
Bulrush wetland	35.14	21.1	28.16	-6.98
Open water	244.94	269.91	264.69	+19.75

Source: Nomad Ecology 2011; ESA 2012

Note:

(a) Due to construction at the Lake Merced Pump Station, the transducer has been offline since summer 2011, and, therefore, 2012 average lake levels are not available.

Two different approaches were used to estimate changes in vegetation associated with increasing and decreasing water surface elevations under the Kennedy/Jenks hydrologic models. For impacts associated with water surface elevation increases, ESA biologists worked with the San Francisco Planning Department to develop action rules for each vegetation type dictating how vegetation would respond to increasing water surface elevation (see Appendix J [Lake Merced Vegetation Change Analysis Methodology] for further details). Under rising water level conditions, there is competition and resistance to replacement of existing vegetation types by those that dominate within the inundated or saturated zone. The action rules used by the GIS-based analysis account for this by prioritizing certain vegetation types over others based on their observed capacity to invade and replace existing vegetation as water levels rise. The resulting estimates of vegetative surface area, by type, were used to estimate impacts on vegetation types due to increases in water surface elevation.

For decreasing water levels, a statistical approach was used to estimate vegetation response because the majority of land that would become available for plants to establish as water levels decrease is currently inundated and free of vegetation (except for certain wetland species). Under receding water levels, much of the land surface that becomes available for vegetation to occupy (with the exception of existing bulrush patches) would be newly exposed, unvegetated sediments of the former lake bottom. As with rising conditions, the GIS-based analysis is best able to predict vegetation types near the waterline (i.e., bulrush, knotweed, and willow), because these vegetation types have predictable distribution patterns relative to water surface elevation, as well as timing and duration of inundation. However, this analysis also acknowledges the uncertainty in the patterns of upland vegetation establishment on newly exposed terrain. Early phases of vegetation establishment are characterized by a patchy distribution of plants that lack organization into recognizable, or easily mapped, plant communities, and may be dominated by weedy and non-native species for years before native plants and communities take hold. For this reason, the GIS-based analysis does not attempt to predict changes under receding water levels for specific upland vegetation types, but instead consolidates them into a single category. For this approach, ESA analyzed the proportions of each vegetation type at each elevation contour relative to the current water surface elevation (in 2012) and applied the estimates to lower water surface elevation. This approach keeps the vegetation distribution the same for each elevation range relative to the water surface elevation, but due to differences in area driven by lake topography, the area of each vegetation type changes at each decreasing water surface elevation. For example, if the contour range of 0 to 1 foot is currently inhabited by 60 percent bulrush wetland and 40 percent knotweed wetland, those proportions would be assigned to the -1 to 0 foot contour range when analyzing a water surface decrease of 1 foot. In other words, the decreasing water vegetation GIS-based analysis assumes that the same basic mix of species and percentages of each vegetation type that exist currently (in 2012) are maintained on the newly exposed ground as water levels recede.

For both lake level increases and declines, lake-level data provide direct insight into the likelihood of impacts on riparian communities and wetlands and are represented in the hydrology model by the following summary estimates: Project performance summary (percentage of time at a given level), and lake-level continuity (number of consecutive months at a given level) (Kennedy/Jenks 2012). In other words, an examination of the percentage of time the lake levels were modeled to be at a given elevation combined with the length of time waters were modeled to stay at that elevation provided information on whether or not there could be a substantial loss of habitat over time under each modeled hydrologic scenario.

Several assumptions were made in the vegetation change analysis:

- The water surface elevations used represent the mean annual water surface elevation. Lake Merced water levels vary seasonally due to hydrologic and climatic conditions; therefore, an annual range in water surface elevation from about 1 foot above and below the mean is assumed, based on the Kennedy/Jenks (2012) hydrologic modeling, which predicts a 1.6-foot mean annual range in lake levels over the 47-year model period for the modeled existing conditions scenario. So, for example, an elevation of 6 feet City Datum, as seen in Table 15.14-4 (Lake Merced Vegetation Acreage: 2002, 2010, and 2012) actually represents a range in water surface elevation between 5 feet and 7 feet City Datum.

- The acreages given for each vegetation type at each mean annual water surface elevation in Tables 15.4-12, 5.14-13, 5.14-14, 5.14-15, and 5.14-17 assume that the water level has been at that particular elevation for a long enough period of time for the changes predicted by the action rules, which incorporate a temporal element based on the tolerances of each general vegetation type, to have taken place. For example, the action rules dictate that upland vegetation types would die if inundated or if soils are saturated for more than 14 consecutive days and that willows would die if inundated for more than 3 consecutive months in the growing season. In addition, wetlands are predicted to establish in areas inundated for more than one month's time; however, the different wetland types are expected to become fully established over periods of time ranging from several months (herbaceous wetlands) to several years (willow riparian scrub).
- The acreages estimated by the GIS-based analysis represent the vegetation that would establish if the mean water surface elevation remained at or near the same level for durations long enough for the various wetland types to establish. The analysis is consistent with the fluctuations depicted in the Lake-level Model hydrographs in that the rate of change is generally slow and water surface elevations remain relatively consistent for relatively long periods of time (Kennedy/Jenks 2012). If annual fluctuations are greater, or the rate of change is faster, than modeled, then changes in vegetation would not necessarily follow the predictions of the vegetation analysis as vegetation would continuously be reestablishing at new water surface elevations.

The impact analysis sections that follow include the results of the GIS-based analysis of vegetation and habitat changes resulting from water level changes described above, determine the Project's biological resources impacts, and determine whether the Project-related impacts would be significant according to the thresholds described above.

Areas of No Project Impact

As explained below, the Project would not result in impacts related to four of the above-listed significance criteria. These significance criteria are not discussed further in the impact analysis for the following reasons:

Direct Impacts Due to Effects on Biological Resources within Project Facility Sites

Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive or special-status plant species in local or regional plans, policies, or regulations, or by the CDFW or USFWS. Based upon biological surveys conducted at the Project facility sites, no federally or State-listed or other special-status plant species are present and none are expected to occur due to the lack of suitable habitat (Ward & Associates 2012). Therefore, neither Project construction nor operation would result in impacts on special-status plant species.

Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by the CDFW or USFWS. Operation of the Project would not result in impacts on riparian habitat or sensitive natural communities because operation of the well facilities would not result in ground-disturbing activities and very limited vehicle traffic and human presence (approximately 30 minutes per day during dry years; see Chapter 3, Project Description, Section 3.8.3 [Maintenance]). Therefore, neither riparian habitat nor other sensitive natural communities would be affected.

Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means. Operation of the Project would not result in impacts to jurisdictional wetlands or waters, because operation of the well facilities would not result in ground-disturbing activities, and no fill to wetlands or waters would occur.

Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites. Based upon biological surveys conducted at the facility sites, no resident or migratory fish or wildlife species with established resident or migratory wildlife corridors are present at the facility sites (Ward & Associates 2012). Therefore, neither Project construction nor operation would result in impacts on the movement of native special-status wildlife species or on wildlife migration corridors. Construction impacts to wildlife nursery sites (i.e., nesting by birds and roosting by bats) are evaluated in the analysis of Impact BR-2; operational impacts to wildlife nursery sites are evaluated in the analysis of Impact BR-5.

Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or State habitat conservation plan. Based on research of local, regional, and State habitat conservation plans and policies, no such plans have been adopted in the areas that would be affected by the Project. Thus, no conflict would occur between Project construction or operation and such plans.

Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance. Operation of the Project would not result in removal or trimming of trees at the facility sites, so no conflict with tree preservation policies or ordinances would occur. No other local policies or ordinances protecting biological resources have been identified; therefore, Project operations would not conflict with any such policies.

Impacts Due to Potential Changes in Water Levels at Lake Merced

Because no facilities would be constructed at Lake Merced, there are no impacts associated with construction. There would be no removal of trees, or other direct effects. Potential impacts associated with changes in water levels are evaluated in the analysis of Impacts BR-6 through BR-9.

5.14.3.3 Summary of Impacts

Table 5.14-5 (Summary of Impacts – Biological Resources) and Table 5.14-6 (Summary of Impacts on Biological Resources at Lake Merced) summarize the biological resource impacts and significance determinations of the GSR Project.

TABLE 5.14-5
Summary of Impacts – Biological Resources

Sites	Construction				Operations	Cumulative
	Impact BR-1: Project construction would adversely affect candidate, sensitive, or special-status species.	Impact BR-2: Project construction could adversely affect riparian habitat or other sensitive natural communities.	Impact BR-3: The Project would impact jurisdictional wetlands or waters of the United States	Impact BR-4: Project construction would conflict with local tree preservation ordinances.	Impact BR-5: Project operations could adversely affect candidate or sensitive special-status species.	Impact C-BR-1: Construction and operation of the proposed Project could result in significant cumulative impacts related to biological resources.
Site 1	LSM	LSM	NI	NI	LSM	LSM
Site 2	LSM	NI	NI	NI	NI	LSM
Site 3	LSM	NI	NI	LSM	LS	LSM
Site 4	LSM	NI	NI	LSM	LS	LSM
Westlake Pump Station	LSM	NI	NI	NI	LSM	LSM
Site 5 (Consolidated Treatment 6 and On-site Treatment options)	LSM	NI	NI	NI	NI	LSM
Site 6 (Consolidated or On-site Treatment options)	LSM	NI	NI	NI	NI	LSM
Site 7 (Consolidated Treatment at Site 6)	LSM	NI	NI	LSM	LS	LSM
Site 7 (On-site Treatment)	LSM	NI	NI	LSM	LSM	LSM
Site 8	LSM	NI	LSM	NI	NI	LSM

TABLE 5.14-5
Summary of Impacts – Biological Resources

Sites	Construction				Operations	Cumulative
	Impact BR-1: Project construction would adversely affect candidate, sensitive, or special-status species.	Impact BR-2: Project construction could adversely affect riparian habitat or other sensitive natural communities.	Impact BR-3: The Project would impact jurisdictional wetlands or waters of the United States	Impact BR-4: Project construction would conflict with local tree preservation ordinances.	Impact BR-5: Project operations could adversely affect candidate or sensitive special-status species.	Impact C-BR-1: Construction and operation of the proposed Project could result in significant cumulative impacts related to biological resources.
Site 9	LSM	NI	LSM	LSM	NI	LSM
Site 10	LSM	NI	NI	LSM	LS	LSM
Site 11	LSM	NI	LSM	LSM	LS	LSM
Site 12	LSM	NI	NI	LSM	LSM	LSM
Site 13	LSM	NI	NI	LSM	LS	LSM
Site 14	LSM	NI	NI	LSM	NI	LSM
Site 15	LSM	NI	NI	LSM	LS	LSM
Site 16	LSM	NI	NI	NI	LS	LSM
Site 17 (Alternate)	LSM	NI	NI	LSM	LS	LSM
Site 18 (Alternate)	LSM	NI	NI	LSM	LSM	LSM
Site 19 (Alternate)	LSM	NI	NI	NI	NI	LSM

Notes:

NI = No Impact
LS = Less than Significant
LSM = Less then Significant with Mitigation

TABLE 5.14-6
Summary of Impacts on Biological Resources at Lake Merced

Impact	Operations	Cumulative
Impact BR-6: Operation of the Project would not adversely affect species identified as candidate, sensitive, or special-status wildlife species in local or regional plans, policies, or regulations, or by the CDFW or USFWS.	LS	--
Impact BR-7: Operation of the Project could adversely affect sensitive habitat types associated with Lake Merced.	LSM	--
Impact BR-8: Operation of the Project could adversely affect wetland habitats and other waters of the United States associated with Lake Merced.	LSM	--
Impact BR-9: Operation of the Project could adversely affect native wildlife nursery sites associated with Lake Merced.	LSM	--
Impact C-BR-2: The Project would result in cumulative construction or operational impacts related to special-status species, riparian habitat, sensitive communities, wetlands, or waters of the United States, or compliance with local policies and ordinances protecting biological resources at Lake Merced.	--	LSM

Notes:
NI = No Impact
LS = Less than Significant
LSM = Less than Significant with Mitigation

5.14.3.4 Construction Impacts and Mitigation Measures

Impact BR-1: Project construction would adversely affect candidate, sensitive, or special-status species. (Less than Significant with Mitigation)

As discussed in the Areas of No Impact section above, no special-status plants are known to occur within the study area, as identified in Section 5.14.1.4 (Special-status Plant Species). Therefore, this impact discussion focuses on special-status animal species.

No animal species listed under FESA or CESA, or which are candidates for either list, are present at any of the well facility sites, and none are expected to occur due to a lack of suitable habitat, as identified in the Section 5.14.1.5 (Special-status Animal Species). Therefore, Project construction would not result in impacts on federally listed, State-listed, or candidate wildlife species.

Nine non-listed, special-status animal species may be present in the study area; these animals are identified by the CDFW as special animals, Species of Special Concern, or, in the case of the white-tailed kite, fully protected species. Migratory birds are also protected under the MBTA and CFGC. Although the potential for their occurrence is considered low, the presence of these special-status species could not be ruled out due to the presence of suitable habitat at or adjacent to one or more of the facility sites. The evaluation of impacts for each species or group of species is provided below. The evaluation of impacts discusses sites with no impacts first, followed with less-than-significant impacts, and sites with significant impacts.

Special-status Birds and Migratory Passerines and Raptors

<u>All Sites</u>

Construction activities could remove the nesting and foraging habitat of special-status birds and other wildlife that depend on grassland, woodland, and riparian habitat through direct removal of habitat, or could result in disruption of breeding and foraging habitat due to construction noise and activities. Project construction could result in the removal of large mature trees in developed and ruderal areas that provide important nesting habitat for nesting birds, raptors, and bats. Suitable nesting habitat for migratory birds is present within the construction areas of Sites 1, 3, 4, 7, 9, 11, 12, 13, 15, 17 (Alternate), and 19 (Alternate). Marginally suitable habitat for migratory birds is present adjacent to Sites 2, 5, 6, 8, 10, 14, 16, 18 (Alternate), and the Westlake Pump Station.

The facility sites have large trees and shrubs either within or near the construction area of the facility sites. The trees and shrubs could provide nesting habitat for special-status bird species including white-tailed kite, oak titmouse, loggerhead shrike, Allen's hummingbird, and California thrasher, as well as migratory raptors and passerine bird species. All facility sites have trees and shrubs in close proximity to the site that could be used for nesting by special-status and other migratory birds. Construction activities would result in tree removal or trimming of nearby trees at some sites which would result in impacts to special-status and migratory birds if present in the trees and shrubs. Construction activities could also disturb nesting and breeding birds in trees and shrubs near the facility sites. Potential impacts on special-status and migratory birds that could result from Project construction activities include the destruction of eggs or occupied nests, mortality of young, and the abandonment of nests with eggs or young birds prior to fledging. Such potential construction-related impacts on special-status and migratory birds would be *significant*.

However, implementation of Mitigation Measure M-BR-1a (Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors) would mitigate these potential impacts on special-status and migratory birds to *less-than-significant* levels by requiring pre-construction surveys by a qualified biologist to determine whether special-status or migratory bird nests are present at or near the well facility sites and implementing related protection measures.

> ***Mitigation Measure M-BR-1a: Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors (All Sites)***
> The SFPUC shall conduct tree and shrub removal at the facility sites during non-breeding season (generally August 31 through February 28) for special status, migratory birds and raptors, to the extent feasible.

If construction activities must occur during the breeding season for special-status birds (March 1 to August 30), the SFPUC shall retain a qualified wildlife biologist who is experienced in identifying birds and their habitat to conduct a pre-construction survey for nesting special-status birds and migratory passerines and raptors. The preconstruction surveys must be conducted within two weeks prior to the initiation of tree removals or pruning, grading, grubbing, structure demolition, or other construction activities scheduled during the breeding season (March 1 to August 30). If the biologist detects no active nesting or breeding activity by special-status or migratory birds or raptors, then work may proceed without restrictions. To the extent allowed by access, all active passerine nests identified within 100 feet and all active raptor nests identified within 250 feet of the limits of work shall be mapped.

If migratory bird and/or active raptor nests are identified within 250 feet of a facility site or if an active passerine nest is identified within 100 feet of a facility site, a qualified biologist shall determine whether or not construction activities might impact the active nest or disrupt reproductive behavior. If it is determined that construction would not affect an active nest or disrupt breeding behavior, construction may proceed without any restriction.

If the qualified biologist determines that construction activities would likely disrupt raptor breeding or passerine nesting activities, then the SFPUC shall establish a no-disturbance buffer around the nesting location to avoid disturbance or destruction of the nest site until after the breeding season or after a wildlife biologist determines that the young have fledged (usually late June through mid-July). The extent of these buffers would be determined by a wildlife biologist in consultation with CDFW and would depend on the species' sensitivity to disturbance (which can vary among species); the level of noise or construction disturbance; line of sight between the nest and the disturbance; ambient levels of noise and other disturbances; and consideration of other topographical or artificial barriers. The wildlife biologist shall analyze and use these factors to assist the CDFW in making an appropriate decision on buffer distances.

Impact Conclusion: Less than Significant with Mitigation

Special-status Bats

The evaluation of impacts that follows discusses sites with no impacts first, followed by those with significant impacts.

<u>Sites 2, 5, 6, 8, 9, 13, 14, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

No trees suitable for bat roosting occur on or adjacent to these sites. Although the proposed Project could include demolition of an existing well and above-ground tank at Site 14, the features do not provide potential habitat for special-status bats. These sites do not support the habitat characteristics necessary for roosting; therefore, no construction-related impacts on special-status bats would occur at these sites.

Impact Conclusion: No Impact

Sites 1, 3, 4, 7, 10, 11, 12, 15, and 16

Significant impacts on special-status bat species could result from well facility construction activities that require tree removals or trimming of trees that provide suitable roosting habitat for special-status bat species or that are occupied by roosting bats. The demolition of the restroom facility (in addition to tree removal) at Site 1, where bats may roost, could also result in significant impacts on special-status bat species. The pallid bat, western red bat, and hoary bat could roost in trees on or near these sites. Disturbance during the maternity roosting season could potentially result in roost abandonment and mortality of young. For instance, bats could abandon their young if impacts were to occur during seasonal periods of breeding activity (about February 15 through April 15 and August 15 through October 30). Therefore, Project construction could result in both permanent and temporary loss of suitable or occupied habitat for, as well as mortality of, special-status bat species, which would be a *significant* impact.

However, implementation of Mitigation Measure M-BR-1b (Protection Measures for Special-status Bats during Tree Removal or Trimming) and Mitigation Measure M-BR-1c (Protection Measures during Structure Demolition for Special-status Bats) would reduce impacts on special-status bat species to *less-than-significant* levels by requiring pre-construction surveys and the avoidance of disturbance to roosting bats.

Mitigation Measure M-BR-1b: Protection Measures for Special-status Bats during Tree Removal or Trimming (Sites 1, 3, 4, 7, 10, 11, 12, 15, and 16)

The SFPUC will ensure that, prior to the removal of large trees scheduled during seasonal periods of bat activity (February 15 through April 15 and August 15 through October 30), a qualified bat biologist conducts a bat habitat assessment to determine the presence of suitable bat roosting habitat. No more than 30 days before removal of any large tree or snag, a biologist familiar with identification of bats and signs of bats will conduct a pre-construction survey for signs of bat activity. If tree removal or trimming is postponed or interrupted for more than 30 days from the date of the initial bat survey, the biologist will repeat the pre-construction survey.

If a tree provides potentially suitable roosting habitat, but bats are not present, the SFPUC shall exclude bats by temporarily sealing cavities, pruning limbs, or removing the entire tree, in consultation with the qualified bat biologist. Trees and snags with cavities or loose bark that exhibit evidence of use by bats shall be scheduled for bat exclusion and/or eviction, conducted during appropriate seasons (i.e., February 15 through April 15 and August 15 through October 30) and supervised by the biologist.

If the biologist determines or presumes bats are present, the biologist shall exclude the bats from suitable tree cavities by installing one-way exclusion devices. After the bats vacate the cavities, the biologist shall plug the cavities or remove the limbs. The construction contractor shall only remove trees after the biologist verifies that the exclusion methods have successfully prevented bats from returning, usually in seven to 10 days. To avoid impacts on non-volant (i.e., non-flying) bats, the biologist shall only conduct bat exclusion and eviction from February 15 through April 15 and from August 15 through October 30. After construction activities are complete, the biologist will remove the exclusion devices.

Mitigation Measure M-BR-1c: Protection Measures during Structure Demolition for Special-status Bats (Site 1)

Not more than two weeks prior to building demolition at Site 1, a qualified biologist (i.e., one familiar with the identification of bats and signs of bats) shall survey the building for the presence of roosting bats or evidence of bats. If no roosting bats or evidence of bats are found in the structure, demolition may proceed. If the biologist determines or presumes bats are present, the biologist shall exclude the bats from suitable spaces by installing one-way exclusion devices. After the bats vacate the space, the biologist shall close off the space to prevent recolonization. The construction contractor shall only demolish the building after the biologist verifies that the exclusion methods have successfully prevented bats from returning, usually in seven to 10 days. To avoid impacts on non-volant (i.e., non-flying) bats, the biologist shall only conduct bat exclusion and eviction from February 15 through April 15 and from August 15 through October 30.

Impact Conclusion: Less than Significant with Mitigation

Overwintering Monarch Butterfly Habitat

The evaluation of impacts that follows discusses sites with no impacts first, followed by those with significant impacts.

<u>Sites 2, 4, 5, 6, 8, 9, 11, 13, 14, 15, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

No dense stands of eucalyptus, Monterey pine, or Monterey cypress trees occur at or adjacent to these sites. Therefore, these sites do not support the habitat suitable for overwintering by monarch butterflies. As a result, no construction-related impacts on roosting monarch butterflies would occur at these sites.

Impact Conclusion: No Impact

<u>Sites 1, 3, 7, 10, and 12</u>

Although unlikely, given that overwintering of monarch butterflies at these locations has not been reported (CDFG 2011f), the dense stands of large eucalyptus, Monterey pine, and Monterey cypress trees at these sites could nevertheless support overwintering monarch butterflies. This species' overwintering sites are considered to have special-status by the CDFG (CDFG 2011c). The removal or pruning of trees actively used by overwintering monarch butterflies during the winter roosting period would therefore constitute a *significant* impact on a special-status species.

However, implementation of Mitigation Measure M-BR-1d (Monarch Butterfly Protection Measures) would reduce this potential impact to *less-than-significant* levels by requiring an inspection by a qualified biologist prior to the limbing or felling of trees or the initiation of construction activities on these sites, whichever comes first; and by delaying construction at a particular site if overwintering congregations of monarch butterflies are identified on site or nearby.

Mitigation Measure M-BR-1d: Monarch Butterfly Protection Measures (Sites 1, 3, 7, 10, and 12)

The SFPUC will ensure that, two weeks prior to removing or pruning large eucalyptus, Monterey pine or Monterey cypress trees that occur in a dense stand, a qualified biologist conduct surveys for monarch butterflies if the trees are to be removed or limbed between October 15 and March 1. If no congregations of monarch butterflies are present within the contiguous stand of dense trees, work may proceed without restriction.

A pre-construction inspection is not needed for construction activities occurring between March 2 and October 14.

If overwintering congregations of monarch butterflies are identified within the tree stand, work may not proceed until the butterflies have left the roosting site. No limbing or tree cutting shall occur in a contiguous stand of trees occupied by monarch butterflies. A qualified biologist shall determine when the butterflies have left and when work in the area may proceed.

Impact Conclusion: Less than Significant with Mitigation

Impact BR-2: Project construction could adversely affect riparian habitat or other sensitive natural communities. (Less than Significant with Mitigation)

The evaluation of impacts that follows discusses sites with no impacts first, followed by those with significant impacts.

<u>Sites 2 through 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

No riparian habitat or other sensitive natural communities are present within the construction area boundaries or in areas adjacent to any of these facility sites. Project construction at these locations therefore would not result in impacts on riparian habitat or other sensitive natural communities; *no impact* would occur.

An isolated patch of willows, classified as ruderal (weedy or disturbed) habitat, is present inside the construction area boundary of Site 18 (Alternate). Ruderal habitat is not considered a sensitive natural community.

Isolated patches of Central Coast riparian scrub habitat not associated with a surface tributary are present near the construction areas for Sites 6 and 17 (Alternate); the habitat in these areas is assumed to be supported by groundwater. Also, an unnamed drainage channel supports a stand of Central Coast riparian scrub near Site 11. The location of the Central Coast riparian scrub near Sites 6, 11, and 17 (Alternate) is shown on Figures 5.14-3 through 5.14-6. Riparian habitat at Site 6 is located approximately 50 feet southwest of the construction area. Riparian habitat at Site 11 is located approximately 15 feet from the northwest corner of the construction area. The willow stand in this area is approximately 5,060 square feet. The habitat near Site 17 (Alternate) is located adjacent to the western edge of the construction area boundary on the north side of Collins Avenue. No Central Coast riparian scrub habitat would be directly impacted at Sites 6, 11, or 17 (Alternate) as the habitat is located outside of the construction area. In addition, the riparian habitat is located at a higher elevation than the construction areas at Sites 6, 11, and 17 (Alternate), so stormwater runoff from the construction site would not affect the habitat. As a result, *no impact* on riparian habitat or other sensitive natural habitat would occur at these facility sites.

Impact Conclusion: No Impact

<u>Site 1</u>

An isolated patch of Central Coast riparian scrub habitat not associated with a surface tributary is present adjacent to the construction area at Site 1. The habitat in this area is assumed to be supported by groundwater. No Central Coast riparian scrub habitat would be directly impacted at Site 1, as the habitat is located out of the construction area boundary. The 305 square feet of riparian habitat adjacent to Site 1 is located immediately adjacent to the northwest edge of the construction area boundary. Although construction at this site would not result in the loss of Central Coast riparian scrub habitat, construction near the habitat could result in stormwater runoff which could carry sediment into the area and adversely impact the habitat. If so, such impacts on Central Coast riparian scrub habitat from excessive sedimentation would be *significant*.

However, implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) and M-BR-2 (Avoid Disturbance to Riparian Habitat) would reduce the potential impacts on riparian habitat at Site 1 to *less-than-significant* levels by requiring the installation of temporary fencing to demarcate the boundary for construction activities at this site and by protecting the area from construction-related runoff and sedimentation.

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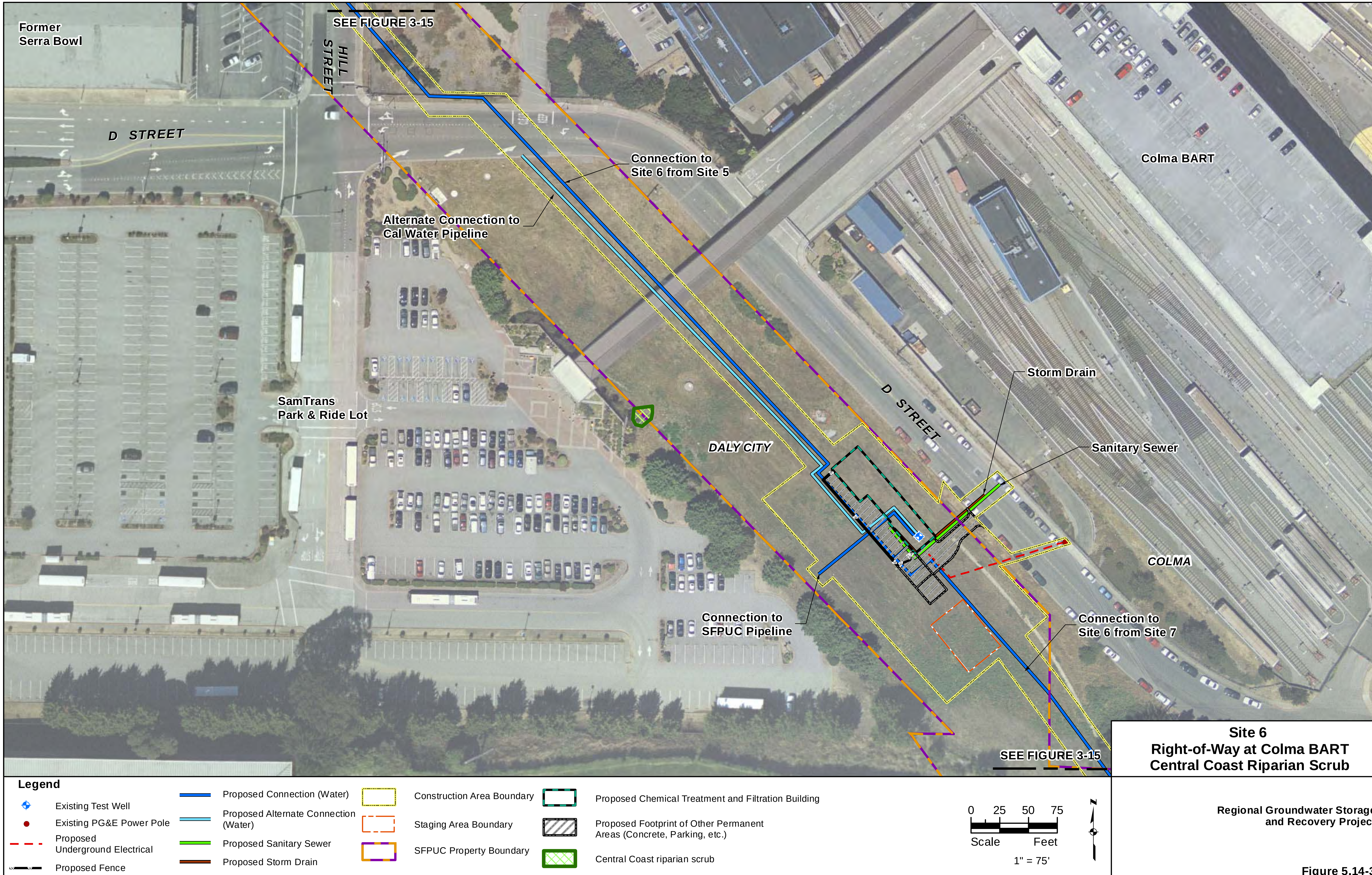

Site 6
Right-of-Way at Colma BART
Central Coast Riparian Scrub

Regional Groundwater Storage and Recovery Project

Figure 5.14-3

Source: SFPUC and Kennedy/Jenks

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Site 11 Pipeline and Access Road
South San Francisco Main Area
Central Coast Riparian Scrub
and Jurisdictional Waters

Regional Groundwater Storage and Recovery Project

Figure 5.14-4

Source: SFPUC and Kennedy/Jenks

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Site 17 (Alternate)
Standard Plumbing Supply
Central Coast Riparian Scrub

Legend

- Proposed Well
- Proposed Underground Electrical
- Proposed Connection (Water)
- Proposed Alternate Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)
- ProposedTemporary Access Driveway
- Central Coast riparian scrub

0 10 20 40
Scale Feet
1" = 40'

N

Regional Groundwater Storage and Recovery Project

Figure 5.14-5

Source: SFPUC and Kennedy/Jenks

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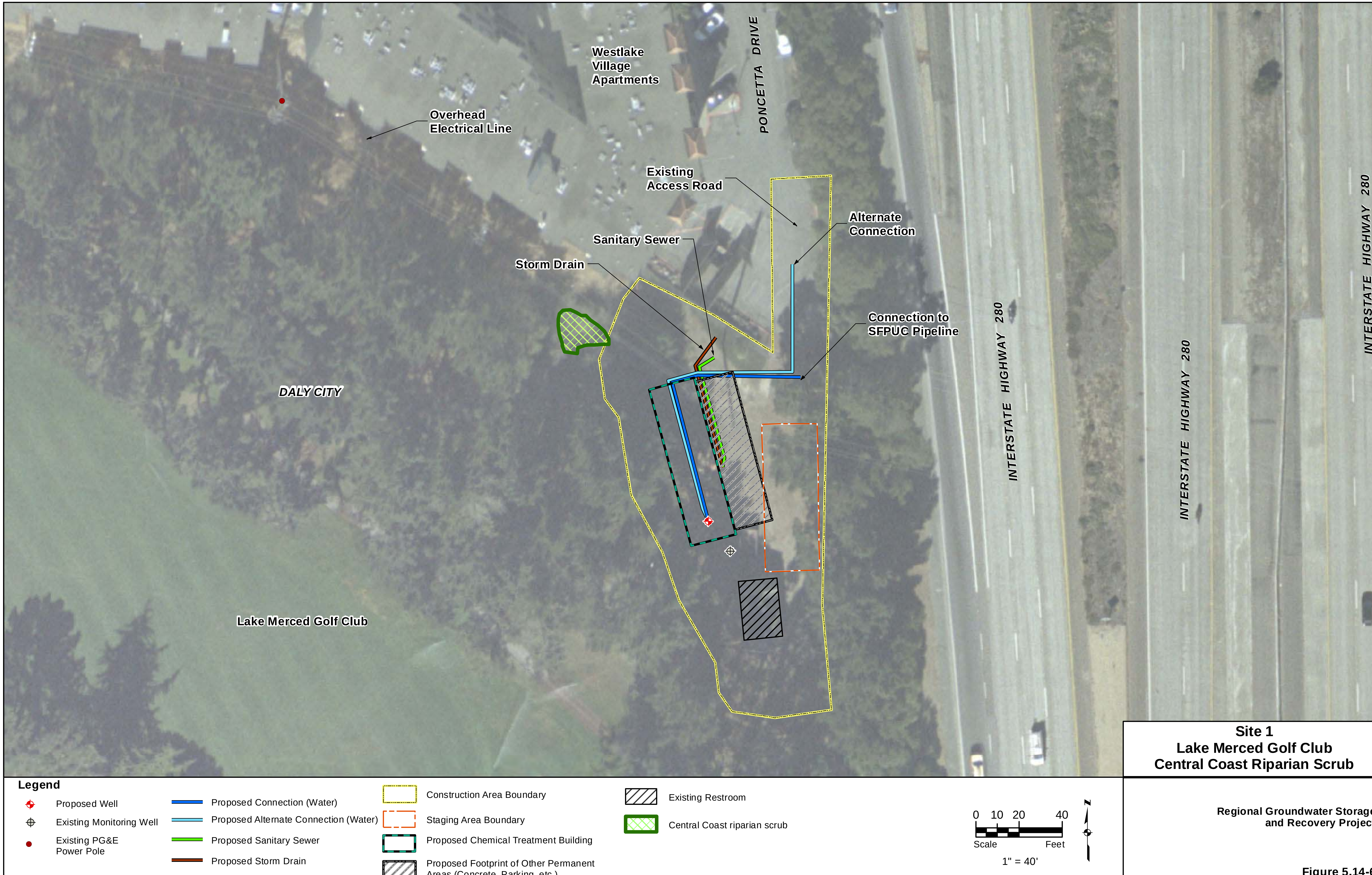

Source: SFPUC and Kennedy/Jenks

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Mitigation Measure M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)
(See Impact HY-1 in Section 5.16, Hydrology and Water Quality for a description)

Mitigation Measure M-BR-2: Avoid Disturbance to Riparian Habitat (Site 1)
The SFPUC shall require its construction contractor to avoid the riparian habitat at Site 1. Prior to any ground disturbing activity, a qualified biologist shall map the location of the Central Coast riparian scrub habitat, and the construction contractor shall install temporary fencing to protect the habitat for the duration of construction.

Impact Conclusion: Less than Significant with Mitigation

Impact BR-3: The Project would impact jurisdictional wetlands or waters of the United States (Less than Significant with Mitigation).

The evaluation of impacts that follows discusses sites with no impacts first, followed by those with significant impacts.

<u>Sites 1, 2, 3, 4, 5, 6, 7, 10, 12, 13, 14, 15, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

No federally regulated wetlands or surface waters of the United States/waters of the State are present within the construction area boundaries of these facility sites. Project construction at these locations would therefore result in *no impact* on wetlands or waters of the United States/waters of the State.

Impact Conclusion: No Impact

<u>Sites 8, 9, and 11</u>

An underground culvert crosses beneath a portion of the Site 8 construction area. Water in the culvert is a tributary to Colma Creek, and therefore would qualify as a jurisdictional water of the United States and the State. However, no direct impacts to the culvert or the tributary would occur as a result of Project construction.

Site 9 would be located approximately 25 feet from channelized sections of the Colma Creek Diversion Channel and the San Mateo County Flood Control Channel as illustrated on Figure 5.14-7 (Site 9, Treasure Island Trailer Court, Jurisdictional Waters). Stormwater runoff from this site could drain to either channel. Site 11 would be located approximately 200 feet from the Colma Creek Diversion Channel, and the construction area at the northwest edge of the site

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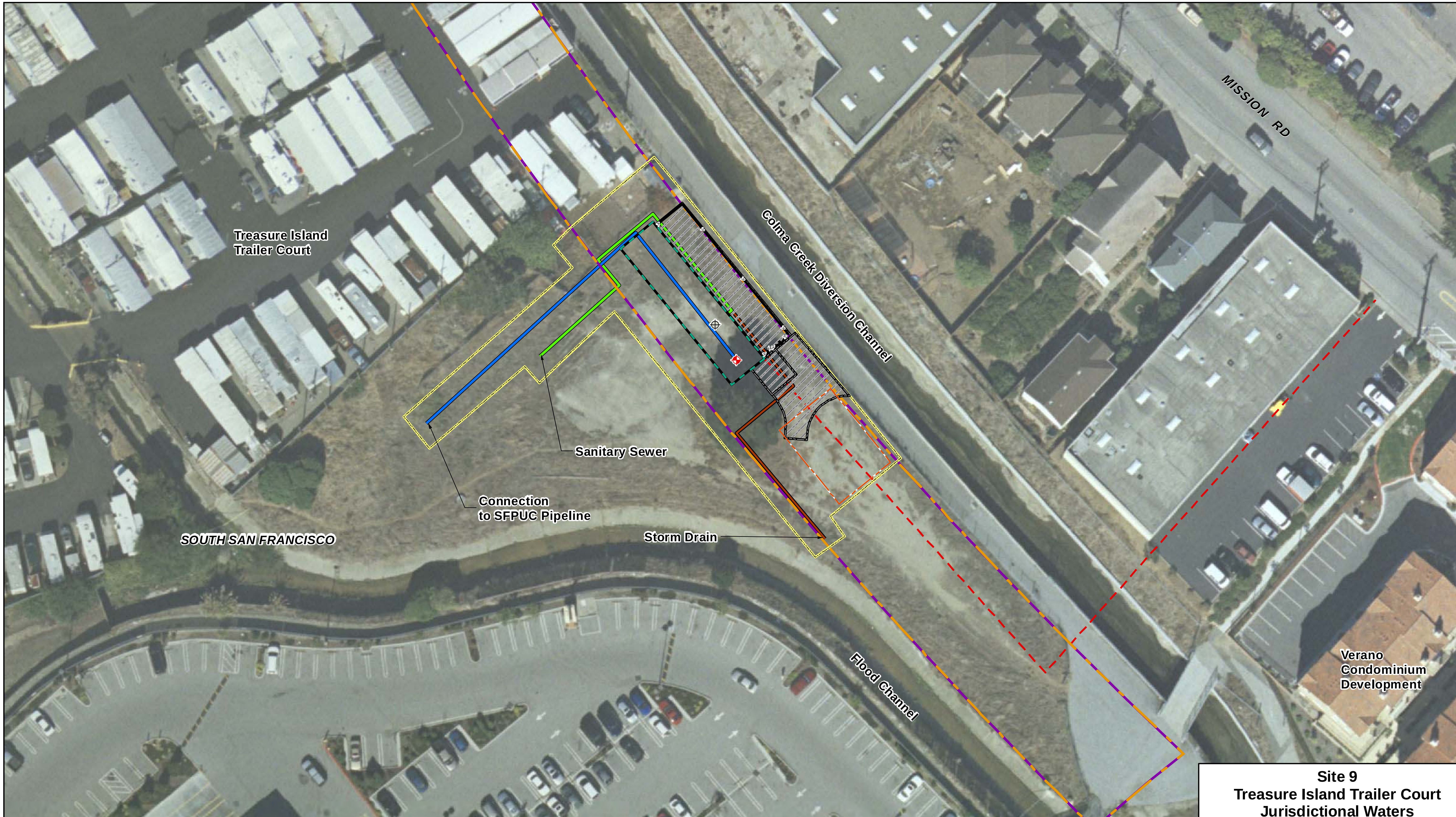

Site 9
Treasure Island Trailer Court
Jurisdictional Waters

Legend

- Proposed Well
- Existing Monitoring Well
- Proposed Overhead Electrical
- Proposed Fence
- Proposed Connection (Water)
- Proposed Sanitary Sewer
- Proposed Storm Drain
- Construction Area Boundary
- Staging Area Boundary
- SFPUC Property Boundary
- Proposed Chemical Treatment and Filtration Building
- Proposed Footprint of Other Permanent Areas (Concrete, Parking, etc.)

0 25 50
Scale Feet
1" = 50'

N

Regional Groundwater Storage and Recovery Project

Figure 5.14-7

Source: SFPUC and Kennedy/Jenks

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would be within approximately 15 feet of an unnamed drainage channel that supports a stand of Central Coast riparian scrub. The Central Coast riparian scrub and jurisdictional waters at Site 11 are shown on Figure 5.14-4 (Site 11 Pipeline and Access Road, South San Francisco Main Area, Central Coast Riparian Scrub and Jurisdictional Waters). No direct impacts on the Colma Creek Diversion Channel, the San Mateo County Flood Control Channel, or the unnamed channel northwest of Site 11 would occur during construction, because these jurisdictional waters are not located within the construction area at Site 9 or Site 11.

Stormwater leaving the Site 11 construction area would not affect the unnamed drainage channel northwest of the site, because the facility is at a lower elevation than the channel. However, stormwater runoff leaving the construction area at Sites 8 and 9 could carry sediment or other contaminants into the on-site culvert at Site 8 or the Colma Creek Diversion Channel or the San Mateo County Flood Control Channel at Sites 9 and 11. Uncontrolled stormwater runoff could result in discharge and sedimentation to jurisdictional waters, which would be a *significant impact.* However, implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would reduce impacts to *less-than-significant* levels by protecting the area from construction-related runoff and sedimentation.

> ***Mitigation Measure M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)***
> (See Impact HY-1 in Section 5.16, Hydrology and Water Quality for a description)

Impact Conclusion: Less than Significant with Mitigation

Impact BR-4: Project construction would conflict with local tree preservation ordinances. (Less than Significant with Mitigation)

As identified in the regulatory framework discussion in Section 5.14.2.3 (Local), the relevant policies and ordinances protecting trees in the study area are the San Mateo County Significant and Heritage Tree Ordinances (San Mateo County Ordinance Code: Part III, Division VIII. (The Significant Tree Ordinance of San Mateo County) and Ordinance Number 2427 (Regulation of the Removal and Trimming of Heritage Trees on Public and Private Property), the City of Daly City Municipal Code (Daly City Municipal Code, Title 12: Chapter 12.40. Chapter 12.40, Urban Forestry), the Town of Colma Municipal Code (Town of Colma Municipal Code: Subchapter Six. Subchapter Six, Tree Cutting and Removal), the City of South San Francisco Municipal Code (City of South San Francisco Municipal Code: Chapter 13.30. Chapter 13.30, Tree Preservation), and City of San Bruno Municipal Code (City of San Bruno Municipal Code: Chapters 8.24 and 8.25. Chapter 8.25, Heritage Tree Ordinance). The criteria for tree protection in each of the local tree preservation ordinances were used to identify protected trees in the study area, assess the impact of the proposed Project on the trees at each facility site, and develop mitigations to address impacts.

The evaluation of impacts that follows discusses sites with no impacts first, followed by those with significant impacts.

Sites 1, 2, 5, 6, 8, 16, 19 (Alternate), and the Westlake Pump Station

Project implementation at the above-listed sites would not result in impacts on trees regulated under local ordinances because either no such trees are present on these sites or, at the Westlake Pump Station, they would be avoided during construction activities. The applicable local jurisdiction for each of these sites is as follows: Sites 1, 5, and 6 would be located in Daly City; Site 2 would be located in unincorporated San Mateo County (Broadmoor); Site 8 would be located in Colma; Site 16 would be located in Millbrae; and Site 19 (Alternate) in South San Francisco. As a result, development of these sites would not conflict with local ordinances aimed at protecting trees. Therefore, *no impact* would occur at these sites relative to this criterion.

Impact Conclusion: No Impact

Sites 3, 4, 7, 9, 10, 11, 12, 13, 14, 15, 17 (Alternate), and 18 (Alternate)

A total of 59 trees within the proposed construction areas that would qualify for protection under local tree protection ordinances could be removed, as shown in Tables 5.14-7 through 5.14-10, if all these sites were developed. An additional 53 protected trees located in the study area surrounding these sites (i.e., those that would be adjacent to the construction areas or along pipeline routes) could be trimmed to accommodate construction.

Sites 3 and 4 would be located in the Broadmoor community of unincorporated San Mateo County. No significant or heritage trees are present within the proposed construction area at Site 3; however, two protected Monterey pines, were identified adjacent to the construction boundary. These trees may be trimmed during construction, and tree trimming of protected trees is regulated in the local preservation ordinances. Three protected Monterey cypress trees are located within the construction area for Site 4 and would be removed during construction. In addition, two protected Monterey cypress trees would be trimmed during construction at this site. Protected trees to be removed or trimmed are identified in Table 5.14-7 (San Mateo County Protected Trees).

TABLE 5.14-7
San Mateo County Protected Trees

Site	Protected Trees *in* the Construction Area Boundary	Tree Species	Protected Trees *Adjacent to* the Construction Boundary	Tree Species
Site 3	0	N/A	2[(a)]	Monterey pine
Site 4	3	Monterey cypress	2[(a)]	Monterey cypress

Note:

(a) Trees do not meet the County's definition of a Heritage Tree (San Mateo County 1977)

Site 7, located in the Town of Colma, has 25 protected trees in the proposed construction area boundary and an additional 13 protected trees adjacent to the boundary and subject to trimming or pruning to accommodate construction activities in the area. Trees within the construction area boundary would be removed during construction. Protected trees to be removed or trimmed are identified in Table 5.14-8 (Town of Colma Protected Trees).

TABLE 5.14-8
Town of Colma Protected Trees

Site	Protected Trees *in* the Construction Area Boundary	Tree Species	Protected Trees *Adjacent to* the Construction Boundary	Tree Species
Site 7	1	Monterey pine	13	Tasmanian blue gum
	19	Tasmanian blue gum		
	1	Scarlet flowing gum		
	1	Horsetail casuarina		
	1	Peruvian pepper		
	1	Myoporum		
	1	Spruce		
Site 17 (Alternate)	0	NA	2	Monterey cypress

In South San Francisco, at Site 9, one large Monterey pine that would be removed during construction qualifies as a locally protected tree. No protected trees are present in the construction area for Sites 10, 11, or 13. However, several protected trees are located adjacent to the boundaries of Sites 10, 11, and 13 which may require trimming or pruning to accommodate construction activities in the area, as shown below. The South San Francisco Tree Preservation Ordinance regulates pruning or altering protected trees in any way. At Site 12, 28 protected trees may be removed and four protected trees trimmed. At Site 18 (Alternate), one protected tree may need to be removed. Protected trees to be removed or trimmed are identified in Table 5.14-9 (South San Francisco Protected Trees).

TABLE 5.14-9
South San Francisco Protected Trees

Site	Protected Trees *in* the Construction Area Boundary	Tree Species	Protected Trees *Adjacent to* the Construction Boundary	Tree Species
Site 9	1	Monterey pine	0	NA
Site 10[a]	0	NA	1	Monterey pine
			2	Monterey cypress
Site 11	0	NA	1	Lombardy poplar
			3	Torrey pine
			2	Tasmanian blue gum
Site 12	5	Monterey cypress	4	Monterey cypress
	10	Monterey pine		
	9	Dwarf blue gum		
	3	Tasmanian blue gum		
	1	Aleppo pine		
Site 13[b]	0	NA	5	Gum tree
			6	Italian stone pine
			1	Tasmanian blue gum
Site 18 (Alternate)	1	Ornamental plum	0	NA

Notes:

(a) Trees adjacent the Site 10 construction area boundary would not require trimming, but are listed in the table as trees adjacent to the construction area.

(b) Trees adjacent to Site 13 would not require trimming, but are listed in the table as trees adjacent to the construction area boundary. The trees are street trees along Huntington Avenue.

Site 15 would be located at the Golden Gate National Cemetery in San Bruno. The City's municipal code restricts removal or alteration of any tree without a permit. No protected tree would need to be removed at Site 14 (also at the Golden Gate National Cemetery in San Bruno). Site 15 has one elm tree in the construction area boundary that meets the definition of a protected tree and that would need to be removed. In addition, the pipelines for Sites 14 and 15 and removal of existing well building may require trimming of 22 protected trees along Sneath Lane and two trees within the cemetery during construction. Although the pipelines for both sites would be installed along Sneath Lane, for purposes of this analysis, these tree impacts are attributed to Site 15 only. Protected trees to be removed or trimmed are identified in Table 5.14-10 (San Bruno Protected Trees).

TABLE 5.14-10
San Bruno Protected Trees

Site	Protected Trees *in* the Construction Area Boundary	Tree Species	Protected Trees *Adjacent to* the Construction Boundary	Tree Species
Site 14	0	n/a	1	Olive
			1	Myoporum
Site 15	1	Elm	4	Monterey pine
			3	myoporum
			2	Spanish bayonette
			3	Tasmanian blue gum
			2	Elm
			3	Aleppo pine
			5	Canary Island pine

Tree removal or tree pruning that is inconsistent with the San Mateo County tree preservation ordinances, the City of Daly City Municipal Code, the Town of Colma Municipal Code, the City of South San Francisco Municipal Code, or the City of San Bruno Municipal Code would be a *significant* impact on a locally protected biological resource. However, these impacts would be reduced to *less-than-significant* levels by implementation of Mitigation Measure M-BR-4a (Minimize Impacts on Protected Trees to Avoid Tree Loss) and Mitigation and Measure M-BR-4b (Protected Tree Replacement), which would fulfill the intent of the local tree preservation ordinances and codes by minimizing impacts on protected trees and by requiring replacement trees for any protected trees that are removed, in substantial accordance with local jurisdiction requirements. These measures would therefore resolve the conflict with the local tree protection ordinances.

Mitigation Measure M-BR-4a: Identify Protected Trees (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate])

The SFPUC shall identify trees to be protected during construction activities. These trees shall be marked on construction plans and protected during construction activities according to requirements presented in Mitigation Measure M-AE-1b (see Section 5.3, Aesthetics for a description of the tree protection measures). For each protected tree that is removed as part of construction activities, replacement trees shall be planted according to local requirements, as stated in Mitigation Measure M-BR-4b (Protected Tree Replacement).

M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate])
(See Section 5.3, Aesthetics for a description)

Mitigation Measure M-BR-4b: Protected Tree Replacement (Sites 4, 7, 9, 12, 15, and 18 [Alternate])
The SFPUC shall replace protected trees in accordance with the requirements specified in this mitigation measure and at the ratios specified in this measure for the jurisdiction where the trees to be removed are located. Protected non-native trees removed shall be replaced with native tree species determined suitable for the site by a qualified arborist, horticulturist, landscape architect, or biologist.

Tree Replacement Requirements Common to All Jurisdictions

- Trees shall be replaced within the first year after completion of construction, or as soon as possible in areas where construction has been completed, during a favorable time period for replanting, as determined by a qualified arborist, horticulturist, or landscape architect.
- Selection of replacement sites and installation of replacement plantings shall be supervised by a qualified arborist, horticulturist, landscape architect, or landscape contractor. Irrigation of trees during the initial establishment period (generally for two to four growing seasons) shall be provided as deemed necessary by a qualified arborist, horticulturist, landscape architect, or landscape contractor.
- Trees shall be planted at or in close proximity to removal sites, in locations suitable for the replacement species. The specialist shall work with the SFPUC to determine appropriate nearby off-site locations that are within the same jurisdiction from which the trees are removed if replanting within the well facility sites is precluded.
- A qualified arborist, horticulturist, landscape architect, or landscape contractor shall monitor newly planted trees at least twice a year for five years. Each year, any trees that do not survive shall be replaced and monitored at least twice a year for five years thereafter.

San Mateo County Tree Ordinance Replacement Requirements

- For each significant/heritage tree removed during construction or lost due to construction-related impacts, a replacement tree shall be planted. Native trees shall be replaced with the same species, and nonnative trees shall be replaced with a native tree species determined suitable for the site by a qualified arborist, horticulturalist, or landscape architect.

- Each protected tree removed shall be replaced at a 1:1 ratio of a native variety that has the potential to reach a size similar to that of the removed trees.

Town of Colma Tree Replacement Requirements

- Each protected tree removed shall be replaced at a 1:1 ratio. Native trees shall be replaced with the same species, and nonnative trees shall be replaced with a native tree species determined suitable for the site by a qualified arborist, horticulturalist, or landscape architect.

City of South San Francisco Tree Replacement Requirements

- Each protected tree removed shall be replaced with three 24-inch-box sized or two 36-inch-box sized landscape trees.

City of San Bruno Tree Replacement Requirements

- Tree replacement shall be a minimum of either two 24-inch box size trees, or one 36-inch box size tree, for each heritage tree removed.

Impact Conclusion: Less than Significant with Mitigation

5.14.3.5 Operational Impacts and Mitigation Measures

Impact BR-5: Project operations could adversely affect candidate or sensitive special-status species. (Less than Significant with Mitigation)

The evaluation of impacts that follows discusses sites with no impacts first, followed by less-than-significant impacts, and significant impacts.

Special-Status Birds and Migratory Passerines and Raptors

<u>Sites 2, 3, 4, 5, 6, 7 (Consolidated Treatment at Site 6), 8, 9, 10, 14, and 19 (Alternate)</u>

Operation and maintenance activities would not result in a loss of habitat for special-status or other migratory birds and would not result in additional loss of suitable nesting trees. Well facilities at some sites (2, 3, 4, Site 7 [Consolidated Treatment at Site 6], Site 14, and Site 19 [Alternate]) would have a submersible pump. Submersible pumps would be installed underground and would, therefore, not result in measurable noise above ground (see Chapter 5.7, Noise and Vibration, Impact NO-5). Maintenance would include well exercising that would occur either weekly or monthly for one hour per week or for a single, four-hour period monthly. (see Chapter 5.7 Noise and Vibration, Impact NO-5, and Chapter 3, Project Description, Section 3.8.3 [Maintenance]). Other operational noise would be limited to supply trucks for operational and maintenance purposes which would slightly increase noise from local vehicle trips, and therefore there would be *no impacts* on sensitive biological resources relative to noise at the submersible pump sites. Sites 5, 6, 8, 9, and 10 would not be located at or near areas that support habitat for special-status birds or migratory passerines or raptors, and therefore these sites would have *no impacts* on such biological resources relative to operational noise.

Impact Conclusion: No Impact

<u>Sites 11, 13, 15, 16, and 17 (Alternate)</u>

Operation and maintenance activities would not result in a loss of habitat for special-status or other migratory birds and would not result in additional loss of suitable nesting trees. Operational noise from the well facilities would result primarily from running the well pump. Supply trucks for operation and maintenance purposes would also slightly increase the vehicle trips and noise generation at these sites (see Section 5.7, Noise and Vibration). Maintenance includes well exercising that would occur either weekly or monthly for one hour per week or for a single, four-hour period monthly (see Chapter 5.7, Noise and Vibration, Impact NO-5 and Chapter 3, Project Description, Section 3.8.3 [Maintenance]).

The proposed operational noise levels at these sites would be within the range of the existing ambient noise levels at the well facility sites or below 50 dBA **(**see Section 5.7, Noise and Vibration, Impact NO-5). Because of this, and also the limited amount of vehicle trips, operation and maintenance of the well facilities would not result in new or increased impacts on nesting special-status or other, migratory birds. Noise associated with operation and maintenance would not likely prevent any birds from nesting in the trees near these sites, given that this potential change in ambient conditions would not be substantial, as compared to existing conditions. Potential operational impacts on special-status and migratory bird species would therefore be *less than significant*.

Impact Conclusion: Less than Significant

<u>Sites 1, 7 (On-site Treatment), 12, 18 (Alternate), and the Westlake Pump Station</u>

As identified Section 5.7, Noise and Vibration, noise levels during well operation at Sites 1, 7 (On-Site Treatment), 12, 18 (Alternate), and the Westlake Pump Station would exceed the ambient noise or exceed 50 dBA. These sites would also be located near habitat for special-status birds that could be impacted by the operational noise expected at these sites, given that this noise could interfere with nesting. Therefore, this potential impact on sensitive biological resources would be *significant*.

However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would also have the effect of reducing this potential impact on sensitive biological resources to *less–than-significant* levels by requiring that the final design of pump stations incorporate features to reduce noise levels below (by at least 1 dBA) the most restrictive threshold (the local noise standard or the sleep interference threshold). The most restrictive threshold used by the noise analysis in Section 5.7, Noise and Vibration, is the sleep interference threshold, which is 50 dBA, as measured at the exterior of the building of the closest noise-sensitive receptor. Reducing operational noise below 50 dBA to address identified operational noise impacts would also have the effect of reducing this potential impact on special-status species utilizing the habitat adjacent to these well facility sites.

Upgrades to the Westlake Pump Station would be necessary to serve the well facilities at Sites 2, 3, and 4. The size and exact location of proposed new equipment at the Westlake Pump Station is not known at this time. Therefore, this analysis conservatively assumes that the impact of operational noise from the Westlake Pump Station on the special-status species habitat adjacent to the pump station would be potentially *significant*. However, implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would also have the effect of reducing this potential impact on sensitive biological resources to *less-than-significant* levels by requiring noise reduction measures at the site.

> ***Measure M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)***
> (See Impact NO-5 in Chapter 5.7, Noise and Vibration for a description)

Impact Conclusion: Less than Significant with Mitigation

Special-Status Bats or Bats of Special Concern

<u>Sites 2, 5, 6, 8, 9, 13, 14, 17 (Alternate), 18 (Alternate), and 19 (Alternate)</u>

No trees suitable for bat roosting occur on or near these sites. As a result, these sites do not support the habitat characteristics necessary for bat roosting. Therefore, no operation-related impacts on special-status bats would occur.

Impact Conclusion: No Impact

<u>Sites 1, 3, 4, 7, 10, 11, 12, 15, 16, and the Westlake Pump Station</u>

Operation and maintenance activities at these sites would not result in a loss of roosting habitat for special-status bats, as such activities would not result in an additional loss of trees suitable for roosting. Maintenance includes well exercising that would occur either weekly or monthly for one hour per week or for a single, four-hour period monthly. Operators may fine-tune the exercise schedule according to the characteristics of individual wells (see Chapter 3, Project Description, Section 3.8.3 [Maintenance]). Maintenance site visits, supply trucks for operation and maintenance purposes, and operation of the well pumps would slightly increase the vehicle trips and noise generation at each site. However, this would not likely result in a substantial increase in ambient noise levels that could affect special-status bats given that operational noise levels at these sites would be within the range of the existing ambient noise levels (see Section 5.7, Noise and Vibration, Impact NO-5). Therefore, operational noise levels would not prevent bats from utilizing habitat near these sites. As a result, potential impacts on special-status bats at these sites would be *less than significant*.

Impact Conclusion: Less than Significant

Overwintering Monarch Butterfly Habitat

Sites 2, 4, 5, 6, 8, 9, 11, 13, 14, 15, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station

Project operations would not impact monarch butterfly, because no dense stands of eucalyptus, Monterey pine or Monterey cypress trees occur at or adjacent to these sites, and potential winter roosting habitat would therefore not be affected during operations and maintenance activities.

Impact Conclusion: No Impact

Sites 1, 3, 7, 10, and 12

Although unlikely, given that overwintering of monarch butterflies at these locations has not been reported (CDFG 2011f), the dense stands of large eucalyptus, Monterey pine, and Monterey cypress trees at these sites could nevertheless support overwintering monarch butterflies. Project operations would have *less-than-significant* impacts on monarch butterflies because no additional trees would be removed during Project operations and potential winter roosting habitat would therefore not be affected during operations and maintenance activities. Maintenance includes well exercising that would occur either weekly or monthly for one hour per week or for a single, four-hour period monthly. Operators may fine-tune the exercise schedule according to the characteristics of individual wells (see Chapter 3, Project Description, Section 3.8.3 [Maintenance]). Maintenance site visits, supply trucks for operation and maintenance purposes, and operation of the well pump would slightly increase the vehicle trips and noise generation at each site, but would not likely result in a substantial increase in ambient noise levels (see Section 5.7, Noise and Vibration, Impact NO-5) or other disturbances likely to affect overwintering monarch butterflies, given that such activities would not occur in the midst of currently utilized winter roosts.

Impact Conclusion: Less than Significant

5.14.3.6 Impacts of Lake Level Changes on Biological Resources at Lake Merced and Mitigation Measures

The following description of modeled existing conditions and predicted impacts of the proposed Project present the data used for the subsequent impact analyses in Impacts BR-6 through BR-9, which address the potential that the project could change water levels at Lake Merced, with resulting effects on biological resources at the lake.

Modeled Existing Conditions

The modeled existing conditions represent a simulated estimation of hydrologic conditions that are expected to occur over the 47-year modeling period without construction and operation of the GSR Project, based upon historic hydrologic conditions. Under the modeled existing conditions, simulated water levels clearly respond to modeled climatic variations, including wet, normal, and dry precipitation years and the same hydrologic sequencing is used for each model scenario. See Section 5.1 Overview, Section 5.1.6 (Groundwater Modeling Overview), for further details on the hydrologic modeling. The modeled mean annual range between maximum and minimum lake levels would be 1.6 feet City Datum (Kennedy/Jenks 2012). Maximum lake levels over the model period are predicted at 12.4 feet City Datum, or 6.7 feet above the average baseline water surface elevation of 5.7 feet City Datum. Minimum water surface elevations could reach as low as -0.8 feet City Datum, or 6.5 feet below the baseline average water surface elevation of 5.7 feet City Datum (see Figures 5.16-11 [Simulated Lake Merced Level Changes] and 5.16-12 [Simulated Lake Merced Levels Relative to Modeled Existing Conditions]) (Kennedy/Jenks 2012).

While the lake-level models are based on historical records, the various hydrologic conditions would not necessarily happen in the same sequence as modeled, although it is assumed for the purposes of the lake level model and for this analysis that they would occur at some point during the modeled time period. The modeled existing conditions (see Figures 5.16-11 and 5.16-12) show an initial sharp increase in lake levels from 5.7 feet City Datum to over 12 feet City Datum, responding to a period of above-average precipitation in model years 1 to 4. Years 4 through 16 show a steady decline in modeled lake levels during a relatively dry period to about 1.5 feet City Datum. Between years 16 and 36, modeled lake levels fluctuate in response to relatively normal climatic conditions and show an increasing trend through the period, rising again to about 11 feet City Datum. Years 36 to 44 simulate a "design drought" period[24] more severe than any observed historical drought, and modeled lake levels decline over this eight-year period to a low of -0.8 feet City Datum. In the three years following the drought, modeled lake levels recover to about 5 feet City Datum.

Predicted Lake Levels under the Proposed Project Relative to Modeled Existing Conditions

For the purposes of this EIR, changes in water surface elevation modeled for the GSR Project are compared to changes predicted under the modeled existing conditions scenario to determine whether water surface elevation changes resulting from the proposed Project would be *significant*

[24] The SFPUC measures water supply reliability using an 8.5-year "design drought." A design drought is a planning and operations tool used by water agencies to define a reasonable worst-case drought scenario in order to establish design and operating parameters for the water system. The WSIP uses a design drought based on the hydrology of the six years of the worst historical drought (1987-1992) on record, plus the 2.5 years of the 1976-1977 drought, for a combined total of an 8.5-year design drought sequence.

when compared to the modeled existing conditions in the context of the effects of varying lake levels on biological resources.

Similar to the modeled existing conditions model, under the proposed Project water levels would also respond to modeled climatic variations in the same hydrologic sequence pumping (see Figures 5.16-11 [Simulated Lake Merced Level Changes] and 5.16-12 [Simulated Lake Merced Levels Relative to Modeled Existing Conditions]). Maximum lake levels over the model period are predicted at 13 feet City Datum, or 0.6 feet above the modeled existing conditions maximum. Minimum lake levels could reach as low as -2.5 feet City Datum, or 1.7 feet below the modeled existing conditions minimum water surface elevation (Kennedy/Jenks 2012).

Compared to the modeled existing conditions, the modeled water levels for the GSR Project (see Figures 5.16-11 and 5.16-12) show a similar initial sharp increase in lake levels from 5.7 feet City Datum to over 12 feet City Datum. Lake levels predicted to result from operation of the Project increase by about 5 feet as compared to modeled existing conditions in Years 1 through 10. This relative difference is maintained by the simulation over climatic variations until the start of the design drought in Year 36. During the design drought, lake levels drop to the predicted minimum of -2.5 feet City Datum and then slowly begin to rise again to reach about 2 feet City Datum at the end of the model period, where water levels are predicted to be about 4 feet lower than predicted under the modeled existing conditions.

Impact BR-6: Operation of the Project would not adversely affect species identified as candidate, sensitive, or special-status wildlife species in local or regional plans, policies, or regulations, or by the CDFW or USFWS. (Less than Significant)

For special-status nesting birds, Project-related water surface elevation decreases of 0.5 feet or more over a 2.5-week period in any single nesting season (conservatively March 1 through August 15) would be considered to result in a *significant* impact on reproductive success. If water level decreases were to occur rapidly, nests could be stranded, resulting in the loss of nests and eggs and thus adversely affecting productivity. It is presently unknown whether western pond turtle are reproducing at Lake Merced. If they are, a water level rise of greater than 3 feet in any given year (measured from March 1st to March 1st) could potentially inundate western pond turtle nests, causing reproductive failure and/or hatchling mortality and would be considered *significant* if the increase were caused by the Project.

A summary of estimates generated by the Lake Merced Lake-Level Model for the modeled existing conditions, as well as the proposed Project, shows that the Project is predicted to result in a maximum modeled monthly lake level decrease of 0.04 feet (Kennedy/Jenks 2012). Therefore, relative to the significance threshold of 0.5 feet over a 2.5-week period, the Project would have a *less-than-significant* impact on the reproductive success of special-status birds nesting at or near the water line and no mitigation is required.

The summary of estimates presented in Attachment 10.2-A of Technical Memorandum 10.2 also include a summary of the predicted annual range between maximum and minimum lake levels possible under the various scenarios (Kennedy/Jenks 2012). As summarized therein and below in Table 5.14-11 (Summary of Predicted Annual Range in Lake Levels), the predicted mean modeled annual lake level elevation range is 1.6. This means that most of the time, modeled lake levels are expected to increase or decrease from the average annual water surface elevation by 0.8 foot. Under the most extreme conditions, such as during a series of above-normal precipitation years, the modeled existing conditions for lake levels are predicted to fluctuate as much as 2.25 feet above or below the predicted average annual water surface elevation in a single year. With implementation of the GSR Project, maximum lake level rise in one year is predicted to be only slightly greater at 2.35 feet; i.e., an increase of only 0.10 foot. Therefore, relative to the significance threshold and modeled existing conditions, the Project would have a *less-than-significant* impact on nesting western pond turtles, and no mitigation is required.

TABLE 5.14-11
Summary of Predicted Annual Range in Lake Levels

Predicted Lake Level Change	Modeled Existing Conditions (feet)	Project (feet)	Difference in Change Between Modeled Existing Conditions and the Project (feet)
Maximum annual range	5.5	5.6	+0.10
95th percentile	3.2	2.8	-0.4
90th percentile	2.7	2.7	0.0
Mean lake level range	1.6	1.5	-0.10

Source: Kennedy/Jenks 2012

Impact Conclusion: Less than Significant

Impact BR-7: Operation of the Project could adversely affect sensitive habitat types associated with Lake Merced. (Less than Significant with Mitigation)

The following have been identified as sensitive vegetation and habitat types at Lake Merced: dune scrub, thimbleberry, wax myrtle, and canyon live oak scrubs, Vancouver rye grassland (perennial grassland), fish-related habitat, wetlands (including arroyo willow riparian scrub), and blue gum eucalyptus forest. Impacts on wetlands are discussed below in Impact BR-8 and impacts on eucalyptus forest are discussed in Impact BR-9. Potential Project-related impacts on the remaining sensitive habitat types are discussed here.

Dune, Thimbleberry, Wax Myrtle, and Canyon Live Oak Scrubs, and Vancouver Rye Grassland Habitat

As discussed in the Section 5.14.3.2 (Approach to Analysis) under Significance Thresholds, reductions of the dune scrub, thimbleberry, wax myrtle, and canyon live oak scrubs, or Vancouver rye grassland (perennial grassland) habitats at Lake Merced would be considered *significant* if losses were to exceed 10 percent, when compared to the modeled existing conditions, for any of these single habitat types. Based on the vegetation analysis and additional GIS-based analysis comparing elevation contours with locations of sensitive biological resources, Table 5.14-12 (Predicted Loss of Sensitive Communities with Rising Water Levels) shows how sensitive plant communities are predicted to decrease with rising water surface elevations and shows the predicted water surface elevation at or near which effects are predicted to begin for each sensitive plant community. The presence of these species is not specifically dependent on water levels and it is expected that, due to their rarity and small patch size around the lake, they would not likely reestablish if they were inundated and then water levels recede. Therefore, unlike changes for wetlands, discussed below in Impact BR-8, predicted vegetation losses for these vegetation types, once they are inundated, are considered permanent and the elevations at which they are affected are considered absolute.

TABLE 5.14-12
Predicted Loss of Sensitive Communities with Rising Water Levels[(a)]

	Acres at Mean Annual Water Surface Elevations of 6 to 13 feet and Percent Change (City Datum)							
Sensitive Community	**6 feet**	**7 feet**	**8 feet**	**9 feet**	**10 feet**	**11 feet**	**12 feet**	**13 feet**
Dune scrub	3.30	3.30	3.29	3.29	3.28	3.24	3.19	3.13
Percent change	--	-0.06%	-0.15%	-0.36%	-0.73%	-1.73%	-3.19%	-5.02%
Canyon live oak scrub	--	--	0.13	0.13	0.13	0.13	0.12	0.12
Percent change	--	--	--	-0.08%	-1.31%	-2.62%	-7.00%	**-10.31%**
Wax myrtle scrub	--	--	0.08	0.08	0.07	0.05	0.03	0.01
Percent change	--	--	--	-2.00%	**-11.25%**	**-36.50%**	**-65.50%**	**-87.00%**
Vancouver rye grassland	--	--	0.013	0.012	0.007	0.005	0.002	0.001
Percent change	--	--	--	-8.59%	**-40.17%**	**-57.81%**	**-82.81%**	**-93.75%**

Note:

(a) Values in **bold** indicate the water surface elevation where a habitat loss of 10 percent or greater is predicted to occur. All acreage calculations were performed in GIS and therefore have a high degree of precision. However, this GIS analysis may not precisely predict actual changes in habitat on the ground, especially at very small scales.

As shown on Table 5.14-12 (Predicted Loss of Sensitive Communities with Rising Water Levels), it is estimated that water surface elevations between 12 and 13 feet City Datum would result in loss of 5 percent of dune scrub habitat at Lake Merced. The losses would be expected to occur primarily at Impound Lake in areas where several special-status plant species have been mapped recently (May & Associates 2009; Nomad Ecology 2011), although most special-status plant populations at Lake Merced are located above 13 feet City Datum. A water level rise to 13 feet City Datum at Impound Lake could also inundate and kill small populations of coastal black gooseberry, although that species is not precisely mapped (SFRPD 2006), and Wight's paintbrush, which occur in coastal scrub on the southeastern shore. It is estimated that thimbleberry scrub would not be inundated by rising water surface elevations under any scenario, as it occurs entirely above the elevation of the spillway at 13 feet City Datum. However, a 10 percent loss of canyon live oak scrub is predicted to occur between water surface elevations 12 and 13 and a 9 percent loss of wax myrtle scrub is predicted to occur at 10 feet City Datum. These vegetation types are not expected to regenerate naturally since the spread of canyon live oak is constrained by other upland vegetation types and the wax myrtle scrub was planted and is also constrained by other upland vegetation types. So the losses would be assumed permanent. Finally, it is estimated that water surface elevations exceeding 9 feet City Datum would result in loss of more than 10 percent of Vancouver rye grassland at Lake Merced.

Should Project operations result in water level increases above the water surface elevations described above, and the change in habitat attributed to the Project were greater than 10 percent, a *significant* impact would occur. In order to determine the Project's contribution to habitat loss potential, the GIS-based analysis was used to predict habitat acreages for the model period where the predicted Lake Merced water surface elevation resulting from the Project, compared to the predicted water surface elevation for the modeled existing condition, is greatest. This represents the potential 'worst case' acreage loss for each habitat type and is represented in model year 22 where modeled existing conditions reflect a normal climactic water year and the GSR Put Period is near completion.

The predicted water surface elevation for modeled existing conditions in model year 22 is 7 feet City Datum, while the predicted water surface elevation for the Project is approximately 12.8 feet City Datum, which is also the predicted maximum lake level under the Project over all model years. Therefore, water levels resulting from implementation of the Project are predicted to exceed the water surface elevations where substantial loss of canyon live oak scrub, wax myrtle scrub, and Vancouver rye grassland could occur, and, as a result, the acreage loss as a result of the Project is predicted to be greater than 10 percent. Table 5.14-13 (Comparison of Predicted Sensitive Community Acreages under Modeled Existing Conditions and the Project) compares the predicted modeled existing conditions acreages for sensitive habitats with the acreages predicted under the Project, and the percentage of acreage lost, for model year 22.

TABLE 5.14-13
Comparison of Predicted Sensitive Community Acreages under Modeled Existing Conditions and the Project[(a)]

Vegetation Community	Acreages Resulting from Modeled Existing Conditions (Model Year 22)	Acreages Resulting from Implementation of the Proposed Project (Model Year 22)	Difference in Acreages Resulting from Implementation of the Proposed Project as Compared to Modeled Existing Conditions	Percent Change Resulting from Implementation of the Proposed Project as Compared to Modeled Existing Conditions
Central dune scrub	3.30	3.13	-0.17	-5%
Canyon live oak scrub	0.13	0.12	-0.01	-10%
Wax myrtle scrub	0.08	0.01	-0.07	-87%
Perennial grassland (Vancouver rye grassland)	0.013	0.001	-0.012	-92%

Note:

(a) Based on modeled water surface elevations of 7 feet City Datum for modeled existing conditions and 12.8 feet City Datum for the proposed Project. Since the vegetation change analysis is based on whole number increments of change, acreages at 13 feet City Datum are given.

As shown on Table 5.14-13 (Comparison of Predicted Sensitive Community Acreages under Modeled Existing Conditions and the Project), the maximum loss of central dune scrub is predicted to be less than 10 percent as a result of the Project. Thus, impacts on this habitat type would be *less than significant*. However, relative to modeled existing conditions, canyon live oak scrub losses may slightly exceed 10 percent and losses of wax myrtle scrub and perennial grassland are predicted to substantially exceed 10 percent; thus, the impacts on these habitats would be *significant*. However, implementation of Mitigation Measure M-BR-7 (Lake Level Management for Water Levels Increases for Lake Merced) would serve to reduce potential impacts on canyon live oak scrub, wax myrtle scrub, and Vancouver rye grassland resulting from Project implementation to *less-than-significant* levels through management of water levels to avoid Project-related losses of sensitive communities. Mitigation Measure M-BR-7 (Lake Level Management for Water Levels Increases for Lake Merced) includes a requirement that Lake Merced water levels be maintained at no more than 9 feet City Datum, or the level that would occur without the Project based on lake-level modeling, whichever is higher. As shown on Table 5.14-13, a water surface elevation of 9 feet City Datum is predicted to result in a less than 10 percent loss of canyon live oak scrub and wax myrtle scrub and therefore, with implementation of Mitigation Measure M-BR-7 (Lake Level Management for Water Levels Increases for Lake Merced), loss of Vancouver rye grassland resulting from Project operation are predicted to be less than 10 percent. Should water levels without the Project be expected to exceed 9 feet City Datum, maintenance of Project-related water surface elevations at the same level as expected without the Project would ensure that loss of habitat is limited to that which would be expected to occur naturally.

Fisheries and Fish Habitat

Rising water levels associated with modeled existing conditions are not expected to have a *significant* impact on Lake Merced fisheries, given that rising water levels would increase the volume of fish habitat overall and would not substantially degrade the quality of fish habitat for warmwater or cold water fish species, because water clarity would not be degraded by rising water levels and temperature decreases would be small and within the normal range of fish species that inhabit an inland coastal lake (EDAW 2004). However, decreasing water levels could substantially reduce aquatic habitat and degrade water quality, thereby negatively affecting fish populations through impacts on fish habitat-related beneficial uses, which would be considered *significant* by this analysis. While no significant impacts on beneficial uses are expected due to a rise in water surface elevations, as noted in Section 5.16, Hydrology and Water Quality, water level decreases below 0 feet City Datum, which are predicted to occur under modeled existing conditions, could result in decreases in water quality with resulting adverse effects on fish-related beneficial uses

Under the modeled existing conditions, lake levels are predicted to drop as low as -0.8 feet City Datum. At about 4 feet City Datum, all of the individual lakes are hydraulically connected and below this water level, reduced hydraulic connection would eliminate water exchanges between these water bodies. Lake volume would decrease and thus lake temperatures and eutrophication would be expected to increase, as would periods of low dissolved oxygen. These factors could combine to lower water quality, resulting in adverse effects on beneficial uses related to fish habitat, as described above in the discussion on significance thresholds for fisheries and fish habitat in Section 5.14.3.2 (Approach to Analysis).

Relative to modeled existing conditions, the proposed Project is predicted to result in water levels approximately 5 feet higher for most of the modeled time period and, during that time, would have *less-than-significant* impacts on fisheries or fish habitat similar to conditions that are predicted to occur under modeled existing conditions when lake levels rise. However, during drought periods, water levels could reach as low as -2.5 feet City Datum, or nearly 2 feet lower than the predicted minimum for modeled existing conditions. This could mean a further significant decrease in water quality from modeled existing conditions, which would be attributable to the Project. However, Mitigation Measure M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) (see Section 5.16, Hydrology and Water Quality) and Mitigation Measure M-BR-7 (Lake Level Management for Water Levels Increases for Lake Merced), require the SFPUC to implement lake level management procedures to maintain Lake Merced at water levels due to the Project at or below 9 feet City Datum and Mitigation Measure M-HY-9b requires the SFPUC to maintain water levels due to the Project at or above 0 feet City Datum. Implementation of this mitigation measure would therefore also serve to mitigate potential *significant* impacts on the fish habitat-related beneficial uses of Lake Merced through management of water levels to avoid a significant Project-related degradation of water quality (SFPUC 2013).

Mitigation Measure M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced
(see Impact HY-9 in Section 5.16, Hydrology and Water Quality for a description)

Mitigation Measure M-HY-9b: Lake Level Management for Lake Merced
(see Impact HY-9 in Section 5.16, Hydrology and Water Quality for a description)

Mitigation Measure M-BR-7: Lake Level Management for Water Level Increases for Lake Merced
In addition to ongoing monitoring and evaluation of lake levels, as well as maintenance of the Lake-level Model so as to be able to evaluate what lake levels may have been without implementation of the Project based on the actual hydrology that occurs during Project implementation, as described in Mitigation Measure M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced), the SFPUC shall implement corrective action if lake levels increase to 9 feet City Datum as an annual average due to the Project. Corrective action shall be taken to reduce the lake levels to 9 feet City Datum or less. These actions may include one of more of the following, which would result in lowering groundwater levels and thereby indirectly lowering lake levels:

- Temporarily suspend in-lieu delivery of surface water supplies to Daly City so that Daly City would increase pumping from Daly City wells.
- Increase pumping from GSR wells at Sites 1 through 4, which are within 1.5 miles of Lake Merced.

Impact Conclusion: Less than Significant with Mitigation

Impact BR-8: Operation of the Project could adversely affect wetland habitats and other waters of the United States associated with Lake Merced. (Less than Significant with Mitigation)

In order to determine the proposed Project's effect on wetlands, the thresholds of no-net-loss of wetlands were compared with the simulated Lake Merced lake levels (Kennedy/Jenks 2012) to assess whether wetland impacts would be expected occur under the Project and cumulative scenarios, relative to the modeled existing conditions scenario.

Wetland extent at Lake Merced is determined primarily by water levels and topography, and has moved up slope with the water levels over time (Stillwater 2009; Nomad Ecology 2011). As seen in Table 5.14-13 (Comparison of Predicted Sensitive Community Acreages under Modeled Existing Conditions and the Project), there are five distinct freshwater marsh and seasonal wetland types at Lake Merced and the wetlands vegetation type is one of the most widespread around the lake, although overall wetland acreage has decreased since 2002 as mean annual lake levels have risen. As noted above, willow riparian scrub has also decreased in acreage since 2002. As lake levels rise and fall, emergent wetlands are expected to follow closely, as willow riparian scrub would, although relative proportions of the various wetland types are expected to change as they move upslope and downslope, depending on topography and adjacent plant communities. Since this basic pattern has been observed and is borne out in the predictions of the GIS-based vegetation change analysis, it is predicted to continue to occur over the time period modeled for the various scenarios under consideration in this EIR.

The predicted vegetation response to rising or declining water levels would differ depending on the baseline water level for a given period, which changes annually due to natural hydrological variation independent of Project operation. Additionally, the amount of shoreline available for wetland establishment at a given water surface elevation differs according to the topography of the lakeshore, which generally is steeper at higher elevations and flatter at lower elevations. The GIS-based analysis predicted vegetation changes for increasing and decreasing water levels compared to each potential water level change, as shown in Appendix J (Lake Merced Vegetation Change Analysis Methodology). As an example of the predicted vegetation changes for increasing and decreasing water levels compared to a baseline value, Table 5.14-14 (Predicted Change in Vegetation Acreages and Percent Change Relative to a 6-foot Water Surface Elevation: Rising Water Levels) presents a summary of the predicted vegetation changes for increasing water levels, compared to a water surface elevation of approximately 6 feet City Datum, while Table 5.14-15 (Predicted Change in Vegetation Acreages and Percent Change Relative to a 6-foot Water Surface Elevation: Receding Water Levels) summarizes predicted vegetation changes for decreasing water levels compared to the same baseline water surface elevation.

TABLE 5.14-14

Predicted Change in Vegetation Acreages and Percent Change Relative to a 6-foot Water Surface Elevation: Rising Water Levels[(a)(b)(c)(d)]

Wetland Type	Mean Annual Water Surface Elevation (feet City Datum)							
	6 feet	**7 feet**	**8 feet**	**9 feet**	**10 feet**	**11 feet**	**12 feet**	**13 feet**
Arroyo willow riparian scrub	17.03	*12.59*	*11.86*	*8.44*	*6.14*	*4.26*	*2.88*	*0.00*
Percent change		-26.1%	-30.4%	-50.4%	-63.9%	-75.0%	-83.1%	-100.0%
Bulrush wetland	25.05	**28.15**	**32.57**	**38.18**	**44.74**	**48.97**	**40.05**	**26.81**
Percent change		12.4%	30.0%	52.5%	78.6%	95.5%	59.9%	7.0%
Giant vetch wetland	0.25	*0.17*	*0.17*	*0.16*	*0.13*	*0.08*	*0.05*	*0.03*
Percent change		-33.0%	-33.0%	-35.2%	-48.5%	-67.3%	-78.9%	-89.9%
Knotweed wetland	7.02	*6.42*	*6.89*	*6.13*	*3.26*	*1.20*	*0.52*	*0.33*
Percent change		-8.5%	-1.8%	-12.6%	-53.5%	-82.9%	-92.6%	-95.2%
Rush meadow	0.40	*0.29*	*0.31*	*0.26*	*0.14*	*0.13*	*0.07*	*0.02*
Percent change		-28.3%	-21.8%	-35.1%	-64.5%	-67.8%	-83.4%	-95.3%
Cattail wetland	0.01	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Percent change		-33.3%	-33.3%	-33.3%	-33.3%	-33.3%	-46.6%	-63.3%
Total herbaceous wetland	32.72	**35.02**	**39.94**	**44.74**	**48.27**	**50.38**	**40.69**	*27.19*
Percent change		7.0%	22.1%	36.7%	47.5%	54.0%	24.4%	-16.9%
Total wetland (riparian + herbaceous)	49.75	*47.61*	**51.80**	**53.18**	**54.41**	**54.64**	*43.57*	*27.19*
Percent change		-4.3%	4.1%	6.9%	9.4%	9.8%	-12.4%	-45.3%
Open water	256.40	**264.86**	**266.15**	**266.46**	**268.62**	**268.30**	**281.06**	**297.43**
Percent change		3.3%	3.8%	3.9%	4.8%	4.6%	9.6%	16.0%

Notes:

(a) Acreages in table are for vegetation at and below 13 feet City Datum.

(b) Values in **bold** indicate an increase in cover type.

(c) Values in *italic* indicate a decrease in cover type.

(d) Predicted vegetation change is measured against a baseline of 6-foot (City Datum) mean annual water surface elevation.

TABLE 5.14-15

Predicted Change in Vegetation Acreages and Percent Change Relative to a 6-foot Water Surface Elevation: Receding Water Levels[a]

Wetland Type	Mean Annual Water Surface Elevation (feet City Datum)																
	-10 feet	-9 feet	-8 feet	-7 feet	-6 feet	-5 feet	-4 feet	-3 feet	-2 feet	-1 feet	0 feet	1 feet	2 feet	3 feet	4 feet	5 feet	6 feet[b]
Arroyo willow riparian scrub	37.89	32.02	27.15	24.11	21.80	20.15	19.31	18.82	18.35	17.77	18.36	21.15	24.45	26.07	24.95	21.54	17.03
Percent change[c]	122.5%	88.0%	59.4%	41.5%	28.0%	18.3%	13.4%	10.5%	7.7%	4.4%	7.8%	24.2%	43.6%	53.1%	46.5%	26.5%	--
Bulrush wetland	49.12	46.43	31.72	30.60	28.06	21.76	16.28	14.36	12.78	11.78	10.82	10.42	10.58	11.80	14.49	19.23	25.05
Percent change	96.1%	85.4%	26.6%	22.2%	12.0%	-13.1%	-35.0%	-42.7%	-49.0%	-53.0%	-56.8%	-58.4%	-57.7%	-52.9%	-42.2%	-23.2%	
Giant vetch wetland	0.38	0.33	0.27	0.20	0.17	0.17	0.17	0.17	0.17	0.16	0.20	0.29	0.38	0.43	0.42	0.35	0.25
Percent change	52.3%	33.2%	7.2%	-19.6%	-29.5%	-31.1%	-31.7%	-32.3%	-32.9%	-33.6%	-20.7%	16.8%	54.9%	74.4%	70.2%	40.7%	--
Knotweed wetland	9.56	6.15	4.94	4.75	3.41	1.91	1.40	1.38	1.39	1.41	1.43	1.45	1.50	1.97	3.46	5.63	7.02
Percent change	36.2%	-12.4%	-29.6%	-32.4%	-51.4%	-72.7%	-80.0%	-80.4%	-80.2%	-79.9%	-79.7%	-79.3%	-78.6%	-71.9%	-50.7%	-19.8%	--
Rush meadow	0.49	0.40	0.32	0.24	0.18	0.16	0.15	0.15	0.15	0.16	0.18	0.27	0.38	0.48	0.53	0.50	0.40
Percent change	23.6%	0.7%	-19.3%	-39.3%	-55.2%	-60.1%	-61.5%	-61.4%	-61.3%	-61.1%	-54.4%	-33.0%	-3.8%	21.1%	31.6%	24.4%	--
Cattail wetland	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
Percent change	35.2%	5.0%	-28.4%	-52.5%	-60.8%	-60.4%	-59.9%	-59.4%	-58.9%	-58.4%	-50.4%	-15.3%	44.0%	87.1%	85.6%	47.2%	--
Total herbaceous wetland	59.54	53.31	37.24	35.79	31.83	24.01	18.01	16.05	14.49	13.51	12.63	12.43	12.85	14.68	18.89	25.70	32.71
Percent change	82.0%	63.0%	13.9%	9.4%	-2.7%	-26.6%	-45.0%	-50.9%	-55.7%	-58.7%	-61.4%	-62.0%	-60.7%	-55.1%	-42.2%	-21.4%	--
Total wetland (riparian + herbaceous)	97.44	85.33	64.39	59.90	53.62	44.16	37.31	34.88	32.84	31.29	30.99	33.58	37.31	40.75	43.85	47.24	49.74
Percent change	95.9%	71.5%	29.5%	20.4%	7.8%	-11.2%	-25.0%	-29.9%	-34.0%	-37.1%	-37.7%	-32.5%	-25.0%	-18.1%	-11.9%	-5.0%	--

TABLE 5.14-15

Predicted Change in Vegetation Acreages and Percent Change Relative to a 6-foot Water Surface Elevation: Receding Water Levels[(a)]

Wetland Type	Mean Annual Water Surface Elevation (feet City Datum)																
	-10 feet	**-9 feet**	**-8 feet**	**-7 feet**	**-6 feet**	**-5 feet**	**-4 feet**	**-3 feet**	**-2 feet**	**-1 feet**	**0 feet**	**1 feet**	**2 feet**	**3 feet**	**4 feet**	**5 feet**	**6 feet[(b)]**
Open Water	*128.78*	*149.87*	*176.77*	*185.61*	*196.09*	*208.97*	*218.34*	*223.08*	*227.45*	*231.36*	*235.23*	*238.76*	*242.17*	*245.57*	*249.14*	*252.35*	*265.75*
Percent change	-51.5%	-43.6%	-33.5%	-30.2%	-26.2%	-21.4%	-17.8%	-16.1%	-14.4%	-12.9%	-11.5%	-10.2%	-8.9%	-7.6%	-6.2%	-5.0%	--

Notes:

(a) Acreages in the table are for vegetation at and below 13 feet City Datum

(b) Vegetation change is measured against a baseline of 6-foot (City Datum) mean annual water surface elevation.

(c) Percent change is relative to vegetation acreage at 6 feet City Datum.

All upland vegetation types were combined for the analysis of receding lake levels.

Values in **bold** indicate an increase in cover type.

Values in *italic* indicate a decrease in cover type.

Under the example where the water surface elevation is approximately 6 feet City Datum, the vegetation change analysis predicts incremental increases in wetlands at average annual water surface elevations between 7 and 11 feet City Datum (Table 5.14-14 [Predicted Change in Vegetation Acreages and Percent Change Relative to a 6-foot Water Surface Elevation: Rising Water Levels]), with a net loss occurring between 6 and 7 feet City Datum and between 11 and 13 feet City Datum. This is due primarily to the fact that between 6 and 12 feet City Datum, water level increases would inundate several large areas of low gradient topography at depths conducive to emergent wetland establishment (between -5 and 2 feet above the water surface elevation). Above 11 feet City Datum, topography begins to steepen, which reduces the area available for wetland colonization because lake depths increase more rapidly and there is less area for wetland species to grow. The analysis also predicts loss of wetlands at water surface elevations lower than 6 feet City Datum, and continuing down to -6 feet City Datum. Again, this is due primarily to topography, as areas of low gradient topography allow for areas of greater wetland establishment and when topography steepens, wetland establishment is restricted by more rapidly increasing water depths. Then wetland acreage begins to increase again to above the estimated baseline acreage between -5 and -10 feet City Datum. Above 6 feet City Datum, bulrush wetlands are predicted to increase in extent at each incremental rise up to 12 feet City Datum and then decrease between 12 and 13 feet City Datum but still remain above the acreage mapped in 2012. Bulrush wetlands are predicted to replace willow scrub, as this vegetation type would die with prolonged inundation, as well as knotweed wetlands, due primarily to changes in topography and water depth. Below 6 feet City Datum, the extent of the various emergent wetland types would vary with elevation and topography relative to water surface elevations, with initial losses primarily of bulrush wetland and increases in the other emergent types, as well as willow scrub. Losses would occur in non-bulrush wetlands generally between 2 and -8 feet City Datum and then increases in all wetland types would occur at the low end of the water surface elevation range.

In general, the predicted vegetation areas compare relatively well with those documented in previous studies at lower water surface elevations (see Table 5.14-15 [Predicted Change in Vegetation Acreages and Percent Change Relative to a 6-foot Water Surface Elevation: Receding Water Levels]). However, for bulrush, there are considerable differences between the current analysis and observations at lower water levels. In part, this may be explained by the uncertainty inherent in predicting patterns of establishment on newly exposed terrain, as described above. In addition, this analysis recognizes that earlier accounts of the extent of bulrush were effectively under rising water surface elevation conditions. For example, bulrush that established when the water surface elevation was at 0 feet City Datum would likely persist when the water rises to 5 feet City Datum. In contrast, bulrush would not establish as readily in deeper water as the water surface drops, so the amount of area available to colonize, in the near term, would be more limited.

As described above, for each water surface elevation that could occur due to hydrologic conditions alone, the GIS-based vegetation change analysis conducted for this EIR predicts that there is an elevation range within which there would be no net loss as a result of the Project, as shown in Appendix J (Lake Merced Vegetation Change Analysis Methodology), and summarized in Table 5.14-16 (Lake Merced Water Surface Elevation Range that Results in a Predicted No-Net-Loss of Wetlands). If Project operations were to exceed the identified ranges, then a net wetlands loss is predicted to occur and, therefore, a *significant* impact on wetlands would result. For example, if the water surface elevation without the Project was projected to be 8 feet City Datum, there would be no project-related effect on wetlands if the water surface elevation was between 7 feet and 11 feet City Datum.

TABLE 5.14-16
Lake Merced Water Surface Elevation Ranges that Result in a Predicted No-Net-Loss of Wetlands[(a)(b)]

Modeled Water Surface Elevation without the Project (City Datum)	Corresponding Project-Related Water Surface Elevation Resulting in a Predicted No-Net-Loss of Wetlands (City Datum)
13 feet	No restriction needed
12 feet	4 to 12 feet
11 feet	9 to 11 feet
10 feet	9 to 11 feet
9 feet	8 to 11 feet
8 feet	7 to 11 feet
7 feet	4 to 11 feet
6 feet	5 to 11 feet
5 feet	4 to 11 feet; -6 to -10 feet
4 feet	3 to 12 feet; -5 to -10 feet
3 feet	2 to 12 feet; -5 to -10 feet
2 feet	1 to 12 feet; -4 to -10 feet
1 feet	0 to 12 feet; -3 to -10 feet
0 feet	-10 to 12 feet
-1 feet	-10 to 12 feet
-2 feet	0 to 12 feet; -2 to -10 feet
-3 feet	1 to 12 feet; -3 to -10 feet
-4 feet	1 to 12 feet; -4 to -10 feet
-5 feet	3 to 12 feet; -5 to -10 feet
-6 feet	8 to 11 feet; -6 to -10 feet
-7 feet	-7 to -10 feet
-8 feet	-8 to -10 feet
-9 feet	-9 to -10 feet
-10 feet	-10

Note:

(a) The water surface elevation values used represent the predicted annual average water surface elevations. Lake Merced water levels vary seasonally due to hydrologic and climatic conditions; therefore, an annual average range in water surface elevation from about 1 foot above and below the mean is assumed. For example, an elevation of 6 feet City Datum, as seen in Table 5.14-16 (Lake Merced Water Surface Elevation Range that Results in a Predicted No-Net-Loss of Wetlands), actually represents a range in water surface elevation between 5 feet and 7 feet City Datum.

(b) According to Mitigation Measure M-BR-7 (Lake Level Management for Water Level Increases for Lake Merced), Lake Merced lake levels would be prohibited from exceeding 9 feet City Datum, so some of the lake levels that would be acceptable relative to wetlands impacts would not be acceptable relative to sensitive habitats.

In order to distinguish the Project's predicted contribution to effects on wetland habitats from the predicted effects of the modeled existing conditions (i.e., to calculate the Project's incremental effect), the threshold for a net loss of wetlands was compared with the simulated Lake Merced water levels (Kennedy/Jenks 2012) to assess whether impacts would occur. During some of the modeled years, no net loss, or even wetlands gains, are expected to occur, while in other years, wetlands losses are expected. For instance, as shown on Figures 5.16-11 (Simulated Lake Merced Level Changes) and 5.16-12 (Simulated Lake Merced Levels Relative to Modeled Existing Conditions), the lake level predicted under modeled existing conditions for model year 16 is approximately 6 feet City Datum and lake level predicted under Project conditions is approximately 7 feet City Datum. As shown on Table 5.14-16 (Lake Merced Water Surface Elevation Range that Results in a Predicted No-Net-Loss of Wetlands), when the water surface elevation without the Project is predicted to be 6 feet (see the row with "6 feet" in the column labeled "Water Surface Elevation without the Project [City Datum]"), an increase of up to 5 feet resulting from Project operations could occur without resulting in loss of wetlands (i.e. the acceptable water surface elevation would be 5 to 11 feet). Therefore, the increase of 1 foot over conditions without the Project that is predicted in model year 16 would not result in a net loss of wetlands. However, the lake level predicted under modeled existing conditions for model year 22 is approximately 7 feet City Datum, whereas the lake level predicted under Project conditions for that same year is approximately 12 feet City Datum. Model year 22 represents modeled existing conditions under a normal climatic water year during a Put Period, and is the year when the difference between the two lake levels is predicted to be the greatest. As shown on Table 5.14-16, when the water surface elevation without the Project is predicted to be 7 feet City Datum, an increase of up to 4 feet resulting from Project operations (which would be up to 11 feet City Datum) could occur without resulting in a net loss of wetlands. Therefore, the increase of 5 feet over conditions without the Project (which would be 12 feet City Datum) that is predicted in model year 22 would result in loss of wetlands, which would be a *significant* impact. The lake levels following the design drought (model year 44) are predicted to be approximately 1 foot City Datum for modeled existing conditions and approximately -2 feet City Datum for the Project, which would also result in a net loss of wetlands, because the decline from a 1 foot City Datum elevation without the Project would need to be greater than 4 feet City Datum to avoid wetland loss (per Table 5.14-16). However, implementation of Mitigation Measures M-BR-8 (Lake Level Management for No-Net-Loss of Wetlands for Lake Merced), M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced), and M-HY-9b (Lake Level Management for Lake Merced) would maintain water levels in a way that would mitigate wetlands impacts to *less-than-significant* levels. Under Mitigation Measures M-BR-8 (Lake Level Management for No-Net-Loss of Wetlands for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced), for each water surface elevation that could occur due to hydrologic conditions alone (i.e., first column of Table 5.14-16), the GIS-based vegetation change analysis conducted for this EIR indicates the elevation range within which no net loss of wetlands would occur as a result of the Project (i.e., last column of Table 5.14-16). Mitigation Measure M-BR-8 (Lake Level Management for No-Net-Loss of Wetlands for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) require that lake levels be maintained within these ranges (i.e., right-hand column of Table 5.14-16), thereby reducing potential impacts on wetlands resulting from Project implementation to *less-than-significant* levels.

Mitigation Measure M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced
(See Impact HY-9 in Section 5.16, Hydrology and Water Quality for a description)

Mitigation Measure M-HY-9b: Lake Level Management for Lake Merced
(See Impact HY-9 in Section 5.16, Hydrology and Water Quality for a description)

Mitigation Measure M-BR-8: Lake Level Management for No-Net-Loss of Wetlands for Lake Merced
In addition to ongoing monitoring, evaluation of lake levels, and maintenance of the Lake-level Model so as to be able to evaluate what lake levels may have been without implementation of the Project based on the actual hydrology that occurs during Project implementation, as described in Mitigation Measure M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced), the SFPUC shall implement corrective action if lake levels exceed the range of lake level changes shown in Table 5.14-16 (Lake Merced Water Surface Elevation Range that Results in a Predicted No-Net-Loss of Wetlands), due to the Project (i.e., the right-hand column). Note that according to Mitigation Measure M-BR-7 (Lake Level Management for Water Level Increases for Lake Merced), Lake Merced lake levels due to the project would be prohibited from exceeding 9 feet City Datum, so some of the higher lake levels that would be acceptable relative to wetlands impacts as identified in Table 5.14-16 would not be acceptable relative to sensitive habitats. In addition, according to Mitigation Measure M-BR-9b (Lake level Management for Lake Merced), Lake Merced lake levels due to the Project would be prohibited from decreasing below 0 feet City Datum, so some of the lower lake levels that would be acceptable relative to wetlands impacts identified in Table 5.14-16 would not be acceptable relative to water quality and associated beneficial uses.

Corrective actions may include one or more of the following, which would result in the lowering of groundwater levels and thereby indirectly lowering lake levels:

- Suspend in-lieu delivery of surface water supplies to Daly City. Daly City would thus increase pumping from Daly City wells, which would lower groundwater levels in the vicinity of Lake Merced.
- Increase pumping from GSR wells at Sites 1 through 4, which are within 1.5 miles of Lake Merced.

Impact Conclusion: Less than Significant with Mitigation

Impact BR-9: Operation of the Project could adversely affect native wildlife nursery sites associated with Lake Merced. (Less than Significant with Mitigation)

As discussed in Section 5.14.3.2 (Approach to Analysis), large eucalyptus along the shores of North and South Lakes support several double crested cormorant and great blue heron rookeries. A loss of 10 percent or more of the eucalyptus forest around Lake Merced, particularly the more isolated stands, as a result of the proposed Project would be considered significant for the purposes of this EIR. Table 5.14-17 (Predicted Loss of Eucalyptus Forest with Rising Water Levels) shows how eucalyptus forest is predicted to decrease with rising water surface elevations and shows the predicted average annual water surface elevation at or near which effects are predicted to begin. As shown, the results of the vegetation modeling prepared for this EIR indicate that a 10 percent loss of eucalyptus forest would begin to occur at a water surface elevation of 8 feet City Datum. However, since the vegetation mapping relies on aerial photograph interpretation of the canopy and individual eucalyptus stems were not mapped, the potential losses at this elevation are likely overestimated. Currently, there are healthy eucalyptus trees at the high water line. Most trees are located at higher elevations than that, and on steeper slopes the trunks may be located well above the 8 foot contour. Therefore, it is conservatively assumed by this EIR analysis that a substantial loss of eucalyptus forest would occur if a water surface elevation of 9 feet City Datum were to be exceeded and persist for more than one month. Similar to impacts on scrub and grassland habitat (see Impact BR-7), the presence of eucalyptus is not specifically dependent on water levels and it is expected that, while they could reestablish if they were inundated and then water levels were to recede, it would be decades before new trees could grow to a size sufficient to support a rookery. Predicted eucalyptus loss following inundation is considered by this analysis to be permanent, and the elevation at which this habitat is affected is considered absolute.

TABLE 5.14-17
Predicted Loss of Eucalyptus Forest with Rising Water Levels[(a)]

Sensitive Community	Acres of Eucalyptus Forest at Mean Annual Water Surface Elevation (City Datum)							
	6 feet	**7 feet**	**8 feet**	**9 feet**	**10 feet**	**11 feet**	**12 feet**	**13 feet**
Blue gum eucalyptus forest	17.63	17.24	15.79	14.93	14.39	13.96	13.58	13.22
Percent change[(b)]	--	-2.24%	**10.42%**	**-15.30%**	**-18.37%**	**-20.83%**	**-22.98%**	**-25.04%**

Notes:

(a) Values in **bold** indicate an increase in cover type.

(b) Due to canopy cover over the lake shoreline, the predicted change for blue gum eucalyptus is likely overestimated.

Should Project operations result in water level increases above 9 feet City Datum that persist for more than one month, and the change in habitat attributed to the Project were 10 percent or greater, a *significant* impact on this wildlife nursery site would occur. In order to determine the Project's contribution to this potential habitat loss, the GIS-based analysis was used to predict habitat acreages for the model period where the predicted Lake Merced water surface elevation resulting from the Project, compared to the water surface elevation for the modeled existing condition is greatest, similar to the analysis described in Impact BR-7. This would represent the potential 'worst case' acreage loss for each habitat type, and is represented in model year 22 where modeled existing conditions reflect a normal climatic water year and the GSR Put Period is near completion. The predicted water surface elevation for modeled existing conditions in model year 22 is 7 feet City Datum, while the predicted water surface elevation for the Project is approximately 12 feet City Datum. Therefore, water levels resulting from implementation of the Project are predicted to exceed the water surface elevations of 9 feet City Datum, the elevation at which the Project could result in a loss of blue gum eucalyptus forest of 10 percent or more. Table 5.14-18 (Comparison of Eucalyptus Forest Acreages with Predicted Acreages under Modeled Existing Conditions and the Project) compares the modeled existing conditions acreages for eucalyptus with the acreages predicted under the Project, and the percentage of acreage lost, for model year 22.

TABLE 5.14-18
Comparison of Eucalyptus Forest Acreages with Predicted Acreages under Modeled Existing Conditions and the Project[(a)]

Vegetation Community	Predicted Acreages Resulting from Modeled Existing Conditions (Model Year 22)	Predicted Acreages Resulting from Implementation of the Proposed Project (Model Year 22)	Difference in Predicted Acreages Resulting from Implementation of the Proposed Project as Compared to Modeled Existing Conditions	Predicted Percent Change Resulting from Implementation of the Proposed Project as Compared to Modeled Existing Conditions
Blue gum eucalyptus forest	17.24	13.58	-3.66	-21%

Note:

Based on modeled water surface elevation of 7 feet City Datum for modeled existing conditions and 12 feet City Datum for the proposed Project.

As shown on Table 5.14-18 (Comparison of Eucalyptus Forest Acreages with Predicted Acreages under Modeled Existing Conditions and the Project), the predicted loss of eucalyptus forest would exceed 10 percent; thus, the impact on native wildlife nursery sites would be *significant*. However, implementation of M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and Mitigation Measure M-BR-7 (Lake Level Management for Water Level Increases for Lake Merced) would serve to reduce potential impacts on eucalyptus forest resulting from Project implementation to *less-than-significant* levels through management of water levels to avoid Project-related losses of this habitat, along with other sensitive communities (see Impact BR-7). Mitigation Measure M-BR-7 (Lake Level Management for Water Level Increases for Lake Merced) includes a requirement that Lake Merced water levels be maintained at no more than 9 feet City Datum, or the level projected to occur without the Project based on lake level modeling, whichever is higher. Should water levels without the Project exceed 9 feet City Datum, maintenance of Project-related water surface elevations at the same level as expected without the Project would ensure that loss of habitat is limited to that which would be expected to occur naturally (SFPUC 2013.

Mitigation Measure M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced.
(See Impact HY-9 in Section 5.16, Hydrology and Water Quality for a description)

Mitigation Measure M-BR-7: Lake Level Management for Water Level Increases for Lake Merced
(See Impact BR-7 for a description)

Impact Conclusion: Less than Significant with Mitigation

5.14.3.7 Cumulative Impacts

The geographic scope for the analysis of potential cumulative impacts on biological resources consists of the overall region in which the facilities are being constructed. Projects throughout the region could have adverse effects on the same sensitive species and habitats that occur within the GSR Project facility sites. Table 5.14-1 (Plant Communities Present within or near Facility Sites and near Lake Merced) identifies the biological resources that are within the geographic scope of analysis for cumulative biological resources impacts relative to the GSR facility sites. Refer to Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis) in Section 5.1, Overview for the location of the cumulative projects.

Impact C-BR-1: Construction and operation of the proposed Project could result in significant cumulative impacts related to biological resources. (Less than Significant with Mitigation)

Construction

Impacts on Special-status Species

As discussed in Impact BR-1, construction of the GSR Project would result in potentially *significant* impacts associated with the temporary, construction-related impacts to habitat loss and disruption of breeding and foraging habitat for nesting birds, raptors, bats, and overwintering Monarch butterflies. It is assumed that several of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), particularly those projects located in the same geographic area, could adversely affect some of the same special-status species through tree removal and potential disturbance during nesting and breeding season. In particular, the Centennial Village Project (cumulative project I) would include demolition and reconstruction of a large shopping center located 400 feet southwest from the well facility and adjacent to the pipeline installation proposed for GSR Site 16. Both projects include construction activities near trees along Huntington Drive that provide nesting habitat for migratory birds. Therefore, cumulative impacts related to the potential for impacts on special-status species would be *significant*, and the GSR Project's contribution to this cumulative impact could be cumulative considerable, given that without mitigation, it could also result in *significant* impacts on special-status species.

However, as discussed in Impact BR-1, the GSR Project's temporary impacts on special-status species would be reduced to *less-than-significant* levels with implementation of Mitigation Measures M-BR-1a (Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors), M-BR-1b (Protection Measures for Special-status Bats during Tree Removal or Trimming), M-BR-1c (Protection Measures during Structure Demolition for Special-status Bats), and M-BR-1d (Monarch Butterfly Protection Measures). These measures address temporary impacts on special-status species by specifying that tree removal occur during the non-breeding season for special-status birds, and by requiring preconstruction surveys to determine if nesting birds are in the area before construction, if trees must be removed during the breeding season. The measures also require special protection measures for special-status bats during tree removal and trimming, and during demolition of buildings, as well as protection measures for Monarch butterflies during tree removal or trimming. Therefore, with implementation of these mitigation measures, the GSR Project's contribution to cumulative impacts related to impacts to special-status species would not be cumulatively considerable (*less than significant*).

Impacts on Riparian Habitat and Other Sensitive Natural Communities

Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) could result in construction-related temporary disturbance to riparian habitat in the area. In particular, the Holy Cross Cemetery Expansion Project (cumulative project E) would expand the cemetery into areas east of Hillside Boulevard that could support riparian habitat or other natural communities.

As described in Impact BR-2, the GSR Project would potentially impact 305 square feet of Central Coast riparian scrub adjacent to Site 1 during construction. Therefore, because other cumulative projects, such as the Holy Cross Expansion Project, could also result in impacts on Central Coast riparian scrub or other sensitive natural communities, cumulative impacts related to impacts to riparian habitat and other sensitive natural communities would be *significant*, and the GSRs Project's contribution to this cumulative impact could be cumulatively considerable, given that, without mitigation, it could also result in *significant* impacts on sensitive natural communities.

However, the GSR Project's impact on these sensitive biological resources would be reduced to a *less-than-significant* level with implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) and Mitigation Measure M-BR-2 (Avoid Disturbance to Riparian Habitat). Implementation of these mitigation measures would ensure the protection of riparian habitat during construction. Therefore, with implementation of these measures, the GSR Project's contribution to cumulative impacts related to the disturbance of riparian habitat and other sensitive natural communities would not be cumulatively considerable (*less than significant*).

Impacts on Jurisdictional Waters

Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) could result in a temporary impact on, or permanent loss of, jurisdictional waters. The SFPUC's Peninsula Pipeline Seismic Upgrade Project Colma Site (cumulative project D-1) would replace an existing water pipeline that traverses proposed GSR Site 8, with the proposed replacement pipeline to be constructed over an existing culvert that may be part of the headwaters of Colma Creek, and if so, would qualify as jurisdictional waters of the United States.

As described under Impact BR-3, the GSR Project could indirectly degrade waters near Site 9 and Site 11. Therefore, cumulative project impacts on jurisdictional waters could be *significant*, and the GSR Project's contribution to this cumulative impact could be cumulatively considerable, given that without mitigation, it could also result in *significant* impacts on jurisdictional waters.

However, the GSR Project's impact on jurisdictional waters would be reduced to a *less-than-significant* level with implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan). The measure requires that an erosion control measures be developed and implemented to control stormwater runoff and reduce the sedimentation of jurisdictional waters. Therefore, with implementation of this measure, the GSR Project's contribution to cumulative impacts related to jurisdictional waters would not be cumulatively considerable (*less than significant*).

Impacts related to Conflicts with Local Policies or Ordinances

Many of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) could adversely affect trees that are protected under local tree preservation ordinances and codes, including the San Mateo County Significant and Heritage Tree Ordinances, the City of Daly City Municipal Code, the Town of Colma Municipal Code, the City of South San Francisco Municipal Code, and the City of San Bruno Municipal Code. In particular, the Holy Cross Cemetery Expansion Project (cumulative project E) would expand the cemetery into areas east of Hillside Boulevard that support a variety of trees that would also be regulated under the Town of Colma Municipal Code.

As discussed in Impact BR-4, construction would result in removal or trimming of protected trees both inside and outside the SFPUC right-of-way at well facilities and along pipeline routes. Trees protected by the San Mateo County Tree Ordinance, and the Town of Colma, the City of South San Francisco, and the City of San Bruno Municipal Codes would be affected resulting in potentially *significant* cumulative impacts related to conflicts with local policies or ordinances. Therefore, the GSR Project's contribution to this cumulative impact could be cumulatively considerable, given that without mitigation, it could also result in *significant* impacts on locally protected trees.

However, as discussed in Impact BR-4, the GSR Project's impacts related to conflicts with local tree ordinances would be reduced to *less-than-significant* levels with implementation of Mitigation Measures M-BR-4a (Minimize Impacts on Protected Trees to Avoid Tree Loss), M-AE-1b (Tree Protection Measures), and M-BR-4b (Protected Tree Replacement), which would substantially fulfill the intent of the local tree preservation ordinances and codes by minimizing impacts on protected trees and by requiring replacement trees for any protected trees that are removed. Therefore, with implementation of these measures, the GSR Project's contribution to cumulative impacts related to conflicts with local policies protecting biological resources would not be cumulatively considerable (*less than significant*).

Operations

As discussed under Impact BR-5, only Sites 1, 7 (On-Site Treatment), 12, 18 (Alternate), and the West Lake Pump Station have the potential to produce operational noise and would be located at or near areas that support habitat for special-status birds or migratory passerines or raptors. Of these sites, only Site 12 would be located near a cumulative project, the Peninsula Pipeline Seismic Upgrade Project South San Francisco Site (cumulative project D-2), which would not generate any operational noise. Other than operational noise at these sites, the proposed GSR Project would not have permanent or ongoing impacts on biological resources during operations given that the Project does not include additional habitat disturbance following construction, and operation of the Project would not impact individual species or their habitat. Therefore, no cumulative operational impact on biological resources would occur, and the GSR Project would have no contribution to a *significant* cumulative impact on biological resources during operation (*less than significant*).

Impact C-BR-2: The Project would result in cumulative construction or operational impacts related to special-status species, riparian habitat, sensitive communities, wetlands, or waters of the United States, or compliance with local policies and ordinances protecting biological resources at Lake Merced. (Less than Significant with Mitigation)

Approach to Cumulative Analysis

As noted above, not all projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) and shown in Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis) would affect Lake Merced lake levels and the biological resources supported by the Lake and its surrounding habitats. Specific additional proposed and existing projects that would affect lake levels were considered in this Lake Merced operational cumulative analysis. As noted in greater detail in the cumulative analysis presented in Section 5.16, Hydrology and Water Quality, these include the SFPUC's proposed San Francisco Groundwater Supply (SFGW) Project (cumulative project A-1 through A-6) and Daly City's proposed Vista Grande Drainage Basin Improvement Project (cumulative project B). The former would affect Lake Merced water surface elevations most directly through groundwater pumping and the latter through direct hydrologic input of stormwater to the Lake (Vista Grande), as well as projected pumping by Partner Agencies in the South Westside Groundwater Basin and potentially increased pumping at the Holy Cross cemetery (i.e., other existing projects).

Predicted Lake Merced water levels, under the cumulative scenario conditions, respond to modeled climatic variations in the same hydrologic sequence as was used for the modeled existing conditions (see Figures 5.16-11 [Simulated Lake Merced Level Changes] and 5.16-12 [Simulated Lake Merced Levels Relative to Modeled Existing Conditions]). The mean annual range between the maximum and minimum lake levels under cumulative conditions is predicted to be 1.6 feet City Datum, which is the same as modeled existing conditions, whereas the mean annual range for the GSR Project alone is predicted to be 1.5 feet over the model period. (Kennedy/Jenks 2012)

The maximum lake level (as a monthly average) under cumulative conditions is predicted to be 9.5 feet City Datum, which is 2.9 feet less than the maximum level under modeled existing conditions, and 3.5 feet less than the maximum level for the GSR Project alone. The minimum lake level (as a monthly average) under cumulative conditions is predicted to be -4.9 feet City Datum, which is 4.1 feet lower than the minimum level under modeled existing conditions, and 2.4 lower than the minimum level for the GSR Project alone. Lake Merced water levels under cumulative conditions are predicted to be consistently within 3 feet above or below the level predicted for the modeled existing conditions, except during the modeled design drought, at which time lake levels under cumulative conditions are predicted to be 4 to 5 feet lower than predicted under the modeled existing conditions. (Kennedy/Jenks 2012)

Overall, the cumulative condition is expected to exhibit less dramatic water level fluctuations in most years than those predicted for the GSR Project alone, as the combined cumulative projects would provide hydrologic inputs that would balance the effects of groundwater pumping from the GSR and SFGW projects by themselves. For example, the proposed Vista Grande Drainage Basin Improvement Project is proposed to provide hydrologic inputs to Lake Merced in the form of excess stormwater buffering lake levels losses that would occur due to the GSR Project during dry years. Also, the SFGW Project would increase pumping to the north of the GSR Project, buffering lake level increases that would occur due to the GSR Project during normal and wet years.

Special-status wildlife species

The cumulative scenario model predicts periods of relatively rapid water surface elevation increase and decrease (see Figures 5.16-11 [Simulated Lake Merced Level Changes] and 5.16-12 [Simulated Lake Merced Levels Relative to Modeled Existing Conditions]). However, as the analysis for Impact BR-6 shows, rapid increases and decreases in water levels, if any were to occur, would be associated with natural hydrologic conditions. As indicated, the GSR Project is expected to have an incremental and less-than-cumulatively considerable contribution to any such increases or decreases. Rapid increases could be associated with the proposed Vista Grande Drainage Basin Improvement Project (cumulative project B), depending on the rate of stormwater inputs to the lake, which is not known at this time. However, the SFGW project and other potential increased groundwater pumping would not increase groundwater levels, and lake levels would not increase as a result of the SFGW project. Nevertheless, due to the potential for the Vista Grande project to cause a rapid increase in lake levels, there could be a *significant* cumulative impact on birds nesting at or near the water line, and on nesting pond turtles, if present, at Lake Merced. However, the contribution of the GSR Project to such rapid increases would be at most 0.04 feet (i.e., less than 0.5 inch) per month, which would have negligible effects on bird or pond turtle nesting, and, therefore, the contribution of the GSR Project to such rapid lake level increases would not be cumulatively considerable (*less than significant*)

Sensitive communities

<u>Dune scrub</u>. Under the cumulative scenario, and for the purposes of this analysis, it is assumed that water surface elevations could not rise higher than 9.5 feet City Datum due to relocation of the spillway to that elevation under the Vista Grande Drainage Basin Improvement Project. Not only would the losses predicted under the project-specific analysis be avoided, but there would be no cumulative impact on dune scrub or rare plant populations at Lake Merced, under this assumption (*no impact*).

<u>Locally sensitive coastal scrub types.</u> Thimbleberry scrub would not be inundated by rising water surface elevations under any of the modeled conditions as it occurs entirely above the existing Lake Merced spillway elevation of 13 feet City Datum. For canyon live oak scrub, a significant loss of greater than 10 percent would not occur unless water surface elevations were to rise to between 12 and 13 feet City Datum, as predicted by the GIS-based vegetation change analysis conducted in support of this EIR. Similarly, a significant loss of greater than 10 percent of wax myrtle scrub would not occur unless water surface elevations were to exceed 10 feet City Datum, as also predicted by the vegetation change analysis. Therefore, cumulative impacts on these sensitive communities would be *less than significant*, as water surface elevations are assumed not to exceed 9.5 feet City Datum under the cumulative scenario (*less than significant*).

<u>Vancouver rye grassland.</u> Based on the 2012 vegetation modeling and further GIS analysis prepared for this EIR, a water surface elevation of 9 feet City Datum would result in loss of 8.5 percent of Vancouver rye grassland and a water surface elevation of 10 feet City Datum is predicted to result in a 40 percent loss of Vancouver rye grassland. With implementation of the cumulative projects and an assumed maximum

possible water surface elevation of 9.5 due to the Vista Grande project, it can be assumed that a greater than 10 percent but less than a 40 percent loss would occur. Therefore, the potential cumulative loss of Vancouver rye grassland is considered *significant* by this analysis. However, implementation of Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-BR-7 (Lake Level Management for Water Level Increases for Lake Merced) for the GSR Project would result in water levels being held below 9 feet City Datum, and therefore, with mitigation, the Project's incremental contribution to cumulative impacts on Vancouver rye grassland would not be cumulatively considerable (*less than significant*).

Fisheries and Fish Habitat

As noted in the modeled existing conditions and project-specific impacts analyses, rising water levels are not expected to have a *significant* impact on Lake Merced fisheries or beneficial uses. However, as described in Section 5.16, Hydrology and Water Quality, water levels decreasing below 0 feet City Datum could substantially reduce aquatic habitat and degrade water quality, thereby negatively affecting fish populations and the fish-related beneficial uses of Lake Merced, as well as potentially indirectly impacting special-status birds.

As modeled by Kennedy/Jenks (Kennedy/Jenks 2012), the cumulative scenario operations are predicted to result in water levels above 0 feet City Datum for about 90 percent of the model period and during that time would have no adverse impacts on fisheries or fish habitat. However, during pumping associated with the Take Periods proposed by the Regional Groundwater Storage and Recovery (GSR) Project combined with the proposed SFGW project pumping during the simulated prolonged drought (see Figures 5.16-11 [Simulated Lake Merced Level Changes] and 5.16-12 [Simulated Lake Merced Levels Relative to Modeled Existing Conditions]), water levels are predicted to fall as low as -4.9 City Datum, or 4.1 feet lower than the predicted minimum water surface elevation for modeled existing conditions. Relative to the modeled existing conditions, this would likely result in a further potential for a decrease in water quality from modeled existing conditions. Therefore, a *significant* cumulative impact on water quality could occur. However, for the majority of the approximately 10 percent of the model period where the water surface elevation is predicted to fall below 0 feet City Datum, which includes GSR Take Periods, the modeling consistently shows that the water surface elevation under the GSR Project is expected to be lower than the modeled existing conditions, but higher than the cumulative water surface elevation, while the water surface elevation under the SFGW project is expected to be significantly lower than any of the other model scenarios (see Figures 5.16-11 and 5.16-12). This suggests that the GSR Project's individual effects would ameliorate the project-specific effects of the SFGW project and that the GSR Project's contribution to the cumulative impact on water quality, fisheries, and fish-related beneficial uses would therefore not be cumulatively considerable (*less than significant*).

The Project's contribution to cumulative impacts is *less than significant*. Nevertheless, Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) require the SFPUC to implement lake level management procedures to address Project-specific impacts by maintaining Lake Merced at water levels similar to conditions that are predicted to occur without the Project. Implementation of this mitigation measure would therefore also serve to mitigate potential impacts on the fish habitat-related beneficial uses of Lake Merced by ensuring that adverse effects to water quality are avoided through lake level management. As a result, the contribution of the GSR Project to a *significant* cumulative impact relative to fish habitat would not be cumulatively considerable (*less than significant*).

Wetlands

Under the modeled cumulative condition, the water surface elevation of Lake Merced is predicted to fluctuate between -4.9 and 9.5 feet City Datum, with a mean of 6.1 feet (Kennedy/Jenks 2012). In addition, the water surface elevation is predicted to be between 6 and 9.5 feet City Datum (levels at which the extent of wetlands is predicted to increase such that there would be no net loss of wetlands) for about 65 percent of the time, and for periods of up to 19 to 26 months. For the remaining 35 percent of time, the water surface elevation of Lake Merced is predicted to be less than 6 feet City Datum, lasting for periods of up to 12 to 68 consecutive months. These durations would provide ample time to induce a loss of wetlands and their conversion to other habitat types. The GIS-based vegetation change analysis prepared for this EIR predicts losses, when compared to existing conditions, of up to 37 percent of wetland area (about 16 acres) at a lake surface elevation of 1 foot City Datum (Tables 5.14-14 and 5.14-15), much of which (about 10.5 acres) would be regained as water levels decline further to the cumulative predicted minimum of -4.9 feet City Datum. Therefore, wetland loss is also expected under the cumulative condition, but the losses would be less than those under modeled existing conditions, due to less frequent and shorter durations of inundation. Nonetheless, with implementation of the cumulative projects, water surface elevations would promote wetland loss for about 35 percent of the model period, and water surface elevations would promote wetland increases for about 65 percent of the model period. Therefore, over the model period, it is not expected that there would be a permanent cumulative loss of wetlands, and therefore the potential cumulative impact relative to loss of wetlands would be *less than significant*.

Wildlife nursery sites

As described in the modeled existing conditions impacts discussion, predicted rises in water surface elevations could result in a loss of rookery trees and other eucalyptus trees that provide potential alternate nesting substrate for herons and cormorants. Under the modeled cumulative scenario, the maximum water surface elevation is assumed not to exceed 9.5 feet City Datum, as discussed previously. The 2012 GIS-based vegetation change analysis conducted in support of this EIR predicts that about 10 percent of eucalyptus forest would be lost at a water surface elevation of 9 feet City Datum and 15 percent would be lost at 10 feet City Datum. Therefore, it is estimated that less than 15 percent would be lost at the maximum cumulative water surface elevation of 9.5 City Datum. While some rookery trees at North and South Lakes would be lost, ample eucalyptus forest would remain for nesting herons and cormorants to utilize. The most isolated stand of eucalyptus on East Lake would remain intact, with no expected loss of rookery trees due to water level rise. As shown in Table 5.14-17 (Predicted Loss of Eucalyptus Forest with Rising Water Levels) in the Impact BR-9 analysis, relative to predicted losses under modeled existing conditions, losses due to the cumulative projects would represent no more than an additional five percent loss of eucalyptus forest. Therefore, the cumulative impact on wildlife nursery sites would be *less than significant*.

5.14.4 References

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5.15 GEOLOGY AND SOILS

The descriptions of geology, soils, and seismic hazards in this section rely on information gathered from the U.S. Geologic Survey (USGS), the Natural Resources Conservation Service ([NRCS]; previously known as the Soil Conservation Service), the California Geologic Survey (CGS), and three geotechnical investigations[1] prepared for the San Francisco Public Utilities Commission (SFPUC) by Geotechnical Consultants, Inc. for Sites 1, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, and 16 (Geotechnical Consultants 2009a, 2009b, 2012). These reports have been reviewed to determine relevant information for the EIR analysis and Project facility sites are evaluated for their potential to be affected by or to increase risks associated with identified geologic and seismic hazards. Appropriate mitigation measures are identified for impacts determined to be significant.

5.15.1 Setting

5.15.1.1 Regional Physiography

The Project would be located on the San Francisco Peninsula (Peninsula), which is part of the Coast Ranges Geomorphic Province (Coast Ranges). The topography of the Coast Ranges is characterized by northwest-southeast-trending mountain ridges and intervening valleys that have formed over millions of years due to movements of the earth's crust (referred to as tectonics). The bedrock underlying the Coast Ranges is referred to as the Franciscan Complex – a mixture of ancient seafloor sediments and volcanic rocks that have undergone alteration by heat and pressure deep within the earth. This rock unit forms most of the hills and mountains of the Peninsula. Overlying the Franciscan Complex bedrock are geologically young sedimentary deposits that are generally flat and underlie most of the urban core of the San Francisco Bay Area (Bay Area). Many of these basin deposits form when streams, bays, and estuaries deposit materials shed from surrounding hills and mountains. The mountains and hills of the San Francisco Peninsula are separated from the parallel range of the East Bay Hills by San Francisco Bay. The proposed facility sites on the Peninsula are located east of the San Andreas Fault Zone, along flatlands adjacent to San Francisco Bay.

5.15.1.2 Project Area Geology

The geological setting of the Project area is based on information from two USGS geologic maps (USGS 1998a, 1998b) and the three geotechnical reports mentioned above (Geotechnical Consultants 2009a, 2009b, 2012).

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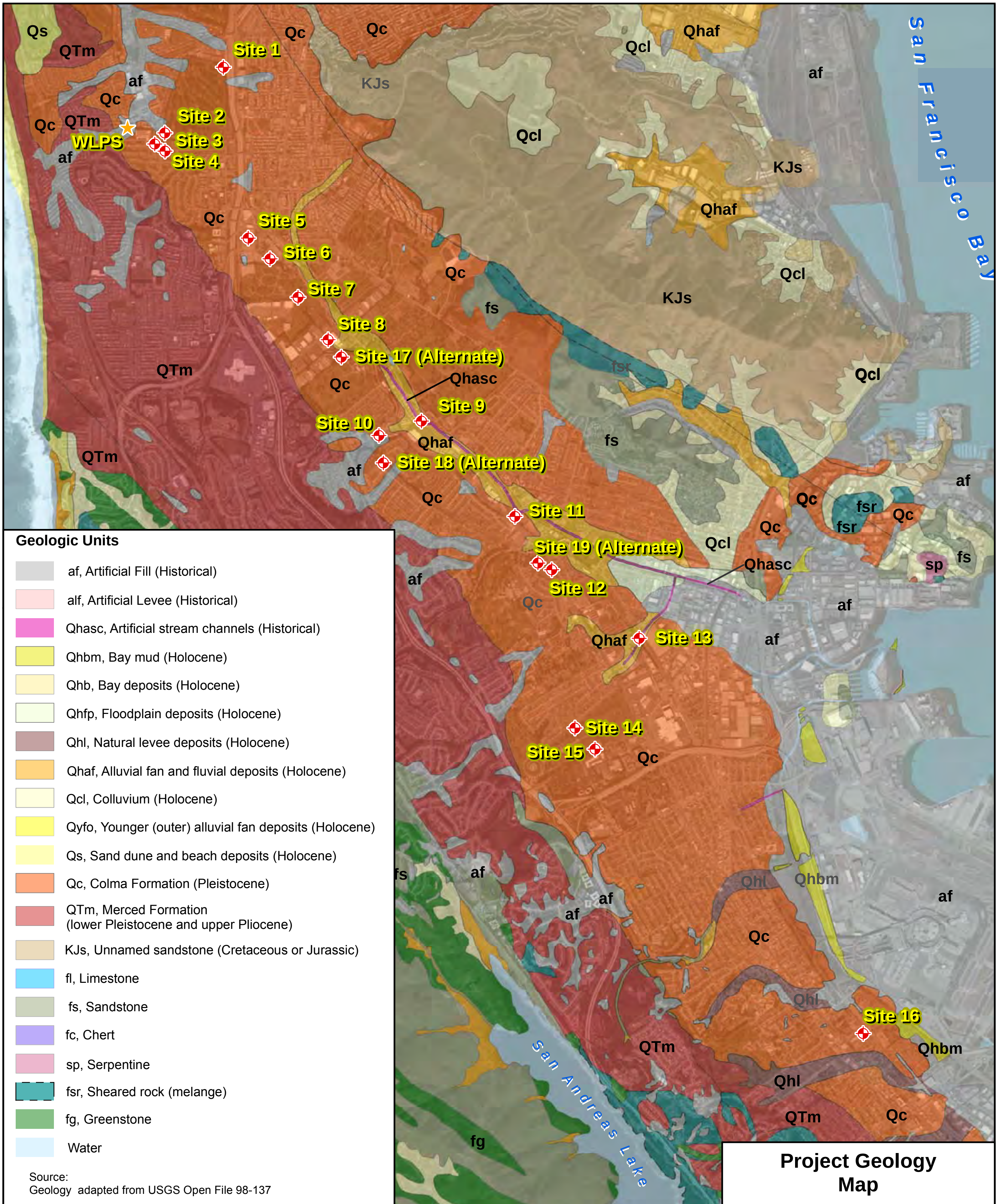
[1] Due to the close proximity of sites, the information in the geotechnical investigation for Site 4 was used to characterize Sites 2 and 3; the information regarding Sites 8, 10, and 12 was used to characterize Sites 17 (Alternate), 18 (Alternate), and 19 (Alternate), respectively; and the information for Site 15 was used to characterize Site 14. Due to access issues, a geotechnical investigation has not yet been performed for Site 11. Regional geologic, liquefaction, and soil mapping was used to characterize Site 11. The SFPUC would conduct site specific investigations for alternate sites if they are chosen for construction (SFPUC 2012).

As shown on Figure 5.15-1 (Project Geology Map), the proposed facility sites would be located on flatlands underlain by Colma Formation, alluvium deposits, slope debris/ravine fill, natural levee deposits, and artificial fill. Table 5.15-1 (Geologic Units, Landslide, Liquefaction Susceptibility and Shaking Severity Levels at Facility Sites) lists the geologic units identified at each site where excavation or other ground disturbance would occur and the landslide and liquefaction susceptibilities of each unit. The Colma Formation consists predominantly of damp to moist, medium dense to very dense, silty sand, and poorly graded sand with silt. Artificial fill consists of damp to moist, loose to medium dense, silty sand, silty fine sand, and sandy silt. Natural levee deposits consist of damp to moist, loose to medium dense, poorly graded fine sand to silty fine sand (Geotechnical Consultants2009a, 2009b). The alluvium in the study area is mostly sand and silt, but locally contains clay, gravel, or boulders (USGS 1998a). Slope debris and ravine fill overlying the Colma Formation is typically silty to clayey sand, or gravel and unstratified or poorly stratified.



Geologic Units

- af, Artificial Fill (Historical)
- alf, Artificial Levee (Historical)
- Qhasc, Artificial stream channels (Historical)
- Qhbm, Bay mud (Holocene)
- Qhb, Bay deposits (Holocene)
- Qhfp, Floodplain deposits (Holocene)
- Qhl, Natural levee deposits (Holocene)
- Qhaf, Alluvial fan and fluvial deposits (Holocene)
- Qcl, Colluvium (Holocene)
- Qyfo, Younger (outer) alluvial fan deposits (Holocene)
- Qs, Sand dune and beach deposits (Holocene)
- Qc, Colma Formation (Pleistocene)
- QTm, Merced Formation (lower Pleistocene and upper Pliocene)
- KJs, Unnamed sandstone (Cretaceous or Jurassic)
- fl, Limestone
- fs, Sandstone
- fc, Chert
- sp, Serpentine
- fsr, Sheared rock (melange)
- fg, Greenstone
- Water

Source:
Geology adapted from USGS Open File 98-137

Legend

- Proposed Project Well Facility Sites
- Westlake Pump Station

0 4,500 Feet

1" = 4,500'

N

Project Geology Map

Regional Groundwater Storage and Recovery Project

Figure 5.15-1

TABLE 5.15-1
Geologic Units, Landslide, Liquefaction Susceptibility and Shaking Severity Levels at Facility Sites

Site	Geologic Unit [(a)]	Landslide Area Type [(b)]	Liquefaction Susceptibility [(c)]	Shaking Severity Level [(d)]
Site 1	Colma Formation, artificial fill	flat land	low	violent
Site 2	Colma Formation, Slope debris and ravine fill	flat land	very low	violent
Site 3	Colma Formation, Slope debris and ravine fill	flat land	very low	violent
Site 4	Colma Formation, artificial fill	flat land	low	violent
Westlake Pump Station	Colma Formation, artificial fill	flat land	low	violent
Site 5	Colma Formation, artificial fill	flat land	low	violent
Site 6	Colma Formation, artificial fill	flat land	low	violent
Site 7	Colma Formation, artificial fill	flat land	low	violent
Site 8	Colma Formation, artificial fill, natural levee deposits	flat land	low	violent
Site 9	Colma Formation, artificial fill	flat land	low	violent
Site 10	Colma Formation, artificial fill, natural levee deposits	flat land	low	violent
Site 11	Colma Formation, Alluvium	flat land	very low, high[(e)]	violent
Site 12	Colma Formation, artificial fill	flat land	low	violent
Site 13	Colma Formation, artificial fill, natural levee deposits	flat land	low	violent
Site 14	Colma Formation	flat land	very low	violent
Site 15	Colma Formation, artificial fill	flat land	low	violent
Site 16	Colma Formation, artificial fill	flat land	low	violent
Site 17 (Alternate)	Colma Formation, Alluvium	flat land	very low, high[(e)]	violent
Site 18 (Alternate)	Colma Formation, artificial fill	flat land	very low, moderate	violent
Site 19 (Alternate)	Colma Formation	flat land	very low	violent

Notes:

(a) From Geotechnical Consultants 2009a, 2009b, 2012; USGS 1998a.

(b) From USGS 1997.

(c) Liquefaction susceptibility for Sites 1, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, and 16 is based on site-specific geotechnical data (Geotechnical Consultants 2009a, 2009b, 2012). Liquefaction susceptibility for Sites 2, 3, Westlake Pump Station, 11, 14, 17 (Alternate), 18 (Alternate), and 19 (Alternate) is based on regional liquefaction mapping (USGS 2006).

(d) Modified Mercalli Intensity Scale Value of IX (Violent) as modeled for 1906 Earthquake.

(e) USGS regional liquefaction mapping indicates liquefaction susceptibilities ranging from “very low” to “high” at Site 11 and Site 17 (Alternate).

5.15.1.3 *Geologic Hazards*

Slope Failure

Slope failures and landslides involve the downslope displacement and movement of material, either triggered by static (i.e., gravity) or dynamic (i.e., earthquake) forces. Exposed rock slopes undergo rockfalls, rockslides, or rock avalanches, while soil slopes experience soil slumps, rapid debris flows, and deep-seated rotational slides. Slope stability can depend on a number of complex variables, including the geology, soil structure, and amount of groundwater, as well as external processes such as climate, topography, slope geometry, and human activity. The factors that contribute to slope movements include those that decrease the resistance in the slope materials and those that increase the stresses on the slope. Landslides can occur on slopes of 15 percent or less, but the probability is greater on steeper slopes that exhibit old landslide features such as scarps[2], slanted vegetation, and transverse ridges[3]. Landslides typically occur within slide-prone geologic units that contain excessive amounts of water, are located on steep slopes, or where planes of weakness are parallel to the slope angle.

In 1998, USGS released a preliminary map and geographic information system (GIS) database that provides a summary of the distribution of landslides evident in the landscape of the San Francisco Bay region (USGS 1997). The map is a digitized nine-county compilation of existing landslides, including San Mateo County and encompassing the facility sites. The landslide area type for each well facility site where excavation or other ground disturbance would occur is summarized in Table 5.15-1 (Geologic Units, Landslide, Liquefaction Susceptibility and Shaking Severity Levels at Facility Sites). The proposed facility sites are located in areas mapped as flat land, which is defined as areas of gentle slope at low elevation that have little or no potential for the formation of slumps, transitional slides, or earth flows except along stream banks or terrace margins (USGS 1997).

Although all sites have been mapped as flat land by the USGS, geotechnical investigations, surveys, and field visits indicate that mild to moderate slopes exist at Sites 4, 6, 7, 17 (Alternate), and 18 (Alternate). The terrain at Site 4 is characterized as mildly sloping, generally less than seven percent slopes, along Park Plaza Drive, with an embankment (about 20-foot high) that descends on an approximately 30 percent slope from the proposed site to the Jefferson Elementary School playing field (Geotechnical Consultants 2012). Site 6 would be located on mildly sloping terrain generally less than 20 percent slopes (Geotechnical Consultants 2009b). Site 7 would be located on mildly sloping grassy terrain (Geotechnical Consultants 2009a). Although geotechnical investigations have not been performed for Sites 17 (Alternate) and 18 (Alternate), field visits indicate that the sites have moderate slopes that are slightly greater than 20 percent.

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[2] A scarp is a cliff formed by faulting, erosion, or landslides.
[3] Transverse ridges are linear ridges within an existing landslide.

Naturally Occurring Asbestos

Asbestos is a common name for a group of naturally occurring fibrous silicate minerals that are made up of thin, but strong, durable fibers. Asbestos is a known carcinogen and presents a public health hazard if it is present in the friable (easily crumbled) form. The underlying geology of the facility sites consists primarily of the Colma Formation, with small pockets of alluvium, slope debris/ravine fill, and artificial fill. Franciscan ultramafic rock, including serpentine, is not mapped in the vicinity of the proposed facility sites (Geotechnical Consultants 2009a, 2009b, 2012; USGS 1998b). In addition, based on review of Open File Report 2000-19 (*A General Location Guide for Ultramafic Rocks in California - Areas More Likely to Contain Naturally Occurring Asbestos*), no ultramafic rock units occur in the areas of the facility sites (CDC 2000). The potential to encounter naturally occurring asbestos is further addressed in Section 5.17, Hazards and Hazardous Materials.

Soils

Soil surveys performed by the NRCS, in cooperation with the Regents of the University of California, provide information on surface and near-surface soil materials in the Project area. Table 5.15-2 (Soil Properties in the Project Area) lists each soil type identified at facility sites and is based on the *Soil Survey of San Mateo County, Eastern Part, and San Francisco County* (NRCS 1991).

Problematic soils, such as those that are expansive or corrosive, can damage structures and buried utilities and increase maintenance requirements. Expansive soils are characterized by their ability to undergo significant volume change (i.e., to shrink and swell) due to variations in moisture content. Changes in soil moisture can result from rainfall, landscape irrigation, utility leakage, roof drainage, and/or perched groundwater. Expansive soils are typically very fine grained and have a high to very high percentage of clay. Expansion and contraction of expansive soils in response to changes in moisture content can lead to differential and cyclical movements that can cause damage and/or distress to structures and equipment.

The corrosivity of soils is commonly related to several key parameters, including soil resistivity, the presence of chlorides and sulfates, oxygen content, and pH. Typically, the most corrosive soils are those with the lowest pH and highest concentration of chlorides and sulfates. Wet/dry conditions can result in a concentration of chlorides and sulfates, as well as movement in the soil, both of which tend to break down the protective corrosion films and coatings on the surfaces of building materials. High-sulfate soils are also corrosive to concrete and may prevent complete curing, reducing the strength of the concrete considerably. Low pH and/or low-resistivity soils can corrode buried or partially buried metal structures. Depending on the degree of corrosivity of the subsurface soils, building materials such as concrete, reinforcing steel in concrete structures and bare-metal structures exposed to these soils can deteriorate, eventually leading to structural failures.

Soil types identified include Orthents, which are soils that have been cut and filled for recreational or urban development, and Urban Land, which is covered by asphalt, concrete, buildings, or other structures.

TABLE 5.15-2
Soil Properties in the Project Area

Soil Unit	Runoff Class	Water Erosion	Shrink/Swell Potential
Orthents, cut and fill, 0-15 percent slope	Medium	Moderate	Low
Orthents, cut and fill-Urban land complex, 5-75 percent slopes	Medium to Very Rapid	Moderate to Very High	Low
Urban Land	Not applicable	Not applicable	Not applicable
Urban land-Orthents, smoothed complex, 5-50 percent slopes	Medium to Rapid	Moderate to High	Low

Source: NRCS 1991

The properties and characteristics of the soil types described above are highly variable because of the differences in the kind and amount of fill material used. These soils vary greatly in thickness and in the texture of the surface layer. Most of these soil units in the Project area are overlain by recreational development, cemeteries, and urban development land uses (NRCS 1991).

5.15.1.4 Regional Faulting and Seismic Hazards

Seismicity

The Bay Area is situated near the boundary between two major tectonic plates, the Pacific Plate to the southwest and the North American Plate to the northeast. Since the Miocene epoch (approximately 23 million years ago), about 200 miles of right-lateral slip has occurred along the San Andreas Fault Zone to accommodate the relative movement between these two plates. This movement has juxtaposed the granitic rocks southwest of the San Andreas Fault with the Franciscan Complex rocks lying to the northeast. The movement between the Pacific Plate and the North American Plate generally occurs across a 50-mile zone extending from the San Gregorio fault in the southwest to the Great Valley Thrust Belt to the northeast. In addition to the right-lateral slip movement between tectonic plates, a compressional component of relative movement has developed during the last 3.5 million years between the Pacific Plate and the Sierran micro-plate of the North American Plate at the latitude of San Francisco Bay.

Figure 5.15-2 (Regional Fault Map) shows the locations of active[4] and potentially active[5] faults in the San Francisco Bay region. The San Andreas, San Gregorio, Hayward, Rodgers Creek, Calaveras, and Greenville strike-slip faults[6] are active faults of the San Andreas system that predominantly

[4] An active fault is one that shows geologic evidence of movement within Holocene time (approximately the last 11,000 years).
[5] A potentially active fault is one that shows geologic evidence of movement during the Quaternary period (approximately the last 1.6 million years).
[6] Strike-slip faults involve the two blocks moving parallel to each other without a vertical component of movement.

accommodate lateral movement between the North American and Pacific tectonic plates. Active blind- and reverse-thrust faults[7] in the San Francisco Bay region that accommodate compressional movement include the Monte Vista-Shannon and Mount Diablo faults. The San Andreas Fault is the nearest active fault, located 1.2 to 2.3 miles from the various proposed facility sites (CDC 1982a, 1982b).

The USGS estimates that there is a 63 percent probability of a strong earthquake (magnitude 6.7 or higher on the Richter Magnitude Scale) occurring on one of the regional faults in the 30-year period between 2007 and 2036, with a 21 percent chance of such an earthquake occurring on the northern San Andreas fault, the closest fault to the proposed Project (USGS 2008). Strong groundshaking and other earthquake-related phenomena could occur at facility sites due to a major earthquake on the San Andreas fault or one of the other regional faults, including the Hayward and Calaveras faults – each of which parallels the San Andreas fault and is capable of generating large (greater than magnitude 6.7) earthquakes.

Fault Rupture

Surface rupture occurs when movement on a fault deep within the earth breaks through to the surface. Surface ruptures associated with the 1906 San Francisco earthquake extended for more than 260 miles, with displacements of up to 21 feet. However, not all earthquakes result in surface rupture. The Loma Prieta earthquake of 1989 caused major damage in the Bay Area, but the fault movement did not break through to the ground surface.

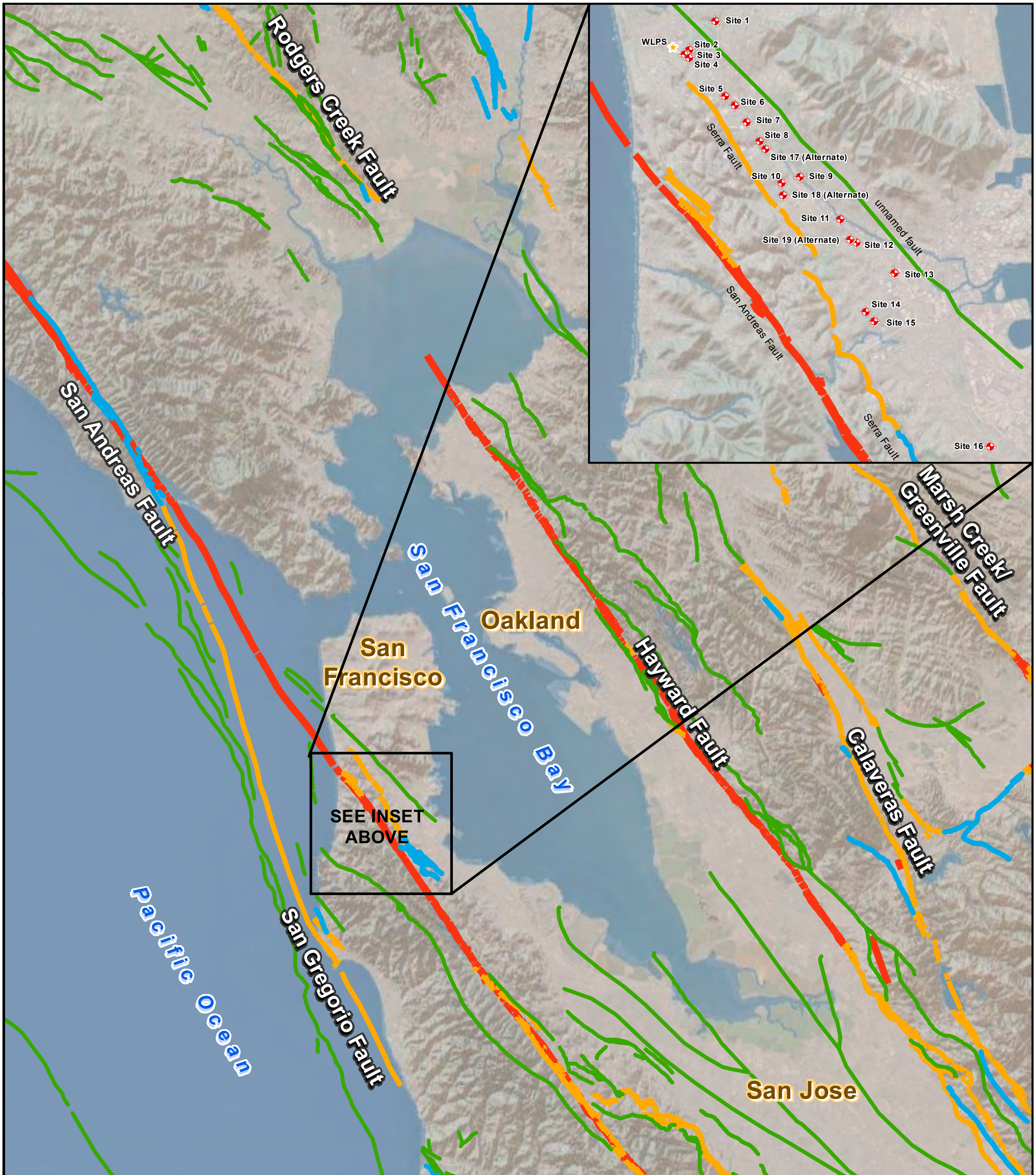
Fault rupture almost always follows pre-existing faults, which are zones of weakness. Rupture may occur suddenly during an earthquake or slowly in the form of fault creep. Sudden displacements are more damaging to structures because they can suddenly displace structures and are accompanied by shaking. Fault creep is the slow rupture of the earth's crust. In developed areas, fault creep can offset and deform curbs, streets, buildings, and other structures that lie on the fault trace. Active fault traces do not cross facility sites (Geotechnical Consultants 2009a, 2009b, 2012; CDC 1982a, 1982b).

Groundshaking

The intensity of the seismic shaking, or strong ground motion, during an earthquake is dependent on the distance between the Project area and the epicenter of the earthquake, the magnitude of the earthquake, and the geologic conditions underlying and surrounding the Project area. Earthquakes occurring on faults closest to the Project area would most likely generate the largest ground motions.

The intensity of earthquake-induced ground motions and the potential forces affecting structures within the Project area can be described using peak ground accelerations, which are represented as a fraction of

[7] A reverse fault is one with predominantly vertical movement in which the upper block moves upward in relation to the lower block; a thrust fault is a low-angle reverse fault. Blind-thrust faults are low-angled subterranean faults that have no surface expression.



Legend

Fault Age

- Potentially Active Fault with Historical (last 1,600,000 years) Displacement
- Potentially Active Fault with Historical (last 130,000 years) Displacement
- Active Fault with Historical (last 15,000 years) Displacement
- Active Fault with Historical (last 150 years) Displacement

- Proposed Project Well Facility Sites
- Westlake Pump Station

N

0 2 4 8 Miles

1 " = 8 miles

Regional Fault Map

Regional Groundwater Storage and Recovery Project

Figure 5.15-2

Source: CA Dept. of Conservation, CGS 2005 the acceleration of gravity (g).[8] The CGS estimates the peak ground accelerations for the 10 percent probability of exceedance in 50 years (475-year return period) at 0.67g to 0.69g (USGS 2008).

Liquefaction

Liquefaction is a phenomenon in which saturated granular sediments temporarily lose their shear strength during periods of earthquake-induced, strong groundshaking. The susceptibility of a site to liquefaction is a function of the depth, density, and water content of the granular sediments and the magnitude of earthquakes likely to affect the site. Saturated, unconsolidated silts, sands, silty sands, and gravels within 50 feet of the ground surface are most susceptible to liquefaction. Liquefaction-related phenomena include vertical settlement from densification, lateral spreading, ground oscillation, flow failures, loss of bearing strength, subsidence, and buoyancy effects.

The USGS classifies liquefaction susceptibility into five categories that describe: the likely proportion of all liquefaction occurrences that could take place in each category; the abundance or frequency of liquefaction occurrence within the category; the strength of shaking required to produce liquefaction; and the Quaternary-age geologic units included (USGS 2006). The five categories are described as follows:

- **Very High.** The USGS estimates that about 40 to 50 percent of future liquefaction effects would occur within geologic units assigned this category. Only modest groundshaking (peak ground acceleration of about 0.1g) would be required to cause liquefaction. Geologic map units that fall within this category include the latest Holocene and historical stream channel deposits, as well as artificial fills over bay and other estuarine mud.
- **High.** The USGS estimates that about 20 to 30 percent of future liquefaction effects would occur within geologic units assigned this category. Relatively modest groundshaking (peak ground acceleration of about 0.1g to 0.2g) would be required to cause liquefaction. Geologic map units within this category include the latest Holocene and historical alluvium, natural levees, and stream terraces.
- **Moderate.** The USGS estimates that about 20 to 30 percent of future liquefaction effects would occur within geologic units assigned this category. Somewhat stronger groundshaking (greater than peak ground acceleration of about 0.1g to 0.2g) would be required to cause liquefaction. Geologic map units within in this category include the latest Pleistocene and Holocene bay and other estuarine mud, alluvial fan and levee deposits, and stream terrace deposits.
- **Low.** The USGS estimates that about two percent of future liquefaction effects would occur within geologic units assigned this category. Stronger groundshaking (peak ground acceleration of about 0.5g) would be required to cause liquefaction. Geologic map units within in this category include the basin deposits, various late Pleistocene deposits and Pleistocene marine terrace deposits.

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[8] Acceleration of gravity (g) = 980 centimeters per second squared. 1.0g of acceleration is a rate of increase in speed equivalent to a car traveling 328 feet from rest in 4.5 seconds.

- **Very Low.** The USGS estimates that about two percent of future liquefaction effects would occur within geologic units assigned this category. Stronger groundshaking (greater than peak ground acceleration of about 0.6g) would be required to cause liquefaction. Geologic map units within in this category include Pleistocene deposits, pre-Quaternary deposits and bedrock.

The liquefaction susceptibility at each facility site requiring excavation or other ground disturbance is shown in Table 5.15-1 (Geologic Units, Landslide, Liquefaction Susceptibility and Shaking Severity Levels at Facility Sites). In general, liquefaction susceptibility levels are low because of the generally dense and clayey nature of the Colma Formation and the depth to groundwater at the sites. However, USGS regional liquefaction mapping indicates moderate to high liquefaction susceptibility at portions of some sites (USGS 2006). Because the USGS mapping has a regional focus, the mapping only generally correlates with areas of known liquefaction hazard. The site-specific data generated from on-site geotechnical borings are considered to be more indicative of liquefaction potential and, therefore, are used instead of the USGS mapping to characterize most of the sites (Geotechnical Consultants 2009a, 2009b, 2012). The aforementioned USGS regional mapping indicates a high liquefaction potential – and geotechnical investigations have not been performed – for portions of Sites 11, 17 (Alternate), and 18 (Alternate). However, these three well facility sites are located in proximity to sites for which geotechnical investigations have been performed (Sites 12, 8, and 10, respectively) and for which site-specific data indicate a low liquefaction susceptibility (Geotechnical Consultants 2009a, 2009b, 2012). Sites 11, 17 (Alternate), and 18 (Alternate) would be located close to, and within, similar geologic units and groundwater conditions as, Sites 12, 8, and 10, respectively; therefore, the liquefaction susceptibility levels at these sites are characterized as low.

Lateral Spreading

Of the liquefaction hazards, lateral spreading generally causes the most damage. Lateral spreading refers to landslides that commonly form on gentle slopes and that have rapid fluid-like flow movement, like water (USGS 2012). During lateral spreading, a mass moves toward an unconfined area, such as a descending slope or stream-cut bluff, and can occur on slope gradients as gentle as one degree. Drainages and swales between hill slopes are generally filled by alluvium[9], colluvium, landslide debris, and slope wash. Unconsolidated deposits often develop soils along steep and shallow slopes in these areas. Well facility Sites 17 (Alternate) and 18 (Alternate) have moderate slopes and are mapped by USGS as having moderate to high liquefaction susceptibility (USGS 2006). These characteristics could potentially make facilities at Sites 17 (Alternate) and 18 (Alternate) susceptible to lateral spreading. However, as described in the previous section on liquefaction, these sites are located in proximity to sites for which geotechnical investigations have been performed (Sites 8 and 10) and for which site-specific data indicate low liquefaction susceptibility (Geotechnical Consultants 2009a, 2009b, 2012). Sites 17 (Alternate) and 18 (Alternate) would be located close by, and within, similar geologic units with groundwater conditions similar to Sites 8 and 10, respectively. Therefore, the liquefaction and associated lateral spreading

[9] Alluvium consists of unconsolidated mixtures of gravel, sand, clay, and silt typically deposited by streams.

susceptibility levels at these sites are characterized as low, consistent with the classification for Sites 8 and 10 in the geotechnical reports prepared by Geotechnical Consultants, Inc.

Earthquake-induced Settlement

Settlement of the ground surface can be accelerated and accentuated by earthquakes. During an earthquake, settlement can occur as a result of the relatively rapid rearrangement, compaction, and settling of subsurface materials (particularly loose, non-compacted, and variable sandy sediments). Settlement can occur both uniformly and differentially (i.e., where adjoining areas settle at different rates). Areas are susceptible to differential settlement if underlain by compressible sediments, such as poorly engineered artificial fill or bay mud. Facility sites with underlying artificial fills and other potentially unstable soils with a moderately high hazard from seismically induced settlement include Sites 1, 5, 8, 12, 13, 14, 15, and 16 (Geotechnical Consultants 2009a, 2009b, 2012). Sites 17 (Alternate) and 18 (Alternate) are close to, and within, similar geologic units and groundwater conditions as Sites 8 and 10, respectively. Therefore, this analysis assumes that hazards from earthquake-induced settlement may be moderately high at these sites, as well.

Seismic Slope Instability/Ground Cracking

Earthquake motion can also induce substantial stresses in slopes, causing earthquake-induced landslides or ground cracking when the slope fails. Earthquake-induced landslides can occur in areas with steep slopes that are susceptible to strong ground motion during an earthquake. The 1989 Loma Prieta earthquake triggered thousands of landslides over an area of 770 square miles. Well facility sites with moderate slopes that could potentially be susceptible to seismic slope instability include Sites 2, 4, 6, and 7 (Geotechnical Consultants 2009a, 2009b, 2012). Sites 17 (Alternate) and 18 (Alternate) also have moderate slopes. Therefore, this analysis assumes that Sites 17 (Alternate) and 18 (Alternate) may be susceptible to seismic slope instability.

5.15.2 Regulatory Framework

5.15.2.1 Federal

No federal regulations are associated with geology, soils, and seismicity for the proposed Project.

5.15.2.2 State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. In accordance with this act, the State Geologist established regulatory zones, called “earthquake fault zones,” around the surface traces of active faults and published maps showing these zones. Within these zones, buildings for human occupancy cannot be constructed across the surface trace of active faults. Because many active faults are complex and consist of more than one branch, each earthquake fault zone extends approximately 200 to 500 feet on either side of the mapped fault trace.

Title 14 of the California Code of Regulations (CCR), Section 3601(e), defines buildings intended for human occupancy as those that would be inhabited for more than 2,000 hours per year. The proposed Project does not cross an Alquist-Priolo Earthquake Fault Zone (Figure 5.15-2 [Regional Fault Map]) and does not include buildings that meet this criterion for human occupancy. Therefore, these provisions of the act do not apply to the Project.

Seismic Hazards Mapping Act

Like the Alquist-Priolo Act, the Seismic Hazards Mapping Act of 1990 (Public Resources Code [PRC] Sections 2690 to 2699.6) is intended to reduce damage resulting from earthquakes. While the Alquist-Priolo Act addresses surface fault rupture, the Seismic Hazards Mapping Act addresses other earthquake-related hazards, including strong groundshaking, liquefaction and seismically induced landslides. Its provisions are similar in concept to those of the Alquist-Priolo Act: the State is charged with identifying and mapping areas at risk of strong groundshaking, liquefaction, landslides, and other corollary hazards, with cities and counties required to regulate development within mapped Seismic Hazard Zones.

Under the Seismic Hazards Mapping Act, permit review is the primary mechanism for local regulation of development. Specifically, cities and counties are prohibited from issuing development permits for sites within Seismic Hazard Zones until appropriate site-specific geologic and/or geotechnical investigations have been conducted and measures to reduce potential damage have been incorporated into the development plans. The Seismic Hazard Maps released for San Mateo County include liquefaction and landslides maps covering the southeastern portion of the County. The Seismic Hazard Maps for the San Francisco South and Montara Mountain USGS quadrangles, which cover the Project area, are under development and have not been published by the CGS.

Building Codes

The California Building Code (CBC), which is codified in CCR Title 24, Part 2, was promulgated to safeguard the public health, safety, and general welfare by establishing minimum standards related to structural strength, egress facilities, and general building stability. The purpose of the CBC is to regulate and control the design, construction, quality of materials, use/occupancy, location, and maintenance of all building and structures within its jurisdiction. Title 24 is administered by the California Building Standards Commission, which, by law, is responsible for coordinating all building standards. The 2007 CBC is based on the 2006 International Building Code (IBC) published by the International Code Conference. In addition, the CBC contains necessary California amendments that are based on the American Society of Civil Engineers (ASCE) Minimum Design Standards 7-05. ASCE 7-05 provides requirements for general structural design and includes means for determining earthquake loads, as well as other loads (e.g., flood, snow, wind) for inclusion in building codes. The provisions of the CBC apply to the construction, alteration, movement, replacement, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout California.

The earthquake design requirements take into account the occupancy category of the structure, site class, soil classifications, and various seismic coefficients, all of which are used to determine a Seismic Design Category (SDC) for a project. The SDC is a classification system that combines the occupancy categories with the level of expected ground motions at the site and ranges from SDC A (very small seismic vulnerability) to SDC E/F (very high seismic vulnerability and near a major fault). Design specifications are then determined according to the SDC.

5.15.2.3 Local

SFPUC General Seismic Design Requirements

The SFPUC established the General Seismic Design Requirements (SFPUC 2009) to implement consistent criteria for the design and retrofit of all facilities and components of the regional water system. These design requirements require that every Water System Improvement Program (WSIP) project must have project-specific design criteria based on the local seismic environment and the importance of the subject facility to achieve the water service delivery goals in the event of a major earthquake. A major earthquake is identified in the General Seismic Design Requirements as earthquakes of M 7.8 or larger on the San Andreas Fault, M 7.1 or larger on the Hayward Fault, or M 6.8 or larger on the Calaveras Fault. The design criteria are based on standard industry practices, codes and standards, but exceed these requirements for facilities that are located in a severe seismic environment and are needed to achieve water system delivery goals. Under these design requirements, each facility is evaluated for its necessity in meeting the water service delivery goals and assigned a seismic performance class for the purposes of determining appropriate seismic design criteria. As described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types), the SFPUC has classified the proposed facilities as "Important" (Class II), which is defined as facilities that may experience damage, but should be capable of restoration to service within 30 days.

5.15.3 Impacts and Mitigation Measures

5.15.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect related to geology, soils, and seismicity if it were to:

- Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:
    - Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault (Refer to Division of Mines and Geology Special Publication 42).
    - Strong seismic ground shaking.
    - Seismic-related ground failure, including liquefaction.
    - Landslides.

- Result in substantial soil erosion or the loss of topsoil.
- Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the Project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse.
- Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property.
- Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.
- Change substantially the topography or any unique geologic or physical features of the site.

5.15.3.2 Approach to Analysis

The potential for impacts related to geology, soils, and seismicity are evaluated according to the significance criteria listed above. Regional and local geologic maps and reports, as well as Project-specific geologic and geotechnical reports, were reviewed to identify geologic conditions and geologic hazards in the study area that, because of their proximity, could be directly or indirectly affected by the proposed Project or could affect the Project.

Area of No Project Impact

The following four significance criteria will not be discussed further in this section for the following reasons:

Expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides. This significance criterion is intended to address facility siting and design impacts and does not apply to temporary construction impacts. Therefore, this significance criterion is not applicable to Project construction activities and is only discussed below as it relates to potential long-term operational impacts.

Result in substantial soil erosion or the loss of topsoil. The proposed well facility sites have been highly altered from their original, natural state. As a result, the depth and amount of grading and excavation proposed by the SFPUC (see Table 3-10, Construction Soil Material Haul Amounts and Anticipated Haul Truck Trips) would result in little disturbance to native soils[10]. In addition, the proposed sites are near areas of moderate to intense urban uses, such as surface streets, schools, single- or multi-family residences, recreational, commercial, and industrial facilities, and the sites are not located in areas supporting agricultural uses. Consequently, no substantial loss of topsoil due to erosion or grading is anticipated during construction or operation of the Project.

[10] Site excavation and grading would be minor, with grading to a maximum depth of five feet for the building foundation (if the well facility is intended to have a building) and utilities underneath the building (see Chapter 3, Project Description, Section 3.5.1.2 [Construction of Well Facilities]); whereas, in general, pipeline trenches would be excavated to a depth of up to six feet and would be approximately 10 feet wide (see Chapter 3, Project Description, Section 3.5.1.3 [Water Distribution and Utility Pipeline Installation]).

Therefore, this significance criterion is not discussed further in this section. In addition, there would be no loss of topsoil or accelerated erosion during well operations given that the disturbed areas around the well facility would be restored to the general pre-construction conditions, and disturbed areas would be hydroseeded and receive erosion control measures as necessary (see Chapter 3, Project Description, Section 3.5.1.1 [Construction Methods for Production Wells]). Nevertheless, potential construction and operation impacts on water quality associated with soil erosion are addressed in Section 5.16, Hydrology and Water Quality.

Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code, creating substantial risks to life or property. This significance criterion is intended to address facility siting and design impacts; it does not apply to temporary construction impacts. Therefore, this significance criterion is not applicable to Project construction activities and is only evaluated as it relates to potential long-term operational impacts.

Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems. Project facility sites would be connected to municipal sewer systems and would not involve the construction or use of septic tanks or alternative wastewater disposal system. Therefore, the criterion related to capability of soils to support septic tanks or alternative wastewater disposal systems is not applicable to construction or operation of the Project.

Change the topography or any unique geologic or physical features of the site(s). Operation of the well facilities would not change the topography or impact geologic features given that the wells and buildings would be in place and no additional ground disturbance would occur during project operations. Therefore, this significance criterion is not applicable to long-term operational impacts and is only discussed below as it relates to Project construction activities.

The evaluation of potential geology and soil impacts in this section relies on information gathered from geotechnical investigations prepared specifically for the proposed Project, as well on published geologic hazard maps and site visits. As stated above, three geotechnical investigations were performed for Sites 1, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, and 16 (Geotechnical Consultants 2009a, 2009b, 2012). For the purposes of this analysis, the information in the geotechnical investigations for Site 4 was used to characterize the conditions at Sites 2 and 3 because these sites are located in close proximity to one another. The information in the geotechnical reports for Sites 8, 10, and 12 were used to characterize conditions at Sites 17 (Alternate), 18 (Alternate), and 19 (Alternate), and information for Site 15 was used to characterize conditions at Site 14 for the purpose of this analysis. Due to access issues, a geotechnical investigation has not yet been performed for Site 11. Regional geologic, liquefaction, and soil mapping was used to characterize Site 11.

5.15.3.3 Impact Summary

For the remaining significance criteria, specific impact analyses below are divided into two subsections: (1) construction impacts (short-term or temporary) and (2) operational impacts (long-term or permanent). Table 5.15-3 (Summary of Impacts – Geology and Soils) provides a summary of geology and soils impacts from the Project.

TABLE 5.15-3
Summary of Impacts – Geology and Soils

	Construction		Operations			Cumulative
Sites	**Impact GE-1: The Project would not be located on a geologic unit or soil that is unstable, or that would become unstable during construction.**	**Impact GE-2: The Project would not substantially change the topography or any unique geologic or physical features of the site(s).**	**Impact GE-3: The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides.**	**Impact GE-4: The Project would be located on a geologic unit or soil that is unstable, or that would become unstable.**	**Impact GE-5: The Project would not be located on corrosive or expansive soil, creating substantial risks to life or property.**	**Impact C-GE-1: Construction and operation of the proposed Project could result in significant impacts related to soils and geology.**
Site 1	NI	LS	LSM	LSM	LS	LS
Site 2	NI	LS	LSM	LS	LS	LS
Site 3	NI	LS	LSM	LS	LS	LS
Site 4	LS	LS	LSM	LS	LS	LS
Westlake Pump Station	NI	LS	LSM	LS	LS	LS
Site 5 (Consolidated Treatment and On-site options)	NI	LS	LSM	LSM	LS	LS
Site 6	LS	LS	LSM	LS	LS	LS
Site 7 (Consolidated Treatment and On-site options)	LS	LS	LSM	LS	LS	LS
Site 8	NI	LS	LSM	LSM	LS	LS
Site 9	NI	LS	LSM	LS	LS	LS
Site 10	NI	LS	LSM	LS	LS	LS

TABLE 5.15-3
Summary of Impacts – Geology and Soils

Sites	Construction		Operations			Cumulative
	Impact GE-1: The Project would not be located on a geologic unit or soil that is unstable, or that would become unstable during construction.	Impact GE-2: The Project would not substantially change the topography or any unique geologic or physical features of the site(s).	Impact GE-3: The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides.	Impact GE-4: The Project would be located on a geologic unit or soil that is unstable, or that would become unstable.	Impact GE-5: The Project would not be located on corrosive or expansive soil, creating substantial risks to life or property.	Impact C-GE-1: Construction and operation of the proposed Project could result in significant impacts related to soils and geology.
Site 11	NI	LS	LSM	LS	LS	LS
Site 12	NI	LS	LSM	LSM	LS	LS
Site 13	NI	LS	LSM	LSM	LS	LS
Site 14	NI	LS	LSM	LSM	LS	LS
Site 15	NI	LS	LSM	LSM	LS	LS
Site 16	NI	LS	LSM	LSM	LS	LS
Site 17 (Alternate)	LS	LS	LSM	LSM	LS	LS
Site 18 (Alternate)	LS	LS	LSM	LS	LS	LS
Site 19 (Alternate)	NI	LS	LSM	LSM	LS	LS

Notes:

NI = No Impact
LS = Less than Significant
LSM = Less than Significant with Mitigation

5.15.3.4 Construction Impacts and Mitigation Measures

Impact GE-1: The Project would not be located on a geologic unit or soil that is unstable, or that would become unstable during construction. (Less than Significant)

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 1, 2, 3, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19 (Alternate), and the Westlake Pump Station</u>

Natural or constructed slopes could become destabilized during construction-related excavation and/or grading operations. Excavations for new pipelines, access roads, and well facilities could result in slope instability, potentially triggering slope failures that could result in landslides, slumps, soil creep, or debris flows. Slope failures are more likely to occur in areas with a history of previous failure and in weak geologic units exposed on unfavorable slopes, such as those areas mapped by the USGS as "few landslides," "many landslides," or "mostly landslides" (USGS 1997). As shown in Table 5.15-1 (Geologic Units, Landslide, Liquefaction Susceptibility and Shaking Severity Levels at Facility Sites), however, none of the proposed locations of the facility sites are mapped as being within these landslide area types.

Sites 1, 2, 3, 5, 9, 10, 11, 12, 13, 14, 15, 16, 19 (Alternate), and Westlake Pump Station would be located in relatively flat areas, which, accordingly, are not subject to slope failures (USGS 1997; Geotechnical Consultants 2009a, 2009b, 2012). Therefore, *no impact* would occur related to unstable soils at these sites.

Site 8 is also located in a flat area, and an elevated automobile dealership parking lot to the west that is at a higher elevation is not likely to pose landslide hazards to Site 8 because of an existing concrete retaining structure that would not be impacted and because Site 8 would have a 30 to 40-foot setback distance between the retaining wall and the proposed station building. Therefore, *no impact* would occur related to unstable soils at Site 8.

Impact Conclusion: No Impact

<u>Sites 4, 6, 7, 17 (Alternate), and 18 (Alternate)</u>

As described in Section 5.15.1.3, Geologic Hazards, geotechnical investigations and field visits indicate that mild (20 percent slopes or less) to moderate (greater than 20 percent slops but less than 30 percent slopes) slopes exist at Sites 4, 6, 7, 17 (Alternate), and 18 (Alternate). The potential for slopes at these sites to become destabilized during construction is considered unlikely due to the mapped and documented presence of generally dense granular materials, the absence of shallow groundwater, and the presence of vegetation that provides additional strengthening of the near surface soils (Geotechnical Consultants 2009a, 2009b, 2012; USGS 1998b). Therefore, impacts related to unstable soils would be *less than significant* at these sites.

Impact Conclusion: Less than Significant

Impact GE-2: The Project would not substantially change the topography or any unique geologic or physical features of the site(s). (Less than Significant)

Unique Geologic or Physical Features

All Sites

The proposed Project would include grading to construct new access driveways, pipeline connections, staging areas and facility buildings. None of the facility sites include rock outcrops or unique geologic or physical features. As a result, *no impact* would occur to unique geologic or physical features at the sites.

Impact Conclusion: No Impact

Topography

All Sites

Sites 1, 3, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19 (Alternate), and Westlake Pump Station would be located on flat land; the Project would not cause a substantial change to the topography of the sites. Sites 2, 4, 6, 7, 17 (Alternate), and 18 (Alternate) are in areas of mildly to moderately sloping terrain. Project grading would not substantially alter the topography of the sites. Site excavation and grading for construction of well facilities would be minor, with grading to a maximum depth of five feet for the building foundation (if the well facility is intended to have a building) and utilities underneath the building (see Chapter 3, Project Description, Section 3.5.1.2, [Construction of Well Facilities]). As a result, impacts related to a substantial change in existing topography would be *less than significant* for all sites.

Impact Conclusion: Less than Significant

5.15.3.5 Operation Impacts and Mitigations

Impact GE-3: The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides. (Less than Significant with Mitigation)

Fault Rupture

All Sites

Figure 5.15-2 (Regional Fault Map) shows the locations of active and potentially active faults in the San Francisco Bay region. The Serra Fault is the nearest active fault in the Project area, located approximately 0.25 to one mile from the various proposed well facilities. The San Andreas Fault Zone is located approximately 1.2 to 2.3 miles from the various proposed well facilities. The facility sites, including pipelines, would not be located within the San Andreas Fault Zone and no other active or potentially active faults are known to cross the sites (CDC 1982a, 1982b; Geotechnical Consultants 2009a, 2009b, 2012). Therefore, geologic impacts on people or structures related to surface fault rupture would be *less than significant.*

Impact Conclusion: Less than Significant

Groundshaking

<u>All Sites</u>

Groundshaking during an earthquake in the Project area is expected to be quite strong (i.e., greater than peak ground acceleration of approximately 0.7 to 0.9g per Geotechnical Consultants, Inc. 2009a, 2009b, 2012), which could result in disruption of water service or cause damage to well facility buildings or the Westlake Pump Station building. The potential for damage and subsequent disruption of water service from strong seismic ground shaking could therefore result in a *significant* impact.

The SFPUC's General Seismic Requirements for Design of New Facilities and Upgrade of Existing Facilities set forth criteria for the seismic design of facilities and components of WSIP facility improvement projects (SFPUC 2009). Under these design requirements, each facility is evaluated for its necessity in meeting the water service delivery goals and assigned a seismic performance class for the purpose of determining appropriate seismic design criteria. The SFPUC has classified the proposed facilities as "Important" (Class II), which is defined as facilities that may experience damage, but should be capable of restoration to service within 30 days (SFPUC 2009) (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types, Seismic Design Requirements]). The SFPUC requirements for ground shaking include specific design ground motion parameters and design spectra for engineering analysis and structure design.

Site-specific design criteria for sites with well facility buildings are provided in the site-specific geotechnical studies prepared for Sites 1, 4, 5, 6, 7, 8, 9, 10, 12, 13, 15, and 16 (Geotechnical Consultants 2009a, 2009b, 2012). Sites 2, 3, 14, 17 (Alternate), 19 (Alternate), and the Westlake Pump Station are adjacent to or very close to sites where a site-specific geotechnical study has been prepared, and where the design criteria for the adjacent site appear to be applicable. Mitigation Measure M-GE-3 (Conduct Site-Specific Geotechnical Investigations and Implement Recommendations) would reduce the impact of seismic ground shaking, as well as settlement (see Impact GE-4), on well facilities by requiring facilities to be designed and constructed in conformance with specific recommendations contained in design-level geotechnical studies, such as site-specific seismic design parameters and lateral earth pressures, use of engineered fill, and subgrade preparations for foundations systems and floor slabs. These measures are described in more detail in Mitigation measure M-GE-3 below. Therefore, with implementation of these measures, geologic impacts on people or structures related to seismic groundshaking following mitigation would be *less than significant*.

Mitigation Measure M-GE-3: Conduct Site-Specific Geotechnical Investigations and Implement Recommendations (All Sites)

The SFPUC shall conduct a site-specific design-level geotechnical study at Site 11 to provide recommendations for protection from property loss, injury, or death from ground shaking or settlement. Similarly, if Site 18 (Alternate) is selected, the SFPUC shall conduct a site-specific design-level geotechnical study for the site.

At all sites, the facilities shall be designed and constructed in conformance with the specific recommendations contained in design-level geotechnical studies. The recommendations made in the geotechnical studies shall be incorporated into the final plans and specifications and implemented during construction The site-specific recommendations in the design-level geotechnical studies relative to ground shaking include the following measures:

- Site-specific seismic design parameters in accordance with the International Building Code Static Force Procedure;
- Specified lateral earth pressures and seismic loading for retaining walls;
- Earthwork recommendations for site preparation, excavations, use of engineered fill and utility trench/pipe backfill; and
- Foundation recommendations for subgrade preparation, foundations systems, and floor slabs.

Site-specific recommendations in the design-level geotechnical studies relative to settlement include the following measures:

- Supporting structures at these sites on structurally rigid mat foundations with contact pressures in accordance with the bearing capacities identified in the geotechnical reports;
- Post-tensioning to reinforce and increase the structural rigidity of grade beams and shallow footings;
- Over-excavating artificial fill materials and loose granular soils and recompaction with moisture treated engineered fill to develop a mass of densified soil beneath the proposed well buildings; and
- Using flexible pipe connections to accommodate dynamic settlements due to seismic loading.

Impact Conclusion: Less than Significant with Mitigation

Seismically-induced Landslides

<u>All Sites</u>

As described under Impact GE-2, the facility sites would be located in areas mapped as flat land (USGS 1998a). However, geotechnical investigations, surveys, and field visits have indicated that mild to moderate slopes exist at Sites 4, 6, and 7. Although no site specific geotechnical reports exist for Sites 17 (Alternate) and 18 (Alternate), mapping shows these sites are underlain by the same geologic units as nearby well facilities, and similar groundwater levels would be expected given the close proximity to other wells for which geotechnical data is available (see Section 5.15.1.3, Geologic Hazards). The potential for seismically induced landslides is considered unlikely at the sites due to the presence of generally dense granular materials and the absence of shallow groundwater (Geotechnical Consultants 2009a, 2009b, 2012; USGS 1998b). At Site 4, roots from vegetation and trees provide additional strengthening of the near surface soil mass (Geotechnical Consultants 2012). Therefore, geologic impacts on people or structures related to seismically induced landslides or slope failures would be *less than significant* for all sites.

Impact Conclusion: Less than Significant

Impact GE-4: The Project would be located on a geologic unit or soil that is unstable, or that would become unstable. (Less than Significant with Mitigation)

Liquefaction

All Sites

Liquefaction-related phenomena can include lateral spreading, ground oscillation, loss of bearing strength, subsidence, and buoyancy effects, all of which could damage the proposed well facilities and associated pipelines. Seismically induced settlement can occur in areas underlain by compressible sediments, which can cause damage to structures when settlement does not occur evenly across the footprint of a structure, resulting in differential settlement. Stream channel deposits and recent valley alluvium are generally the most susceptible to earthquake-induced settlement. Additionally, artificial fills, especially fills placed before 1965 and those placed on top of bay mud, are highly susceptible to mobilization and densification, resulting in earthquake-induced subsidence. The liquefaction susceptibility for each site is summarized in Table 5.15-1 (Geologic Units, Landslide, Liquefaction Susceptibility and Shaking Severity Levels at Facility Sites).

Sites 1, 2, 3, 4, 5, 6, 7, 11 (not including the sanitary sewer pipeline), 12, 14, 15, 16, 19 (Alternate), and the Westlake Pump Station would be located in areas mapped by the USGS as having very low to low liquefaction susceptibility (USGS 2006). In addition, the site-specific data from geotechnical borings for Sites 1, 4, 5, 6, 7, 12, 15, and 16 indicate that these sites would not be susceptible to liquefaction because of the generally dense and clayey nature of the Colma formation (Geotechnical Consultants 2009a, 2009b, 2012). Therefore, potential geologic impacts on people or structures related to liquefaction would be *less than significant* for these sites.

Sites 9, 13, and 18 (Alternate) would be located in areas mapped by the USGS as having moderate liquefaction susceptibility associated with artificial fill and alluvial deposits of Colma Creek (USGS 2006). However, the site-specific data from the geotechnical borings at Sites 9 and 13 indicate that these sites would not be susceptible to liquefaction due to the generally dense and clayey nature of the Colma Formation at the sites (Geotechnical Consultants 2009a, 2009b). In addition, and as shown on Figure 5.15-1 (Project Geology Map), the Colma formation also underlies Site 18 (Alternate). Due to the dense and clayey nature of the Colma formation, this site would also not be susceptible to liquefaction. Therefore, potential geologic impacts on people or structures related to liquefaction would be *less than significant* for these sites.

Sites 8, 10, and 17 (Alternate) would be located in an area mapped by the USGS as having high liquefaction susceptibility associated with alluvial deposits of Colma Creek (USGS 2006). In addition, a portion of the proposed sanitary sewer connection at Site 11 would be located in an area mapped as having high liquefaction susceptibility. However, the site-specific data from the geotechnical borings at Sites 8 and 10 indicate that these sites would not be susceptible to liquefaction due to the generally dense and clayey nature of the Colma formation, including the clayey nature of the natural levee deposits at Site 10 (Geotechnical Consultants 2009a, 2009b). In addition, and as shown on Figure 5.15-1 (Project Geology Map), the Colma formation also underlies the sanitary sewer pipeline route at Site 11 and Site 17

(Alternate). Due to the dense and clayey nature of the Colma formation, these sites would also not be susceptible to liquefaction.

Moreover, the proposed facilities would be designed to meet current seismic standards in accordance with the 2010 California Building Code and with the SFPUC's General Seismic Design Requirements (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]), which include characterizing and addressing the potential for liquefaction through geotechnical evaluations, building design, and pipeline construction techniques and materials, such as chained joints. Therefore, geologic impacts on people or structures related to liquefaction would be *less than significant* for these sites.

Impact Conclusion: Less than Significant

Lateral Spreading

<u>All Sites</u>

At Site 1, an isolated layer of potentially liquefiable silty sand within the upper portion of the Colma formation was identified at a depth of about 35 feet. An approximately 8-foot high embankment descending on an about 3:1 slope is located approximately 20 feet to the west of the nearest edge of the proposed well facility building at Site 1. The potential susceptibility of Site 1 to lateral spreading toward the embankment free face is considered low because the isolated layer of potentially liquefiable medium is at a depth well below the toe of the 8-foot tall embankment (Geotechnical Consultants 2012).

The potential susceptibility of the other sites to lateral spreading is considered to be low, because the Colma formation soils at the sites are not susceptible to liquefaction. Therefore, potential geologic impacts on people or structures related to lateral spreading would be *less than significant* for all the sites.

Impact Conclusion: Less than Significant

Settlement

The evaluation of impacts that follows discusses sites with less-than-significant impacts, followed by sites with significant impacts.

<u>Sites 2, 3, 4, 6, 7, 9, 10, 11, 18 (Alternate), and the Westlake Pump Station</u>

The site-specific data from the geotechnical borings at Sites 4, 6, 7, 9, and 10 indicate that these sites would be located in soils susceptible to a low hazard from settlement due to strong groundshaking during an earthquake (Geotechnical Consultants 2009a, 2009b, 2012). The low hazard is related to the relatively dense nature of the near-surface Colma formation at the sites, and the relatively thin stratum of artificial fill and silty fine sands at the sites. Sites 2, 3, 11, 18 (Alternate), and the Westlake Pump Station are located in proximity to and in similar geologic units as Sites 4 and 10 and would, therefore, likely have a similarly low hazard from settlement. Therefore, potential geologic impacts on people or structures related to settlement would be *less than significant* for these sites.

Impact Conclusion: Less than Significant

<u>Sites 1, 5, 8, 12, 13, 14, 15, 16, 17 (Alternate), and 19 (Alternate)</u>

The site-specific data from the geotechnical borings at Sites 1, 5, 8, 12, 13, 15, and 16 indicate that these sites would be located in soils susceptible to a moderately high hazard from settlement due to strong groundshaking during an earthquake (Geotechnical Consultants 2009a, 2009b, 2012). The moderately high hazard is related to the presence of compressible soils at these sites, including up to 20 feet of unsaturated, loose to medium dense fill sand near the surface of Site 1, artificial fill at Sites 5 and 12, a relatively loose layer of poorly graded sand near the upper stratum of natural levee deposits at Site 8, a loose layer of silty fine sand that spans the upper six feet of the natural levee deposits at Site 13, medium dense silty sand within the upper 15 feet at Site 15, and medium dense silty sand in the Colma Formation above the groundwater level at Site 16. Site 17 (Alternate), Site 19 (Alternate), and Site 14 are located in proximity to Sites 8, 12, and 15, respectively, and could, therefore, have similar soils with a moderately high hazard from settlement. The potential for damage and subsequent disruption of water service from settlement at these sites represents a *significant* potential impact.

Geotechnical recommendations relative to settlement are provided in the site-specific geotechnical studies prepared for Sites 1, 5, 8, 12, 13, 15, and 16 (Geotechnical Consultants 2009a, 2009b, 2012). Sites 14, 17 (Alternate), and 19 (Alternate) are adjacent to or very close to sites where a site-specific geotechnical study has been prepared, and where the design criteria for the adjacent site appear to be applicable. Mitigation Measure M-GE-3 (Conduct Site-Specific Geotechnical Investigations and Implement Recommendations) would reduce the impact of settlement on these well facilities by requiring facilities to be designed and constructed in conformance with specific recommendations contained in design-level geotechnical studies, such as over-excavation of artificial materials, re-compaction with moisture treated engineered fill, supporting structures on structurally rigid mat foundations, post-tensioning to reinforce and increase structural rigidity, and using flexible pipe connections. Therefore, geologic impacts on people or structures related to settlement following mitigation would be *less than significant* for these sites.

> ***Mitigation Measure M-GE-3: Conduct Site-Specific Geotechnical Investigation and Implement Recommendations (All Sites)***
> (See Impact GE-3 for a description)

Impact Conclusion: Less than Significant with Mitigation

Impact GE-5: The Project would not be located on corrosive or expansive soil, creating substantial risks to life or property. (Less than Significant)

<u>All Sites</u>

Soil types identified at facility sites include Orthents and Urban Land (NRCS 1991). As indicated in Table 5.15-2 (Soil Properties in the Project Area), Orthents soils have a low shrink/swell potential, while Urban Land consists of areas where more than 85 percent of the surface is covered by asphalt, concrete, buildings, and other structures. Therefore, potential soils impacts on life or property related to expansive soils would be *less than significant*.

The geotechnical investigations for Sites 5, 6, 7, 8, 9, 10, 12, 13, 15, and 16 indicated that the soils present are mildly to highly corrosive to ferrous metals (Geotechnical Consultants 2009a, 2009b). Given that the mapped soil types at other sites are similar to the confirmed soil types found at sites for which geotechnical investigations have been undertaken, it is reasonable to assume that the remaining sites would also display mild to high corrosive characteristics in soils. Corrosive soils could, over time, deteriorate the newly installed pipelines proposed under the Project. If such deterioration were to cause a rupture in the pipelines, substantial damage to adjacent properties could result from the temporary uncontrolled flow of water (until valves can be operated to cease the flow of water). However, a combination of coating and/or pipe wrapping, and possibly passive cathodic protection would be used to protect the new pipelines from corrosion. The pipeline coating would be made of materials that would prevent the external corrosion process. In addition, a cathodic protection system would be placed along the length of the new pipeline to prevent corrosion of the pipeline (see Chapter 3, Project Description, Section 3.4.2.4 [Water Connection, Sanitary Sewer, and Storm Drain Piping]). With incorporation of these design features, as proposed, soils impacts on life or property related to corrosive soils would be *less than significant.*

Impact Conclusion: Less than Significant

5.15.3.6 Cumulative Impacts and Mitigation Measures

Impact C-GE-1: Construction and operation of the proposed Project could result in significant impacts related to soils and geology. (Less than Significant)

The geographic scope for cumulative impacts on geology and soils consists of each proposed GSR facility site (including the construction area for the well, the well facility, and the pipelines) and the immediate vicinity around each of these sites. Geologic and seismic impacts are generally site-specific, because they depend upon the local geology and soil conditions.

The Peninsula Pipelines Seismic Upgrade (PPSU) Project, Colma Site (cumulative project D-1) would occur in the vicinity of Sites 8 and 17 (Alternate). Because of the dense and clayey nature of the Colma formation underlying these sites, the sites would not be subject to geologic or soil instability. Because of the localized nature of the geologic and soils impacts, the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), including the PPSU Project, Colma Site, would not contribute to potential cumulative impacts associated with the GSR Project, including geologic or soil instability (Impact GE-1 during construction and Impact GE-4 during operations), topographic changes (Impact GE-2), fault rupture and ground shaking (Impact GE-3) and exposure to corrosive or expansive soil (Impact GE-5). For this reason, the potential cumulative impact related to geology and soils would be *less than significant*.

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5.16 HYDROLOGY AND WATER QUALITY

This section describes the existing conditions and regulatory setting for hydrology and water quality in the Project area and assesses potential impacts on hydrology and water quality that could result from implementation of the proposed Project. For construction of the Project, the surface water effects are generally associated with construction-related stormwater runoff and discharges; therefore, the study area is restricted to the individual well facility sites and the pipeline routes. For operation of the Project, surface water effects would be related to stormwater runoff from the well facilities; effects from operation of the Project could also occur in the Westside Groundwater Basin as a whole because of Project-related groundwater pumping and in-lieu recharge of the Basin. Therefore, the study area is expanded to the Westside Groundwater Basin for the analysis of impacts on groundwater from operation of the proposed Project.

5.16.1 Setting

5.16.1.1 Climate and Precipitation

The study area is located in a valley between the Pacific Ocean and San Francisco Bay, giving it a variable, but mild, marine climate. Winters are mild and moderately wet and summers are cool and dry. Most precipitation occurs as rainfall from November through April, with annual precipitation ranging from less than 20 inches along San Francisco Bay near the San Francisco International Airport (SFO) to approximately 24 inches in the center of the valley near Colma and South San Francisco (San Bruno et al. 2012).

5.16.1.2 Regional Surface Water Hydrology

San Mateo County encompasses four hydrologic basins and a total of 34 watersheds, all of which ultimately drain west to the Pacific Ocean or east to the San Francisco Bay (San Francisco Bay or Bay). The Pacific Ocean coast is located to the west of the proposed GSR facility sites and the San Francisco Bay is located to the east.

The proposed Project is located within the hydrologic boundaries of several watersheds in San Mateo County, including the watersheds of Vista Grande Drainage Canal, Colma Creek, San Bruno Creek, Green Hills Creek, and Millbrae Creek as illustrated on Figure 5.16-1 (Surface Water Hydrology Map). These watersheds are described below.

The relation of surface water features, including Lake Merced, Pine Lake, and the Golden Gate Park Lakes, to groundwater is described in Section 5.16.1.4 (Groundwater-Surface Water Interactions) below.

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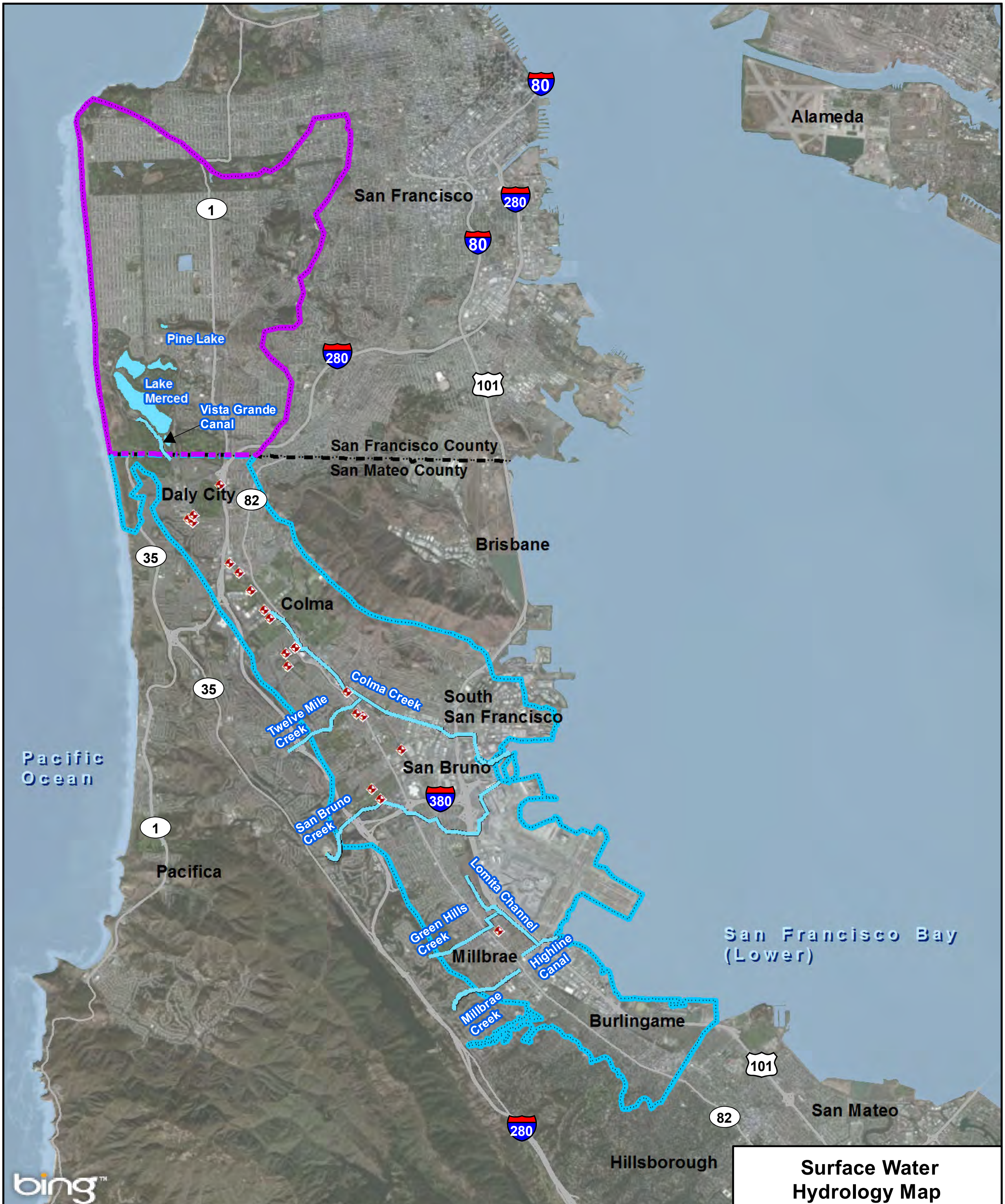

Surface Water Hydrology Map

Regional Groundwater Storage and Recovery Project

Figure 5.16-1

Legend

- Proposed Project Well Facility Sites
- County Boundary
- Creeks and Other Waterbodies
- North Westside Groundwater Basin[1]
- South Westside Groundwater Basin[1]

0 0.5 1 2

Scale Miles

1 " = 2 miles

N

[1]The Westside Groundwater Basin has been administratively divided at the San Francisco-San Mateo County line.

Data Sources: San Mateo County 2010; Oakland Museum, Upper Peninsula Watershed Finder; SF Public Works Dept. 2004. As modified by GHD 2012.

Vista Grande Canal Watershed

The Vista Grande Watershed historically drained into Lake Merced but has since been altered to flow to the Pacific Ocean. The Westlake Pump Station and Sites 1, 2, 3, and 4 would be located within the Vista Grande Watershed, with stormwater from the sites flowing northward through underground storm drains to the Vista Grande Drainage Canal. Stormwater flows through the Vista Grande Drainage Canal for about 3,500 feet before flowing into the Vista Grande Outfall Tunnel, which discharges to the Pacific Ocean through an outfall beach structure below Fort Funston in Golden Gate National Recreation Area. (San Bruno et al. 2012)

Colma Creek Watershed, including Twelve Mile Creek

Colma Creek is a small creek draining much of South San Francisco and the surrounding area before entering into San Francisco Bay just north of SFO and the eastern terminus of Interstate 380 (I-380). Sites 5 through 13 would be located within the Colma Creek Watershed. Within the valley portion of the watershed, Colma Creek is an open, concreted lined engineered channel from San Francisco Bay to near the Colma/South San Francisco city limits. This engineered section of creek is maintained by the San Mateo County Flood Control District. Much of the area upstream of South San Francisco and some small tributaries within South San Francisco flow through underground storm drains. Some of the uppermost reaches of the creek on San Bruno Mountain are natural channels (San Bruno et al. 2012). The Colma Creek Watershed includes Twelve Mile Creek, which flows northeast in underground storm drains and enters Colma Creek upstream of Woodlawn Memorial Park in the vicinity of Sites 12 and 19 (Alternate) in South San Francisco.

San Bruno Creek Watershed

San Bruno Creek flows from the uplands along the west side of the South Westside Basin near Highway 35, discharging into the Bay at a location just south of the Colma Creek discharge. Sites 14 and 15 would be located within the watershed for San Bruno Creek, which flows eastward, primarily through underground storm drains.

Green Hills Creek Watershed, including Lomita Channel and Highline Canal

Green Hills Creek flows east through underground storm drains from the Millbrae Meadows through the City of Millbrae. The creek connects to the Lomita Channel, which is an open channel that parallels the west side of U.S. Highway 101 (U.S. 101), and then to the Highline Canal also adjacent to U.S. 101. Highline Canal is an engineered concrete-lined channel that crosses under U.S. 101 and discharges to the Bay south of SFO. Site 16 would be located in the eastern portion of the Green Hills Creek Watershed, with stormwater flowing through underground storm drains to the Highline Canal adjacent to U.S. 101.

Millbrae Creek Watershed

Millbrae Creek is in the southernmost part of the South Westside Basin, with its headwaters also located in the western uplands and with a discharge to the Bay south of SFO. No GSR facility sites are planned within the Millbrae Creek Watershed.

Surface Water Quality

In accordance with Section 303(d) of the federal Clean Water Act, state governments must present the U.S. Environmental Protection Agency (U.S. EPA) with a list of "impaired water bodies." Such water bodies are defined as those that do not meet surface water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. This is explained in greater detail in Section 5.16.2 (Regulatory Framework). The surface water bodies in the Project area included on the list of impaired water bodies are shown in Table 5.16-1 (Impaired Surface Water Bodies). The remaining water bodies in the Project area, including the Vista Grande Drainage Canal, Twelve Mile Creek, San Bruno Creek, Green Hills Creek, Highline Canal, and Millbrae Creek are not listed as impaired water bodies (SWRCB 2007; RWQCB 2011).

TABLE 5.16-1
Impaired Surface Water Bodies

Water Body	Pollutant/Stressor
Lake Merced	Low Dissolved Oxygen, pH
San Francisco Bay (Lower)	Chlordane, DDT, Dieldrin, Dioxin Compounds (including 2, 3, 7, 8-TCDD), Exotic Species, Furan Compounds, Mercury, PCB's (Polychlorinated biphenyls), PCB's (dioxin-like), Trash (proposed)
Colma Creek	Trash (proposed)

Sources: SWQCB 2007; RWQCB 2011

Flood, Seiche, and Tsunami

The Federal Emergency Management Agency (FEMA) delineates regional flooding hazards as part of the National Flood Insurance Program. The most recent Flood Insurance Study for San Mateo County became effective on October 16, 2012, and investigates the existence and severity of flood hazards in the Project area (FEMA 2012). The primary area of mapped 100-year flooding in the Project area is located along Colma Creek in the City of South San Francisco, near Site 9. A Colma Creek Flood Control Zone was created in 1964 by the San Mateo County Flood Control District to alleviate flooding in the City of South San Francisco. Flood control projects have included channel and culvert improvements, as well as bridge replacements. Localized areas of 100-year flooding are also located in South San Francisco at the intersection of Spruce Avenue and Huntington Avenue near Site 13 and in Millbrae along the Lomita Channel, which flows adjacent to U.S. 101 east of Site 16. The City of San Bruno has no mapped flood hazard areas identified (FEMA 2012).

Water supply reservoirs in San Mateo County can also present a remote risk of downstream inundation in the event of a dam failure. Dam failure inundation maps prepared by the Association of Bay Area Governments (ABAG) and San Mateo County indicate that the proposed Project is not located within an area subject to inundation from failure of a levee or dam (ABAG 2012; San Mateo County 2005).

Flooding hazards can also occur as a result of seiches (i.e., earthquake-induced oscillating waves in an enclosed water body) and tsunamis (i.e., earthquake-induced waves formed in the open ocean that reach a shoreline). The proposed Project is not located near isolated bodies of water that would be subject to inundation by seiche, and the proposed well sites are not located within an area subject to inundation from tsunami (Cal EMA 2009).

5.16.1.3 Regional Groundwater Hydrology

Most of northern San Mateo County is underlain by the Westside Groundwater Basin, shown on Figure 5.16-1 (Surface Water Hydrology Map) (DWR 2006). With an area of about 45 square miles, this groundwater basin extends from San Francisco south to San Mateo County. The Westside Groundwater Basin is separated from the Lobos Basin to the north by a northwest-trending bedrock ridge through the northeastern part of Golden Gate Park. San Bruno Mountain and San Francisco Bay form the eastern boundary, and the San Andreas Fault and Pacific Ocean form the western boundary. The southern limit of the Westside Groundwater Basin, which roughly follows the Burlingame-San Mateo common city limit, is defined by an area of high bedrock that separates it from the San Mateo Plain Groundwater Basin. The basin opens to the Pacific Ocean on the northwest and San Francisco Bay on the southeast.

There is no geologic feature that restricts groundwater flow between the northern and southern parts of the groundwater basin. However, groundwater development in the two parts of the Basin are different from each other, as groundwater has been more heavily developed as a water supply in the South Westside Groundwater Basin. For discussion purposes, the 14-square-mile portion of the Westside Groundwater Basin north of the San Francisco/San Mateo County line is referred to in this EIR as the North Westside Groundwater Basin and the 31-square-mile portion of the Westside Groundwater Basin south of the San Francisco/San Mateo County line is referred to herein as the South Westside Groundwater Basin. The South Westside Groundwater Basin underlies Daly City, Colma, South San Francisco, San Bruno, Millbrae, and portions of unincorporated San Mateo County, Burlingame, and Hillsborough.

Regional Geology

The five major geologic units in the Westside Groundwater Basin are the Mesozoic-age Franciscan Complex, Pleistocene-age Merced and Colma Formations, and the Pleistocene to recent Dune Sands and Bay Mud deposits. There are also minor, but widespread, units of recent alluvium along historical stream channels. (LSCE 2010)

Exposed in the low hills east and northeast of Lake Merced, the Franciscan Complex forms the basement rock for the aquifer system, which defines the lateral and vertical limits of the primary groundwater-bearing formations in the Westside Groundwater Basin. To the north of Lake Merced, the bedrock slopes gently westward towards the Pacific Ocean; beneath Golden Gate Park there is an apparent buried stream valley that results in a thicker accumulation of sediment in that area. South of Lake Merced to the Daly City area, the surface of the bedrock slopes southwestward to Daly City, occurring at depths of almost 600 feet near the center of Lake Merced and nearly 1,000 feet beneath the southern portion of Daly City. The bedrock configuration is more speculative beneath the Pacific Ocean, to the west of the Westside Groundwater Basin.

The Merced Formation is a 5,000-foot-thick sequence of shallow marine and non-marine deposits comprising three units (lower, middle, and upper). It is the thickest water-bearing formation overlying the basement rock (see Figure 5.16-2 [North South Geologic Cross Section, Westside Groundwater Basin]). The lower unit of the Merced Formation is about 4,000 feet thick and is composed of fine sandstone to siltstone. This unit is strongly to moderately deformed and shows some evidence of folding. The middle unit of the Merced Formation is up to about 600 feet thick and is composed of thinner bedded, near-shore marine, beach, estuary, dune, and fluvial deposits of fine sandstone, siltstone, and mudstone. The middle unit of the Merced Formation is moderately deformed with some evidence of folding and steeper dip near the Serra Fault. The upper unit of the Merced Formation is approximately 500 feet thick and consists of a sequence of thin bedded beach, dune, estuarine, and fluvial deposits of weakly consolidated fine sandstone with some gravel and mudstone beds. This unit is only deformed in a minor fashion. A thick clay unit referred to as the "W" clay layer is present in this unit.

The Colma Formation and Dune Sands comprise the majority of the surficial geologic units in the North Westside Groundwater Basin. The Colma Formation is a surficial unit consisting of fine- to medium-grained sand with some clay, silt, and gravel beds of fluvial, floodplain, alluvial fan, and dune sand origin. It is exposed from Lake Merced, south to San Bruno, and the maximum thickness is about 200 feet. The separation between the Colma Formation and the underlying Merced Formation is not clearly defined because of the similarity in the geologic materials comprising the units.

Dune Sands are also a surficial unit of fine- to medium-grained sands that are exposed across the San Francisco Peninsula north of Lake Merced. Because of the similarity in geologic materials comprising the Dune Sands and older formations, there is uncertainty regarding the thickness of this unit.

The Bay Mud deposits generally consist of clays and silts with some sand. In the Westside Groundwater Basin, the extent of this surficial unit is limited to the San Francisco Bay shore in the South Westside Groundwater Basin.

There are two primary structural features affecting the groundwater basin, including the San Andreas Fault system and the Serra Fault. The northwest-trending San Andreas Fault system, defining the southwest boundary of the Westside Groundwater Basin, is an active right-lateral, strike-slip fault with the west side moving northward relative to the east side. The Serra Fault parallels the San Andreas Fault and is a southwest dipping reverse fault with the west side up thrust relative to the east side. The fault extends from south of San Bruno to the Lake Merced area and extends offshore.

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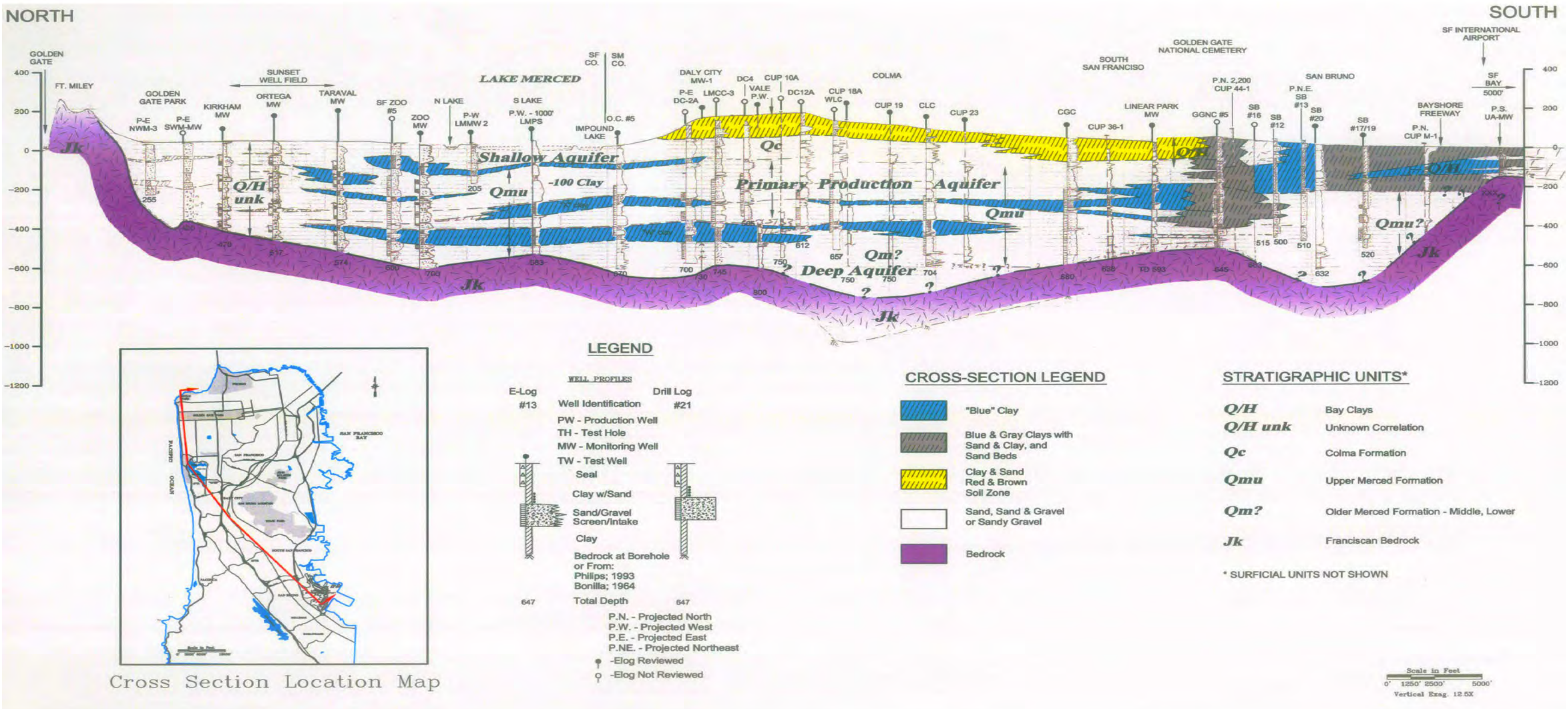

Source: LSCE 2010

North-South Geologic Cross Section, Westside Groundwater Basin

Regional Groundwater Storage and Recovery Project

Figure 5.16-2

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Offshore of the Westside Groundwater Basin, the ocean floor dips gently westward with ocean depths reaching only 60 feet at two miles offshore, 100 feet at eight miles offshore and 300 feet at 25 miles offshore at the edge of the continental shelf. The continental shelf is underlain by a thick sequence of Quaternary and Tertiary age sedimentary deposits, crossed by the San Andreas Fault approximately two miles offshore, and possibly crossed by the Serra Fault as well. These faults may act as hydraulic barriers and, combined with the thick sequence of sedimentary rocks beneath the ocean floor, may preclude direct communication between the water-bearing units of the Westside Groundwater Basin and the Pacific Ocean.

South Westside Groundwater Basin Geology

The majority of the surficial geologic units in the South Westside Groundwater Basin are composed of the Colma and Merced Formations. In the Daly City and Colma area, the upper Merced is poorly defined, massive, fine-grained sand to sandstone with thinner, discontinuous clay horizons. The upper 200 feet of these deposits (Colma Formation) appear to be more non-marine in nature, possibly reflecting alluvial fan aprons or dune fields fed by sources from the north and, possibly, the south. (LSCE 2010)

Beneath the Colma area, a thick sequence of massive fine sand occurs with a few thin clay beds. Overlying the thick sands in the Colma area is a surficial clayey sand to clay and sand that is interpreted to be a weathered zone of the Colma Formation and younger units. The higher, finer-grained clay and sand sequence appears to thicken and grade into clay beds toward the Bay. These relationships may reflect changing depositional character, from sand-dominated upper Merced and Colma to the west, to the fine-grained estuary and mudflat deposits of the San Francisco Bay region to the east. (LSCE 2010)

In the San Bruno area, well logs and geophysical logs indicate a deep sandy unit overlain by about 200 to 250 feet of predominately fine-grained material that includes silts, clays, sandy clays, and gravelly clays. A southward extending ridge of Franciscan bedrock along with fine-grained Bay Deposits appear to separate San Bruno from the San Francisco Bay to the east. South of San Bruno, surficial mapping may indicate a relationship to exposures of sand and gravel deposits in the Burlingame area, which are mapped as non-marine Santa Clara Formation. (LSCE 2010)

Aquifer System

The Westside Groundwater Basin includes three aquifers informally known as the Shallow Aquifer, Primary Production Aquifer, and Deep Aquifer shown on Figure 5.16-2 (North South Geologic Cross Section, Westside Groundwater Basin) (LSCE 2010). In the North Westside Groundwater Basin, the Shallow Aquifer is present to a depth of about 100 feet and the aquifer is unconfined. In the Lake Merced area and southern portion of the Sunset District, south to Daly City, this aquifer is separated from the Primary Production Aquifer by the "-100-foot clay" layer. The Primary Production Aquifer is at least partially confined and is separated from the Deep Aquifer by the "W" clay layer, and also includes two discontinuous clay layers referred to as the "X" and "Y" clay layers that may locally restrict groundwater flow within the aquifer. The Deep Aquifer underlies the "W" clay layer.

The -100-foot clay layer and "W" clay layer extend north approximately to the vicinity of where the West Sunset well facility is proposed; these clay layers are absent from that point to the northern extent of the groundwater basin. Because these clay layers are absent, the aquifers are hydraulically connected and can effectively be considered one aquifer beneath Golden Gate Park. The Shallow Aquifer is absent in the South Westside Groundwater Basin from Daly City to the south.

Cross-section data oriented north-south and east-west through the South Westside Basin indicate that from Daly City south to South San Francisco, the Primary Production Aquifer is separated from shallow groundwater by at least 50 feet to 100 feet aggregate thickness of intervening clay and sand deposits. Some groundwater elevation data suggest the shallowest groundwater may be locally perched. The relatively low-permeability shallow sediments in the Daly City to South San Francisco area are markedly different than the higher-permeability shallow sands found in the North Westside Basin. South of Daly City in the eastern area of South San Francisco, San Bruno, and Millbrae, the presence of thick surficial Bay Mud deposits of even lower relative permeability likely provides an even greater degree of isolation to the Primary Production Aquifer in that area. (Kennedy/Jenks May 2012e)

Additional evidence for hydraulic separation between shallow groundwater and the Primary Production Aquifer beneath Colma and Millbrae is apparent from relative groundwater levels measured in multi-level Project monitoring well clusters installed in 2008 and 2009. At each monitoring well location, there are three or four separate wells installed at discrete depths. The completion depths for these wells generally correspond to potential water bearing zones in the Primary Production Aquifer and the Deep Aquifer. Differences in groundwater levels measured in the Project monitoring wells suggest the presence of unsaturated zones and localized perched water at shallow depths and likely hydraulic separations between the localized perched zones, shallow groundwater zones, Primary Production Aquifer, and Deep Aquifer in the central and southern portions of the South Westside Basin. (Kennedy/Jenks 2012e)

Groundwater Monitoring Network and Program

The SFPUC, in cooperation with its Partner Agencies,[1] has implemented a groundwater monitoring program since 2001 to evaluate groundwater and lake elevations and groundwater quality throughout the Westside Groundwater Basin, including both the North and South Basins and the portion of the Basin near Lake Merced. (Kennedy/Jenks 2012d)

A network of monitoring facilities consisting of 46 wells includes existing monitoring wells plus new monitoring wells that have been installed at Sites 1, 2, 5, 7, 8, 9, 10, 11, 12, 13, 15, and 16 (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). Several of the monitoring wells are "nested;" that is, multiple wells are located together in the same borehole and screened at different depths. In addition, two monitoring well clusters are used to collect groundwater level and groundwater quality data near the San Francisco Bay (see Figures 5.16-3 [Groundwater Quality Monitoring Network] and Figure 5.16-4

[1] Since the 1990s the SFPUC has worked cooperatively on Westside Groundwater Basin investigations, monitoring and coordinated studies with the Partner Agencies (SFPUC 2011b).

[Groundwater Elevation Monitoring Network]). Those wells that comprise the monitoring network in the North Westside Groundwater Basin are also shown on Figures 5.16-3 and 5.16-4.

The coastal monitoring network consists of five locations in San Francisco along the Pacific Coast extending from the western end of Golden Gate Park south to the vicinity of Lake Merced (South Windmill Replacement, Kirkham, Ortega, Taraval, and Zoo). Each monitoring location includes two to four individual monitoring wells completed at different depths to monitor groundwater levels and quality in the Shallow, Primary Production and Deep aquifers. Each well in the coastal monitoring network is sampled for water quality parameters that are indicative of the potential for seawater intrusion, including chloride, total dissolved solids (TDS), and electrical conductivity.

The lake-aquifer monitoring network around Lake Merced includes continuous monitoring of water levels in South Lake and a dedicated network of eight monitoring sites that include four groundwater monitoring well clusters (LMMW1, LMMW2, LMMW3, and LMPS MW) around Lake Merced that are screened in the Shallow, Primary Production, and Deep aquifers to provide data on lake-aquifer interactions. Each of these well clusters includes at least one well screened in the Shallow Aquifer. At some locations there are two wells completed in the Shallow Aquifer, with one well completed in the shallower part of the aquifer (designated with an “SS”) and one well completed in the deeper portion of the Shallow Aquifer (designated with an “S”). The remaining monitoring sites include monitoring wells screened in the Shallow Aquifer (LMMW4, LMMW7, LMMW8, and LMMW9). An additional well cluster (LMMW-5SS and 5S) is located near Pine Lake. Water levels in Lake Merced are monitored on a continuous basis, and additional monitoring is conducted on a periodic basis.

Three monitoring well clusters in the South Westside Groundwater Basin are used to collect groundwater level and groundwater quality data near the San Francisco Bay (Figures 5.16-3 and 5.16-4, Groundwater Quality Monitoring Network and Groundwater Elevation Monitoring Network, respectively). The “SFO” well cluster consists of two wells that were installed in the northern portion of SFO in 2006. These wells are identified as SFO-S and SFO-D: SFO-S is 74 feet deep and monitors the shallow groundwater zones; and SFO-D is 146 feet deep and monitors the Primary Production Aquifer. The “UAL” well cluster also consists of two wells that were installed in the southern part of SFO in 2003. These wells are identified as UAL MW13C and UAL MW13D: UAL MW13C is 146 feet deep and monitors the Primary Production Aquifer; and UAL MW13D is 41.5 feet deep and monitors the shallow groundwater zones. The southernmost monitoring well cluster was installed in 2006. The three wells in this cluster are identified as Burlingame-S, Burlingame-M, and Burlingame-D: Burlingame-S is 98 feet deep and monitors the shallow groundwater; Burlingame-M is 166 feet deep; and Burlingame-D is 280 feet deep and monitors the Primary Production Aquifer. (Kennedy/Jenks 2012e)

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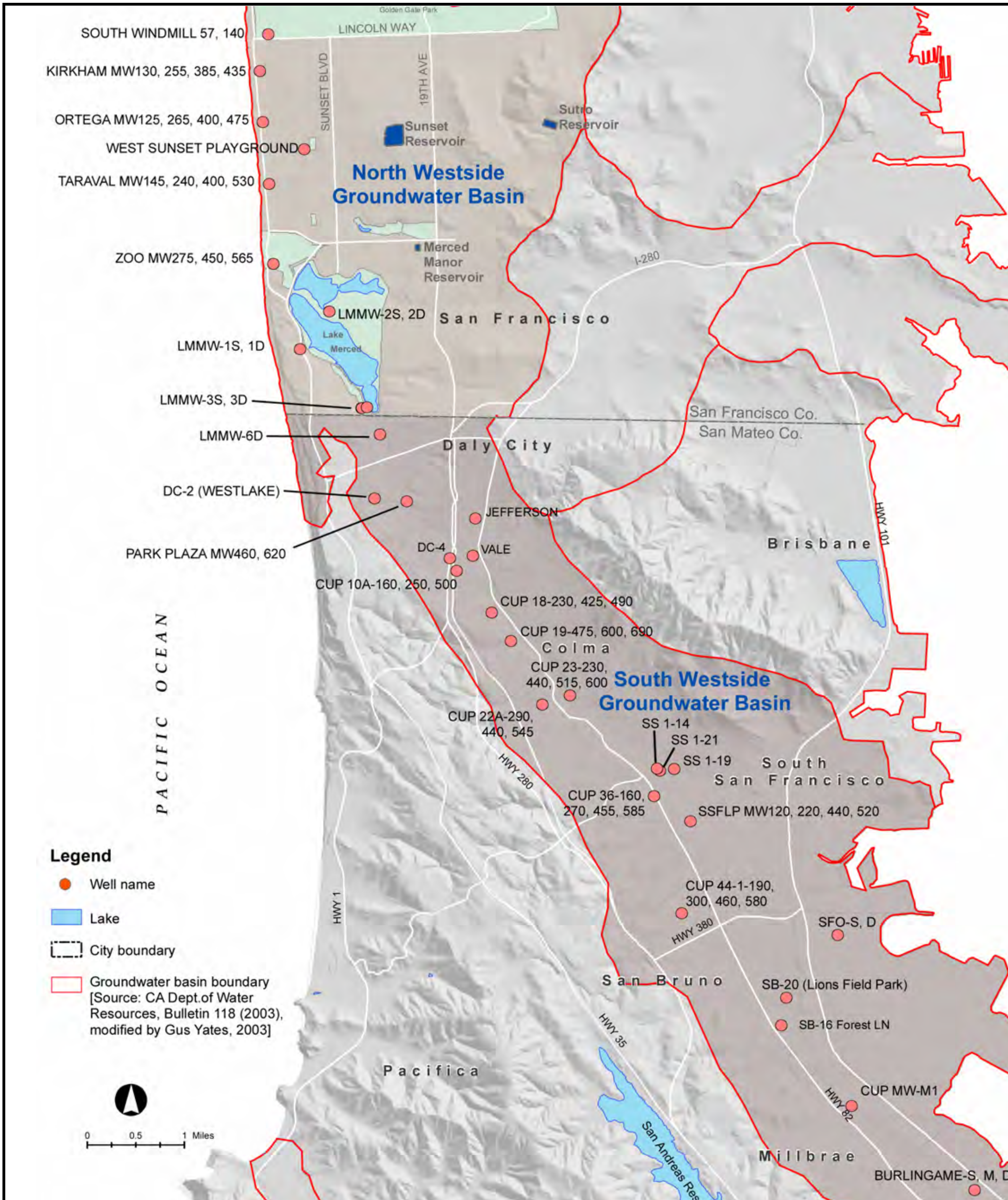

Groundwater Quality Monitoring Network

Regional Groundwater Storage and Recovery Project

Figure 5.16-3

Source: SFPUC 2012b

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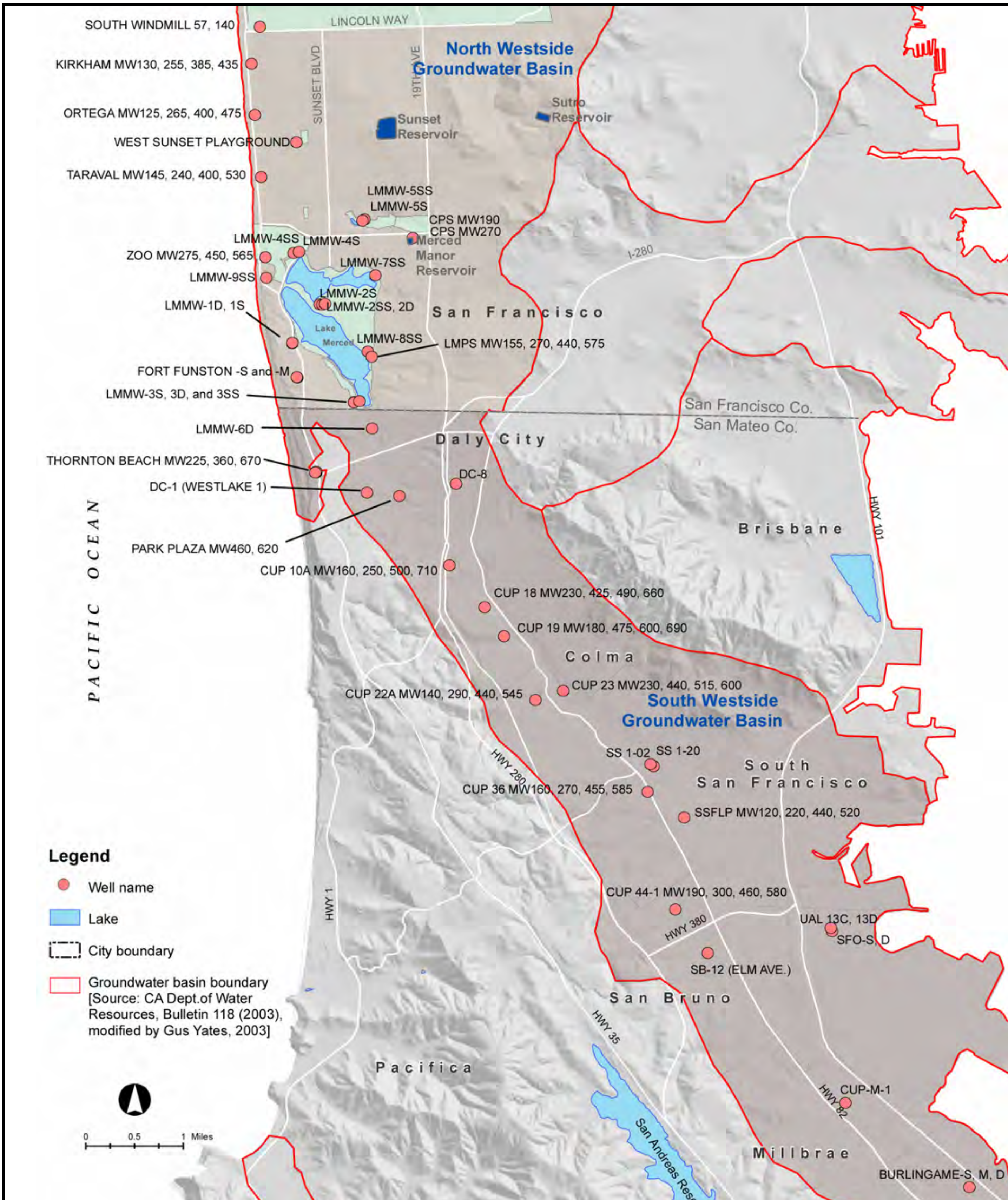

Groundwater Elevation Monitoring Network

Regional Groundwater Storage and Recovery Project

Source: SFPUC 2012b

Figure 5.16-4

Groundwater Levels and Flow Directions

North Westside Groundwater Basin

Prior to the early 1940s, water levels in the North Westside Groundwater Basin and in the northern portions of San Mateo County were above sea level, with a northwesterly gradient in the shallow and primary production aquifers (SFPUC 2005). Based on regular monitoring of groundwater levels in the North Westside Groundwater Basin since 2004, groundwater levels along the Pacific Ocean coast, north of Lake Merced, generally remain above sea level in the Shallow and Primary Production Aquifers, with the exception of Primary Production Aquifer groundwater levels in the vicinity of South Windmill location in Golden Gate Park where irrigation season groundwater levels have been below sea level (SFPUC 2011b). At the San Francisco Zoo, groundwater levels have, during drought periods, occasionally declined to levels slightly below sea level. At the South Windmill location, Primary Production Aquifer levels periodically decrease below sea level due to irrigation pumping at the South Windmill Replacement well.

In the southern portion of Lake Merced, Primary Production Aquifer groundwater levels in LMMW-3D have historically been below sea level, probably due to pumping in the adjacent South Westside Groundwater Basin. Primary Production and Deep Aquifer levels in the North Westside Groundwater Basin have historically decreased to below sea level at some locations, but since 2001 (Primary Production Aquifer) and 2004 (Deep Aquifer), when comprehensive monitoring began, were generally on the rise.

Groundwater levels generally remained stable or increased from 2004 through 2010 (SFPUC 2012e). The increase is likely due to decreased pumping from the groundwater basin including reduced golf club irrigation pumping in the vicinity of Lake Merced and reduced municipal pumping in the South Westside Groundwater Basin under the In-Lieu Recharge Demonstration Study (discussed below) (LSCE 2005). In 2010, the groundwater flow direction in the Shallow Aquifer of the North Westside Groundwater Basin was westerly and groundwater levels ranged from approximately 10 to 39 feet, pursuant to the North American Vertical Datum of 1988 (NAVD 88)[2]. North of Lake Merced, the groundwater flow direction in the Primary Production Aquifer was also westerly and groundwater levels ranged from approximately 3 to 77 feet NAVD 88. South of Lake Merced, the groundwater flow in the Primary Production Aquifer shifts to the south toward the South Westside Groundwater Basin, with groundwater levels dipping to approximately -15 feet NAVD 88 at LMMW-6D, the

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[2] Groundwater elevations are commonly referenced to the North American Vertical Datum of 1988 (NAVD 88) and/or the National Geodetic Vertical Datum of 1929 (NGVD 29). NAVD 88 was established in 1991 and is the most up-to-date and accurate datum. NGVD 29 was used by surveyors and engineers for most of the 20th century and is 2.8 feet lower than NAVD 88 in San Francisco and northern San Mateo County. The technical reports prepared in support of the GSR Project used both datums; therefore, for consistency, this EIR uses the same datum employed in a given technical report when discussing information obtained from that report. Mean sea level is equivalent to 0 feet NGVD 29, which is also equivalent to 2.8 feet NAVD 88.

southernmost groundwater monitoring well in the Primary Production Aquifer in the North Westside Groundwater Basin.

South Westside Groundwater Basin

Beginning in the 1950s and 1960s, groundwater levels in the South Westside Groundwater Basin declined to below sea level. This decline continued into the 1970s, after which groundwater levels stabilized at elevations of more than 100 feet below mean sea level (msl), resulting in vacated aquifer storage[3] of up to 75,000 acre-feet (af) in the Daly City, South San Francisco, and northern San Bruno areas (Kirker, Chapman & Associates 1972; LSCE 2005).

In 2005, groundwater elevations in the Primary Production Aquifer in the South Westside Groundwater Basin ranged from approximately -8 feet NAVD 88 immediately south of Lake Merced to -102 feet NAVD 88 in Daly City and -75 feet NAVD 88 in South San Francisco. At that time, groundwater flow in the vicinity of Lake Merced continued to be to the south; the steepest groundwater gradient was between Lake Merced and Daly City (LSCE 2006). On the bayside, groundwater levels in the Primary Production Aquifer beneath San Bruno were approximately -180 feet NAVD 88 in 2005.

The depth to groundwater in the South Westside Groundwater Basin is largest in the eastern area of Daly City and in San Bruno in the Primary Production Aquifer. Overall, the depth to groundwater in the Primary Production Aquifer ranges from 200 feet to 300 feet below ground surface in the Daly City area, within 50 feet to 100 feet of the ground surface in the California Water Service Company (Cal Water) service area, and about 260 to 270 feet below ground surface in the San Bruno area (SFPUC 2011b). At the southern portion of Lake Merced and immediately to the south, the groundwater flow direction in the Primary Production Aquifer is to the south and southeast towards Daly City. In these areas and further south, the depth can exceed 300 feet below ground surface, due largely to the effects of long-term pumping in the Daly City, Colma, South San Francisco, and San Bruno areas. The groundwater depressions caused by concentrated areas of long-term pumping induce flow locally towards those depressions.

In the South Westside Groundwater Basin, shallow groundwater is also present within shallow units overlying the Primary Production Aquifer. In the eastern portion of the Basin from South San Francisco southward to Burlingame, shallow groundwater generally flows east towards the Bay. Throughout this eastern portion of the Westside Basin, groundwater flow in the Deep Aquifer is also generally east toward the Bay. In the vicinity of San Bruno, groundwater extraction has created a depression in the groundwater levels. A flow divide near the south end of SFO separates the area where groundwater flows toward the pumping depression in San Bruno from the area where groundwater flows toward the Bay. The divide trends southwest from near the Millbrae exit on U.S.

[3] Vacated aquifer storage is the volume of groundwater which is estimated to have been present historically in the aquifer, but which is no longer present, usually due to pumping.

101; groundwater northwest of the divide is captured by the City of San Bruno wells. (Kennedy/Jenks 2012e)

In-Lieu Recharge Demonstration Study

The SFPUC and the Partner Agencies participated in the In-lieu Recharge Demonstration Study in the South Westside Groundwater Basin from October 2002 through April 2007 to study the effects of the groundwater recharge component of a conjunctive use program, in which the Partner Agencies received supplemental surface water from the SFPUC in-lieu of their normal groundwater pumping. The purpose of the Demonstration Study was to determine if this in-lieu recharge would result in an accrual of groundwater storage that would result in an increase in groundwater availability for pumping in dry years and for emergency supply when the regional water system supply may be reduced. (Kennedy/Jenks 2012a)

The SFPUC undertook groundwater monitoring throughout the South Westside Groundwater Basin and adjacent areas along the Pacific Coast and San Francisco Bay, before, during, and after the Demonstration Study to determine the extent to which groundwater levels and storage were affected. After approximately three years (from fall 2002 to spring 2005) of operating the Demonstration Study, the SFPUC reported that in-lieu recharge can be successfully accomplished by reducing pumping, resulting in increases in groundwater storage. As expected, monitoring results indicated that reduction of pumping by the Partner Agencies resulted in increased groundwater levels in the Primary Production Aquifer, where the Partner Agencies' wells are screened. (LSCE 2005)

During the In-lieu Recharge Demonstration Study, the SFPUC delivered approximately 20,000 af of supplemental surface water to the Partner Agencies in exchange for a reduction in their groundwater pumping. This 20,000 af has been credited to the SFPUC Storage Account. However, this water would not be withdrawn unless and until the GSR Project and the Operating Agreement are approved by the SFPUC and the Project wells are constructed to enable use of the water in storage (see explanation of the SFPUC Storage Account in Chapter 3, Project Description, Section 3.8.1 [Operating Agreement]). (Kennedy/Jenks 2012a)

Seawater Intrusion

Seawater intrusion refers to the migration of seawater into a freshwater aquifer and can occur when groundwater levels are lowered by pumping. Seawater intrusion becomes an environmental concern when the degradation of groundwater quality would make the groundwater potentially unsuitable for its identified use, or when inland surface water features are affected by the seawater, compromising habitats or uses of the surface water.

Two areas of the Westside Groundwater Basin are susceptible to seawater intrusion under certain conditions. One area is in the North Westside Groundwater Basin along the Pacific Coast, where the Shallow Aquifer is open to the ocean; this area is discussed below in Section 5.16.1.3 (Regional Groundwater Hydrology) under the sub-heading "Seawater Intrusion in the North Westside Groundwater Basin." The other is in the South Westside Groundwater Basin along San Francisco Bay.

Seawater Intrusion in the North Westside Groundwater Basin

In the North Westside Groundwater Basin, the Shallow Aquifer is in direct hydraulic connection with the Pacific Ocean between Lincoln Park (north of Golden Gate Park) and the San Francisco Zoo area, indicating a potential for seawater intrusion to occur in the Shallow Aquifer in this area. Although existing offshore seismic studies suggest that there might be some depositional or structural features in the offshore sediments that would preclude seawater intrusion directly from the ocean into the Primary Production and Deep Aquifers, the geologic information for this offshore area is not sufficient to conclusively make this determination (Kennedy/Jenks 2012c). Therefore, seawater intrusion into the Primary Production Aquifer as a result of direct hydraulic connection with the ocean is considered possible.

If seawater intrusion were to occur within the Shallow Aquifer, the Primary Production Aquifer could also be affected in areas where no clay layer separates the aquifers or where gaps are present in the clay layers that separate the aquifers, assuming a downward hydraulic gradient between the two aquifers. South of the Sunset area in western San Francisco, the -100-foot clay layer separating the Shallow Aquifer and the Primary Production Aquifer may protect the Primary Production Aquifer from seawater intrusion occurring in the Shallow Aquifer (if it were to occur). However, there are gaps in the -100-foot clay layer (as illustrated in Figure 5.16-2 [North-South Geologic Cross Section, Westside Groundwater Basin]), including one between the Taraval and San Francisco Zoo coastal groundwater monitoring locations (refer to Section 5.16.1.3 [Regional Groundwater Hydrology] under the sub-heading “Groundwater Monitoring Network and Program”). At these gaps the Shallow and Primary Production Aquifers could be hydraulically connected. North of the Sunset District, including Golden Gate Park, there are not pronounced or laterally extensive clay layers and the Shallow Aquifer and Primary Production Aquifers are merged, meaning that in this area the aquifers are hydraulically connected to a greater degree and can effectively be considered one aquifer. South of the San Francisco Zoo, in the vicinity of Lake Merced, the Serra Fault could act as a barrier to seawater intrusion as far north as the Great Highway, where the fault heads offshore. (LSCE 2010)

<u>Coastal Groundwater Levels</u>

Coastal groundwater levels measured in the coastal monitoring network, as described in Section 5.16.1.3 (Regional Groundwater Hydrology) under the sub-heading “Groundwater Monitoring Network and Program”, provide an indication of the potential for seawater intrusion to occur. In general, the potential for seawater intrusion is lower when coastal groundwater levels are above sea level. Although coastal groundwater levels that are below sea level indicate a higher potential for seawater intrusion, the occurrence of seawater intrusion would need to be confirmed through other means, such as groundwater quality monitoring.

Shallow Aquifer Coastal Groundwater Levels

Through 2010, groundwater levels in all Shallow Aquifer coastal monitoring wells have been consistently above sea level, except at the South Windmill Deepwell monitoring location (USGS

South Windmill MW-57). Groundwater levels in the Shallow Aquifer at the South Windmill monitoring location have varied as much as approximately 19 feet seasonally and have historically declined to below sea level by as much as 2 feet during the irrigation season. However, none of the groundwater levels were below sea level in 2010, likely because of reduced irrigation pumping at the South Windmill Deepwell facility (SFPUC 2011b).

Primary Production Aquifer Coastal Groundwater Levels

Primary Production Aquifer groundwater levels at the coastal monitoring locations have consistently remained above sea level, except for brief deviations below sea level at the San Francisco Zoo location. At the Kirkham location, the Primary Production Aquifer groundwater levels also show a seasonal variation that may be a response to pumping at the South Windmill Deepwell facility, with dry-season elevations as low as approximately 3 feet NAVD 88 in 2007. (SFPUC 2011b)

Continuous monitoring at the South Windmill Deepwell location (USGS South Windmill MW-140[4]) was not conducted in the Primary Production Aquifer until 2008; however, current monitoring indicates that Primary Production Aquifer groundwater levels at this location have declined to below sea level by as much as 20 feet during the irrigation season while rebounding to above sea level by as much as 13 feet during the wet season. Groundwater levels in the Primary Production Aquifer at the South Windmill location have not shown the same declining trend as groundwater levels in the shallower portion of the aquifer at this monitoring location. (SFPUC 2011b)

Deep Aquifer Coastal Groundwater Levels

Groundwater levels in the Deep Aquifer have periodically declined to below sea level at the Kirkham, Ortega, Taraval, and San Francisco Zoo monitoring locations (SFPUC 2011b). In August and September 2007, groundwater levels in the Deep Aquifer at the Kirkham location were briefly as much as -1 foot NAVD 88. At the Ortega monitoring location, groundwater levels in the Deep Aquifer were below sea level for parts of 2006 and 2007, with the deepest elevation of -5 feet NAVD 88; groundwater levels at this location have been on the rise and consistently above sea level since 2008. At the Taraval monitoring location, groundwater levels were below sea level for most of the period between August 2004 and January 2009, declining to a minimum of -9 feet NAVD 88 in September 2007. Since late 2009, Deep Aquifer groundwater levels at this location have been above sea level, reaching approximately 4 feet NAVD 88 by the end of 2010. Except for March and April 2006, Deep Aquifer groundwater levels at the San Francisco Zoo monitoring location were consistently below sea level between January 2004 and January 2009 due to

[4] Note that this well is screened at an elevation that corresponds to the upper part of the Primary Production Aquifer as it exists further to the south where it is separated from the Shallow Aquifer by a clay layer. However, the sand pack extends partially into the uppermost portion of the aquifer. (SFPUC 2011a)

pumping at San Francisco Zoo Well No. 5 and Daly City's municipal wells, with a minimum elevation of approximately -14 feet NAVD 88. Throughout 2010, Deep Aquifer groundwater levels at this location have been much higher, ranging from about -2 to 2 feet NAVD 88. (SFPUC 2011b)

Coastal Chloride Concentrations

With the exception of the South Windmill Deepwell monitoring location in the southwestern part of Golden Gate Park (discussed below), chloride concentrations in the coastal monitoring wells were less than 75 milligrams per liter (mg/L) between 2004 and 2011. The highest concentrations were detected at the San Francisco Zoo monitoring location, and observed concentrations over the six years of reported monitoring data for all four locations are relatively constant (SFPUC 2011b). These results indicate that seawater intrusion into the Shallow, Primary Production, and Deep Aquifers has not occurred despite long-term irrigation pumping at the zoo since the 1930s and in Golden Gate Park since the 1920s.

Between 2006 and 2010, chloride concentrations in the uppermost portion of the aquifer at the South Windmill monitoring location ranged from a low of 115 mg/L in April 2006 to a high of 193 mg/L in November 2009. Since 2009, chloride concentrations have decreased; the concentration in November 2011 was 154 mg/L. Chloride concentrations in the Primary Production Aquifer at the South Windmill monitoring location ranged from a low of 48 mg/L in October 2007 to a high of 70 mg/L in November 2009. Since 2009, chloride concentrations have decreased; the concentration in November 2011 was 59 mg/L.

Monitoring results indicate that the highest chloride concentration (393 mg/L) was detected in the November 2009 Shallow Aquifer groundwater sample from well LMMW-1S; this well is not part of the coastal monitoring network but is located between Lake Merced and the Pacific Ocean (SFPUC 2011b). As of November 2011, this concentration had declined to 260 mg/L. The maximum chloride concentration in the Primary Production Aquifer at the same location (LMMW-1D) was 105 mg/L. The cause of these high chloride concentrations is unknown. While the proximity of these wells to the Pacific Ocean (which is approximately 1,300 feet to the west) indicates that the ocean is a potential source, LMMW-1S is separated from the ocean by the Serra Fault, which acts as a barrier to seawater intrusion (Kennedy/Jenks 2012c). Further, groundwater level elevations in this well have historically exceeded 12 feet, NAVD 88, and the average pH of the groundwater at this location is 6.8, which suggests a freshwater source and is lower than the pH of seawater (about 7.8 to 8.4). In addition, this pH is lower than the values measured in other monitoring wells in the basin (7.2 to 8.6), and other chemical constituents are not typical of seawater (Kennedy/Jenks 2012c).

Seawater Intrusion in the South Westside Groundwater Basin

Because the South Westside Groundwater Basin is in contact with the San Francisco Bay, seawater intrusion is possible along the eastern edge of the basin. The Bay Mud observed along the eastern edge of the Basin may impede seawater intrusion. However, the Bay Mud may also contain connate[5] waters with high salinity. Because the Bay Mud was deposited in the San Francisco Bay, any connate water in the Bay Mud will have salinities similar to seawater, and it will be difficult to distinguish between the two. Flow of these connate waters into the South Westside Groundwater Basin would have an impact identical to seawater intrusion.

The northwestern-most edge of the South Westside Groundwater Basin is in contact with the Pacific Ocean. The section that is in contact with the Pacific Ocean is west of the Serra Fault. The Serra Fault, along with steeply dipping and offset beds of the Merced Formation, likely provides a barrier to seawater intrusion (LSCE 2010; Kennedy/Jenks 2012c). Therefore, the main portion of the South Westside Groundwater Basin is not susceptible to seawater intrusion from the Pacific Ocean.

Groundwater Levels Relative to Sea Level

Shallow groundwater zone

Groundwater levels for the shallow groundwater zone near the San Francisco Bay are obtained from the SFO-S, Burlingame-S, and UAL MW13D monitoring wells. Groundwater levels measured in these wells have been consistently at or above zero feet NAVD 88. Groundwater levels in the SFO-S monitoring well have been measured since November 2006 and are consistently found at approximately 2 feet NAVD 88. Groundwater levels in UAL MW13D have been measured since 2000 and are consistently between zero and 3 feet NAVD 88. Groundwater levels in Burlingame-S have been measured since November 2006 and seasonally fluctuate between approximately 1.5 and 4 feet NAVD 88. The groundwater levels in the Burlingame-S monitoring well show a slight declining trend.

Primary Production Aquifer

Groundwater levels for the Primary Production Aquifer near the bayside are obtained from the SFO-D and UAL MW13C monitoring wells. Groundwater levels measured in these wells have been consistently between -29 and -35 feet NAVD 88. Groundwater levels in well SFO-D have been measured since November 2006, and show minor fluctuation between -29 and -31 feet NAVD 88. Groundwater levels in well UAL MW13C have been measured since 2000, and fluctuate between approximately -32 and -35 feet NAVD 88.

Chloride Concentrations as an Indicator of Seawater Intrusion

Chloride concentrations are generally higher in the northern portion of the bayside and lower in the southern portion of the bayside.

[5] Connate waters are seawater trapped in a formation when the sediments are deposited.

The two monitoring wells in the northernmost SFO well cluster both show chloride concentrations above the secondary MCL[6] of 250 mg/L (SFPUC 2012e). Chloride concentrations in the shallow monitoring well SFO-S have ranged between 8,400 and 12,000 mg/L with an average concentration of 9,910 mg/L, and do not show an increasing trend. Chloride concentrations in the deeper monitoring well SFO-D are generally at or below 500 mg/L with the exception of a single measurement of 2,210 mg/L, and show no apparent trend. These concentrations suggest either connate water or seawater has intruded into the shallow groundwater at this site. The chloride concentrations in the Primary Production Aquifer at this site are above the secondary MCL.

The two monitoring wells in the UAL cluster both show chloride concentrations above the secondary MCL of 250 mg/L. In 2006, a sample from the shallow monitoring well MW13D showed a chloride concentration of 13,000 mg/L. In 2006 and 2007, samples collected from monitoring well MW13C in the Primary Production Aquifer showed chloride concentrations of 510 and 530 mg/L (WRIME 2007).

The three monitoring wells in the southernmost Burlingame cluster show relatively lower chloride concentrations compared to the other two well clusters. Chloride concentrations in the shallow well Burlingame-S have ranged between 110 and 518 mg/L and show an increasing trend. Chloride concentrations in the middle Burlingame-M monitoring well have ranged between 63 and 140 mg/L. Chloride concentrations in the deep well Burlingame-D have ranged between 41 and 140 mg/L. These concentrations suggest either seawater or saline connate waters may have intruded into the shallow aquifer at this site (SFPUC 2010a). Detected chloride concentrations from the remaining San Bruno wells are below the secondary MCL (SFPUC 2011b).

Groundwater Budget

A groundwater budget (also referred to as a water balance or hydrologic budget) is a measure of the balance between the quantity of water supplied to a groundwater basin and the amount leaving the basin (Todd 1980). Groundwater entering a groundwater basin is called an "inflow," and groundwater leaving the basin is called an "outflow." The volume of groundwater in a basin is called "groundwater storage," and storage changes as the respective quantities of groundwater inflow and outflow vary from season to season and from year to year.

In the Westside Groundwater Basin, inflow or recharge components of the groundwater basin include subsurface inflows from outside of the basin, recharge from precipitation, recharge from applied water (irrigation), recharge from surface water such as Lake Merced and Pine Lake, and recharge from leakage of sewer and water pipes (LSCE 2010). Outflow components include groundwater pumping, subsurface outflows to the Pacific Ocean, and discharge to Lake Merced. Lake Merced can either lose water to the

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[6] The U.S. EPA and Title 22 of the California Code of Regulations establish secondary Maximum Contaminant Limits (MCLs) to prevent drinking water that may appear colored or taste or smell bad, causing people to stop using water from their public water system These contaminants are not considered to present a risk to human health at the Secondary MCL, but are enforceable by the State nonetheless.

groundwater system or gain water and, therefore, can be considered a component of groundwater inflow or outflow, depending on lake and groundwater levels, which vary seasonally and annually. Pine Lake, on the other hand, discharges water to the groundwater system and would only be considered a component of the groundwater inflow.

The predicted average annual groundwater budget for the Westside Groundwater Basin under modeled existing conditions is shown in Table 5.16-2 (Modeled Annual Average Groundwater Budget for the Westside Groundwater Basin under Modeled Existing Conditions). As with all of the other modeling scenarios, the modeled existing conditions scenario includes a design drought for planning purposes (see Section 5.1 Overview, Section 5.1.6.1 [Westside Basin Groundwater Model]). This drought is longer than any experienced in the available historical record (1958-2005) and is largely responsible for the predicted overall negative change in annual average storage shown in Table 5.16-2.

The predicted annual decline in groundwater storage under modeled existing conditions is primarily due to the assumptions used for the hydrologic inputs to the modeling which are consistent with the design drought used in the PEIR (San Francisco Planning Department 2008). The design drought extends the 1976-77 drought. As a result, the modeling assumes a rainfall deficit over the 47-year modeling period of nearly 20 inches compared to the 1958-2005 sequence used in the HydroFocus 2008 No-Project Scenario (HydroFocus 2011). Over the duration of the HydroFocus 2008 No-Project Scenario there is little to no change in groundwater storage. Therefore, the hydrologic assumptions used for this EIR for modeled existing conditions provide a conservative analysis of groundwater storage (Kennedy/Jenks 2012b).

TABLE 5.16-2
Modeled Annual Average Groundwater Budget for the Westside Groundwater Basin under Modeled Existing Conditions

Inflow and Outflow Categories	Modeled Average Annual Inflow and Outflow Values (acre-feet per year [afy])[(a)]
Inflow from Surface Water to Groundwater	
Rain and irrigation water	14,034
Seepage from Lake Merced	846
Seepage from Golden Gate Park lakes	551
Inflow from San Francisco Bay and Ocean	12
Outflow from Groundwater to Surface Water	
Pumping of municipal and irrigation wells	-10,814
Outflow to San Francisco Bay and Ocean	-4,172
Seepage to Lake Merced	-960
Other Outflows	-94
Total	**-597**

Source: Kennedy/Jenks 2012b

Note:

(a) In this table, positive values represent water flowing into the groundwater basin (inflows), and negative values represent water flowing out of the groundwater basin (outflows).

Subsidence

Land subsidence is a gradual settling or sudden sinking of the Earth's surface due to subsurface movement of earth materials (Galloway et al. 1999). Land subsidence due to groundwater pumping can occur when groundwater levels are lowered and water drains out of clay layers that are within or between aquifers.

Subsidence can damage infrastructure, including pipelines, bridges, roads, railroads, and buildings, by causing them to crack during settling. Subsidence can also increase flooding or change drainage patterns by lowering the ground surface.

Subsidence either has not occurred in the Westside Groundwater Basin or insufficient monitoring information exists to document its occurrence (Fugro 2012b). No subsidence has been observed in land overlying the Westside Groundwater Basin, even though historical groundwater pumping has lowered the groundwater levels in portions of the Basin more than 200 feet (Fugro 2012b). Since the mid-1970s, pumping in the Westside Groundwater Basin has been between 6,000 and 8,000 acre-feet per year (afy) (LSCE 2010). These lowered groundwater levels from previous pumping have apparently not triggered any recognizable level of subsidence.

Groundwater Quality

Groundwater monitoring indicates that groundwater quality in the Westside Groundwater Basin generally meets drinking water standards according to the Maximum Contaminant Levels (MCLs) of the primary and secondary drinking water standards set by the California Department of Public Health (CDPH), with the exception of nitrate and volatile organic compounds (VOCs) in specific areas, and other secondary constituents in specific areas (i.e., pH, color, hardness, turbidity, conductivity, total dissolved solids [TDS], sulfate, chloride, manganese, and iron) (Kennedy/Jenks 2012e, Kennedy/Jenks 2012g). Refer to Section 5.16.2 (Regulatory Framework) for a discussion of primary and secondary drinking water standards, MCLs, and fluoridation.

Table 5.16-3 (Range of Existing Ambient Groundwater Quality for Selected Constituents in the Westside Groundwater Basin) provides the range of existing water quality for selected constituents from 2002 to 2011, as identified in the SFPUC 2011 annual monitoring report, together with the primary and secondary MCLs for these constituents, if they have been established. (SFPUC 2012e)

TABLE 5.16-3

Range of Existing Ambient Groundwater Quality for Selected Constituents in the Westside Groundwater Basin (mg/L)[(a), (b)]

Constituent	Range of Existing Water Quality[(c),(d)]		Primary MCL	Secondary MCL
	North Westside Groundwater Basin	South Westside Groundwater Basin		
Chloride	15 to 393	20 to 14,000	None	250
Iron	Non-detect to 5.07	Non-detect to 14.7	None	0.3
Manganese	Non-detect to 0.63	Non-detect to 1.71	None	0.05
Nitrate (as NO_3)	Non-detect to 65	Non-detect to 140	45	None
Sulfate	0.8 to 122	Non-detect to 1,200	None	250
Total Dissolved Solids (TDS)	129 to 1,305	128 to 21,200	None	500

Source: SFPUC 2012e

Notes:

(a) mg/L is milligrams per liter.

(b) Groundwater from municipal wells located in areas with higher nitrate concentrations is blended with SFPUC surface water prior to distribution; the resulting blend fully meets all Primary MCLs and Secondary MCLs (Kennedy/Jenks 2012e, Daly City 2012). Sample results are taken from throughout the Westside Groundwater Basin including shallow monitoring wells and monitoring wells adjacent to San Francisco Bay. Sample results do not include the Thornton Beach Monitoring Well or Fort Funston Monitoring Well located west of the Serra Fault, because those monitoring wells are not indicative of water quality in the central part of the Basin where the proposed Project would be located.

(c) Sample results reported as anomalous or questionable in the 2011 Annual Monitoring Report (SFPUC 2012e) were not included in the range of existing water quality.

(d) Sample results are from 2000 to 2011.

Monitoring data indicate isolated occurrences of elevated nitrate concentrations in groundwater above the primary drinking water MCL of 45 mg/L in portions of Daly City and South San Francisco, but not in the Colma or San Bruno areas. The extent of nitrate concentrations may at least be partially attributed to past agricultural fertilizer applications and possibly to past confined animal facilities such as stockyards. In the Daly City area, data available since 2000 show nitrate concentrations ranging up to 131 mg/L, but most sampling indicated concentrations range from 20 to 50 mg/L in supply wells perforated in the Primary Production Aquifer. In the South San Francisco area, data since 2000 show nitrate concentrations ranging up to 120 mg/L, with most sampling indicating concentrations from 40 to 80 mg/L in the upper portion of the Primary Production Aquifer. In the lower portion of the Primary Production Aquifer, nitrate concentrations decrease, often to levels at or below 1 mg/L (Kennedy/Jenks 2012e). (Note that groundwater from municipal wells located in areas with higher nitrate concentrations is blended with

SFPUC surface water prior to distribution; the resulting blend fully meets all drinking water standards (Kennedy/Jenks 2012e; Daly City 2012).

Based on sampling results, common contaminants, such as volatile organic compounds (VOCs), have rarely been found in the Primary Production and Deep Aquifers in the Westside Groundwater Basin (Kennedy/Jenks 2012e, Kennedy/Jenks 2012g). In a few cases, contaminants have reached groundwater, and the constituents have been detected in the shallow water-bearing zones approximately 30 to 50 feet below ground surface. The shallow water-bearing zones are underlain by low permeability fine-grained materials, separating the shallow zones from the Primary Production and Deep Aquifers. (Kennedy/Jenks 2012e)

The VOCs tetrachloroethylene (PCE) and trichloroethylene (TCE) have been detected in the Primary Production and Deep Aquifers at monitoring wells near Sites 1 and 11 in samples taken approximately 240 to 580 feet below ground surface. The source of the VOCs has not been identified (Kennedy/Jenks 2012g). In October 2012, the monitoring wells at Sites 1 and 11 were resampled. No VOCs were detected at Site 1, indicating that the earlier detections may not be representative of groundwater quality at Site 1 (SFPUC 2013c). VOCs were detected at Site 11, and the potential presence of these VOCs is under review by the SFPUC.

Information on the quality of groundwater in the South Westside Groundwater Basin is also available from the studies performed as part of the Groundwater Ambient Monitoring and Assessment (GAMA) program. The GAMA program is a comprehensive assessment of statewide groundwater quality implemented by the State Water Resources Control Board (SWRCB) in coordination with the U.S. Geological Survey (USGS) and Lawrence Livermore National Laboratory. The South Westside Groundwater Basin was included in a 2007 GAMA study as part of the investigation of the San Francisco Bay study unit, which includes portions of San Francisco, San Mateo, Santa Clara, and Alameda counties. Between April and June of 2007, the GAMA program included an assessment of groundwater quality in the San Francisco Bay study unit through sampling of 79 wells, 11 of which were located in or near the South Westside Groundwater Basin. (Ray et al. 2009)

As part of the GAMA study, groundwater samples were analyzed for a large number of organic constituents, including VOCs, pesticides, pharmaceutical compounds, and potential wastewater-indicator compounds. Groundwater samples were also analyzed for constituents of special interest (perchlorate and N-nitrosodimethylamine [NDMA]), naturally occurring inorganic constituents (e.g., nutrients, major and minor ions, trace elements), and radioactive constituents and microbial indicators.

The study was designed to provide an assessment of untreated groundwater quality. Although regulatory thresholds apply to treated water rather than untreated groundwater, in order to provide some context for the groundwater results, the GAMA report compared the concentrations of constituents measured in the untreated groundwater with regulatory limits. (Ray et al. 2009)

VOCs were detected in five of the 11 wells within the South Westside Groundwater Basin. All of the detections of VOCs were below health-based[7] thresholds, and most were less than one-tenth of the threshold values. Pesticides, pharmaceutical compounds, and wastewater indicator compounds were not detected in any of the 11 wells within the South Westside Groundwater Basin. Perchlorate was detected in seven of the 11 wells and NDMA in four of the wells. All detections of perchlorate and NDMA were below established thresholds. (Ray et al. 2009)

5.16.1.4 Groundwater-Surface Water Interactions

Lake Merced

This 300-acre freshwater lake is the largest freshwater lake in San Francisco and is composed of four individual, but connected, water bodies (North Lake, South Lake, East Lake, and Impound Lake). Lake Merced is located in southwestern San Francisco, approximately 0.25 mile east of the Pacific Ocean (see Figure 5.16-1 [Surface Water Hydrology]). The lake is incised into the upper portion of the Shallow Aquifer and is hydraulically connected to that aquifer (see Figure 5.16-2 [North-South Geologic Cross Section, Westside Groundwater Basin]) (Kennedy/Jenks 2012d). Previous investigations have shown that the lake is essentially an exposed part of the water table that defines the upper boundary of the Shallow Aquifer (LSCE 2002; 2004).

North and East Lakes, which are joined by way of a narrow channel, are almost completely separated from South Lake by natural or constructed barriers; however, a conduit connects South and North Lakes at an elevation of 3.35 feet City Datum[8]. Therefore, when the lake level drops below the conduit, North and South Lakes no longer have direct hydraulic connection and typically exhibit different lake levels. When the lake elevation in North and South Lakes is sufficiently higher than the bottom of the conduit, i.e., approximately 4 feet City Datum, water can freely flow through the conduit between the two lakes. South and Impound Lakes are also partially separated by a low berm; flow between these lakes is restricted below an elevation of approximately 4.3 feet. (Kennedy/Jenks 2012d)

Lake Merced does not currently have a natural outlet to the Pacific Ocean, but discharges instead to the Vista Grande Drainage Canal, which is a Daly City stormwater channel that serves a 2.5-square-mile basin within Daly City and which discharges to the Pacific Ocean in the vicinity of Fort Funston (Daly City 2011). Lake Merced discharges to the Vista Grande Drainage Canal at a spillway located near the

[7] The GAMA study refers to "health-based" thresholds which include thresholds promulgated by the U.S. EPA and the CDPH, including primary MCLs, Action Levels, Notification Levels, Treatment Techniques, Lifetime Health Advisory Levels, and Risk Specific Dose 5 Levels.

[8] City Datum is a measurement system that has been used at Lake Merced since at least 1926 and is used throughout this document for Lake Merced water levels. The City Datum does not represent the depth of the lake. An elevation of 0 feet City Datum is equal to 11.37 feet above mean sea level (NAVD 88) and 8.57 NGVD 29. Since mean sea level is equivalent to 0 feet NGVD 29, a lake level of -8.57 City Datum is equal to mean sea level, and negative lake elevations above this level are not below mean sea level.

midpoint of the southwest bank of South Lake at an elevation of 13 feet City Datum (Kennedy/Jenks 2012d). The spillway is a 30-inch-diameter pipe that connects to the existing Daly City Tunnel immediately downstream of the tunnel connection to the Vista Grande Drainage Canal. This spillway limits the operational level of the lake to 13 feet City Datum.

The bottom elevation of each individual lake varies. The bottom of the two largest lakes, South Lake and North Lake, are at elevations of approximately -17 and -15 feet City Datum, respectively (EDAW/Talavera & Richardson 2003). East Lake and Impound Lake are smaller and shallower; the bottoms of these lakes are at elevations of approximately -11 and -6 feet City Datum, respectively.

Existing Uses of Lake Merced

Lake Merced supports numerous recreational activities, including boating and fishing as well as other uses managed by the San Francisco Recreation and Park Department (SFRPD), as described in Section 5.11, Recreation. The SFPUC also maintains Lake Merced as a nonpotable emergency water supply for the City to be used for firefighting or sanitation purposes if no other sources of water are available (SFPUC 2011a). In the event of a major disaster (i.e., catastrophic earthquake), Lake Merced water could be pumped into the City's drinking water distribution system to maintain firefighting, basic sanitary (e.g., toilet flushing), and other critical needs. In the event of such an emergency, residents would be directed to boil tap water before consuming it.

Historical Water-level Fluctuations and Water Additions

Historically, Lake Merced was fed by a combination of groundwater, surface water from local streams and springs, direct precipitation, and occasional saltwater inputs from the ocean. Urbanization during the 1900s resulted in the development of the lake's watershed, which rerouted streams out of the lake and closed it off from the ocean. The lake has historically experienced water-level declines due to rerouting of the natural streams and springs; closing the lake off from the ocean; diversions of stormwater runoff to the City's combined sewer system that previously discharged to the lake; drought conditions; and regional and local groundwater pumping. Increases in the amount of impervious surfaces within San Francisco have also reduced natural recharge to the Shallow Aquifer. Lake Merced is now replenished primarily by direct precipitation, limited runoff from immediate adjacent areas, periodic overflows of the Vista Grande Drainage Canal, and shallow groundwater inflows. As a result, lake levels are sensitive to annual changes in precipitation and can be slow to recover from drought conditions.

Prior to 1935 (before the completion of the Hetch Hetchy water system), the lake was used for municipal water supplies. Lake levels typically ranged from -10 to 0 feet City Datum, but increased to over 13 feet City Datum by the late 1930s and early 1940s after water deliveries from the Hetch Hetchy water system began. However, water levels began to decline again in the 1940s. During the 1940s to late 1950s, lake elevations varied between 8 and 13 feet City Datum. Between the late 1950s and early 1980s, lake levels experienced a long-term declining trend, with lake elevations ranging between 4 and 10 feet City Datum. The reasons for the overall decline in lake levels between the 1950s and 1980s are reported to be drought, increased municipal groundwater pumping in the Westside

Groundwater Basin, and diversion of runoff into the City's combined sewer system due to increased urbanization. (Kennedy/Jenks 2012d)

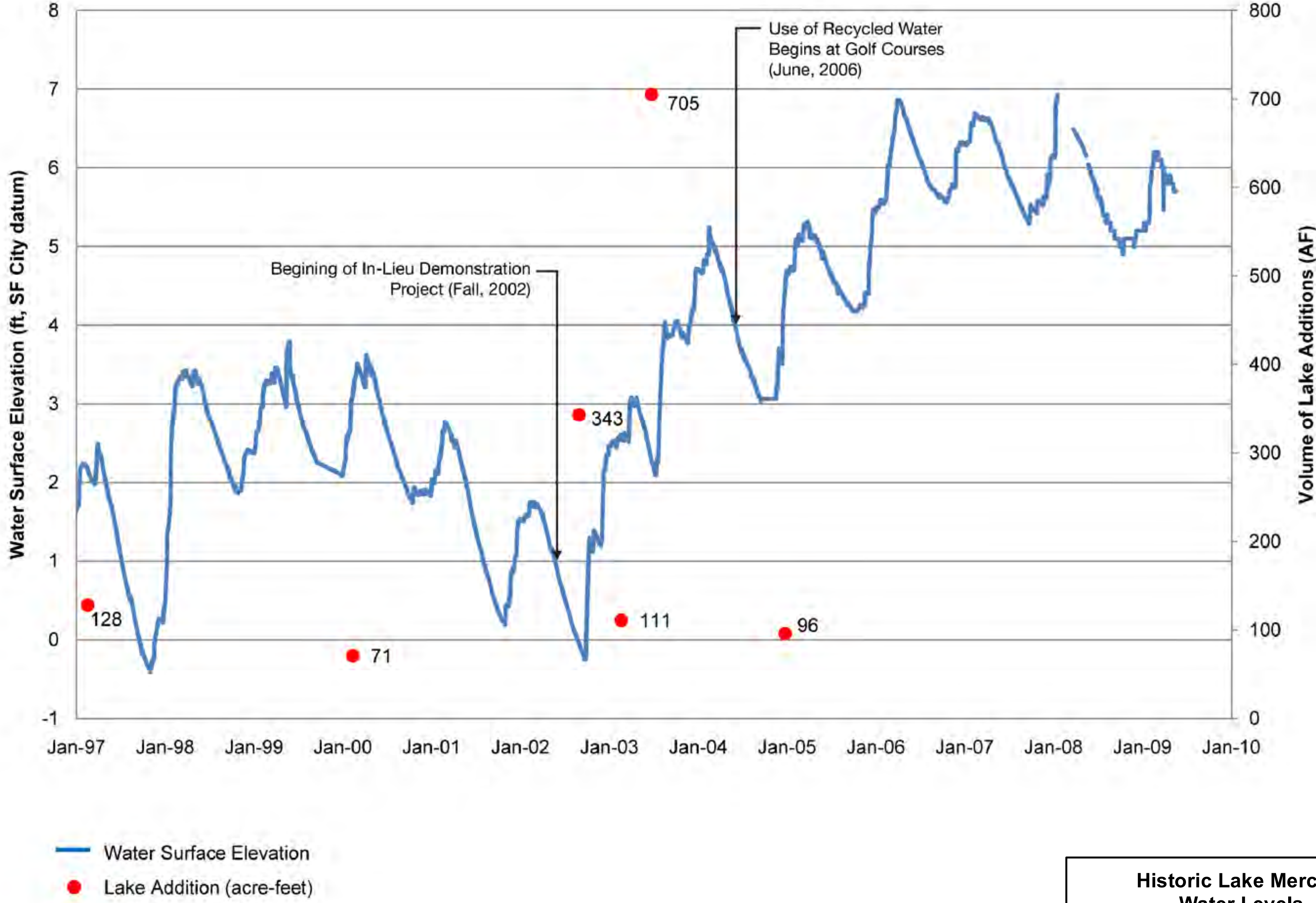
During the late 1980s and early 1990s, Lake Merced water levels declined well below historical averages. The lowest water level observed was about -3.2 feet City Datum in 1993 after the major drought of the late 1980s and early 1990s. Since that time, the lake levels have steadily risen as a result of above-average precipitation, SFPUC water additions to the lake between 2002 and 2005, reduced irrigation pumping at the Lake Merced-area golf courses as a result of recycled water deliveries, and reduced municipal groundwater pumping as a result of the SFPUC's In-lieu Recharge Demonstration Study (see Figure 5.16-5 [Historic Lake Merced Water Levels]). Since 2006, lake levels have consistently remained between about 5 and 7 feet City Datum. In 2009, the lake level ranged from approximately 4.9 to 6.9 feet City Datum. As of June 2009, the lake level was 5.7 feet City Datum. (Kennedy/Jenks 2012d)

Groundwater Interactions

As stated above, Lake Merced is incised in the Shallow Aquifer, and the lake surface is essentially considered an exposed part of the water table. This hydraulic connection was further demonstrated by groundwater monitoring conducted during the SFPUC's water additions in 2002 and 2003, when 70 to 80 percent of the volume of water additions contributed to lake storage and the remaining 20 to 30 percent contributed to the net outflow to groundwater and evaporative losses during the water addition periods. (Kennedy/Jenks 2012d)

Currently, the direction of groundwater flow in the unconfined Shallow Aquifer in the vicinity of, and north of, Lake Merced is predominantly toward the west. However, in the southern portion of Lake Merced, groundwater flow in this aquifer is more to the southwest. The general direction of groundwater flow in the underlying Primary Production Aquifer exhibits a more pronounced north-to-south flow direction from the southern portion of the Lake Merced area towards the Daly City area, probably due to greater pumping stresses in these aquifers to the south. This results in lower groundwater levels in the Shallow Aquifer at the southern portion of Lake Merced, indicating that there is a higher net outflow of lake water to the groundwater in South and Impound Lakes, and more inflow of groundwater to Lake Merced in North and East Lakes. (Kennedy/Jenks 2012d)

A 2009 aquifer test conducted on the Lake Merced Pump Station Test Well, completed in the Primary Production Aquifer, demonstrated that in the vicinity of Lake Merced, the lowermost portion of the Primary Production Aquifer exhibits characteristics of a confined aquifer (Kennedy/Jenks 2012d). The aquifer test also demonstrated that the Shallow Aquifer is unconfined and hydraulically separated from the lowermost portion of the Primary Production Aquifer by multiple confining layers.



Historic Lake Merced Water Levels

Regional Groundwater Storage and Recovery Project

Figure 5.16-5

Source: Kennedy/Jenks 2010a

Lake Merced Water Quality

Regulatory Considerations

As described in more detail in Section 5.16.2 (Regulatory Framework), the RWQCB has identified the following existing beneficial uses for Lake Merced: body-contact recreation (fishing), noncontact recreation, warm freshwater habitat, cold freshwater habitat, fish spawning, and wildlife habitat. Potential beneficial uses include municipal and domestic supplies. The RWQCB has established water quality objectives that are designed to be protective of beneficial uses. In addition, in 2007, the RWQCB listed Lake Merced as an impaired water body for dissolved oxygen and pH because of a listing made by the U.S. EPA (SWRCB 2011), despite a request by the SFPUC not to list Lake Merced based on existing water quality data (RWQCB 2009a). The listing does not identify a source for the impairment.

SFPUC's Existing Water Quality Monitoring Program

To monitor lake health, the SFPUC monitors a broad range of water quality constituents at various depths within Lake Merced on a quarterly basis at four locations: North, Northeast, South–Pistol Range, and South–Pump Station (Kennedy/Jenks 2010a). The sampling is conducted between three and eight times per year, but is typically conducted quarterly. For the majority of the parameters, samples at each location are collected at various depths, starting at the lake surface, and decreasing at five-foot intervals to the lake bottom. Table 5.16-4 (Lake Merced Water Quality Data and Basin Plan Water Quality Objectives) shows the range of values for each constituent measured between 1997 and 2009, as well as the corresponding water quality objectives provided in the *Water Quality Control Plan for the San Francisco Bay Basin* (Basin Plan, further discussed under Section 5.16.2 [Regulatory Framework]). A previous water quality evaluation (Kennedy/Jenks 2010a) identified seven water quality parameters that represent lake health; these parameters can be grouped as follows:

- Dissolved oxygen, which is required for fish habitat and healthy biological processes.
- Secchi depth, which is a measurement of lake clarity, and can be affected by algae production and suspended solids.
- Algae, total available nitrogen and nitrogen-to-phosphorous ratio (N:P), which are indicators of algal production and nutrients, both of which affect long-term lake health.
- Total coliform and Escherichia coli (E. coli), both of which are indicators of pathogenic microorganisms and fecal contamination.

Based on a review of these parameters, the previous water quality evaluation (Kennedy/Jenks 2010a) determined that the water quality of Lake Merced remained relatively constant from 1997 to 2009 and that there was a slight improvement in lake clarity (secchi depth). Also, during the 1997 to 2009 sampling period, no substantial changes in algal biomass levels occurred, although there were periodic increases in concentration due to algae blooms. Dissolved oxygen levels remained above the warmwater habitat criterion of 5 mg/L and the coldwater habitat criterion of 7 mg/L for the majority of the data set. However, dissolved oxygen levels were determined to be affected by periods of weak stratification[9], and there were episodes of dissolved oxygen lower than 5 mg/L during the summer and late fall in the deeper portions of the lake. Average pH levels never exceeded the freshwater criterion of 8.5 during the 1997 to 2009 sampling period.

TABLE 5.16-4
Lake Merced Water Quality Data and Basin Plan Water Quality Objectives

Parameter	Units	Range in Values, 1997 – 2009	Basin Plan Water Quality Objective
Algal biomass	Micrograms per liter (µg/L)	402-6,705	Waters shall not contain biostimulatory substances such as nitrogen and phosphorous in concentrations that would promote aquatic growths to the extent that the growths would cause nuisance or adversely affect beneficial uses. Adverse effects are indicated by irregular and extreme levels of chlorophyll a or phytoplankton blooms.
Alkalinity	mg/L	136-230	None
Ammonium	mg/L	Not detected to 0.65	None
Bromide	mg/L	0.22-0.34	None
Chloride	mg/L	58-98	Controllable water quality factors shall not increase the total dissolved solids or salinity of the water so as to affect any designated beneficial uses, particularly fish migration and estuarine habitat.
Chlorophyll	µg/L	4.7-100	Waters shall not contain biostimulatory substances such as nitrogen and phosphorous in concentrations that would promote aquatic growths to the extent that the growths would cause nuisance or adversely affect beneficial uses. Adverse effects are indicated by irregular and extreme levels of chlorophyll a or phytoplankton blooms.
Specific conductance	µmhos/cm	431-715	Controllable water quality factors shall not increase the total dissolved solids or salinity of the water so as to affect any designated beneficial uses, particularly fish migration and estuarine habitat.

[9] Lake stratification is the separation of a lake into layers. The amount of lake stratification can vary over the day, as well as seasonally, depending on a number of factors.

TABLE 5.16-4
Lake Merced Water Quality Data and Basin Plan Water Quality Objectives

Parameter	Units	Range in Values, 1997 – 2009	Basin Plan Water Quality Objective
Dissolved oxygen	mg/L	0.1-12.2	• Warmwater habitat: 7.0 mg/L • Coldwater habitat: 5.0 mg/L • The median dissolved oxygen level shall not be less than 80 percent saturation for three months.
E. Coli	CFU/100 mL	2.0-100	• Moderately used areas: 298 • Lightly used areas: 406 • Infrequently used areas: 576
Fluoride	mg/L	0.22-0.68	None
Hardness	mg/L	140-230	None
Iron	mg/L	Not detected to 0.14	None
Lead	µg/L	0.03-0.81	4-day average: 2.5 1-hour average: 2.4
Manganese	mg/L	0.02-0.3	None
MTBE	µg/L	Not detected to 1.9	None
Nitrate	mg/L	Not detected to 0.62	Waters shall not contain biostimulatory substances such as nitrogen and phosphorous in concentrations that would promote aquatic growths to the extent that the growths would cause nuisance or adversely affect beneficial uses. Adverse effects are indicated by irregular and extreme levels of chlorophyll a or phytoplankton blooms.
Orthophosphate	mg/L	Not detected to 0.2	Waters shall not contain biostimulatory substances such as nitrogen and phosphorous in concentrations that would promote aquatic growths to the extent that the growths would cause nuisance or adversely affect beneficial uses. Adverse effects are indicated by irregular and extreme levels of chlorophyll a or phytoplankton blooms.

TABLE 5.16-4
Lake Merced Water Quality Data and Basin Plan Water Quality Objectives

Parameter	Units	Range in Values, 1997 – 2009	Basin Plan Water Quality Objective
Oxidation-reduction potential	mV	29-543	None
pH	–	6.8-8.8	• The pH shall not be depressed below 6.5 or raised above 8.5. • Controllable water quality factors shall not cause changes greater than 0.5 units in normal ambient pH levels.
Plankton	NU/mL	17-2,511	Waters shall not contain biostimulatory substances such as nitrogen and phosphorous in concentrations that would promote aquatic growths to the extent that the growths would cause nuisance or adversely affect beneficial uses. Adverse effects are indicated by irregular and extreme levels of chlorophyll a or phytoplankton blooms.
Secchi depth (lake clarity)	feet	1.0-3.0	None
Sulfate	mg/L	6.5-16	None
Temperature	°F	50-72	The temperature of any coldwater or warmwater freshwater habitat shall not be increased by more than 5 °F above the natural receiving water temperature.
Total coliform	MPN/100 mL	109-2,420	• Municipal Supply: geometric mean less than 100 • Water Contact Recreation: median less than 240 and no sample greater than 10,000
Total dissolved solids	mg/L	276-458	Controllable water quality factors shall not increase the total dissolved solids or salinity of the water so as to affect any designated beneficial uses, particularly fish migration and estuarine habitat.
Total Kjeldahl nitrogen	mg/L	Not detected to 28.2	Waters shall not contain biostimulatory substances such as nitrogen and phosphorous in concentrations that would promote aquatic growths to the extent that the growths would cause nuisance or adversely affect beneficial uses. Adverse effects are indicated by irregular and extreme levels of chlorophyll a or phytoplankton blooms.

TABLE 5.16-4
Lake Merced Water Quality Data and Basin Plan Water Quality Objectives

Parameter	Units	Range in Values, 1997 – 2009	Basin Plan Water Quality Objective
Total organic carbon	mg/L	Not detected to 16.4	None
Total phosphorous	mg/L	Not detected to 0.26	Waters shall not contain biostimulatory substances such as nitrogen and phosphorous in concentrations that would promote aquatic growths to the extent that the growths would cause nuisance or adversely affect beneficial uses. Adverse effects are indicated by irregular and extreme levels of chlorophyll a or phytoplankton blooms.
Turbidity	NTU	2.5-33	Increases from normal background light penetration or turbidity relatable to waste discharge shall not be greater than 10 percent in areas where natural turbidity is greater than 50 NTU.

Sources: Kennedy/Jenks 2010a; RWQCB 2011

Notes:

° C = degrees Celsius
F = degrees Fahrenheit
μmhos/cm = micromhos per centimeter
μg/L = micrograms per liter
mL = milliliters
mg/L = milligrams per liter
MPN = most probably number; mV = millivolts
NU/mL = natural units per milliliter
NTU = Nephelometric Turbidity Units
CFU = Colony-forming Units.

Lake Level Water Quality Analysis Conducted for the EIR

Existing water quality data from 1997 to 2009 were reviewed as part of this EIR analysis to identify any potential relationships between lake levels, stratification, and water quality. This analysis considered water quality data collected at various depths (lake surface, 10-foot depth, and lake bottom) and compared the data to lake levels at the time of sampling. During the monitoring period, lake levels ranged from approximately 0 to 7 feet City Datum, with the minimum level of 0 feet City Datum occurring in 1998 and 2003, prior to conducting the In-lieu Recharge Demonstration Study discussed above. The analysis focused on the following constituents and processes, as they are the primary drivers of ecosystem health, eutrophication,[10] biogeochemistry,[11] and the suitability of the lake for the Basin Plan's identified beneficial uses of freshwater habitat, recreation, and, potentially, municipal water supply:

- **Dissolved oxygen:** Dissolved oxygen is critical to the survival of aquatic species such as fish and invertebrates, and is an indicator of the lake's overall ecological health. Dissolved oxygen is affected by (and can in turn affect) a broad range of drivers such as external pollution inputs, internal loads of certain nutrients, mixing, and primary production[12] (described below). Low dissolved oxygen levels limit habitat for aquatic organisms and can contribute to internal nutrient loading (the release of ammonia, orthophosphates, and other compounds) from bottom sediments.
- **Algal biomass and chlorophyll:** Algal biomass and chlorophyll are indicators of the levels of primary productivity in the lake. Primary productivity is the conversion of inorganic nutrients such as nitrogen and phosphorus into organic biomass through uptake by organisms such as algae and cyanobacteria. Algae and other primary producers can increase dissolved oxygen during the day due to photosynthesis, and take up dissolved oxygen at night through respiration. In addition, the decomposition of dead algae uses dissolved oxygen and can exacerbate eutrophication.
- **Secchi depth:** Secchi depth is an indicator of turbidity (i.e., the cloudiness of the water) that can also be empirically linked to algal biomass/chlorophyll concentrations. Low secchi depths (high turbidity) can indicate the presence of organic and inorganic suspended solids that influence dissolved oxygen and nutrient levels. In general, areas with low secchi depths are considered aesthetically unappealing.
- **Nitrogen and phosphorus:** Nitrogen and phosphorus are the main nutrients that drive eutrophication and primary production in Lake Merced. They enter the lake primarily through external stormwater and internal nutrient cycling. Previous studies have shown that groundwater inflow to the lake introduces significant amounts of nitrogen (Yates et al. 1990). High levels of nitrogen and phosphorus can contribute to blooms of algae and cyanobacteria within a lake. At Lake Merced, nitrogen is measured as nitrate, ammonia/ammonium, and total Kjeldahl nitrogen (the sum of organic nitrogen and ammonia/ammonium). This analysis focuses on inorganic nitrogen (nitrate and ammonia/ammonium). Phosphorus at Lake Merced is measured as orthophosphate and total phosphorus; the former is considered in this analysis.

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[10] The process by which a body of water acquires a high concentration of nutrients, especially phosphates and nitrates, which can promote excessive growth of algae.

[11] The scientific discipline that involves the study of the chemical, physical, geological, and biological processes and reactions that govern the composition of the natural environment.

[12] Primary production is the production of organic matter from inorganic carbon sources, generally through photosynthesis. Through the process of photosynthesis, plants, and algae in lakes capture energy from light and use it to combine carbon dioxide and water to produce carbohydrates and oxygen.

- **pH:** The pH of a water body describes its acidity or alkalinity on a scale of 0 to 14, where 7 is neutral. Water bodies with a pH of less than 7 are acidic and water bodies with a pH above 7 are alkaline or basic. The pH level is influenced by a broad range of factors, including basin geology, watershed runoff, bacterial respiration/decomposition of organic matter, and primary productivity (more productive ecosystems tend to have higher pH levels).

The EIR investigation focused on three constituents, dissolved oxygen, orthophosphate, and ammonia, to evaluate whether lower lake levels would lead to decreased (less frequent, weaker, shorter in duration) stratification and increased mixing within the lake (see Appendix K [Lake Merced Water Quality Data and Graphs]). Increased mixing affects water quality in two primary ways:

- It brings surface water with generally higher dissolved oxygen levels into contact with hypoxic (less than 5 mg/L dissolved oxygen) or anoxic (less than 2 mg/L dissolved oxygen) bottom sediments. This contact can help form an oxygenated layer on the bottom sediments and biogeochemically "seal" them off from the water column, minimizing the release of nutrients such as ammonia and orthophosphate from sediments into the lake. The release of nutrients from bottom sediments is called "internal nutrient loading," and it can have a substantial effect on water quality within lakes, ponds, and reservoirs.
- It brings bottom water that has been in contact with sediments up to the surface into the photic zone[13], where any nutrients released from bottom sediments due to internal nutrient loading can fuel the growth of phytoplankton blooms. These blooms can exacerbate the process of eutrophication and create a positive feedback loop that results in further degradation of water quality.

In summary, this investigation indicated that from 1997 through 2009 there appeared to be no substantial correlations between the depth of Lake Merced and the indicator water quality parameters evaluated. While a depth threshold for Lake Merced water quality may exist (i.e., a depth below which water quality consistently and significantly decreases), none of the depths recorded from 1997 through 2005 appeared to represent such a threshold for the constituents analyzed. It is likely that factors external to Lake Merced are largely driving water quality or are, at the very least, a more dominant driver than lake level on its own. Specifically, the magnitude, duration, frequency, and characteristics (e.g., pollutants, dissolved oxygen demand) of urban runoff to the lake – from either the local watershed or the Vista Grande Drainage Canal – likely play a major role in introducing nutrients and other pollutants that can drive water quality impacts. Shallow, urban lakes such as Lake Merced tend to be strongly influenced by episodic events such as storms and wind events as well as more regular events such as urban runoff. While lake level is an important factor, it is likely that these factors have a relatively greater influence on water quality within Lake Merced than lake levels.

[13]The upper layer of water of a body, defined by the depth to which sunlight can penetrate to permit photosynthesis.

Pine Lake

Pine Lake is a relatively shallow 3.4-acre freshwater lake located in the westernmost portion of Stern Grove and Pine Lake Park, about 0.5 mile northeast of Lake Merced (Figure 5.16-1 [Surface Water Hydrology Map]). Like Lake Merced, Pine Lake is incised into the upper portion of the Shallow Aquifer. Although records pertaining to Pine Lake were limited until the past 10 to 15 years, it has been reported that in the 1930s as much as one-third of the total lake was filled at the eastern end to accommodate additional park development. (Kennedy/Jenks 2010d)

Historically, Pine Lake has received inflows from precipitation and stormwater runoff, and the primary outflows have been evapotranspiration and groundwater outflows (Kennedy/Jenks 2012d). Over time, the lake has become shallower; in the early 1900s, the depth of the lake was reportedly about 20 feet deep. During a period of low lake levels in the early 2000s, maximum depths were only 7 to 8 feet. In 2004, the lake level was reported to be very low, at an elevation of 33.5 feet, pursuant to the National Geodetic Vertical Datum of 1929 (NGVD 29)[14], or 3 to 5 feet deep. The historical change in Pine Lake levels has been attributed to a combination of long-term sedimentation and local declines in groundwater levels. It is also likely that intense urbanization in the area surrounding Pine Lake reduced the amount of natural inflow to the lake (Kennedy/Jenks, 2012d). Pine Lake is primarily a scenic resource used for recreational purposes (i.e., aesthetic enjoyment) and has never been used as a drinking water supply.

The SFRPD has conducted studies and implemented several projects under its capital improvement program to address declining water levels and ecological issues at Pine Lake. As part of these efforts, the SFRPD eradicated invasive plants in 2007 and replaced them with native vegetation. In addition, the SFRPD installed a new pump in the Stern Grove well and constructed a six-inch-diameter pipe from the well to an outlet channel that drains to Pine Lake, with the goal of maintaining lake levels at a water elevation of 40.1 feet NGVD 29. This elevation is about 4 feet higher than average historical lake levels, and about 7 feet higher than the lake level in 2004. (Kennedy/Jenks 2012d)

Lake levels in Pine Lake are currently maintained at the desired water elevation (i.e., 40.1 feet NGVD 29) with groundwater input from the Stern Grove well, which has resulted in a lake depth of about 10 to 12 feet NGVD 29. The Stern Grove well is 270 feet deep and draws water from the Primary Production Aquifer. Based on information from the SFRPD, this well is operated approximately three to four times each year to maintain Pine Lake water levels. At that pumping rate and operational duration, the total amount of water added to Pine Lake to maintain water levels is approximately 4.8 afy (Kennedy/Jenks

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[14] Groundwater elevations are commonly referenced to the North American Vertical Datum of 1988 (NAVD 88) and/or the National Geodetic Vertical Datum of 1929 (NGVD 29). NAVD 88 was established in 1991 and is the most up-to-date and accurate datum. NGVD 29 was used by surveyors and engineers for most of the 20th century and is 2.8 feet lower than NAVD 88 in San Francisco and northern San Mateo County. The technical reports prepared in support of the GSR Project used both datums; therefore, for consistency, this EIR uses the same datum employed in a given technical report when discussing information obtained from that report. Mean sea level is equivalent to 0 feet NGVD 29, which is also equivalent to 2.8 feet NAVD 88.

2012d). The SFRPD continues to use groundwater from the Stern Grove well to augment water levels in Pine Lake as part of its long-term goal of maintaining the water level at 40.1 feet NGVD 29.

Groundwater Interactions and Lake Levels

Shallow Aquifer groundwater levels in the vicinity of Pine Lake are monitored in two nearby monitoring wells: LMMW-5SS and LMMW-5S (Kennedy/Jenks 2012d). Monitoring well LMMW-5SS (shallow well adjacent to Pine Lake and screened between 38 and 48 feet below ground surface) was designed to monitor the uppermost groundwater zone in the Shallow Aquifer near Pine Lake, and measurements from this well can be used to infer water levels in Pine Lake. Since 2002, groundwater elevations in this well have typically ranged from 37 to 40 feet NGVD 29. However, during periods of low levels in Pine Lake, groundwater levels in this well declined to about 33 feet NGVD 29 (Kennedy/Jenks May 2012d). Variations in groundwater elevations measured in this well appear to closely approximate changes in water levels in Pine Lake.

Monitoring well LMMW-5S, which is screened between 65 and 85 feet below ground surface in the Shallow Aquifer, is also designed to monitor groundwater levels in the Shallow Aquifer near Pine Lake. However, this well monitors water from deeper within the Shallow Aquifer than does LMMW-5SS, and may be separated from the shallower portions of the aquifer by a clay layer. Generally, groundwater levels in LMMW-5SS are about 1 to 4 feet higher than those observed in LMMW-5S (Kennedy/Jenks, 2012d). Pine Lake levels can also be inferred to be slightly higher than groundwater levels in LMMW-5S. The Stern Grove well pumps groundwater from the Primary Production Aquifer, below the clay aquitard[15] that forms the base of the Shallow Aquifer; pumping from this well is not considered to directly affect shallow groundwater levels near Pine Lake. (Kennedy/Jenks 2012d)

As part of the studies discussed above, the SFRPD added approximately 14 af of groundwater from the nearby Stern Grove well to Pine Lake in November 2004 to evaluate the potential use of the well to maintain Pine Lake at the design water level. During the test, groundwater levels in LMMW-5SS rapidly rose about 5 to 6 feet and leveled out at an elevation of 40.2 feet NGVD 29, which was near the lake elevation at that time, confirming that Pine Lake is in direct hydraulic connection with the shallower portion of the Shallow Aquifer. Groundwater levels in LMMW-5S rose less than 1 foot during the test and were about 8 feet lower than the lake level at the end of the test, thus confirming that direct hydraulic connection between the lake and the deeper parts of the Shallow Aquifer is limited (possibly due to an intervening clay layer) (Kennedy/Jenks 2012d). This limited hydraulic connection with the deeper parts of the Shallow Aquifer limits losses from Pine Lake to the aquifer and allows for maintenance of Pine Lake water levels with minimal water additions.

15 A semi-impermeable layer that confines an aquifer.

Golden Gate Park Lakes

Golden Gate Park is located over the northernmost part of the North Westside Groundwater Basin, approximately three miles north of the Lake Merced area. There are 13 lakes, ponds, or water features within Golden Gate Park in the northernmost extent of the Westside Groundwater Basin: Stow Lake, Spreckels Lake, North Lake, Lily Pond, Lloyd Lake, Elk Glen Lake, Metson Lake, Mallard Lake, South Lake, Middle Lake, Alvord Lake, Fly Casting Pools, and Rainbow Falls and Pond. The largest lakes are Stow, Spreckels, and North, with surface areas of approximately 13, six, and four acres, respectively (Kennedy/Jenks 2012d). The other lakes are smaller, ranging from about 0.2 to 0.5 acres in surface area. Alvord Lake, Fly Casting Pools, and Rainbow Falls and Pond are very small, with paved bottoms and fountains or falls; they are considered ornamental water features rather than lakes.

All of the Golden Gate Park lakes are either constructed or have been substantially altered by human activity. It is believed that Elk Glen, Middle, and North Lakes were originally natural groundwater-fed ponds that were deepened, while the other lake locations may or may not have coincided with preexisting natural surface water features. (Kennedy/Jenks 2012d)

The constructed Golden Gate Park lakes were excavated into the shallow soils approximately 100 years ago. Most of these lakes were constructed to a maximum depth of 5 feet; Elk Glen Lake was originally 7 feet deep. With subsequent accumulation of sediment in the lakes, the average depths by 1994 were about 1 foot shallower than originally constructed, except for the north portion of North Lake, which was deepened to approximately 9 to 10 feet in 1990.

Groundwater Conditions

As discussed above, the Shallow Aquifer is not present in this area. Rather, the Shallow and Primary Production Aquifers are merged because of the absence of the -100-foot clay layer in this area. Historically, shallow groundwater levels throughout most of Golden Gate Park have ranged from 40 to 60 feet below ground surface, but are as shallow as 14 to 15 feet below ground surface at the far western edge of Golden Gate Park, near the Pacific Coast. (Kennedy/Jenks 2012d)

Most of the lakes were constructed with a gravelly clay liner in an attempt to minimize leakage of lake water into the shallow soils. Lily Pond did not require this addition of material because it was constructed within an old shale quarry, and the existing gravelly clay bottom already minimized leakage. The natural lakes (Elk Glen, Middle, and North) have not been lined. A 1994 study determined that most of the Golden Gate Park lakes leak appreciable amounts of water, including those lined with clay materials. The study estimated that the combined leakage from the park lakes was about 0.5 mgd (1.5 af per day), with about 77 percent of the leakage coming from Elk Glen Lake, Middle Lake, and North Lake, which are the three natural lakes confirmed to be unlined (Kennedy/Jenks 2012d). Some of the water lost from the lakes is periodically made up by additions of groundwater pumped from the Elk Glen, South Windmill, and North Lake irrigation wells in Golden Gate Park, while the remainder is replenished by direct precipitation and stormwater runoff.

The average depths to groundwater in the Golden Gate Park area indicate that the shallow lakes do not intersect the groundwater table and are hydraulically separated from the groundwater. On the other hand, the lakes do recharge the aquifer through leakage to the shallow soils described above. However, this exchange is not considered a groundwater/surface water interaction because the water flows in one direction only, and the water table is too far below the bottom of the lakes for changes in groundwater levels to affect lake levels.

Colma Creek, San Bruno Creek, Millbrae Creek, and Lomita Channel

As is typical of surface water features located in heavily urbanized areas, much of the stream reaches of Colma Creek, San Bruno Creek, Millbrae Creek, and the Lomita Channel have been channelized, buried, and/or lined with impervious materials. Except for its upper reaches on San Bruno Mountain, all of historic Colma Creek and its tributaries have been diverted into engineered channels or underground storm drains. Similar alterations have also been made to San Bruno Creek and Millbrae Creek. These modifications have resulted in major changes to the natural hydrologic and ecologic processes that previously existed. In the portion of the South Westside Groundwater Basin where Colma Creek is located (except for the eastern area closer to the Bay), the depth to groundwater ranges from many tens to hundreds of feet below ground surface, due to drawdown of the groundwater caused by historic municipal pumping in the Daly City, South San Francisco, and San Bruno areas. Large production wells in these areas pump from the Primary Production and Deep Aquifers (the Shallow Aquifer is not present). Where the lower reaches of Colma Creek are located, in South San Francisco, the depth to groundwater is highly variable, depending largely on proximity to pumping wells and the depth of the aquifer being measured. (Kennedy/Jenks 2012d)

Where San Bruno Creek, Millbrae Creek, and the Lomita Channel are located (in San Bruno and Millbrae), the groundwater in the Primary Production Aquifer is typically at elevations ranging from -100 to -200 feet NGVD 29. However, in areas closer to the Bay, groundwater levels are in the range of approximately 10 to -30 feet NGVD 29. (Kennedy/Jenks 2012d)

Extensive modifications to Colma Creek, San Bruno Creek, the Lomita Channel and Millbrae Creek have effectively isolated almost all of the creek reaches from the underlying groundwater, precluding any substantial degree of groundwater-surface water interaction with the creeks. Furthermore, groundwater beneath much of Colma Creek is far below ground surface, further reducing the likelihood of direct groundwater-surface water interaction. Even where groundwater levels are relatively shallow in the southernmost portion of the South Westside Basin near the Bay, the heavy alteration of all three creeks (i.e., concrete lining) precludes exchanges between surface water and shallow groundwater. (Kennedy/Jenks 2012d)

Colma Creek is apparently in some degree of communication with shallow groundwater in its upper, least-altered reaches near San Bruno Mountain, because water use by stands of eucalyptus trees there is believed to deprive the creek of some baseflow. However, any shallow groundwater in this area exists in a highly localized system, far removed from the deeper groundwater of the Primary Production Aquifer, which exists at lower elevations in the Basin. Similar conditions are likely present for the unaltered upland portions of San Bruno Creek and Millbrae Creek. (Kennedy/Jenks 2012d)

5.16.2 Regulatory Framework

5.16.2.1 Federal and State Regulations

Clean Water Act

The federal Clean Water Act, enacted by Congress in 1972 and amended several times since, is the primary federal law regulating water quality in the United States and forms the basis for several State and local laws throughout the country. It was established to "restore and maintain the chemical, physical, and biological integrity of the Nations' waters." The Act established the basic structure for regulating discharges of pollutants into the waters of the United States. The Clean Water Act gave the U.S. EPA the authority to implement federal pollution control programs, such as setting water quality standards for contaminants in surface water, establishing wastewater and effluent discharge limits for various industry categories, and imposing requirements for controlling nonpoint-source pollution. At the federal level, the Clean Water Act is administered by the U.S. EPA and U.S. Army Corps of Engineers (USACE). At the state and regional levels in California, the act is administered and enforced by the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs).

Drinking Water Regulations

U.S. Environmental Protection Agency/California Department of Public Health

The California Safe Drinking Water Act is implemented by the California Department of Public Health (CDPH) and provides that drinking water in the State shall not exceed primary and secondary Maximum Contaminant Levels (MCLs) (CDPH 2011). Primary and secondary MCLs for specific constituents are set in Title 22 of the California Code of Regulations (commonly referred to as simply "Title 22"). Primary MCLs are established to protect public health; secondary MCLs are established for contaminants that may cause the water to appear colored or taste or smell bad, causing people to stop using water from their public water system even though the water is safe to drink (U.S. EPA 2012b). The U.S. EPA also sets primary and secondary MCLs through its National Primary Drinking Water Regulations. California and federal MCLs are generally similar, although California's levels may be more stringent. MCLs are set for bacteria and other micro-organisms, chemicals and radionuclides. Title 22 also requires that public water systems with 10,000 service connections or more fluoridate their water supply to protect oral health; fluoride concentrations are specified by the regulations.

CDPH has also established Notification and Response Levels for 30 constituents for which no MCLs have been established. The Notification Levels are health-based advisory levels; public water systems must notify their customers annually if concentrations of these constituents exceed the Notification Level. The CDPH recommends removal of the drinking water source from service when concentrations of these constituents exceed Response Levels. (CDPH 2011)

After Project construction and prior to distribution of groundwater for domestic use, the CDPH would monitor water quality to confirm that primary and secondary MCLs are not exceeded at each connection point (MWH et al. 2008). California Environmental Protection Agency Office of Environmental Health Hazard Assessment (OEHHA) has set Public Health Goals at concentrations that pose no significant health risk if consumed for a lifetime. Public Health Goals may be more stringent than MCLs for certain constituents, because the CDPH must consider detectability, treatability, and cost of treatment, as well as health risk when setting MCLs.

Drinking Water Source Assessment and Protection Program

The State's Drinking Water Source Assessment and Protection (DWSAP) Program requires a Drinking Water Source Assessment to assess the potential for contamination and vulnerability of drinking water supplies (CDPH, Division of Drinking Water and Environmental Management 2000). The Assessment shows whether the source of the drinking water would be vulnerable to Potentially Contaminating Activities (PCA). If the source of drinking water would be vulnerable, a voluntary source water protection program is recommended. Source water protection is not a mandated element of the DWSAP program, but is required for a complete wellhead protection program and for permitting municipal supply wells and affords a public water system or community the opportunity to build on work performed for the drinking water source assessment.

The DWSAP for groundwater sources (i.e., wells) requires California drinking water purveyors to assess local hydrogeology, well construction and production, and land use in the vicinity of proposed water supply wells. These components are then used to delineate Groundwater Protection Zones for each well, which represent the area of groundwater that may be drawn in by the well in two (Zone A), five (Zone B5), and ten (Zone B10) years of pumping. The CDPH requires a minimum radius for each protection zone: 600 feet for Zone A, 1,000 feet for Zone B5, and 1,500 feet for Zone B10. Within these three Groundwater Protection Zones, PCAs are identified and evaluated.

Porter-Cologne Water Quality Control Act

The Porter-Cologne Water Quality Control Act is the primary statute covering the quality of waters in California. Under the act, the SWRCB has the ultimate authority over the State's water quality policy. The nine RWQCBs regulate water quality under this Act through the regulatory standards and objectives set forth in Water Quality Control Plans (also referred to as Basin Plans) prepared for each region.

Regional Water Quality Control Board, Beneficial Uses

The *Water Quality Control Plan for the San Francisco Bay Basin* (Basin Plan), prepared by the San Francisco Bay RWQCB, identifies the beneficial uses of surface waters and groundwater within its region to maintain the continued beneficial uses of the groundwater (RWQCB 2011). The RWQCB is responsible for protecting the beneficial uses of San Francisco Bay Area water resources, including water bodies in the Project area. The Basin Plan was last revised on December 31, 2011 (RWQCB 2011). The water bodies in the Project area that have designated beneficial uses include Lake Merced, San Francisco Bay, Colma Creek, and San Bruno Creek. The beneficial uses provide the basis for determining appropriate water quality objectives for these water bodies. The RWQCB has not assigned beneficial uses for the Vista Grande Drainage Basin, Twelve Mile Creek, Green Hills Creek, Lomita Channel, Highline Canal, Millbrae

Creek, or Pine Lake. Although there are no designated beneficial uses of Pine Lake, the lake is used primarily for noncontact recreational purposes (i.e., aesthetic enjoyment) in Pine Lake Park.

Table 5.16-5 (Designated Beneficial Uses of Surface Water Bodies in Project Area) lists the designated beneficial uses for water bodies in the vicinity of the proposed Project. Agricultural supply is identified as an existing beneficial use for groundwater in the Westside Groundwater Basin in San Francisco; municipal and domestic supply as well as industrial service supply and industrial process supply are listed as "potential" beneficial uses. Existing beneficial uses of Lake Merced identified in the Basin Plan include body contact recreation (e.g., fishing), noncontact recreation (e.g., rowing), warm freshwater habitat, cold freshwater habitat, fish spawning, and wildlife habitat. Municipal and domestic supplies are also potential beneficial uses of Lake Merced.

TABLE 5.16-5
Designated Beneficial Uses of Surface Water Bodies in Project Area

Water Body	Designated Beneficial Uses [(a)]
Lake Merced	COMM, COLD, SPWN, WARM, WILD, REC-1, REC-2, MUN (potential)
San Francisco Bay (Lower)	IND, COMM, SHELL, EST, MIGR, RARE, SPWN, WILD, REC-1, REC-2, NAV
Colma Creek	WARM, WILD, REC-1, REC-2
San Bruno Creek	WARM, WILD, REC-1, REC-2

Source: RWQCB 2011

Notes:

(a) Beneficial Uses Key: COLD (Cold Freshwater Habitat); COMM (Commercial Sport and Fishing); EST (Estuarine Habitat); IND (Industrial Service Supply); MUN (Municipal and Domestic Supply); NAV (Navigation); RARE (Rare, Threatened, or Endangered); REC-1 (Body Contact Recreation); REC-2 (Noncontact Recreation); SHELL (Shellfish Harvesting); SPWN (Fish Spawning); WARM (Warm Freshwater Habitat); WILD (Wildlife Habitat)

The RWQCB also oversees and regulates groundwater investigations, cleanup, and abatement activities at sites with identified pollution problems in accordance with Resolution No. 92-49 – Policies and Procedures for Investigation and Cleanup and Abatement of Discharged Under California Water Code Section 13304 (the resolution established procedural and substantive requirements that apply cleanups of waste). The RWQCB manages groundwater investigations through five main program areas:

- Spills, Leaks, Investigations, and Cleanups (SLIC) Program;
- UST Program;
- Landfill Program;
- Department of Defense/Department of Energy (DOD/DOE) Program; and
- Aboveground Petroleum Storage Tank Program.

The RWQCB approves soil and groundwater clean-up levels for polluted sites. The overall clean-up level established for a waterbody is based upon the most sensitive beneficial use identified. Soil clean-up levels for the unsaturated zone are established using guidance from the U.S. EPA, Department of Toxic Substances Control and OEHHA.

Federal Clean Water Act Section 401 Water Quality Certification

Under Section 401 of the Clean Water Act, the RWQCB has regulatory authority over actions in waters of the United States and/or the State of California through the issuance of water quality certifications, which are issued in conjunction with any federal permit (e.g., permits issued by the USACE under Section 404 of the Clean Water Act, described below). Section 401 of the Clean Water Act provides the SWRCB and the RWQCBs with the regulatory authority to waive, certify, or deny any proposed activity that could result in a discharge to surface waters of the State. To waive or certify an activity, these agencies must find that the proposed discharge would comply with State water quality standards, including those protecting beneficial uses and water quality. If these agencies deny the proposed activity, the federal permit cannot be issued. This water quality certification is generally required for projects involving the discharge of dredged or fill material to wetlands or other water bodies.

Federal Clean Water Act Section 404

Proposed discharges of dredged or fill material into waters of the United States require USACE authorization under Section 404 of the CWA (33 U.S.C. 1344). Waters of the United States generally include tidal waters, lakes, ponds, rivers, streams (including intermittent streams), and wetlands (with the exception of isolated wetlands).

The USACE identifies wetlands using a "multi-parameter approach," which requires positive wetland indicators in three distinct environmental categories: hydrology, soils, and vegetation. According to the *Corps of Engineers Federal Wetlands Delineation Manual*, except in certain situations, all three parameters must be satisfied for an area to be considered a jurisdictional wetland (Environmental Laboratory 1987). The *Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (USACE 2008) is also utilized when conducting jurisdictional wetland determinations in areas identified within the boundaries of the arid west. The study area falls within the Arid West Region (which includes most of the Central California Coast and inland) and, therefore, the assessment of wetlands used the Arid West guidance and the federal manual.

Section 303(d) List of Impaired Water Bodies and Total Maximum Daily Loads

In accordance with Section 303(d) of the Clean Water Act, state governments must present the U.S. EPA with a list of “impaired water bodies,” defined as those water bodies that do not meet water quality standards, even after point sources of pollution have been equipped with the minimum required levels of pollution control technology. Placement of a water body on the Section 303(d) List of Impaired Water Bodies acts as the trigger for developing a Total Maximum Daily Load (TMDL) pollution control plan for each water body and associated pollutant/stressor on the list. The TMDL is the quantity of a pollutant that can be safely assimilated by a water body without violating water quality standards. The TMDL serves as the means to attain and maintain water quality standards for the impaired water body to support designated and potential beneficial uses identified in the Basin Plan. During each Section 303(d) listing cycle, the water bodies on the list are prioritized and a schedule is established for completing the TMDLs. Table 5.16-1 (Impaired Surface Water Bodies) lists impaired water bodies in the Project area.

NPDES Waste Discharge Regulations

In 1987, amendments to the Clean Water Act added Section 402, which established a framework to protect water quality by regulating industrial, municipal, and construction-related sources of pollutant discharges to waters. In California, the National Pollutant Discharge Elimination System (NPDES) program is administered by the SWRCB through the RWQCBs and requires municipalities to obtain permits that outline programs and activities to control wastewater and stormwater pollution. The NPDES program provides two levels of control for the protection of water quality: technology-based limits and water-quality-based limits. Technology-based limits are based on the ability of dischargers to treat the water, while water-quality-based limits are required if technology-based limits are not sufficient to protect the water body. The water-quality-based effluent limitations required to meet water quality criteria in the receiving water are based on the National Toxics Rule, the California Toxics Rule, and the Basin Plan. NPDES permits must also incorporate TMDL waste load allocations when they are developed.

NPDES Construction General Permit (SWRCB Order No. 2009-09-DWQ)

The federal Clean Water Act prohibits discharges of stormwater from construction projects unless the discharge is in compliance with an NPDES permit. The SWRCB, the permitting authority in California, adopted an NPDES General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Construction General Permit) (Order No. 2009-0009, as amended by Order No. 2010-0014; SWRCB 2010, 2011). Order No. 2009-0009 took effect on July 1, 2010 and was amended on February 14, 2011. The Order applies to construction sites that include one or more acre of soil disturbance. Construction activities include clearing, grading, grubbing, excavation, stockpiling, and reconstruction of existing facilities involving removal or replacement.

The Construction General Permit requires that the landowner and/or contractor file permit registration documents prior to commencing construction and then pay a fee annually through the duration of construction. These documents include a notice of intent, risk assessment, site map, stormwater pollution prevention plan (SWPPP), and signed certification statement. The permit specifies a risk-based permitting approach that includes requirements specific to three overall levels of risk, which are determined based on the potential for a project to cause sedimentation, as well as the sensitivity of the receiving water to sedimentation. The three risk levels are used to determine specific numeric action levels and effluent limitations for pH and turbidity, as well as requirements for a rain event action plan, best management practices (BMP) implementation, monitoring, and reporting.

The SWPPP must include measures to ensure that: all pollutants and their sources are controlled; non-stormwater discharges are identified and eliminated, controlled, or treated; site BMPs are effective and result in the reduction or elimination of pollutants in stormwater discharges and authorized non-stormwater discharges; and the BMPs installed to reduce or eliminate pollutants after construction are completed and maintained. The SWPPP must demonstrate that calculations and design details, as well as BMP controls for site runoff, are complete and correct. Non-stormwater discharges include those from improper dumping, accidental spills, and leakage from storage tanks or transfer areas. The Construction General Permit specifies minimum BMP requirements for stormwater control based on the risk level of the site. Post-construction stormwater runoff reduction requirements must be implemented at project sites not covered by a Phase I or Phase II municipal stormwater permit. The post-construction stormwater standards address water quality, runoff reduction, drainage density, and channel protection requirements for the receiving water. San Mateo County, including the Project area, is covered under a Phase I municipal stormwater permit. Thus, the Project would not be subject to the post-construction stormwater standards specified in the Construction General Permit.

The Construction General Permit stipulates that effluent and receiving water monitoring must demonstrate compliance with permit requirements and that project proponents must take corrective action if these limitations are exceeded. The results of the monitoring and corrective actions must be reported annually to the SWRCB. The Construction General Permit specifies minimum qualifications for a qualified SWPPP developer and qualified SWPPP practitioner (SWRCB 2010).

5.16.2.2 Local Regulations

San Mateo Countywide Water Pollution Prevention Program

The San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) helps municipalities and unincorporated areas to comply with the countywide NPDES permit by ensuring that new development and redevelopment projects mitigate, to the maximum extent practicable, stormwater runoff impacts on water quality during both construction and operation of projects. As mentioned above, RWQCB Order No. R2-2009-0074 (Order) regulates discharges of stormwater water from municipalities in San Mateo County (RWQCB 2009b). Individual project sites creating more than 10,000 square feet of new impervious cover are subject to the "C.3" requirements established in Section C.3 of the Order and required to mitigate for water quality, including stormwater treatment measures to minimize stormwater pollutant discharges. In addition, development sites that create or replace one acre or more of impervious service may be subject to flow and volume reduction requirements. None of the GSR facility sites would create more than 10,000 square feet of new impervious cover and, therefore, are not subject to the C.3 requirements, nor to the flow and volume reduction requirements.

5.16.3 Impacts and Mitigations

5.16.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on hydrology and water quality if it were to:

Surface Water

- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site.
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site.
- Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff.
- Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other authoritative flood hazard delineation map.
- Place within a 100-year flood hazard area structures that would impede or redirect flood flows.
- Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam.
- Expose people or structures to a significant risk of loss, injury or death involving inundation by seiche, tsunami, or mudflow.
- Violate any water quality standards or waste discharge requirements.
- Otherwise substantially degrade water quality.

Groundwater

- Deplete groundwater supplies in a manner that would result in a lowering of the local groundwater to a level where the production rate of preexisting nearby wells would drop to a level that would not support existing or planned land uses.
- Lower groundwater levels in a manner that would result in onsite or offsite land subsidence that would cause substantial structural damage, increased flooding, or altered drainage patterns.
- Lower groundwater levels in a manner that would result in seawater intrusion such that loss of beneficial uses of groundwater would occur.
- Change groundwater levels in a manner that would affect beneficial uses of surface water bodies.
- Violate any water quality standards or waste discharge requirements.
- Otherwise substantially degrade water quality.
- Deplete groundwater supplies or interfere with groundwater recharge in a manner that would result in a substantial regional deficit in aquifer storage that would not support existing or planned land uses.

5.16.3.2 Approach to Analysis of Construction Impacts

This section describes the approach to analyzing impacts related to construction of the proposed Project on surface water and groundwater resources. As explained below, construction of the proposed Project would not result in impacts related to some of the above listed significance criteria. The following criteria are not discussed further in the impact analysis, below, for the following reasons:

Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other authoritative flood hazard delineation map. The proposed Project does not include the construction of new housing or structures for human occupancy. Therefore, the significance criterion related to the placement of housing within a 100-year flood hazard zone is not applicable to the proposed Project and is not discussed further.

Place within a 100-year flood hazard area structures that would impede or redirect flood flows. The majority of the Project facility sites are not located within a FEMA mapped 100-year flood hazard zone. Although portions of the construction area boundaries at Sites 9 and 13 are located within a FEMA mapped 100-year flood hazard zone (FEMA 2012), construction within designated 100-year flood zones would have no impact given the negligible potential for stockpiles of soil or construction materials to displace floodwaters, raise flood elevations, or create new flooding impacts. Therefore, this significance criterion is not applicable to Project construction activities and is only discussed below as it relates to potential long-term operational impacts.

Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam. The proposed Project does not include the construction of structures within an area subject to inundation from failure of a levee or dam (ABAG 2012). Therefore, the significance criterion related to flooding as a result of the failure of a levee or dam is not applicable to the proposed Project and is not discussed further.

Expose people or structures to a significant risk of loss, injury, or death involving inundation by seiche, tsunami, or mudflow. The proposed Project would have no effect on the frequency or probability of seiches (i.e., earthquake-induced oscillating waves in an enclosed water body), because the Project would not create new enclosed water bodies or affect the frequency of earthquakes. Further, the proposed Project does not include the construction of habitable structures near any isolated bodies of water subject to inundation by seiche. The proposed Project does not include the construction of structures within an area subject to inundation from tsunami (Cal EMA 2009). No mudflows have been mapped at the facility sites (USGS 1997). Other types of slope instability issues are discussed in Section 5.15, Geology and Soils. Therefore, the significance criterion related to inundation by seiche, tsunami, or mudflow is not applicable to the proposed Project and is not discussed further.

Surface Water Hydrology

The approach to analysis of construction impacts describes the methodology used to identify and evaluate impacts from construction activities. Construction could impact surface water hydrology and water quality.

The surface water hydrology and water quality analysis evaluates the proposed Project's construction activities that may have the potential to degrade existing water quality and increase erosion, or cause flooding. The analysis evaluates potential impacts from well facilities and proposed pipelines including the proposed and alternate water connection pipelines. Regional documents and maps were reviewed to identify hydrology and water quality resources that could be directly or indirectly affected by construction, operation, or maintenance activities. The analysis focuses on how construction of the proposed Project would affect hydrology or water quality of regional and local surface waters.

5.16.3.3 Approach to Analysis of Operational Impacts

This section describes the approach to analyzing impacts related to operations of the proposed Project.

The analysis of impacts of groundwater pumping operations relies on predicted groundwater-level changes in the South Westside Groundwater Basin that were modeled with the Westside Basin Groundwater Model, Version 3.1, supplemented by a spreadsheet-based Lake-Level model to evaluate predicted changes in Lake Merced water levels, as described in Section 5.1, Overview, Section 5.1.6 (Groundwater Modeling Overview). The technical report describing the groundwater modeling analysis is included as Appendix G (Groundwater Technical Reports) (Kennedy/Jenks 2012a). The results of the two models were used together with other appropriate analytical techniques to assess the potential for groundwater pumping to result in well interference, subsidence, surface water quality, groundwater quality, and groundwater depletion effects. Each impact analysis below includes a more detailed approach to analysis relevant to the particular impact.

Groundwater-level Modeling

As described in Section 5.1 Overview, Section 5.6.1 (Groundwater Modeling Overview), the Westside Basin Groundwater-flow Model was developed by the City of Daly City, with assistance from the City of San Bruno, Cal Water, and the SFPUC (HydroFocus 2011). The Westside Basin Groundwater-flow Model was used to model existing conditions and Project impacts to groundwater levels over a 47-year modeling period with initial conditions beginning in 2009, the year that the Notice of Preparation of an Environmental Impact Report (NOP) was issued (the NOP is provided in Appendix A). Three scenarios were modeled including the modeled existing conditions, pumping under the proposed Project, and cumulative pumping, which includes the proposed Project and other reasonably foreseeable groundwater pumping and surface water projects in the groundwater basin. The model inputs and results prepared for this EIR are called the Westside Basin Groundwater Model (Kennedy/Jenks 2012a).

As shown on Table 5.1-2 (Model Input – Pumping Assumptions for Modeling Scenarios) of Section 5.1, Overview, the modeled existing conditions include existing groundwater pumping under a variety of rainfall and temperature conditions for the entire 47-year simulation period, based upon historic hydrology data modified to include a design drought[16]. For the Project, the Westside Basin Groundwater Model considers a Put, Take, Hold sequence to simulate in-lieu groundwater recharge during wet (i.e., above-average) and normal rainfall years and groundwater extraction during dry years.

The cumulative model scenario combines the existing pumping in the Westside Groundwater Basin and Project pumping with other reasonably foreseeable changes in pumping in the basin (described in Section 5.1.6), including pumping that would occur with implementation of the San Francisco Groundwater Supply (SFGW) Project and the Holy Cross Cemetery buildout. The Vista Grande Drainage Basin Improvement Project is also included in the cumulative model scenario. While this project does not propose groundwater pumping, it is included as a cumulative project in the modeling because it would involve additions of stormwater runoff to Lake Merced, which would increase Lake Merced water levels and associated groundwater levels in the Shallow Aquifer.

As discussed in Section 5.1.6, the Westside Basin Groundwater Model is best used for evaluating relative changes in groundwater levels and also uses an assumed set of hydrologic conditions over the 47-year simulation period for each model scenario. Although future hydrologic conditions cannot be expected to occur exactly as modeled, using a broad range of hydrologic conditions observed over the recent 47-year historical period allows a reasonable evaluation of changes in groundwater levels that would be expected to occur over the simulation period. The modeled existing conditions include groundwater level changes that are predicted to occur over the 47-year simulation period in response to the assumed hydrology without Project-related or cumulative pumping. Therefore, in the impact analyses, the Project-related effects under Project and cumulative conditions are compared to the modeled existing conditions to distinguish the effect of Project-related pumping from the effects that would occur based only on changes in hydrologic conditions. Additional information used to evaluate specific impacts is addressed in the approach to analysis provided for each specific impact below.

The Westside Basin Groundwater Model was also used to predict groundwater levels during the 47-year simulation period. To characterize basin-wide groundwater conditions, which is necessary for the analysis of cumulative impacts, graphs showing modeled groundwater levels from representative locations in the North and South Westside Groundwater Basins are included in Appendix G (Groundwater Technical Reports). The graphs present results for each water year during the 47-year simulation period, which extends from October of the previous year through September of the subsequent year.

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[16] The SFPUC measures water supply reliability using an 8.5-year "design drought." A design drought is a planning and operations tool used by water agencies to define a reasonable worst-case drought scenario in order to establish design and operating parameters for the water system. The WSIP uses a design drought based on the hydrology of the six years of the worst historical drought (1987-1992) on record, plus the 2.5 years of the 1976-1977 drought, for a combined total of an 8.5-year design drought sequence.

The graphs show predicted groundwater levels for modeled existing conditions, the proposed Project, and cumulative conditions in the Shallow Aquifer (or shallow water-bearing zones) and the Primary Production Aquifer. Evaluation of the water-level trends predicted in these graphs provides an overview of how the Project would likely affect groundwater levels in the North and South Westside Groundwater Basins. These effects are detailed in the impact analyses under the relevant hydrology and water quality impacts discussed below.

Summary of Groundwater Modeling Results

As indicated in the graphs, under the modeled existing conditions, there would likely be a normal variation in groundwater levels in the Basin in response to changing hydrologic conditions.

In the South Westside Groundwater Basin, groundwater levels in both the shallow water-bearing zone and the Primary Production aquifer are predicted to be higher under the Project than under modeled existing conditions for 70 to 80 percent of the simulation. As shown in Figure 5.1-2 (Effects of Project and Cumulative Conditions relative to Modeled Existing Conditions on Groundwater Storage Volumes in the Westside Groundwater Basin), groundwater storage volumes in the Westside Groundwater Basin as a whole are also predicted to be higher under the Project for 70 to 80 percent of the 47-year simulation than under modeled existing conditions. Groundwater levels and groundwater storage volumes are predicted to be lower under the Project than under modeled existing conditions for approximately 20 to 30 percent of the simulation, especially during the design drought.

In the South Westside Groundwater Basin, predicted changes in groundwater levels and groundwater storage volumes under the cumulative conditions generally follow the same trend as the Project, except with slightly lower groundwater levels relative to modeled existing conditions in the Daly City area, as a result of pumping under the SFGW Project. The effect of cumulative pumping would be diminished farther to the south, due to the intervening distance, and no effect would be observed as far south as San Bruno.

Westlake Pump Station

Due to the nature of the proposed Project, there would be no operational impacts on hydrology or water quality related to Project operations at the Westlake Pump Station for the reasons described below:

Project operations at the Westlake Pump Station would have no impacts on groundwater. The Project at this location includes operation of new or upgraded pumps to convey water from the Project wells at Sites 2, 3, and 4 to the Daly City water distribution system and does not include pumping of groundwater. Upgrades to the Westlake Pump Station would include new chemical storage tanks, metering pumps, a resized transformer, and new booster pumps. The upgrades would not discharge waste to the groundwater or pump groundwater to the surface. As a result, there would be no impact from potential groundwater contamination at this site. In addition, no discharges to surface waters would occur from increased treatment volumes at the pump station site, as any discharges would go to the sanitary sewer. Operational impacts at the Westlake Pump Station are therefore not discussed further.

Groundwater-surface Water Interactions

Due to the location of the proposed Project and its distance from Golden Gate Park, there would be no impact related to the Groundwater-Surface Water Interactions significance criterion for the Golden Gate Park lakes; therefore, no impact discussion is provided for the reasons described below:

Golden Gate Park Lakes Surface Water Effects. Golden Gate Park is located at the northernmost extent of the Westside Basin. The average depths to groundwater indicate that these shallow lakes do not intersect the water table and thus groundwater-surface water interaction does not affect surface water conditions in the Golden Gate Park lakes. The operation of the GSR Project, including both Put and Take Years, is not anticipated to affect this area, because it is too far away from Project pumping and in-lieu recharge. For both reasons – the lack of groundwater-surface water interaction and distance – the Project would not affect water levels or water quality in the Golden Gate Park lakes. (Kennedy/Jenks 2012d)

Water Quality Standards

As described below there would be no operation-related water quality impacts relative to the following issues:

Violate waste discharge requirements. The proposed Project operation would not discharge any type of waste to groundwater; therefore, no waste discharge requirements would apply to the Project relative to groundwater.

Violate drinking water standards relative to specific constituents for which the SFPUC would provide treatment. As described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types), the SFPUC proposes to provide treatment as needed to meet State and federal drinking water standards for bacteria and micro-organisms, pH, iron, manganese, nitrate, VOCs, or other similar constituents. The SFPUC also proposes to provide fluoridation as required to meet Title 22 of the California Code of Regulations, as described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types). Project Description Table 3-3 (Site-specific Facility Characteristics), describes the proposed treatment of groundwater at each of the well sites. Treatment systems include disinfection to comply with the primary MCLs for bacteria and micro-organisms, pH adjustment, iron and/or manganese removal to comply with secondary MCLs regarding odor and taste, and fluoridation. At Sites 12 and 19 (Alternate), blending of Project groundwater with existing surface water supplies is proposed to comply with secondary MCLs for iron and/or manganese. The proposed treatment systems are capable of providing required levels of disinfection, pH adjustment, reduction in iron and manganese concentrations, and fluoridation so that State and federal drinking water standards would be met (MWH et al. 2008). Because the SFPUC's proposal, as described in Chapter 3, Section 3.4.2.2 (Well Facility Types), provides treatment as needed to meet State and federal drinking water standards for these constituents, no additional analysis of the potential to violate these drinking water standards is needed. Therefore, the significance criterion related to drinking water standards (for constituents for which treatment would be provided) is not applicable to operation of the Project and is not discussed further.

5.16.3.4 Summary of Impacts

For the significance criteria that have not already been deemed "not applicable" in the Approach to Analysis section above, the specific impact analyses below are divided into two subsections: (1) construction impacts (short-term) and (2) operational impacts (long-term). Table 5.16-6 (Summary of Surface Water Hydrology and Water Quality Construction and Operational Impacts) provides a summary of potential impacts from construction and operation of the Project, including cumulative construction impacts that would occur on a site-specific basis. Table 5.16-7 (Summary of Hydrology and Water Quality Operational and Cumulative Impacts relative to Proposed Project Pumping and In-Lieu Recharge) provides a summary of potential impacts from operation of the Project, including cumulative impacts, which would occur due to overall Project pumping and in-lieu recharge. There would be no operational impacts at the Westlake Pump Station; therefore the Westlake Pump Station is not included in the operational impacts summary table.

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TABLE 5.16-6
Summary of Surface Water Hydrology and Water Quality Construction and Operational Impacts

	Construction		Operations			Cumulative
Sites	**Impact HY-1: Project construction activities would degrade water quality as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals during construction.**	**Impact HY-2: Discharge of groundwater could result in minor localized flooding, violate water quality standards, and/or otherwise degrade water quality.**	**Impact HY-3: Project operation would not alter drainage patterns in such a manner that could result in degraded water quality or cause on- or off-site flooding.**	**Impact HY-4: Project operations would not impede or redirect flood flows.**	**Impact HY-5: Project operations would not result in a violation of water quality standards or in the degradation of water quality from the discharge of groundwater during well maintenance.**	**Impact C-HY-1: Project construction could result in a cumulatively considerable contribution to cumulative impacts on surface water hydrology and water quality.**
Site 1	LSM	LSM	LS	NI	LS	LSM
Site 2	LSM	LSM	LS	NI	LS	LSM
Site 3	LSM	LSM	LS	NI	LS	LSM
Site 4	LSM	LSM	LS	NI	LS	LSM
Westlake Pump Station	LSM	NI	NI	NI	NI	LSM
Site 5 (Consolidated Treatment and On-site options)	LSM	LSM	LS	NI	LS	LSM
Site 6	LSM	LSM	LS	NI	LS	LSM
Site 7 (Consolidated Treatment and On-site options)	LSM	LSM	LS	NI	LS	LSM
Site 8	LSM	LSM	LS	NI	LS	LSM
Site 9	LSM	LSM	LS	LS	LS	LSM
Site 10	LSM	LSM	LS	NI	LS	LSM
Site 11	LSM	LSM	LS	NI	LS	LSM
Site 12	LSM	LSM	LS	NI	LS	LSM
Site 13	LSM	LSM	LS	NI	LS	LSM
Site 14	LSM	LSM	LS	NI	LS	LSM
Site 15	LSM	LSM	LS	NI	LS	LSM
Site 16	LSM	LSM	LS	NI	LS	LSM
Site 17 (Alternate)	LSM	LSM	LS	NI	LS	LSM
Site 18 (Alternate)	LSM	LSM	LS	NI	LS	LSM
Site 19 (Alternate)	LSM	LSM	LS	NI	LS	LSM

Notes:

NI = No Impact

LS = Less than Significant Impact

LSM = Less than Significant with Mitigation

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TABLE 5.16-7
Summary of Hydrology and Water Quality Operational and Cumulative Impacts relative to Proposed Project Pumping and In-lieu Recharge

Impact	Significance Level
Project Operational Impacts	
Impact HY-6: Project operation would decrease the production rate of existing nearby irrigation wells due to localized groundwater drawdown within the Westside Groundwater Basin such that existing or planned land use(s) may not be fully supported.	SUM[(a)]
Impact HY-7: Project operation would not result in substantial land subsidence due to decreased groundwater levels in the Westside Groundwater Basin where the historical low water levels are exceeded.	LS
Impact HY-8: Project operation would not result in seawater intrusion due to decreased groundwater levels in the Westside Groundwater Basin.	LS
Impact HY-9: Project operation could have a substantial, adverse effect on water quality that could affect the beneficial uses of Lake Merced.	LSM
Impact HY-10: Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Pine Lake.	LS
Impact HY-11: Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Colma Creek, San Bruno Creek, Lomita Channel, or Millbrae Creek.	LS
Impact HY-12: Project operation would not cause a violation of water quality standards due to mobilization of contaminants in groundwater from changing groundwater levels in the Westside Groundwater Basin.	LS
Impact HY-13: Project operation would not result in degradation of drinking water quality or groundwater quality relative to constituents for which standards do not exist.	LS
Impact HY-14: Project operation may have a substantial adverse effect on groundwater depletion in the Westside Groundwater Basin over the very long term.	LSM
Operational Cumulative Impacts	
Impact C-HY-2: Operation of the proposed Project would result in a cumulatively considerable contribution to cumulative impacts related to well interference.	SUM[(a)]
Impact C-HY-3: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to subsidence.	LS
Impact C-HY-4: Operation of the proposed Project would not have a cumulatively considerable contribution to seawater intrusion.	LS
Impact C-HY-5: Operation of the proposed Project could have a cumulatively considerable contribution to cumulative impacts on beneficial uses of surface waters.	LSM
Impact C-HY-6: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality standards.	LS
Impact C-HY-7: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality degradation.	LS
Impact C-HY-8: Operation of the proposed Project would have a cumulatively considerable contribution to a cumulative impact related to groundwater depletion effect.	LSM

Notes:

(a) Implementation of Mitigation Measure M-HY-6 (Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation) depends in part upon the willingness of the well owner to participate in the monitoring program. Therefore, while Mitigation Measure M-HY-6 could reduce the impacts of well interference to a *less-than-significant* level, its implementation cannot be assured at this time. As a result, Impact HY-6 is conservatively categorized as *significant and unavoidable with mitigation*.

LS = Less than Significant Impact, LSM = Less than Significant with Mitigation, SUM=Significant and Unavoidable Impacts

5.16.3.5 Construction Impacts and Mitigation Measures

Impact HY-1: Project construction activities would degrade water quality as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals during construction. (Less than Significant with Mitigation)

Discussion of Water Quality Degradation

The proposed Project could degrade water quality as a result of erosion caused by earthmoving activities during construction or the accidental release of hazardous construction chemicals. In general, water quality impacts would be substantial if a water quality standard were to be exceeded or a beneficial use were to be impacted due to changes in water quality caused by erosion and/or siltation or release of hazardous construction chemicals resulting from Project earthmoving activities.

Approach to Analysis

The surface water hydrology analysis evaluates the proposed Project's construction that may have the potential to increase erosion and/or siltation or otherwise degrade existing water quality. The analysis evaluates potential impacts from the construction of well facilities and proposed pipelines, including the proposed and alternate water connection pipelines.

Impact Discussion and Significance Determination

<u>All Sites</u>

Earthmoving activities associated with Project construction at well facility sites would temporarily alter existing drainage patterns at well facility sites, including vegetation removal, grading, excavation, and soil stockpiling. New pipelines would be installed using open-trench construction methods. Exposed soil from stockpiles, excavated areas, and other areas where ground cover would be removed could be transported elsewhere by wind or water. If not properly managed, this could increase sediment loads in receiving water bodies, thereby adversely affecting water quality and designated beneficial uses. Earthmoving activities could, therefore, have a *significant* impact on water quality.

Site excavation and grading would be minor, with grading to a maximum depth of five feet for building foundations and underlying utilities (see Chapter 3, Project Description, Section 3.5.1.2 [Construction of Well Facilities]). Pipelines to connect the new wells to the water, storm drain, and sanitary sewer systems would generally be excavated to a depth of up to six feet. The discharge of sediment-laden groundwater to the storm drain system during excavation dewatering could degrade water quality and violate water quality standards. Construction water discharges from excavation dewatering could, therefore, have a *significant* impact on water quality. Construction activities at all sites could also result in the accidental release of hazardous construction chemicals, such as adhesives, solvents, and fuels. If not managed appropriately, these chemicals could adhere to soil particles, become mobilized by rain or runoff, or infiltrate into groundwater, degrading water quality. Earthmoving activities and use of construction chemicals at all facility sites could, therefore, have a *significant* impact on water quality.

Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would reduce potential water quality impacts during Project construction activities to a *less-than-significant* level by requiring measures to control erosion and sedimentation of receiving water bodies and minimize the risk of hazardous materials releases to surface water bodies. At sites where more than one acre of land would be disturbed, compliance with the requirements of the NPDES General Permit for Storm Water Discharges Associated with Construction Activity would be required. As a result, the potential impact on water quality would be *less than significant with mitigation*.

Mitigation Measure M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)

Consistent with the requirements of the NPDES General Permit for Storm Water Discharges Associated with Construction Activity, at sites where more than one acre of land disturbance would occur (Sites 3, 4, 5, 6, 7, 12, 13, and 14), the SFPUC or its contractor(s) shall develop a Storm Water Pollution Prevention Plan (SWPPP), submit a notice of intent to the SWRCB's Division of Water Quality and implement site-specific BMPs to prevent discharges of nonpoint-source pollutants in construction-related stormwater runoff into downstream water bodies.

At sites where less than one acre of land disturbance would occur (Sites 1, 2, 8, 9, 10, 11, 15, 16, 17 Alternate, 18 Alternate, 19 Alternate, and the Westlake Pump Station), the SFPUC or its contractor(s) shall prepare and implement Erosion and Sediment Control Plans (ESCPs).

The SWPPPs and ESCPs shall include sufficient measures to address the overall construction of the Project and, at a minimum, construction contractors should all undertake the following measures, as applicable, to minimize any adverse effects on water quality:

Scheduling

- Schedule construction to minimize ground disturbance during the rainy season.
- Stabilize all disturbed soils as soon as possible following the completion of soil disturbing work in the Project area.
- Stabilize soil with vegetation or physical means in the event rainfall is expected.
- Install erosion and sediment control BMPs prior to the start of any ground-disturbing activities.

Erosion and Sedimentation

- Preserve existing vegetation in areas where no construction activity is planned or where construction activity will occur at a later date.
- Stabilize and revegetate disturbed areas as soon as possible after construction by planting or seeding and/or using mulch (e.g., straw or hay, erosion control blankets, hydromulch, or other similar material).
- Install silt fences or fiber rolls or implement other suitable measures around the perimeters of the construction zone, staging areas, temporary stockpiles, spoil areas, stream channels, and swales, as well as down-slope of all exposed soil areas and in other locations determined necessary to prevent offsite sedimentation.

- Install temporary slope breakers during the rainy season on slopes greater than five percent where the base of the slope is less than 50 feet from a water body, wetland, or road crossing at spacing intervals required by the SWRCB Construction General Permit.
- Use filter fabric or other appropriate measures to prevent sediment from entering storm drain inlets.
- Detain and treat water produced by the dewatering of construction sites using sedimentation basins, sediment traps (when water is flowing and there is sediment), or other measures to ensure that discharges to receiving waters meet applicable water quality objectives.

Tracking Controls

- Grade and stabilize construction site entrances and exits to prevent runoff from the site and to prevent erosion.
- Remove any soil or sediment tracked off paved roads during construction by employing street sweeping.

Non-stormwater Control

- Keep construction vehicles and equipment clean; do not allow excessive buildup of oil and grease.
- Check construction vehicles and equipment daily at startup for leaks and repair any leaks immediately.
- Do not refuel vehicles and equipment within 50 feet of surface waters to prevent run-on and runoff and to contain spills.
- Conduct all refueling and servicing of equipment with absorbent material or drip pans underneath to contain spilled fuel. Collect any fluid drained from machinery during servicing in leak-proof containers and deliver to an appropriate disposal or recycling facility.
- Contain fueling areas to prevent run-on and runoff and to contain spills.
- Cover all storm drain inlets when paving or applying seals or similar materials to prevent the offsite discharge of these materials.

Waste Management and Hazardous Materials Pollution Control

- Remove trash and construction debris from the Project area regularly. Provide an adequate number of waste containers with lids or covers to keep rain out of the containers and to prevent trash and debris from being blown away during high winds.
- Locate portable sanitary facilities a minimum of 50 feet from creeks or waterways.
- Ensure the containment of sanitation facilities (e.g., portable toilets) to prevent discharges of pollutants to the stormwater drainage system or receiving water.

- Maintain sanitary facilities regularly.
- Store all hazardous materials in an area protected from rainfall and stormwater run-on and prevent the offsite discharge of leaks or spills.
- Inspect dumpsters and other waste and debris containers regularly for leaks and remove and properly dispose of any hazardous materials and liquid wastes placed in these containers.
- Train construction personnel in proper material delivery, handling, storage, cleanup, and disposal procedures.

BMP Inspection, Maintenance and Repair

- Inspect all BMPs on a regular basis to confirm proper installation and function.
- Inspect all stormwater BMPs daily during storms.
- Inspect sediment basins, sediment traps and other detention and treatment facilities regularly throughout the construction period.
- Provide sufficient devices and materials (e.g., silt fence, fiber rolls, erosion blankets, etc.) throughout Project construction to enable immediate repair or replacement of failed BMPs.
- Inspect all seeded areas regularly for failures and remediate or repair as soon as feasible.

Permitting, Monitoring, and Reporting

- Provide the required documentation for inspections, maintenance and repair requirements.
- Monitor water quality to assess the effectiveness of control measures.
- Maintain written records of inspections, spills, BMP-related maintenance activities, corrective actions and visual observations of any offsite discharge of sediment or other pollutants.
- Notify the RWQCB and other agencies as required (e.g., California Department of Fish and Wildlife) if the criteria for turbidity, oil/grease, or foam are exceeded and undertake corrective actions.
- Immediately notify the RWQCB and other agencies as required (e.g., California Department of Fish and Wildlife) of any spill of petroleum products or other organic or earthen materials and undertake corrective action.

Post-construction BMPs

- Revegetate all temporarily disturbed areas as required after construction activities are completed.
- Remove any remaining construction debris and trash from the Project area and staging areas upon Project completion.

- Phase the removal of temporary BMPs as necessary to ensure stabilization of the site.
- At sites covered under the NPDES General Construction Permit, correct post-construction site conditions, as necessary, to comply with the SWPPP and any other pertinent RWQCB requirements.

Impact Conclusion: Less than Significant with Mitigation

Impact HY-2: Discharge of groundwater could result in minor localized flooding, violate water quality standards, and/or otherwise degrade water quality. (Less than Significant with Mitigation)

Discussion of Water Quality Degradation

The proposed Project could cause minor localized flooding and degrade water quality as a result of groundwater discharges associated with well construction as discussed below. In general, water quality impacts would be substantial if a water quality standard were to be exceeded or a beneficial use were to be impacted due to changes in water quality caused by discharge activities.

Approach to Analysis

The analysis evaluates potential impacts from groundwater discharge during well development and testing activities. The amount and location of groundwater discharge were evaluated to determine potential impacts on water quality and flooding for each well facility site. Regional documents and maps were reviewed to identify hydrology and water quality resources that could be directly or indirectly affected by construction activities. The analysis focuses on how discharge of groundwater would affect hydrology or water quality of regional and local surface waters.

Impact Discussion and Significance Determination

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with significant impacts.

<u>Westlake Pump Station</u>

Upgrades at the Westlake Pump Station would be located within the existing pump station building and would not generate groundwater that would need to be discharged to a local storm drain or sanitary sewer system. Therefore, there would be *no impact* on flooding or water quality resulting from groundwater discharges at the Westlake Pump Station.

Impact Conclusion: No Impact

<u>Sites 1 through 19 (Alternate)</u>

Sites 1, 3, 4, 7, 9, 11, 12, 14, 15, 16, 17(Alternate), 18 (Alternate), and 19 (Alternate)

Following drilling of the production wells at these sites, the wells would be developed and various well pumping tests would be performed. Final development of the well would be performed by surging and pumping using a temporary test pump. Well pumping tests would include pumping for durations of two hours each at different discharge rates, as well as continuous pumping for 12 to 48 hours at the final design capacity of the well. Up to three million gallons of groundwater would be produced from a well during the final well development and pumping tests, which would be discharged to the local storm drain and/or the sanitary sewer. The peak discharge rate during well development (lasting for a few hours) would be approximately 800 gallons per minute (gpm); the typical discharge rate would be closer to 500 gpm. The development and testing would occur over the course of approximately 150 hours for each well resulting in an average discharge of 0.5 million gallons per day (see Chapter 3, Project Description, Section 3.5.1.1 [Construction Methods for Production Wells]).

The discharge of sediment-laden groundwater to the storm drain system during well development and pumping tests could degrade water quality and violate water quality standards. Depending on the rate of discharge, the discharged effluent could also cause minor localized flooding if discharge rates exceeded the capacity of local storm drains. Discharges of groundwater from well development and pump tests at these sites could, therefore, have a *significant* impact on water quality.

Before being placed into service, the chemical and filtration facilities and new pipelines would be flushed and disinfected to meet water quality regulations (see Chapter 3, Project Description, Section 3.5.1.4 [Dewatering and Other Potential Discharges]). All water used for flushing would come from the new wells and would be discharged to the nearest sanitary sewer and conveyed to local wastewater treatment plants for processing. Therefore, there would be *no impact* on surface water quality related to disinfection of new chemical and filtration facilities and pipelines.

Mitigation Measure M-HY-2 (Management of Well Development and Pump Testing Discharges) would reduce potential water quality impacts from well development and pump testing to a *less-than-significant* level by requiring the construction contractor to prepare and implement a Project-specific discharge plan that specifies how effluent would be managed to protect water quality.

Mitigation Measure M-HY-2: Management of Well Development and Pump Testing Discharges (All Sites, Except Westlake Pump Station)

To address potential impacts on receiving water quality that could result during the construction period related to well development and pump testing, the SFPUC and its contractor shall: 1) prepare and implement a site-specific discharge plan; and 2) fully comply with NPDES requirements.

The discharge plan shall specify how the water will be collected, contained, treated, monitored, and discharged to the vicinity storm drainage system or sanitary sewer system. Discharges to storm drains are subject to review and approval by the RWQCB. The discharge plan shall at a minimum:

- Identify methods and locations for collecting and handling water on site prior to discharge, determine treatment requirements, and determine the capacity of holding tanks.
- Identify methods for treating water on site prior to discharge, such as filtration, coagulation, sedimentation settlement areas, oil skimmers, pH adjustment, and other BMPs.

- Establish procedures and methods for maintaining and monitoring discharge operations to ensure that no breach in the process occurs that could result in a failure to achieve/maintain the applicable water quality objectives of receiving waters.
- Identify discharge locations and include details regarding how the discharge will be conducted to minimize erosion and scour.

The proposed discharge is anticipated to be conditionally covered under San Mateo County's municipal stormwater permit (Order No. 99-059, NPDES Permit No. CAS002992), contingent upon compliance with certain conditions (RWQCB 2009b, 2012). Prior to any discharge to a storm drainage system, the SFPUC and its contractor shall request a determination from the RWQCB as to the type of permit under which the Project effluent discharges will be regulated. Based on that determination, the SFPUC shall prepare and submit all required and relevant Project information so that the RWQCB can issue appropriate guidelines and requirements (e.g., numerical effluent limitations, monitoring and reporting requirements). Based on previous discussions with the RWQCB (RWQCB 2009a, 2012), anticipated conditions include, but would not be limited to:

- The SFPUC shall notify affected stormwater agencies of the volume, rate, and location of the planned discharge at least 14 days before discharging.
- The discharged water shall not exceed 50 NTU. Turbidity shall be monitored every 15 minutes during the first hour of operation of any sedimentation or filtration device used to meet discharge limitations and once every two hours thereafter. If turbidity limits are exceeded for more than two hours, the discharge shall be terminated until turbidity limits can be complied with.
- The pH of the discharged water shall be within the range of 6.5 and 8.5 and pH shall be measured once per day during the discharge.
- The discharged water shall not cause pollution, contamination, or nuisance.
- The discharged water shall not cause scouring or erosion at the point of discharge of downstream from the discharge.
- Self-Monitoring Reports shall be submitted no later than 30 days following the last day of each month in which the discharges occur. These reports shall summarize turbidity measurements and approximate volumes of the discharges.

The construction contractor(s) shall comply with all monitoring and reporting requirements established by the RWQCB for discharges to storm drainage system. Any failure to achieve/maintain established narrative or numeric water quality objectives shall be reported to the RWQCB and corrective action taken. Corrective action may include an increase in residence time in treatment features (e.g., longer holding time in settling tanks) and/or incorporation of additional treatment measures, which could include but are not limited to the addition of sand filtration prior to discharge.

Sites 2, 5, 6, 8, 10, and 13

Test wells at Sites 2, 5, 6, 8, 10, and 13 have been installed and, therefore, would not further generate groundwater associated with initial well drilling and pumping test activities that would need to be discharged to a local storm drain or sanitary sewer system. Therefore, there would be *no impact* on surface water quality related to discharges from well drilling and pumping test activities.

As summarized for the other well sites above, before being placed into service, the chemical and filtration facilities and new pipelines at these sites would be flushed and disinfected to meet water quality regulations. All water used for flushing would come from the new wells and would be discharged to the nearest sanitary sewer and conveyed to local wastewater treatment plants for treatment. Therefore, there would be *no impact* on surface water quality related to the disinfection of new chemical and filtration facilities and pipelines.

Mitigation Measure M-HY-2 (Management of Well Development and Pump Testing Discharges) would reduce water quality impacts from dewatering discharges at these sites to a *less-than-significant* level by requiring by requiring the construction contractor to prepare and implement a Project-specific discharge plan that specifies how effluent would be managed to protect water quality.

> ***Mitigation Measure M-HY-2: Management of Well Development and Pump Testing Discharges (All Sites, Except Westlake Pump Station)***
> (See above for a description)

Impact Conclusion: Less than Significant with Mitigation

5.16.3.6 Operational Impacts and Mitigation Measures – Surface Water

Impact HY-3: Project operation would not alter drainage patterns in such a manner that could result in degraded water quality or cause on- or off-site flooding. (Less than Significant)

Description of Flooding Impacts

Operational impacts that have the potential to increase runoff that results in water quality impacts or on- or off-site flooding impacts would be significant.

Approach to Analysis

The amount of new impervious coverage at each site was evaluated to determine if it would increase runoff and impact water quality or cause on- or off-site flooding.

Impact Discussion and Significance Determination

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

Westlake Pump Station

Upgrades at the Westlake Pump Station would be located within the existing pump station building and would not alter drainage patterns or add new impervious surfaces. Therefore, there would be *no impact* to water quality at the Westlake Pump Station related to alteration of drainage patterns.

Impact Conclusion: No Impact

Sites 1 through 19 (Alternate)

Project pipelines would be constructed below ground and would not increase the rate or amount of surface water runoff. The amount of proposed new impervious surfaces at the well facility sites ranges from a minimum of 205 square feet to a maximum of 3,675 square feet at individual sites (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). The buildings and paved parking areas at all sites would result in limited amounts of new impervious surfaces. Therefore, project-related increases in stormwater runoff resulting from increases in impervious surfaces would not increase the potential for on- or off-site flooding and the impact would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HY-4: Project operations would not impede or redirect flood flows. (Less than Significant)

Description of Flooding Impacts

Project facilities located within the 100-year flood hazard area could impede and redirect flood flows around the site resulting in inundation or flooding of the surrounding areas. If a Project facility were to be constructed in the 100-year flood hazard area and it were to redirect flood flows to a previously unaffected area, then the impact could be significant.

Approach to Analysis

As described in Section 5.16.1.2 (Regional Surface Water Hydrology) under the sub-heading "Flood, Seiche, and Tsunami," a portion of the construction areas for Sites 9 and 13 would be located in areas of a mapped 100-year flood zones. Locations, elevations, and sizes of the proposed facilities were evaluated to determine whether there would be a potential to redirect flood flows that could then impact previously unaffected areas with flooding.

Impact Discussion and Significance Determination

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

Sites 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station

Permanent Project facilities at these sites would not be located within a FEMA mapped 100-year flood hazard zone. While portions of the construction work areas at Site 13 would be situated within 100-year flood hazard zones, there would be no permanent aboveground structures remaining in the flood zone at this site. Therefore, there would be *no impact* at these sites related to the potential for impeding or redirecting flood flows.

Impact Conclusion: No Impact

Site 9

Site 9 would be located approximately 25 feet from channelized sections of the Colma Creek Diversion Channel and the San Mateo County Flood Control Channel. According to the current FEMA Flood Insurance Rate Mapping for the area near Site 9, a portion of the proposed chemical treatment building and parking lot would be within the mapped 100-year flood hazard zone along the San Mateo County Flood Control Channel (FEMA 2012). The placement of fill and construction of aboveground facilities within a flood hazard zone have the potential to impede or redirect flood flows. Aboveground facilities that are not designed to withstand inundation can be damaged during flood events. Underground facilities, such as pipelines, would not affect flood flows.

The potential for the site facilities to displace floodwaters, raise flood elevations, create new flooding impacts (e.g., by causing flooding of existing facilities or structures that previously would not have been inundated), or exacerbate existing flooding problems would be *less than significant*, given that the chemical treatment building at Site 9 would be elevated above the 100-year flood elevation (Chapter 3, Project Description, Section 3.4.3 [Facility Sites]). Also, the presence of the at-grade parking area would have a negligible effect on impeding or redirecting flood flows and would therefore not adversely affect surrounding areas.

Impact Conclusion: Less than Significant

Impact HY-5: Project operations would not result in a violation of water quality standards or in the degradation of water quality from the discharge of groundwater during well maintenance. (Less than Significant)

Description of Water Quality Impacts

Water quality impacts could occur from groundwater discharge during well maintenance activities such that water quality standards are exceeded or a beneficial use is adversely affected. If groundwater discharges were to contribute to runoff that could exceed the capacity of an existing storm drain system or if runoff from maintenance activities were to alter existing drainage patterns of the site or area and thereby cause substantial erosion or siltation, then such impacts could be significant.

Approach to Analysis

The proposed groundwater discharge volumes and durations were evaluated to determine whether the existing storm drain and sanitary sewer systems could accommodate the anticipated flow rates.

Impact Discussion and Significance Determination

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

Westlake Pump Station

Upgrades at the Westlake Pump Station would be located within the existing pump station building and would not generate groundwater that would need to be discharged to a local storm drain or sanitary sewer system. Therefore, there would be *no impact* on water quality at the Westlake Pump Station related to groundwater discharges during Project operation.

Impact Conclusion: No Impact

Sites 1 through 19 (Alternate)

Weekly or monthly exercising of the production wells for one to four-hour periods would be required to ensure that the facilities remain operational. The wells at Sites 2, 3, 4, 5 (Consolidated at Site 6), 7 (Consolidated at Site 6), 14, and 19 (Alternate) would be connected to the storm drain system for disposing of pumped water that would be generated during well exercising. Chemical treatment and filtration would not be needed at these sites; therefore, these wells would not generate chloraminated water or filter backwash.

Underground piping would connect well facilities at Sites 1, 5 (On-site Treatment), 6, 7 (On-site Treatment), 8, 9, 10, 11, 12, 13, 15, 16, 17 (Alternate), and 18 (Alternate) to the local storm drain system and/or the sanitary sewer system to allow the discharge of groundwater during well exercising, including chloraminated water or filter backwash. Chloraminated water would be dechlorinated and sent to the storm drain or, if not treated, sent to the local sanitary sewer system, as described in Chapter 3, Project Description, Section 3.8.3, Maintenance. The determination of where to send the chloraminated water would be based on operational constraints such as the duration and volume of the discharge and the distance to the closest sanitary sewer. Backwash from the iron/manganese removal facilities would be sent to the local sanitary sewer system.

As discussed in the Section 5.12, Utilities and Service Systems, Section 5.12.1.1 (Utilities) and under Impacts UT-2 and UT-5, the existing sanitary sewer and storm drain systems have adequate capacity to accommodate the discharge volumes from the proposed well exercising. All discharge water would be sent to either the sanitary sewer or the storm drain system; therefore, the discharge water associated with operations of the Project would not violate water quality standards or degrade water quality and any such potential impacts would be *less than significant*.

Impact Conclusion: Less than Significant

5.16.3.7 Operation Impacts and Mitigation Measures – Groundwater

Impact HY-6: Project operation would decrease the production rate of existing nearby irrigation wells due to localized groundwater drawdown within the Westside Groundwater Basin such that existing or planned land use(s) may not be fully supported. (Significant and Unavoidable with Mitigation)

Description of Estimated Project Effects on Existing Irrigation Wells

Existing irrigation wells are wells owned and operated by parties other than the Project Partner Agencies. The existing irrigation wells identified in the South Westside Groundwater Basin are wells used to irrigate cemeteries and golf clubs, as shown in Figure 5.16-6 (Existing Irrigation Wells in the South Westside Groundwater Basin). During most Put and Hold Years, the Project would increase groundwater levels relative to modeled existing conditions, and existing irrigation wells would benefit from the higher water levels, by experiencing increased production rates. Higher water levels are expected during about 70 to 80 percent of the modeled time period (Kennedy/Jenks 2012b). During Take Years (dry years), pumping at Project wells would take place and could cause groundwater levels to decline below levels that are predicted under modeled existing conditions (i.e., levels predicted to occur without operation of the Project under existing conditions considering the historic range of hydrologic and rainfall conditions). If the Project were to decrease groundwater levels in the Westside Groundwater Basin near existing irrigation wells, adverse effects from well interference could result. If well interference were great enough, irrigation water currently supplied by existing irrigation wells could be decreased to the extent that existing irrigation uses, such as for turf at cemeteries and at golf clubs, would not be fully supported. The quality of turf grass at cemeteries and golf clubs is an important component of the attractiveness of these facilities and hence for the economic viability of these land uses. Insufficient irrigation water would result in a deterioration of existing turf grass and landscaping, affecting operating conditions at both golf clubs and cemeteries.

Pumping at a well causes groundwater levels to decline in the area around the well. The area of groundwater level decline is known as the cone of depression. Well interference occurs when a well's cone of depression comes into contact with or overlaps the cone of depression from another well (see Figure 5.16-7 [Well Interference Schematic]) (Driscoll 1986).

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Legend

- Proposed Project Well Facility Sites
- Westlake Pump Station
- Existing Irrigation Wells
- County Boundary
- North Westside[1] Groundwater Basin
- South Westside[1] Groundwater Basin

0 0.5 1
Scale Miles
1 inch = 1 mile

Existing Irrigation Wells in the South Westside Groundwater Basin

Regional Groundwater Storage and Recovery Project

Figure 5.16-6

Data Source: Fugro 2012a, as modified by GHD. [1] The Westside Groundwater Basin has been administratively divided at the San Francisco-San Mateo County line.

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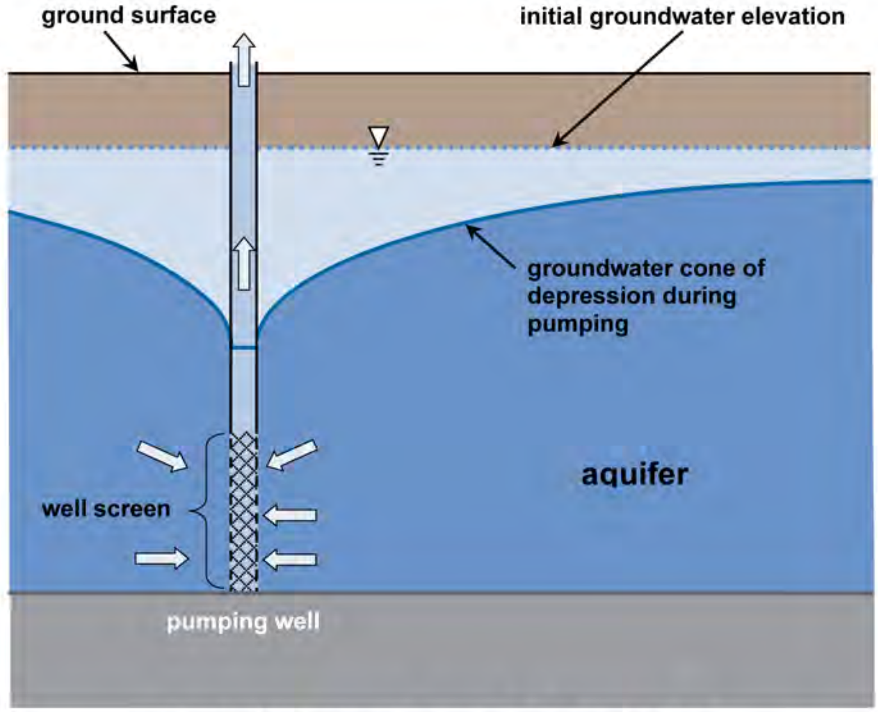
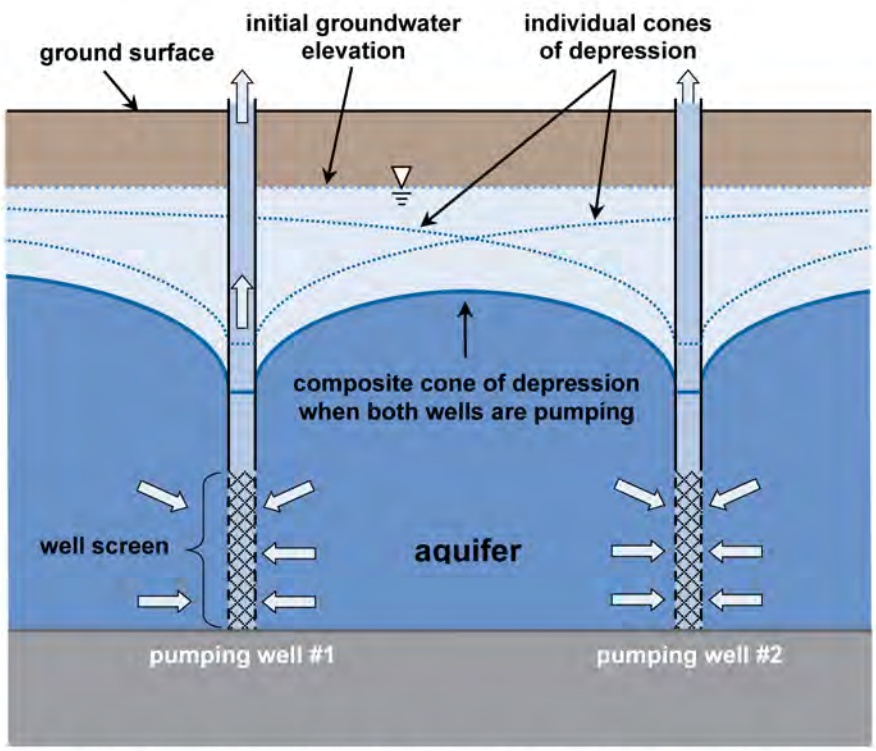


Cone of Depression around a Pumping Well



Well Interference from Overlapping Cones of Depression

Composite cone results in a lower pumping water level in each well, compared to individual cone of depression pumping water level.

Well Interference Schematic

Regional Groundwater Storage and Recovery Project

Figure 5.16-7

In the Westside Groundwater Basin, well interference (i.e., lower groundwater levels at an affected well) can affect operation of a well in several ways:

- Lower groundwater levels increases the distance the water has to travel vertically to reach the ground surface (this distance is known as the pumping lift). Greater pumping lift results in a decrease in the pump's discharge rate, which is the rate that water is delivered from the aquifer to the surface by the pump.
- If groundwater levels drop below the top of the well screen[17], less of the well screen provides water, which may result in a decrease in the pump's discharge rate.
- If groundwater levels drop below the top of the well screen, there is an increased risk of damage to the well from corrosion of the screen and/or to the pump from aeration of the well water. While such damage may not occur immediately or decrease the pump's discharge rate immediately, it may decrease the discharge rate over time.

The reduction in a pump's discharge rate or an increase in risk of damage to a pump or well does not necessarily prevent a well from meeting the demand for water needed to support a particular land use, because overall demand can sometimes be met with longer durations of pumping at a reduced rate.

To understand the potential for well interference impacts from the Project, this section describes existing wells that may experience well interference, including the depth and pump discharge rate of each well.

Existing Irrigation Wells and Associated Land Uses

Proposed Project wells would be located in areas near existing wells where well interference would potentially occur. These existing irrigation wells are not owned by the Project proponent (the SFPUC) or the Partner Agencies, but instead are owned by private land owners. Significant well interference is not expected to occur beyond 1.5 miles from a Project well and, therefore, the study area for well interference is limited to areas within 1.5 miles of a Project well[18]. The limitation of 1.5 miles was selected to represent a reasonable extent for a cone of depression given consideration of vertical leakage from one aquifer to another, groundwater recharge, interception of groundwater flow that otherwise discharges from the aquifer, and/or encountering a surface water body. (Fugro 2012a)

The primary land uses supported by groundwater in the South Westside Groundwater Basin – and within the study area – are cemeteries and golf clubs, which use groundwater to irrigate turf. Three of these golf clubs use mostly recycled water to irrigate their golf courses, but also use some groundwater

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[17] The well screen is a perforated section of the well casing which allows groundwater from the aquifer to be pumped into the well casing and then to the ground surface.

[18]The Green Hills Golf Club wells are approximately 0.75 mile from the southernmost proposed Project well at Site 16. The Green Hills Golf Club wells are screened in the Shallow Aquifer under unconfined conditions. The Green Hills Golf Club wells would not be affected by pumping from the Project due to the smaller proposed pumping capacity at Site 16 (which is the only Project well that would be within 1.5 miles) and because of differences in well screen depths and geologic conditions between the Green Hills Golf Club wells and the proposed Project well at Site 16 (Fugro 2012a).

(LSCE 2010). The other cemeteries and golf clubs are reliant upon groundwater or surface water as their source of irrigation water supply.

The SFPUC invited cemetery and golf club owners and representatives to a Project workshop held on June 25, 2009 at the Colma Town Hall. Plans for the Project were presented and attendees were informed that the SFPUC was conducting a survey of existing irrigators' well owners as part of a series of studies in the Westside Groundwater Basin. A data request list pertaining to the well survey was made available to all attendees. (Fugro 2012a)

As a follow-up to the workshop, the SFPUC conducted site visits and/or meetings at the cemeteries and golf clubs. If permitted by the site owner or representative, site visits included well visits where Global Positioning System (GPS) coordinates were obtained and water levels measured if the well had an access port. Well visits occurred at all the cemeteries and golf clubs listed in Table 5.16-8 (Existing Irrigators' Wells Identified as a Primary, Active, or Secondary Well that May Be Affected by the Project) (well visits to the San Francisco Golf Club and Olympic Club occurred prior to 2009). (Fugro 2012a)

Table 5.16-8 lists the cemetery and golf club irrigation wells in the South Westside Groundwater Basin that may be affected by well interference from the Project. The table includes wells identified as primary, active, or secondary wells. Backup wells are not included, because they do not support land use on a regular basis. Based on a review of California Department of Water Resources (DWR) well completion reports and information from well owners (Fugro 2012a), the cemetery and golf club wells are generally found to be screened in the Primary Production Aquifer (see Figure 5.16-6 [Existing Irrigation Wells in the South Westside Groundwater Basin]). Some of the cemetery and golf club wells have screen intervals that extend into the Deep Aquifer.

Table 5.16-8 also lists the top of screen of the wells. The screen of a well is open to groundwater inflow from the aquifer. The rated capacity of the pump installed in each well for which the information is available is also provided in Table 5.16-8 (Fugro 2012a). The rated capacity of the pump is the discharge rate established by the manufacturer applied to specified conditions.

TABLE 5.16-8
Existing Irrigators' Wells Identified as a Primary, Active, or Secondary Well that May Be Affected by the Project

Well Name	Top of Well Screen (feet below ground surface)	Rated Pump Capacity (gpm)
San Francisco Golf Club #2	360	700
Olympic Club #8	200	1000
Olympic Club #9	260	700
Lake Merced Golf Club #3	294	INA
Woodlawn Memorial Park	275	500
Italian Cemetery	300	260
Eternal Home Cemetery	280	200
Olivet Memorial Park	308	300
Home of Peace Cemetery	400	600
Hills of Eternity Cemetery	216	235
Cypress Lawn Memorial Park #3	191	INA
Cypress Lawn Memorial Park #4	330	INA
Holy Cross Cemetery #1	368	800
Holy Cross Cemetery #4	420	800
California Golf Club #7	255	200
California Golf Club #8	320	800

Source: Fugro 2012a

Note:
INA: Information not available.

Estimated Peak Irrigation Demand for Land Uses Supported by Existing Irrigators' Wells

The existing wells where interference may occur due to the Project are irrigation wells that pump groundwater to maintain turf at either cemeteries or golf clubs. In most cases, the SFPUC does not have data showing the actual volume of irrigation water used at the cemeteries and some golf clubs[19]. Therefore, demand for irrigation water at these facilities was estimated in order to determine if the water

[19] The volume of irrigation water used at cemeteries and golf clubs is not available in most cases, because the irrigation users do not meter their existing wells. In some cases, data regarding the volume of irrigation water may exist, but the irrigation user declined to provide such data to the SFPUC upon request. For detailed information about meetings with irrigation users, see *South Westside Basin Third Party Well Survey and Well Interference Analysis* (Fugro 2012a).

supply to support that demand could be affected by Project pumping. Irrigation water demand is estimated, as described below, using information from the *Final Recycled Water Feasibility Study* (Feasibility Study) (Carollo 2008). The Feasibility Study was developed cooperatively with the City of South San Francisco, the City of San Bruno, and the City of Brisbane, the SFPUC, and Cal Water. The Feasibility Study encompasses South San Francisco, San Bruno, Brisbane, and Colma and evaluated evapotranspiration in the study area and applied standard irrigation use coefficients to estimate the irrigation demand of cemeteries and golf clubs in the region. The annual water demand was estimated to be 1.7 af per acre of irrigated turf.

The Feasibility Study also estimated peak demand for irrigation water. Peak demand is important, because the need for irrigation water supply varies greatly throughout the year, with peak demand occurring on the hottest day of the hottest month. The peak month is estimated to require 20 percent of the total annual demand. The peak day is estimated to require 30 percent more than the average day in the peak month (Carollo 2008). Finally, golf clubs and cemeteries must be irrigated at night to accommodate daytime use by golfers and visitors and, therefore, must deliver the water over an approximately 12-hour period. As a result, peak demand is estimated be 0.0147 af/acre over a 12-hour period[20]. The acreage of potentially affected land uses was multiplied by this peak demand factor to determine the peak demand of each of the potentially affected irrigators, and the results are shown in Table 5.16-9 (Existing Irrigated Acreage and Estimated Peak Demand at Potentially Affected Land Uses).

TABLE 5.16-9
Existing Irrigated Acreage and Estimated Peak Demand at Potentially Affected Land Uses

Land Use	Irrigated Acreage (acres) [(a)]	Estimated Peak Demand (af per 12-hour period)
Woodlawn Memorial Park	50	0.7
Italian Cemetery	28	0.4
Eternal Home Cemetery	13	0.2
Olivet Memorial Park	57	0.8
Salem Cemetery, Hills of Eternity and Home of Peace	43	0.6
Cypress Lawn Memorial Park	146	2.2
Holy Cross Cemetery	150	2.2
California Golf Club	120	1.8

Note:

(a) Acreage from SFPUC 2010b

[20] The Feasibility Study (Carollo 2008) estimated that annual irrigation demand for turf in the Colma area is 1.7 af/acre and peak month demand is 20 percent of that – or 0.34 af/acre. An average day in the peak month is 1/30 of the monthly demand, or 0.011 af/acre. The peak day of the peak month is 30 percent higher than the average day, or 0.0147 af/acre. This water must be provided in a 12-hour period to accommodate nighttime irrigation.

The San Francisco Golf Club, the Olympic Club, and Lake Merced Golf Club use mostly recycled water to irrigate their golf clubs, but also use groundwater. Table 5.16-10 (Existing Average Annual Recycled Water and Groundwater Use and Estimated Peak Demand at Potentially Affected Land Uses that Use Recycled Water) shows average annual recycled water deliveries and groundwater use from 2005 to 2008 at these golf clubs (LSCE 2010). Peak groundwater demand (rather than annual average groundwater demand) is not known; therefore, peak demand is estimated using factors from the Feasibility Study to estimate total peak daily demand for both recycled water and groundwater. This estimated total peak daily demand is multiplied by the annual groundwater percentage to estimate the peak demand for groundwater over a 12-hour period[21]. Table 5.16-10 shows the estimated peak groundwater demand for each of the three golf club sites receiving recycled water.

TABLE 5.16-10
Existing Average Annual Recycled Water and Groundwater Use and Estimated Peak Demand at Potentially Affected Land Uses that Use Recycled Water [(a)]

Land Use	Average Annual Recycled Water Use 2005-2008 (af)	Average Annual Groundwater Use 2005-2008 (af)	Estimated Peak Day Demand for Groundwater (af per 12-hour period)
San Francisco Golf Club [(b)]	134	39	0.3
Olympic Club	321	10	0.1
Lake Merced Golf Club [(c)]	94	21	0.2

Notes:

(a) Data for the average annual recycled water use and groundwater use are taken from Final Task 8B Technical Memorandum #1, Hydrologic Setting of the Westside Basin (LSCE 2010). Slightly different data were subsequently made available for the San Francisco and Lake Merced golf clubs in the Final - 2011 Annual Groundwater Monitoring Report (SFPUC 2012e), which provides slightly different data for the years 2005 through 2008 and additional data for the year 2009. It is unknown which data from 2005 to 2008 are more accurate. The difference in groundwater use presented in the two sources is small and would not result in a change in the level of significance before or after mitigation compared to the results presented in this section, and therefore the earlier data from Technical Memorandum #1 have been used.

(b) Groundwater use for San Francisco Golf Club available for 2005, 2007 and 2008 from LSCE 2010.

(c) Groundwater use for Lake Merced Golf Club available only for 2005 and 2007 from LSCE 2010.

Approach to Analysis

Well interference could occur due to Project-related pumping in a manner that would result in a lowering of the local groundwater to a level where the production rate of preexisting nearby wells would drop to a level that would not fully support existing or planned land uses. For purposes of this analysis, a significant impact would result if the Project were to cause groundwater levels to decrease such that (1)

[21] For example, average annual combined recycled water and groundwater demand at San Francisco Golf Club is 172.4 af and peak month demand is 20 percent of that, or 34.5 af. An average day in the peak month is 1/30 of the monthly demand, or 1.15 af. The peak day of the peak month is 30 percent higher than the average day, or 1.5 af. The annual percentage of the total 172.4 af water use that is supplied by groundwater is 39/172.4, or 22 percent. The estimated peak groundwater daily demand is 22 percent of 1.5 af or 0.3 af.

the pump discharge rates of existing irrigators' wells decrease substantially enough that existing or planned land uses would not be fully supported, or (2) groundwater levels fall below the top of the well screen of existing irrigators' wells, resulting in decreased pump discharge rates and potential damage to the well that are substantial enough that existing or planned land uses would not be fully supported. The former cause of well interference is analyzed quantitatively and the latter cause is analyzed qualitatively, as described below.

Pump Discharge Rates at Existing Irrigators' Wells

The purpose of this analysis is to determine the extent to which groundwater levels at existing irrigators' wells would be decreased by the Project, thereby resulting in decreased pump discharge rates substantial enough that existing or planned land uses would not be fully supported. Groundwater level changes that are predicted to be caused by the Project are estimated by combining regional and localized groundwater level changes. Regional groundwater level changes during operation of the Project would include groundwater level decreases caused by pumping multiple Project wells and Partner Agency wells, as well as groundwater level increases caused by in-lieu recharge occurring when Partner Agency wells are not pumping groundwater. Localized groundwater level decreases would be caused by pumping nearby individual Project wells. Modeling conducted for this Project predicts that for 68 to 83 percent of the years during the 47-year simulation period (depending upon the location in the Basin), the Project would result in increased groundwater levels relative to levels predicted under modeled existing conditions (Fugro 2012a).

At each existing irrigation well, regional groundwater levels at the end of the modeled design drought are estimated for the Project based on the Project's hydrologic sequence of Put Years, Hold Years, and Take Years, as described above and in Chapter 3, Project Description, Section 3.8.1 (Operating Agreement). Calculation of regional groundwater level changes during Put Years and Take Years is based on groundwater level monitoring data collected as part of the SFPUC's In-Lieu Recharge Demonstration Study and proposed changes in pumping during Put Years and Take Years. Indicative regional groundwater level decreases during Hold Years and every year of the existing conditions are based on results of the Westside Basin Groundwater Model. (Fugro 2012a)

Localized drawdowns are combined with the regional groundwater levels to account for localized effects from pumping nearby proposed Project wells. Local drawdown caused by Project pumping is estimated using the Theis equation, a standard method for calculating well interference effects. Using the Theis equation, groundwater level declines at the existing irrigators' wells were calculated based on aquifer tests in Daly City and San Bruno in 2003 and adjusted to reflect aquifer conditions. (Fugro 2012a)

Combining localized drawdowns and regional groundwater levels results in estimates of groundwater levels at wells during droughts (Take Years). The groundwater level with the Project would be at its lowest at the end of the design drought.

Lowered groundwater levels increase pumping lift and decrease pump discharge rates. During operation of the Project, pump discharge rates at affected existing irrigation wells are estimated to have the greatest decreases at the end of the design drought when groundwater levels are estimated to be lowest. The impact of the Project on a given pump's discharge rate is calculated at the end of the design drought as the difference in the pump's discharge rate with and without the Project.

Pump discharge rates at each existing irrigation well are calculated based on the estimated groundwater level at the end of the design drought for both modeled existing conditions and for the Project scenario.

To determine the ability of the well or wells to support a land use, the estimated pump discharge rate in gpm is converted to the production capacity of the well over a 12-hour irrigation period in acre-feet. The 12-hour capacity for each well is calculated by multiplying the pumping discharge rate in gpm by the number of minutes in 12 hours, or 720 minutes. The 12-hour production capacity for each potentially affected land use is calculated by totaling the 12-hour capacities of all existing primary, active, and secondary wells serving the land use.

If primary, active, and secondary wells together cannot supply the estimated peak demand for a land use over a 12-hour period (nighttime irrigation) at the end of the design drought, due to well interference from the Project, then well interference impacts would be significant. In the case where the total capacity of existing primary, active, and secondary wells for a land use cannot supply the estimated peak demand under modeled existing conditions, the existing supply is only marginally adequate. Under these conditions, if well interference from the Project would cause any reduction in pumping capacity, the effect would be significant.

Well Screen Elevations at Existing Irrigators' Wells

The purpose of this analysis is to determine whether groundwater levels would drop below the top of the well screen of existing irrigators' wells, thereby resulting in decreased pump discharge rates and potential damage to the well substantial enough that existing or planned land uses would not be fully supported. Groundwater levels that drop below the top of well screens result in decreases in pump discharge rates and can potentially lead to well or pump damage. Both static groundwater levels and pumping groundwater levels are considered when evaluating whether the Project would cause groundwater levels to drop below the top of the well screens of existing irrigators' wells. The static groundwater level is the level when the well is not being pumped; the pumping groundwater level is the level when the well is pumping[22].

If predicted groundwater levels fall substantially below the top of the well screen due to the Project at the end of the design drought – and those levels are predicted to remain above the top of the well screen

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[22] Both pumping and static groundwater levels are relevant when considering mitigation options. Pumping groundwater levels that drop below the top of well screen can result in both additional decreases in pump discharge rates and well or pump damage. Although higher than pumping groundwater levels, static groundwater levels are also important to consider because well owners have much less control over static groundwater levels than pumping groundwater levels. If groundwater levels drop below the top of the well screen only when the well is pumping, well owners potentially can lower the pump or install a new pump to maintain groundwater levels above the well screen. Although these changes may result in a decreased pump discharge rate, the rate may still be able to meet demand while eliminating the risk of well or pump damage. Similar pump management options are not available to the well owner if static (i.e., non-pumping) groundwater levels drop below the top of well screens. In this case, the increased risk of damage cannot be addressed by the well owner without more involved modifications to the well or well replacement.

under modeled existing conditions – then the risk of damage to the well or pump due to the Project may eventually prevent the well from meeting demand, and well interference would be significant.

Impact Discussion and Significance Determination

During wet and normal years, pumping from the GSR wells would be minimal (0.04 mgd to exercise the wells) and well interference effects would not result. During these years, groundwater levels would be higher than levels without the Project, which would reduce pump lifts at the irrigation wells with corresponding increases in production capacities during these times. However, Project pumping would occur at the maximum proposed rate (i.e., 7.2 mgd) during dry years. At the end of the design drought, Project pumping would have continued at maximum levels for 7.5 years. Therefore, this analysis focuses on the well interference that could occur at the end of the design drought.

Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) shows the projected static and pumping groundwater levels at the end of the design drought at the existing irrigators' wells, when the greatest groundwater level decreases would be expected to occur. Table 5.16-11 also shows which well facility sites could affect which existing irrigation wells.

TABLE 5.16-11
Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought

Existing Irrigators' Wells	Proposed GSR Sites Considered in Analysis at Existing Irrigators' Wells	Estimated Static Depth to Water (feet below ground surface)			Estimated Pumping Depth to Water (feet below ground surface)		
		Existing Conditions	With Project	Decrease from Project	Existing Conditions	With Project	Decrease from Project
San Francisco Golf Club #2	1-4	182	196	14	217	228	11
Olympic Club #8	1-4	122	136	14	185	195	10
Olympic Club #9	1-4	122	136	14	160	164	4
Lake Merced Golf Club #3	1-6	271	358	87	INA	INA	INA
Woodlawn Memorial	2-10	253	369	116	312	405	93
Italian Cemetery	2-10	290	400	110	345	430	85
Eternal Home Cemetery	4-10	258	363	105	280	374	94
Olivet Memorial Park	5-10	264	363	99	297	381	84
Home of Peace, also serving Salem Cemetery and Hills of Eternity	5-10	273	370	97	325	406	81
Hills of Eternity	5-10	239	334	95	253	342	89
Cypress Lawn Memorial Park #3	5-10	289	384	95	INA	INA	INA
Cypress Lawn Memorial Park #4	5-11	232	330	98	INA	INA	INA

TABLE 5.16-11
Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought

Existing Irrigators' Wells	Proposed GSR Sites Considered in Analysis at Existing Irrigators' Wells	Estimated Static Depth to Water (feet below ground surface)			Estimated Pumping Depth to Water (feet below ground surface)		
		Existing Conditions	With Project	Decrease from Project	Existing Conditions	With Project	Decrease from Project
Holy Cross Cemetery #1	6-12	233	337	104	307	393	86
Holy Cross Cemetery #4	5-11	253	352	99	386	467	81
California Golf Club #7	9-15	233	401	168	302	417	115
California Golf Club #8	9-15	233	402	169	286	433	147

Source: Fugro 2012a

Note:

INA: Information not available. Information on the existing irrigators' wells that would allow calculation of impacts of the Project on production capacity is not available.

The estimated decrease from the Project at the end of the design drought compared to existing conditions is less for the pumping water levels than the static water levels. As discussed below, the predicted lower water levels during Project operations at the end of the drought, compared to modeled existing conditions, would result in a lower pump discharge capacity, which would reduce the drawdown. Since pumping depth to water is the static depth to water plus drawdowns, decreases for pumping water levels are less than static water levels. When the wells at the San Francisco Golf Club and Olympic Club are not being pumped (i.e., static condition), groundwater levels at the end of the design drought are projected to decrease by approximately 14 feet due to the Project; when the wells are active (i.e., pumping condition), groundwater levels are projected to decrease approximately 4 to 11 feet due to the Project. When the wells at the other golf clubs and cemeteries are not being pumped (i.e., static condition), groundwater levels at the end of the design drought are projected to decrease by 85 to 169 feet due to the Project; when the wells are active (i.e., pumping condition), groundwater levels are projected to decrease by 81 to 147 feet due to the Project.

The Project pumping and resulting groundwater level decreases at the end of the design drought are projected to affect the pump discharge rates of existing irrigators' wells as shown in Table 5.16-12 (Estimated Pump Discharge Rate at the End of the Design Drought). Pump discharge rates at the San Francisco Golf Club and Olympic Club wells are projected to decrease by approximately two to four percent as a result of Project pumping. Pump discharge rates at the other golf clubs and cemeteries are projected to decrease by 10 to 87 percent. Higher percentage declines predicted at some wells are due to the characteristics of the specific pumps installed in the well, which can magnify the effect of lower water levels.

TABLE 5.16-12
Estimated Pump Discharge Rate at the End of the Design Drought

Existing Irrigators' Wells	Existing Conditions (gpm)	With Project (gpm)	Percent Reduction due to Project
San Francisco Golf Club #2	675	660	2
Olympic Club #8	970	935	4
Olympic Club #9	685	660	4
Lake Merced Golf Club #3	INA	INA	10-30
Woodlawn Memorial Park	450	60	87 (a)
Italian Cemetery	265	145	45
Eternal Home Cemetery	200	100	50
Olivet Memorial Park	300	180	40
Home of Peace, also serving Salem Cemetery and Hills of Eternity	600	440	27
Hills of Eternity Cemetery	235	135	43
Cypress Lawn Memorial Park #3	INA	INA	INA
Cypress Lawn Memorial Park #4	INA	INA	INA
Holy Cross Cemetery #1	800	625	22
Holy Cross Cemetery #4	800	700	13
California Golf Club #7	200	45	78 (b)
California Golf Club #8	800	475	41 (b)

Source: Fugro 2012a

Notes:

(a) The predicted large percentage reduction is largely due to the particular pump installed in the well as opposed to differences in water level declines (e.g., decline is about 15 feet more at Woodlawn than at other cemetery wells).

(b) The difference in pumping capacity decline predicted at the two California Golf Club wells is mostly a function of the characteristics of the pump curve for the specific pumps installed in each well.

INA: Information not available. Information on the existing irrigators' wells that would allow calculation of impacts of the Project on production capacity is not available.

If primary, active, and secondary wells supporting a land use together cannot supply the peak demand for that land use over a 12-hour period (nighttime irrigation) due to reduced pump discharge rates from the Project, then well interference impacts would be significant. For this analysis, Table 5.16-13 (Estimated Peak Demand and 12-Hour Production Capacities) compares the 12-hour production capacity at each golf club and cemetery to the estimated peak demand needed to maintain adequate irrigation for the land use.

TABLE 5.16-13
Estimated Peak Demand and 12-Hour Production Capacities

Land Use	Estimated Peak Demand (af per 12-hour period)	12-Hour Production Capacity for Primary, Active, and Secondary Wells (af)		Significant Impact relative to Pump Discharge Rates?	Significant Impact relative to Well Screen Elevations?[(a)]
		Existing Conditions	With Project		
San Francisco Golf Club	0.3	1.5	1.5	No	No
Olympic Club	0.1	3.7	3.5	No	No
Lake Merced Golf Club	0.2	INA	INA	INA	Yes
Woodlawn MemorialPark[(b)]	0.7	1.0	0.1	Yes	Yes
Italian Cemetery	0.4	0.6	0.3	Yes	Yes
Eternal Home Cemetery	0.2	0.4	0.2	No	Yes
Olivet Memorial Park	0.8	0.7	0.4	Yes	Yes
Salem Cemetery, Hills of Eternity and Home of Peace	0.6	1.3	1.0	No	Yes
Cypress Lawn Memorial Park	2.2	INA	INA	INA	Yes
Holy Cross Cemetery	2.2	3.5	2.9	No	Yes
California Golf Club[(c)]	1.8	2.2	1.1	Yes	Yes

Note:

(a) Results for this column are taken from Table 5.16-14 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought), below.

(b) The predicted large decline in capacity from 1.0 to 0.1 is largely due to the particular pump installed in the well as opposed to differences in water level declines (e.g., decline is about 15 feet more at Woodlawn than other cemetery wells).

(c) The predicted pumping capacity decline at the two California Golf Club wells is mostly a function of the characteristics of the pump curve for the specific pumps installed in each well.

INA: Information not available. Information on the existing irrigators' wells that would allow calculation of impacts of the Project on production capacity is not available.

If water levels were to fall below the top of screen, there could be decreases to discharge capacities in addition to those estimated in Table 5.16-13 and an increase in risk of damage to the well. Table 5.16-14 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) compares the estimated depth to water at the end of the drought with the top of the well screen.

TABLE 5.16-14
Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought

Existing Irrigators' Wells	Top of Well Screen (feet below ground surface)	Static Water Level Relative to Top of Well Screen (feet) [(a)]		Pumping Water Level Relative to Top of Well Screen (feet) [(a)]	
		Existing Conditions	With Project	Existing Conditions	With Project
San Francisco Golf Club #2	360	178	164	143	132
Olympic Club #8	200	78	64	15	5
Olympic Club #9	260	138	124	100	96
Lake Merced Golf Club #3	294	23	-64	INA	INA
Woodlawn Memorial Park	275	22	-94	-37	-130
Italian Cemetery	300	10	-100	-45	-130
Eternal Home Cemetery	280	22	-83	0	-94
Olivet Memorial Park	308	44	-55	11	-73
Home of Peace, also serving Salem Cemetery and Hills	400	127	30	75	-6
Hills of Eternity Cemetery	216	-23	-118	-37	-126
Cypress Lawn Memorial Park #3	191	-98	-193	INA	INA
Cypress Lawn Memorial Park #4	330	98	0	INA	INA
Holy Cross Cemetery #1	368	135	31	61	-25
Holy Cross Cemetery #4	420	167	68	34	-47
California Golf Club #7	255	22	-146	-47	-162
California Golf Club #8	320	87	-82	34	-113

Note:

(a) Positive number indicates water level is above top of screen and negative number indicates water level is below top of screen.

INA: Information not available. Information on the existing irrigators' wells that would allow calculation of impacts of the Project on production capacity is not available.

At the Olympic Club and San Francisco Golf Club, the 12-hour pumping capacities are expected to meet or exceed their estimated peak demand even when Project pumping is at a maximum at the end of the design drought (see Table 5.16-13 [Estimated Peak Demand and 12-Hour Production Capacities]). In addition, static and pumping groundwater levels are not estimated to drop below the top of the screen at the Olympic Club and San Francisco Golf Club wells (see Table 5.16-13). Therefore, the Project impact at the Olympic Club and San Francisco Golf Club would be *less than significant*.

At the Home of Peace well, which also serves Salem Cemetery and Hills of Eternity Cemetery, the 12-hour pumping capacity is estimated to meet or exceed its estimated peak demand even when Project pumping is at a maximum at the end of the design drought (see Table 5.16-13 [Estimated Peak Demand and 12-Hour Production Capacities]). The pumping groundwater level at the recently constructed well at the Home of Peace Cemetery is estimated to drop below the top of the screen at the end of the design drought due to the Project, but only by six of the 140 feet of screen (see Table 5.16-14 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought]), which is unlikely to reduce the pumping capacity such that the well would not meet demand given that pumping capacity could be reduced another 40 percent and still meet peak demand. However, pumping groundwater levels dropping below the top of the screen increases the risk of well or pump damage. This risk results in the potential for the well to be unable to meet demand over the long term, if damage should occur. Therefore, the Project would have a *significant* impact relative to well interference at the Salem Cemetery, Hills of Eternity Cemetery, and Home of Peace Cemetery.

At Holy Cross Cemetery and Eternal Home Cemetery, the 12-hour pumping capacities are estimated to meet peak demand even when Project pumping is at a maximum at the end of the design drought (see Table 5.16-13 [Estimated Peak Demand and 12-Hour Production Capacities]). However, static groundwater levels at the end of the design drought are estimated to fall below the top of the screen by a substantial length of the screen at the Eternal Home Cemetery well due to the Project. Pumping groundwater levels at the end of the design drought at the Holy Cross Cemetery wells, in addition to the Eternal Home Cemetery well, are estimated to fall below the top of the screen by a substantial length of the screens due to the Project (see Table 5.16-14 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought]). Additional reductions in pumping capacities due to less of the screens providing water have not been quantified, but it is possible that 12-hour pumping capacities could be reduced more than estimated, such that peak demand would not be met. The Eternal Home site has a 10,000-gallon storage tank (Fugro 2012a), but that equates to only 0.03 af, which may not be enough storage to offset the additional reduction in pumping capacity due to less of the screen providing water. Therefore, the Project would have a *significant* impact relative to well interference at Holy Cross Cemetery and Eternal Home Cemetery.

At Woodlawn Memorial Park, Italian Cemetery, and the California Golf Club, pumping capacities are estimated to decline 41 to 87 percent[23] when Project pumping is at a maximum compared to modeled existing conditions at the end of the design drought (see Table 5.16-12 [Estimated Pump Discharge Rate at

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[23] Greater decreases in pumping capacities were estimated for the Woodlawn Primary Well (87 percent) and California Golf Club Wells (41 and 78 percent) due to the specific characteristics of the pumps installed in these wells.

the End of the Design Drought]). As a result, the 12-hour pumping capacities under the Project are estimated to not meet the peak demand at these sites (see Table 5.16-13 [Estimated Peak Demand and 12-Hour Production Capacities]). In addition, estimates of static groundwater levels at the end of the design drought at the wells at Woodlawn Memorial Park, Italian Cemetery, and California Golf Club drop below the top of the screen due to the Project (see Table 5.16-14 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought]). The reduction in the effective screen length of the well could result in additional reductions in well capacities that have not been quantified and make it more likely that the well would not fully support existing land uses. Impacts relative to well interference would therefore be *significant* at the Woodlawn Memorial Park, Italian Cemetery, and California Golf Club.

The only cemetery or golf club that is estimated to have insufficient existing 12-hour pumping capacity for meeting peak demand at the end of the design drought would be Olivet Memorial Park (see Table 5.16-13 [Estimated Peak Demand and 12-Hour Production Capacities]). As a result, the existing groundwater supply pumped from this well for this land use is only marginally adequate at present and a 40 percent reduction of pumping capacity at this cemetery at the end of the design drought, as shown in Table 5.16-12 (Estimated Pump Discharge Rate at the End of the Design Drought), would prevent the well from fully supporting the existing land use. In addition, estimates of static groundwater levels at the end of the design drought at the Olivet Memorial Park wells show dewatering of a substantial amount of the well screen due to the Project (see Table 5.16-14 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought]). The reduction in the effective screen length of the well could result in additional reductions in well capacities that have not been quantified and make it more likely that the well would not fully support the existing land use. Therefore, the Project would have a *significant* impact at Olivet Memorial Park relative to well interference. However, the Project would result in increased groundwater levels relative to modeled existing conditions at the Olivet Memorial Park during 74 percent of the 47-year modeling period (Fugro 2012a). As a result, pumping capacity at Olivet Memorial Park would increase and make it more likely for the well to meet its estimated peak demand in those years.

Information about the size and type of pump is not available for the Cypress Lawn Memorial Park wells, so Project effects on pumping capacity cannot be quantified. However, groundwater levels due to Project pumping at the end of the design drought are estimated to be approximately 95 to 98 feet lower than under modeled existing conditions (see Table 5.16-11 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought]). This difference is similar to the differences estimated for wells at Woodlawn Memorial Park, Italian Cemetery, and California Golf Club, where reductions in well yield from the lower groundwater levels at the end of the design drought during Project operations are predicted to prevent the wells from fully supporting existing land uses. In addition, the estimated groundwater levels with Project pumping at the end of the design drought would likely dewater a substantial portion of the well screens of Cypress Lawn Memorial Park's well #3 (see Table 5-16-11), which could add to the estimated reductions in well yield. Therefore, the Project would have a *significant* impact relative to well interference at Cypress Lawn Memorial Park.

Information about the size and type of pump is not available for the Lake Merced Golf Club wells, so Project effects on pumping capacity cannot be quantified as precisely as other wells. However, groundwater levels due to Project pumping at the end of the design drought are estimated to be approximately 87 feet lower than under modeled existing conditions (see Table 5.16-11 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought]). It is estimated that this decrease would reduce discharge rates of the Lake Merced Golf Club wells by 10 to 30 percent (Fugro 2012a).

Although it is unknown what discharge rate would result from this decrease, it is likely that the well could meet its estimated peak daily demand[24]. However, the estimated static groundwater levels with Project pumping at the end of the design drought would likely fall below the top of the well screen of the Lake Merced Golf Club well by a substantial length, increasing the risk of well or pump damage. This risk results in the potential for the well to be unable to meet demand if damage should occur. Therefore, the Project would have a *significant* impact relative to well interference at the Lake Merced Golf Club.

Evaluation of Three Alternate Well Sites

To evaluate the well interference impacts of operating the three alternate well sites, the analysis assumed that 16 wells would be operated, including Sites 17 (Alternate), 18 (Alternate), and 19 (Alternate), but not including Sites 1, 4, and 15. Given the locations of wells removed from the modeling scenario (two at the northern end and one at the southern end of the GSR Project area) versus the locations of the alternate wells (generally in the middle of the GSR Project area), the alternate well configuration would reduce drawdowns in the Daly City and San Bruno areas and increase drawdowns in the Colma and South San Francisco area (Fugro 2012a). This configuration would represent only one possible alternate configuration. However, this configuration demonstrates what could be viewed as a worst-case scenario for the Colma and South San Francisco areas, and the configuration with the preferred 16 wells as the worst-case scenario for the Daly City and San Bruno areas.

Therefore, the analyzed alternate configuration includes pumping from Sites 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 17 (Alternate), 18 (Alternate), and 19 (Alternate). Under this alternate configuration, more Project pumping would occur in the Colma and South San Francisco areas and less Project pumping would occur in the Daly City and San Bruno areas. As a result, groundwater levels at the Olympic Club and San Francisco Golf Club wells at the end of the design drought are estimated to be higher than shown on Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) (Fugro 2012a). Therefore, under this alternate configuration, the Project would still have a *less than significant* impact relative to well interference at the Olympic Club and San Francisco Golf Club.

Also under this alternate configuration, groundwater levels at the end of the design drought in the wells serving the Colma cemeteries and the California Golf Club are estimated to be lower than shown on Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) (Fugro 2012a). Under the SFPUC's preferred configuration (i.e., wells at Sites 1 through 16), the Project would have a *significant* impact on the California Golf Club and the Colma cemeteries. Therefore, under the alternate configuration, the Project would still have a *significant* impact relative to well interference at the Colma cemeteries and California Golf Club.

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[24] Although it is unknown what discharge rate would result from the projected groundwater level declines, the well would meet its estimated peak daily demand of 0.2 af if the resulting discharge rate is at least 104 gpm. Assuming a 30 percent reduction, the existing discharge rate would have to be 150 gpm or greater to meet demand with the Project. It is reasonable to assume that Lake Merced Golf Club has a pump with a discharge rate greater than 150 gpm, because wells at other golf courses in the Westside Groundwater Basin have existing discharge rates in the range of 200 to 970 gpm. Also, the well at the Lake Merced Golf Club was the sole source of irrigation water prior to recycled water becoming available.

Groundwater levels at Lake Merced Golf Club wells at the end of the design drought are estimated to be 21 to 22 feet higher than shown on Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) under the analyzed alternate configuration (Fugro 2012a). However, static groundwater levels are estimated to still drop below the top of the well screen, and the Project would therefore still have a *significant* well interference impact at the Lake Merced Golf Club.

Mitigation Approach

As provided below, Mitigation Measure M-HY-6 (Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation) establishes a performance standard to ensure that well interference impacts caused by the Project would be avoided or reduced to *less-than-significant* levels. The mitigation measure also requires a Monitoring Program at the existing irrigators' wells to provide reliable and timely data to determine if the performance standard is being met and requires the analysis of monitoring data twice a year during Take Years (i.e., when Project Wells are regularly pumping) to determine whether or not reduced pumping capacities at existing irrigation wells are found to occur as a result of the Project.

If the results of the Monitoring Program and biannual analyses during Take Years indicate that well interference impacts of the Project would cause the performance standard to be exceeded, then a list of example mitigation actions are provided that would maintain an uninterrupted supply of groundwater to the affected land use. Mitigation actions that may need to be implemented would vary depending on site-specific conditions at the existing irrigators' wells and a determination of the extent of the decrease in pumping capacity that is occurring due to Project operations and, therefore, the list of mitigation actions includes actions both at the existing irrigators' wells and also at the Project wells. Each action item may be suitable to address impacts on an existing irrigator's well, either alone or in combination with one or more of the other mitigation actions. Each of the mitigation actions, or a combination of mitigation actions, may be feasible and effective in particular circumstances. However, not every one of the mitigation actions alone are anticipated to be feasible and effective at reducing impacts to *less-than-significant* levels in all circumstances, because the irrigation systems, wells, and parcels where the existing irrigators' wells are located are all different and may experience a range of impacts due to Project-caused well interference. Either one or a combination of the mitigation actions identified in Mitigation Measure M-HY-6 is anticipated to reduce impacts to a *less-than-significant* level.

Mitigation actions #1, Improve irrigation efficiency, and #2, Modify irrigation operations, would install measures such as more-efficient sprinkler heads or soil-moisture sensors and would modify operations, for example, through the use of longer irrigation cycles or revised scheduling of irrigation to respond to evapotranspiration data. These actions would tend to mitigate impacts if the irrigation well capacity were only slightly less than the performance standard due to Project pumping. Effectiveness of the actions would vary depending on the design of the existing irrigation system, and would not be expected to be feasible and effective in all cases. (SFPUC 2012c)

Mitigation actions #3, Redistribute GSR pumping, and #4, Reduce GSR pumping, would reduce the rate of groundwater level decline in an affected area by redistributing Project pumping to other areas or by reducing Project pumping. Redistribution of GSR pumping would not be undertaken where the resulting groundwater levels would then decline more than what was originally predicted to be caused by the Project by modeling, therefore, redistribution would be effective at reducing well interference impacts at existing irrigation wells only if some GSR wells are determined to be capable of producing more water with less drawdown than originally predicted (SFPUC 2012a, 2012c). Reduction of GSR pumping would be effective at reducing well interference impacts at existing irrigation wells to *less-than-significant* impacts, but this would be an interim measure, implemented until such time as an alternate measure can be implemented that also mitigates the impact to *less-than-significant* levels.

Mitigation actions #5, Lower pump in irrigation well, and #6, Lower and change pump in irrigation well, would lower the well pump to accommodate groundwater level fluctuations induced by Project pumping that exceed historic levels, or lower and replace the well pump using a more suitable pump for the conditions that are encountered in order to meet demands. These actions would mitigate impacts if the irrigation well capacity were moderately less than the performance standard due to Project pumping. Effectiveness of the actions would vary depending on the design of the existing irrigation well and type of pump used. The actions would also be dependent upon the existing irrigation well being deep enough to accommodate lowering of the pump. For this reason, these actions would not necessarily be feasible and effective in all cases. (SFPUC 2012c)

Mitigation action #7, Add storage capacity for irrigation supply, would add storage; for example, an above-ground tank of 20,000 gallons, which could be up to 20 feet in height. Increased storage capacity may provide the ability to meet peak flow rates that would otherwise be less than the performance standard, in that irrigators could store the additional water in the tank to use during the period of peak demand. It appears likely that each of the existing irrigators could feasibly place a tank on their property, however, increased storage may not be sufficient to meet the performance standard if the reduced well capacity due to the Project is large. (SFPUC 2012c)

Mitigation action #8, Replace irrigation well, would be effective at any of the affected land uses, because the replacement well could be constructed deep enough at each of the cemeteries or golf clubs to operate under the new conditions and thereby meet peak irrigation demand. This mitigation action would be feasible from the standpoint that each of the existing irrigators' well sites has available areas in which a replacement well could be installed, and groundwater resources are deep enough in the area of each irrigator to drill deeper wells (SFPUC2012d). Well permits would need to be obtained from the San Mateo County Department of Environmental Health or City of Daly City, depending on the location of the replacement well. The County's and Daly City's well ordinances provide that granting of a well permit is dependent upon the well meeting the health, safety, and welfare of its citizens. Because wells that would be installed under Mitigation action #6 would replace existing and currently operational irrigation wells, it is expected that the required well permits would be issued by the County and Daly City.

Mitigation action #9, Replace irrigation water source, would provide a new temporary source of water only until another mitigation action could be implemented. Water would be provided via temporary aboveground pipes from Partner Agency or SFPUC supply from distribution or transmission pipelines close to the location where additional irrigation supplies are needed. This action would not be implemented on a permanent basis.

Implementation of Mitigation Measure M-HY-6 (Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation) would depend upon the willingness of the well owner to participate in the monitoring program and to allow the SFPUC to install a replacement well or take other corrective action as mutually determined necessary to address the impacts from the Project and meet the performance standard. Therefore, while Mitigation Measure M-HY-6 could reduce the impacts of well interference to a level where existing and planned land uses would continue to be fully supported, its implementation cannot be assured at this time. Nevertheless, with participation in the monitoring program and concurrence to allow implementation of the mitigation actions by all affected existing irrigation well owners, the well interference impacts would be less than significant with mitigation. However, because such assurance cannot be attained prior to Project approval, Impact HY-6 with implementation of Mitigation Measure H-HY-6 is deemed at this time to be *significant and potentially unavoidable with mitigation*.

Mitigation Measure M-HY-6: Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation

This mitigation measure is organized into five sections, as follows:

- Performance standard,
- Mitigation Actions to be Undertaken to Meet the Performance Standard,
- Method for Determining Whether Loss of Pumping Capacity at an Existing Irrigator's Well Is Due to the Project,
- Existing Irrigator Well Monitoring Program, and
- Definitions of terms

Performance Standard: The SFPUC will ensure that the production capacity at existing irrigators' wells is equivalent to the existing production capacity of the wells or is sufficient to meet existing and planned peak irrigation demand at the land use, whichever is less, provided that the loss of capacity at the existing irrigators' wells is reasonably expected to have been caused by the Project.

If the production capacity at an existing irrigator's well is shown to drop below this performance standard due to the Project, measures to avoid or reduce Project contributions to the loss of capacity or measures to meet irrigation needs will be implemented by the SFPUC. The SFPUC will implement these measures, or a combination thereof, so that water supply provided to the land use by the existing irrigators' well(s) is not interrupted. The method for determining whether the loss of pumping capacity is attributable to the Project is described in detail below.

In order to implement one or more of the mitigation actions, it is necessary to, and the SFPUC shall, conduct monitoring at existing irrigators' wells to determine whether the performance standard is being met. The monitoring program is described in detail below.

Mitigation Actions to be Undertaken to Meet the Performance Standard: The SFPUC shall, in cooperation with the existing irrigators, implement actions to meet the performance standard in this mitigation measure when the production capacity of an existing irrigator's well drops below the performance standard. The following mitigation actions are examples of the type of actions that, alone or in combination, will avoid or reduce Project impacts, depending on the circumstance:

1. *Improve irrigation efficiency.* Seek ways to reduce applied water demand through irrigation efficiency measures. For example, sprinkler nozzles can be replaced with more efficient models, sprinklers can be added to achieve more evenly distributed irrigation, and installation of soil-moisture sensors can aid in irrigation scheduling.

2. *Modify irrigation operations.* Seek ways to modify operations to accommodate reduced well capacity. For example, use longer irrigation cycles to meet the same irrigation demand or use evapotranspiration data to modify irrigation scheduling.

3. *Redistribute GSR pumping.* Seek to reduce the rate of groundwater level decline in the affected area by redistributing Project pumping to other areas; however, in no case would redistribution be undertaken where the resulting groundwater levels would then decline more than what was originally predicted to be caused by the Project by modeling. The bi-annual analyses of data from the Monitoring Program would continue while this action is undertaken. The action would cease when the data analysis shows that the performance standard is met without continued redistribution of GSR pumping.

4. *Reduce GSR pumping.* Seek to reduce the rate of groundwater level decline through a reduction in Project pumping (including a cessation in Project pumping at wells in the vicinity of existing irrigation wells). The bi-annual analyses of data from the Monitoring Program would continue while this action is undertaken. The action would cease when the data analysis shows that the performance standard is met without continued reduction of GSR pumping.

5. *Lower pump in irrigation well.* A pump may be lowered to accommodate water level fluctuations induced by Project pumping that exceed historic levels.

6. *Lower and change pump in irrigation well.* A pump may be replaced and set to a lower depth to accommodate new head conditions because of lowered water levels induced by Project pumping.

7. *Add storage capacity for irrigation supply.* Under certain conditions, storage may be added (e.g., an above-ground tank) to offset reduced well capacity caused by Project pumping. The availability of storage capacity (or of increased capacity) can provide an ability to meet peak flow rates that are otherwise reduced by lowered water levels.

8. *Replace irrigation well.* An existing irrigation well may be replaced with a new well which may be designed with different screen intervals or depth. The new irrigation well could therefore access additional groundwater resources at new depths in the aquifer.

9. *Replace irrigation water source.* In the event that the preceding options cannot be implemented without causing an interruption in the irrigation supply, a temporary replacement water supply source would be provided from the regional water system or Partner Agency distribution system via temporary aboveground pipes close to the location where additional irrigation supplies are needed until another mitigation option(s) is implemented.

Method for Determining Whether Loss of Pumping Capacity at an Existing Irrigation Well(s) Is Due to the Project. Any loss in production capacity of an existing irrigation well(s) is assumed to be caused by the Project if: 1) it is temporally correlated with the onset of increased Project pumping; 2) it occurs in an area predicted in this EIR to be affected by well interference; 3) static groundwater levels have dropped; 4) pumping groundwater levels have not dropped more than static groundwater levels (if pumping groundwater levels drop more than static groundwater levels it could indicate the drop in production capacity is due to increased well inefficiency and not due to the Project); or 5) no other obvious reason exists for the drop in production capacity If another reason is identified, it will be based on the written professional opinion of a certified hydrogeologist or professional engineer with expertise in groundwater hydrology that will be submitted to the San Francisco Planning Department's Environmental Review Officer (ERO), or designee, for review and concurrence. The ERO may require the SFPUC to hire an independent expert to advise the ERO.

To support this determination, the SFPUC will develop at least the following information:

- *Item 1. It is temporally correlated with the onset of increased Project pumping.* The SFPUC will develop a graph that shows the pumping of Project and Partner Agency wells within 1.5 miles of the existing irrigator's well over time, compared to the production capacity of the existing irrigator's well over the same period.
- *Item 2. It occurs in an area predicted to be affected by well interference.* The SFPUC will calculate the cone of depression, using the same methodology as used in evaluating the impact in the EIR, at Project and Partner Agency wells within 1.5 miles of the existing irrigator's well, as well as at the existing irrigator's well.
- *Items 3 and 4. Static water levels have dropped and pumping water levels have not dropped more than static water levels*. The SFPUC will develop a graph showing the difference between static and pumping water levels at the existing irrigator's well over time.
- *Item 5. Another reason exists for the drop in production capacity.* If the SFPUC believes that the drop in production capacity of the existing irrigation well(s) is caused by factors other than the Project – and the owner of the existing irrigation well(s) disagrees – then the SFPUC will have a certified hydrogeologist or professional engineer with expertise in groundwater hydrology prepare documentation regarding the reasons for the drop in production capacity and submit this documentation to the San Francisco Planning Department's ERO, or designee, with a copy to the existing well owner. The ERO may require the SFPUC to hire an independent expert to advise the ERO.

In addition, the following Monitoring Program will assist the SFPUC in obtaining the data necessary to support the determination of probable cause for any groundwater level decreases at an existing irrigator's well.

Existing Irrigation Well Monitoring Program. The SFPUC will monitor short- and long-term changes in groundwater conditions and operations at existing irrigators' wells. This Existing Irrigator Well Monitoring Program applies to existing well owners who choose to participate in the program. Participation in this monitoring program is assumed to be necessary for the mitigation actions to be effectively implemented by the SFPUC at the affected well.

At least 18 months prior to the commencement of pumping of Project wells, the SFPUC shall contact existing irrigators with information about the monitoring program. To participate in the program, existing irrigators will complete a registration form and an agreement with the SFPUC. The monitoring program will include the installation of a flow meter to allow for daily well production volumes to be recorded and a groundwater level transducer/data logger (a device for automatically detecting and recording groundwater levels) for measuring groundwater levels. Baseline monitoring of flow meter data and groundwater level data in the existing irrigators' well will occur among willing participants for at least one year prior to pumping the Project wells. In addition to baseline monitoring of well production and groundwater levels, pumping tests will be conducted prior to commencement of pumping Project wells to collect baseline data on pump and well performance. The pumping tests will collect data on well capacity and drawdown, well specific capacity, pump efficiency and head-capacity characteristics, sand content, and selected water quality parameters.

The SFPUC shall also collect any existing information and data available regarding the existing irrigator's well from the well owner, including any estimates or measurements of historical, existing, and planned land and water use (e.g., driller's logs, water level data, pumping records, acres irrigated) to provide information upon which to evaluate the performance of the existing irrigator's well over time and to establish baseline operating conditions. When there is an opportunity to open an existing irrigator's well (such as when a pump is removed by a well owner), the SFPUC may seek to conduct video log surveys in wells to determine the condition of the well structure. The monitoring effort will continue through the life of the Project, unless canceled by the well owner as part of the well owner's decision to remove itself from the monitoring program. Continued participation in this monitoring program is assumed to be necessary for the mitigation actions to be effectively implemented by the SFPUC at the affected well. Periodic re-testing of a well may occur as prompted by the need to evaluate performance throughout the life of the Project. If there is uncertainty or disagreement about whether the Project is responsible for a loss in production capacity at an existing irrigator's well, the SFPUC shall undertake more frequent monitoring and/or testing to help resolve the disagreement.

Data from the water level transducers/data loggers and flow meters shall be recorded daily during the first year. Following the first year of data collection, the frequency may be modified (e.g., as prompted by a need to evaluate pump and/or well performance to determine effects of the Project). The SFPUC shall provide participants with 14-day advance notice for the site visit(s) that would be scheduled within a 48-hour window.

Data shall be analyzed two times each year during Take Periods when Project wells are pumping regularly. The first data analysis period shall end April 30th when production capacity can be compared to peak demand prior to the peak demand period. The second data collection period shall end October 30th when groundwater levels will likely be lowest at the end of the peak irrigation season and production capacity of the well would be at its lowest. The data shall be compiled and analyzed by SFPUC's certified hydrogeologist or professional engineer with expertise in groundwater hydrology by June 30th and January 15th for the two data analysis periods. The data collected from each existing irrigator's well shall also be shared with the well owner upon request. In Project Put and Hold Periods, data shall be analyzed once per year for the data collected through October with analysis completed by January 15th.

Definition of Terms

Existing or planned land use. All existing and planned land uses served by existing irrigators' wells are related to turf irrigation. The only planned known (future) land use is the potential expansion of the Holy Cross Cemetery to include up to an additional 30 acres of irrigated turf.

Existing well capacity. Existing well capacity is the production capacity of the existing irrigator's well during the 12-month monitoring period prior to operation of the Project. The well capacity will be determined by the Monitoring Program described herein.

Peak irrigation demand. Peak irrigation demand is defined either as the actual peak irrigation demand determined from well production records obtained by the Monitoring Program described herein or as identified in Table M-HY-6 (developed from Table 5.16-14 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought] of the EIR), whichever is agreed to by the parties.

TABLE M-HY-6
Existing or Planned Peak Irrigation Demand at Sites with Significant Impacts Due to Project Operation

Irrigation Site	Existing and Planned Peak Demand[(a)] (af per 12-hour period)	
	Existing	**Planned**
Lake Merced Golf Club	0.2	0.2
Woodlawn Memorial Park	0.7	0.7
Italian Cemetery	0.4	0.4
Eternal Home Cemetery	0.2	0.2
Olivet Memorial Park	0.8	0.8
Salem Cemetery, Hills of Eternity and Home of Peace	0.6	0.6
Cypress Lawn Memorial Park	2.2	2.2
Holy Cross Cemetery	2.2	2.24
California Golf Club	1.8	1.8

Note:

(a) These values are taken from Tables 5.1-2 (Model Input – Pumping Assumptions for Modeling Scenarios), 5.16-9 (Existing Irrigated Acreage and Estimated Peak Demand at Potentially Affected Land Uses), and 5.16-10 (Existing Average Annual Recycled Water and Groundwater Use and Estimated Peak Demand at Potentially Affected Land Uses that Use Recycled Water) in the Draft EIR.

af = acre-feet

Production capacity. Production capacity of a well is the quantity of water that can be produced by a well in a 12-hour period. Production capacity will be calculated based on daily production, as measured by the flow meter, divided by pumping duration, as measured by the flow meter, multiplied by 12 hours.

Existing irrigators' wells. The existing wells that support the following land uses are the only wells that meet the definition of existing irrigators' wells for the purposes of this mitigation measure: Lake Merced Golf Club, Woodlawn Memorial Park, Italian Cemetery, Eternal Home Cemetery, Olivet Memorial Park, Home of Peace Cemetery, Cypress Lawn Memorial Park, Holy Cross Cemetery and the California Golf Club. Existing wells are those wells that are in operation prior to the approval of the Project.

Impact Conclusion: Significant and Unavoidable with Mitigation

Impact HY-7: Project operation would not result in substantial land subsidence due to decreased groundwater levels in the Westside Groundwater Basin where the historical low water levels are exceeded. (Less than Significant)

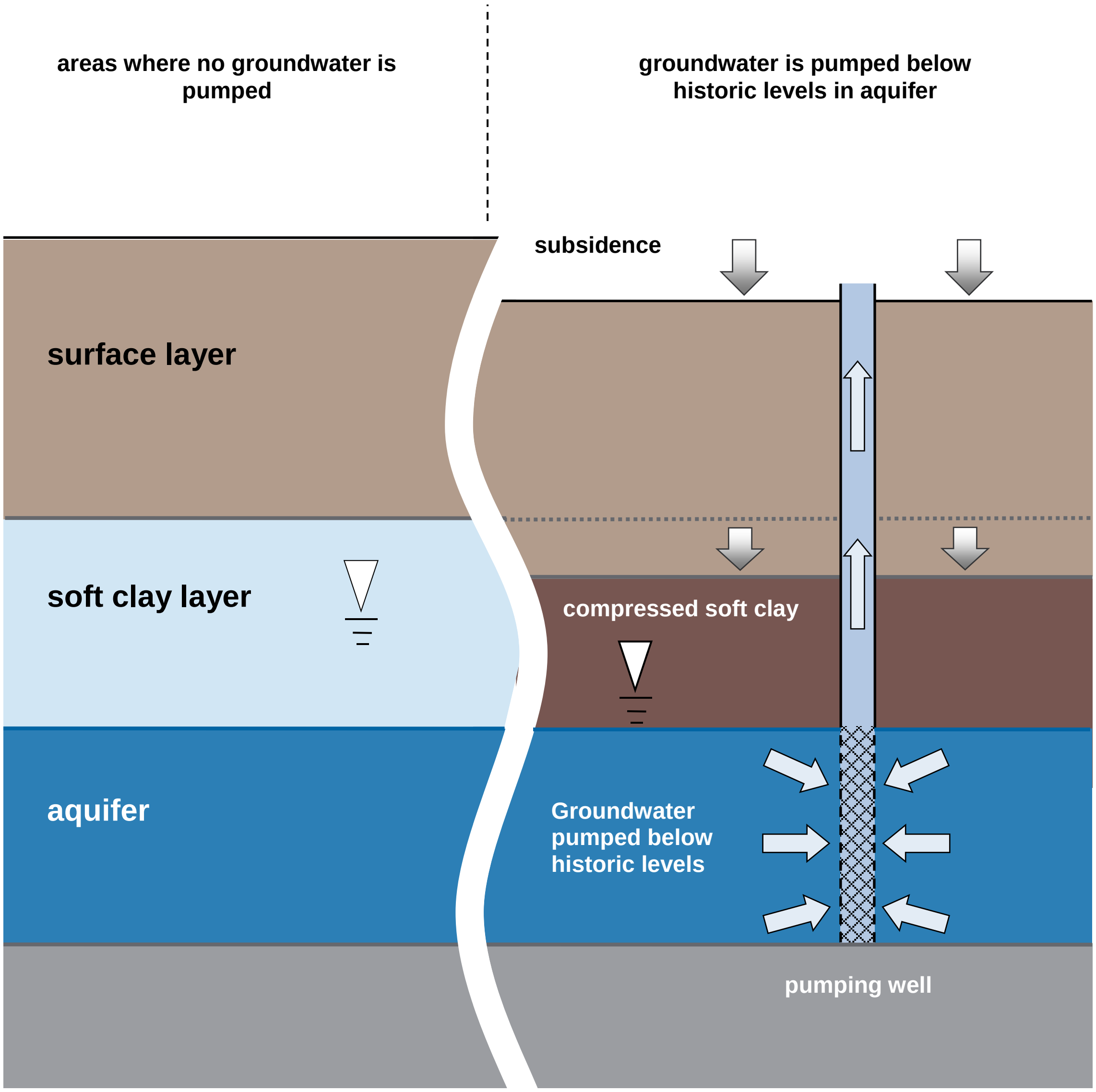
Description of Land Subsidence

Land subsidence is a gradual settling or sudden sinking of the earth's surface due to subsurface movement of earth materials (Galloway et al. 1999). While land subsidence can result from a number of processes, subsidence from groundwater pumping is the focus of the analysis for the Project. Land subsidence due to groundwater pumping can occur when groundwater elevations are lowered, and water drains out of an aquifer or clay layers that are within or between aquifers.

Subsidence in granular materials, such as sand and gravel that typically comprise the water-bearing portion of an aquifer, is generally minor and can be reversed when groundwater levels are raised again. However, as groundwater drains from the clay layers, there is less water supporting the clay particles and the clay layers can compress or compact. This can be a slow process, occurring over several months, or even years. With sufficient time, the magnitude of the compression can be great enough to result in a measurable, permanent lowering or subsidence of the ground surface (see Figure 5.16-8 [Subsidence Schematic]). Clays are far more compressible than sands or gravels; therefore, it is the presence of thick clays, rather than sands or gravels that indicates a potential for subsidence.

Approach to Analysis

Operation of the Project could cause land subsidence if Project-related groundwater pumping were to result in decreased groundwater levels in the Westside Groundwater Basin that are lower than the historic low groundwater levels for an extended period of time. Clay layers that are located above the historic low groundwater levels have already been drained of water and have already compressed, if they were susceptible to compression, as a result of long-term historic pumping in the Basin. This initial compaction of clay layers tends to be permanent (Fugro 2012b). Therefore, future land subsidence that could occur due to the Project would result only if historic low groundwater levels were exceeded. This analysis assumes that if predicted groundwater levels were to drop below historical low levels, they would be maintained at these low levels long enough to induce subsidence.



Subsidence Caused by Groundwater Pumping

LEGEND

Water Levels

Subsidence Schematic

Regional Groundwater Storage and Recovery Project

Figure 5.16-8

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This is a conservative assumption that results in reporting the maximum amount of possible subsidence. The relevant factors that influence the expected amount of subsidence due to Project operation include:

- The extent to which groundwater levels are decreased by the Project compared to predicted groundwater levels for modeled existing conditions;
- The presence and thickness of clay layers or clayey sand layers;
- The compressibility of the clay or clayey sand layers; and
- The amount of time low groundwater levels are maintained. This analysis assumes low groundwater levels are maintained long enough to induce the maximum possible subsidence.

Anticipated subsidence from Project operations was estimated using the following methodology (Fugro 2012b; Fugro 2012d):

Four locations within the Westside Groundwater Basin were selected as representative locations to estimate the potential extent of subsidence due to the Project. These locations were selected based on a review of the basin geology. These four sites were considered representative of anticipated subsidence, because subsidence would tend to be greater at these sites due to thicker clay layers and greater drawdown of groundwater levels due to the Project. Selection of these four locations should not be interpreted to mean that potential subsidence would occur only around a specific well site; if subsidence were to occur, the results at these four locations would be representative of the maximum effect that could occur at any of the proposed well locations throughout the Basin.

- Two proposed well locations were selected for subsidence analysis in the North Westside Groundwater Basin: (1) the eastern side of Lake Merced (at the SFPUC's proposed SFGW Project Lake Merced Pump Station well site); and (2) the Sunset area of western San Francisco (at the SFPUC's proposed SFGW Project South Sunset Playground well site) (see Figure 5.1-3 [Location of Projects Considered in the Cumulative Analysis] in Section 5.1, Overview). These two sites were selected over other locations, such as Golden Gate Park, because of the greater prevalence of clay layers in the Sunset and Lake Merced areas compared to Golden Gate Park. This prevalence of clay layers would tend to result in greater estimated subsidence at the selected sites than in Golden Gate Park (Fugro 2012b). No subsidence calculations were performed for the South Sunset Well location relative to the Project, because the South Sunset well site is located too far from the GSR Project's well facility sites for there to be any subsidence effects from Project pumping; however, cumulative impact analyses on subsidence at the South Sunset Well location have been performed (SFPUC 2012b).
- Two proposed well locations were selected in the South Westside Groundwater Basin at Site 8 in the Town of Colma and Site 13 in the City of South San Francisco (see Figure 3-4 [Project Location Map – Central] in Chapter 3, Project Description). Site 8 was chosen for analysis because it appears to have clay layers that are representative of other well locations in the Colma area. Site 13 was selected over other locations due to the presence of multiple clay layers at shallow, intermediate, and deep depths. A very thick, intermediate-depth clay at this location makes this site particularly susceptible to subsidence. (Fugro 2012b)
- Historical low groundwater levels were estimated for each of the four sites, as subsidence is predicted to occur only when groundwater levels fall below historical low groundwater

levels. Historical low water elevations were estimated from historical groundwater level measurements where available. These data were supplemented with groundwater levels as estimated by the Westside Basin Groundwater Model. (Fugro 2012b)

- The difference between groundwater levels for the modeled existing conditions scenario and the Project scenario was obtained from the results of the Westside Basin Groundwater Model (Kennedy/Jenks 2012b). The lowest simulated groundwater levels predicted at each site were used for the subsidence analysis, resulting in the maximum differences that would be caused by the Project. Under the GSR Project, the lowest groundwater levels would occur at the end of the design drought. In the cumulative scenario, the lowest simulated groundwater levels are generally predicted to occur at the end of the 47-year simulation. (Fugro 2012b)
- Historical low groundwater levels, the difference between simulated groundwater levels for existing conditions and the Project, and clay properties were used to calculate subsidence. Subsidence was calculated using equations based on standard and well accepted soil mechanics theories detailed by Terzaghi et al. (Terzaghi et al. 1996). These equations relate the amount of subsidence to a clay's compressibility and thickness, as well as the change in groundwater levels.

The compressibility property of clay particles is one of the parameters required to perform the methodology described above. Knowledge of such values is limited and often imprecise; hence, so are the predictions of the extent of compaction and resulting subsidence. Site-specific laboratory test results of the compressibility of clays in the Westside Groundwater Basin were not available and, therefore, typical soil compressibility values of the Merced Formation (which underlies much of the Westside Groundwater Basin) were used in the estimations of subsidence.

Subsidence can affect surface features such as structures and pipelines, the extent of flooding, and drainage patterns. In general, structures, including pipelines, can withstand subsidence or settlement of six inches or less without damage (Lambe and Whitman 1969; SFPUC 2013d); therefore, projected subsidence of six inches or more is considered a significant impact on structures. Flood zones, as defined by the National Flood Insurance Program Regulations in 44 CFR Part 60.3(c)(10), are subject to revision when the Base Flood Elevation within a 100-year flood zone changes by one foot or more. The calculation and mapping of 100-year flood zones are generally not accurate to more than a one-foot elevation change, and changes to flood elevations of less than one foot should not be interpreted as necessarily causing an increased risk of flooding. Therefore, subsidence impacts on flooding are considered significant if projected subsidence exceeds one foot within a 100-year flood zone. Subsidence impacts on drainage patterns are considered significant if projected subsidence exceeds six inches.

Impact Discussion and Significance Determination

As described in Section 5.16.1.3 (Regional Groundwater Hydrology), historic subsidence in the Westside Groundwater Basin has not been documented. The fact that extensive historic groundwater extraction has resulted in associated declines in groundwater levels, but without any apparent substantial subsidence, suggests that the semi-consolidated Merced Formation sediments in the Westside Groundwater Basin have limited compressibility. Therefore, based on a conceptual understanding of the mechanisms required for land subsidence and the apparent lack of historic subsidence in the area, the potential for future subsidence due to the Project would likely be limited due to low compressibility of semi-consolidated Merced Formation sediments. (Fugro 2012b)

Estimates of land subsidence due to Project pumping were calculated at a Lake Merced site and GSR Sites 8 and 13 because these wells would be located where substantial clay layers occur, as described above under Approach to Analysis. Predicted groundwater levels at the end of the design drought are estimated to be lower than historic low groundwater levels by up to 58 feet at the Lake Merced site, by up to 173 feet at Site 8 in Colma, and by up to 174 feet at Site 13 in South San Francisco during operation of the Project. The difference between modeled existing conditions (i.e., conditions without the Project) and the estimated Project effects at the end of the design drought (i.e., conditions reflecting the lowest groundwater levels that would occur during operation of the Project) would be a decrease in predicted groundwater levels of up to 63 feet at the Lake Merced site, up to 149 feet at Site 8, and up to 151 feet at Site 13. (Fugro 2012b)

Table 5.16-15 (Estimated Subsidence due to Project Operations) shows the estimated subsidence due to the Project at the locations selected for the analysis. The estimated subsidence is based on the difference between groundwater levels for modeled existing conditions and the lowest groundwater levels that are projected to occur with the Project.

TABLE 5.16-15
Estimated Subsidence due to Project Operation (in inches)

Site ID	Estimated Subsidence
San Francisco, eastern Lake Merced	1.0
Colma, Site 8	2.9
South San Francisco, Site 13	3.4

Source: Fugro 2012b

The estimated subsidence due to Project operation ranges between 1.0 and 3.4 inches at the three representative locations where subsidence was calculated. This estimated subsidence due to Project operation is less than the significance threshold of six inches for impacts on structures and drainage patterns. Estimated subsidence due to project operation is also less than the significance threshold of one foot for flooding impacts on land within the 100-year flood zone. Therefore, subsidence due to Project operation would be *less than significant* relative to structures and pipelines, drainage patterns, and flooding.

Impact Conclusion: Less than Significant

Impact HY-8: Project operation would not result in seawater intrusion due to decreased groundwater levels in the Westside Groundwater Basin. (Less than Significant)

Description of Seawater Intrusion

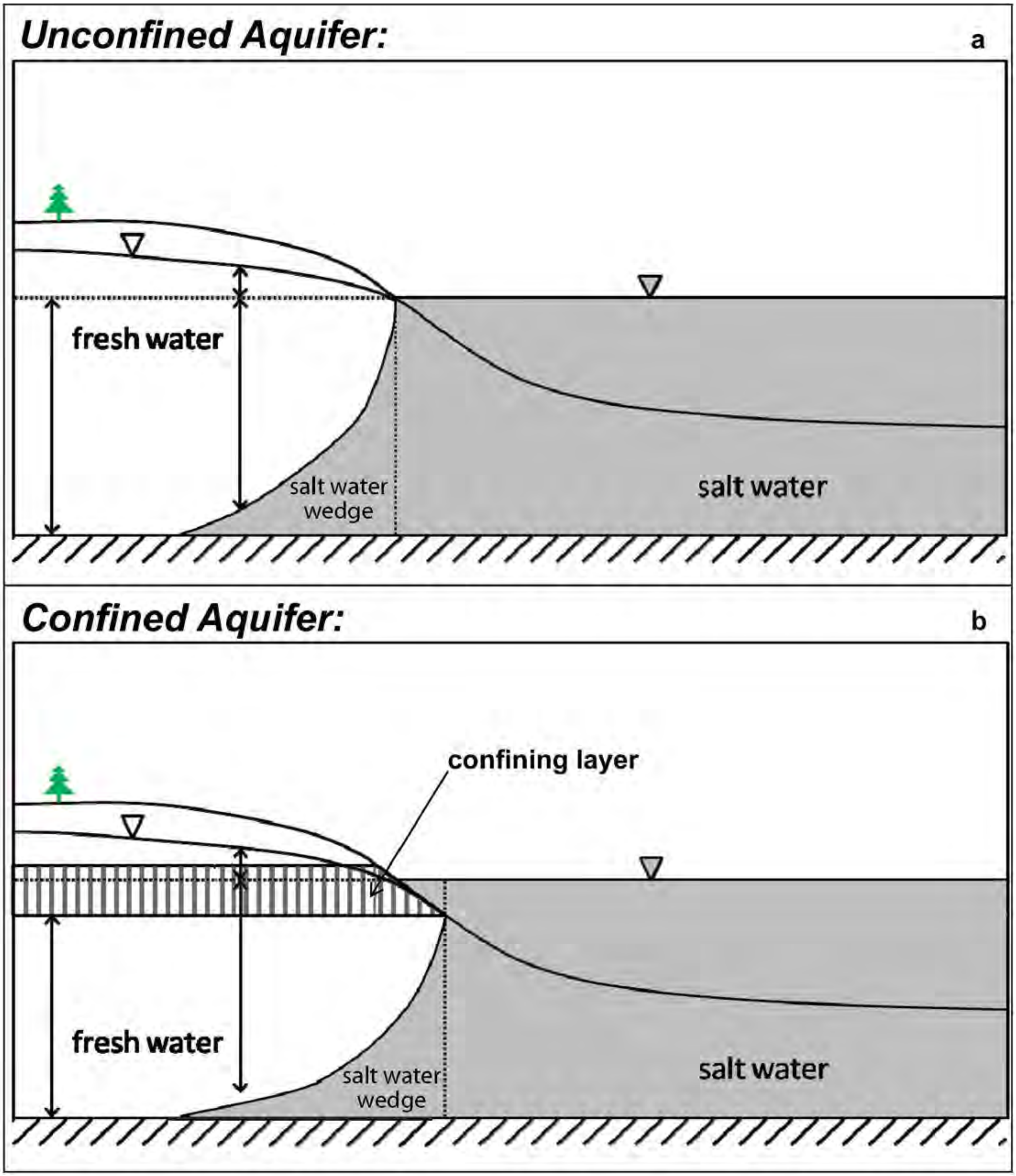
Seawater intrusion refers to the migration of seawater into a freshwater aquifer and can occur when groundwater levels are lowered by pumping. Seawater intrusion becomes an environmental concern when the degradation of groundwater quality would make the groundwater potentially unsuitable for its identified use, or when inland surface water features are affected by the seawater, compromising habitats or uses of the surface water.

Where an aquifer is in direct hydraulic connection with an ocean or bay, the hydrologic zone where fresh groundwater and ocean saltwater meet—referred to as the saltwater/freshwater interface—is comprised of brackish water (a mixture of freshwater and saltwater) to saline water (water with high concentrations of salt). Aquifers that are not actively pumped typically provide freshwater outflow at the coast. Because this ocean outflow exerts seaward hydraulic pressure, it can generally hold seawater at equilibrium offshore from the coast and hinder its onshore advancement.

Seawater intrusion occurs when the freshwater-groundwater gradient declines toward the ocean or bay and the resulting seawater intrusion along the base of the aquifer is termed a "saltwater wedge" (see Figure 5.16-9 [Seawater Intrusion Schematic]). Because of the wedge-shaped boundary, the shallowest portion of the landward side of the saltwater/freshwater interface may remain relatively close to the point where the aquifer is in connection with the ocean or bay, but the deepest portion of the landward side of the saltwater wedge may extend further landward, even when freshwater is flowing to the ocean.

The extent of seawater intrusion into a freshwater aquifer is affected by the relative difference between water levels in the ocean or bay and the freshwater aquifer with which it is in direct hydraulic connection. The theoretical groundwater level necessary to prevent seawater intrusion is termed the "exclusion head." When groundwater levels drop below the exclusion head, the interface between the seawater and freshwater can theoretically move inland under certain conditions. The interface would move back toward the ocean or bay if groundwater levels were raised again. However, some of the salt can remain in the fresh water (even after the interface has moved back toward the ocean or bay), and this remaining saltwater can be difficult to remove (Kennedy/Jenks 2012c). The seawater/freshwater interface is not a sharp interface. Instead, diffusion and dispersion result in a transition zone at the interface where salt concentrations (typically measured as chloride or total dissolved solids [TDS]) range from values typical of freshwater at the leading edge (furthest inland) to those typical of seawater at the following edge (closest to the ocean or bay). The movement of the interface is controlled by changing conditions on the freshwater side of the interface. Seawater contains approximately 35,000 mg/L of TDS, which includes about 19,000 mg/L of chloride (USGS 2003). As discussed in Section 5.16.1.3 (Regional Groundwater Hydrology) under the sub-heading "Coastal Chloride Concentrations," the most recent chloride concentrations in the shallow water bearing zone, Primary Production Aquifer and Deep Aquifer in the North Westside Groundwater Basin are all below 160 mg/L (except at Monitoring Well LMMW-1S, as explained in 5.16.1.3 [Regional Groundwater Hydrology] under the sub-heading "Coastal Chloride Concentrations"). Therefore, there is a large contrast between the chloride concentrations in the seawater and the groundwater. In the North Westside Groundwater Basin, seawater intrusion has not been observed in coastal monitoring wells and the seawater/freshwater interface is assumed to be west of the shoreline.

Movement of the seawater/freshwater interface can be a slow process. The rate of movement depends on aquifer conditions, and seawater intrusion occurs only when the conditions that cause seawater intrusion are sustained for a sufficient period of time given the existing conditions. Fluctuating groundwater elevations can result in a wider transition zone.



Seawater Intrusion Schematic

Regional Groundwater Storage and Recovery Project

Figure 5.16-9

Source: Kennedy/Jenks 2012c

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Approach to Analysis

The Westside Basin Groundwater Model does not simulate seawater and freshwater flows or their interface but instead simulates groundwater-level changes. Therefore, the potential for seawater intrusion to occur in the Westside Groundwater Basin is evaluated using the results of the groundwater model in conjunction with groundwater contours, changes in flux to the ocean or bay, and analytical approaches to evaluate exclusion heads in the aquifer and the estimated rate of seawater intrusion (Kennedy/Jenks 2012c). If the Project were to not cause changes in these groundwater parameters in such a fashion that seawater intrusion would be more likely to occur, then the Project would not cause the chloride concentrations in groundwater to degrade to significant levels above 250 mg/L.

Three methods are used to estimate the potential for seawater intrusion at any location in the Westside Groundwater Basin:

- Comparing simulated groundwater elevations to calculated exclusion heads[25],
- Analyzing the changes in the simulated flux of groundwater flowing to the ocean, and
- Analyzing simulated groundwater contours.

This impact analysis does not discuss groundwater levels and quality at the Thornton Beach and Fort Funston monitoring locations because these monitoring points are located southwest of the Serra Fault, between the San Andreas Fault and Lake Merced, as described in the "Regional Geology" subsection of Section 5.16.1.3 (Regional Groundwater Hydrology). Previous analyses have determined that this area would not be subject to seawater intrusion, because the Serra Fault presents an effective barrier to seawater intrusion (Kennedy/Jenks 2012c).

Groundwater Elevations and Exclusion Heads

Average modeled groundwater levels were compared to the average groundwater levels predicted to occur under modeled existing conditions in order to determine the effect of Project-related pumping on the potential for seawater intrusion to occur. Average groundwater levels were used because short-term movement of the seawater interface towards land during periods of low groundwater can be offset by movement of the seawater interface towards the ocean during periods of high groundwater. Average groundwater elevations are appropriate because they address both the magnitude and duration of short term seawater intrusion.

If predicted average groundwater levels with the Project are lower than predicted average groundwater levels under modeled existing conditions, the groundwater levels are further compared to the exclusion head. Groundwater levels higher than the exclusion head indicate that seawater intrusion would not likely reach that well location. Groundwater levels lower than the exclusion head do not necessarily indicate that seawater intrusion would occur, but rather that the hydrologic potential exists for the

[25] The theoretical groundwater level that must be maintained at a well location to prevent seawater intrusion from reaching the well.

landward migration of the seawater-freshwater interface. Generally, however, seawater intrusion would occur eventually if groundwater levels remain lower than the exclusion head indefinitely, unless there are other factors, such as physical barriers, that control seawater intrusion (Kennedy/Jenks 2012c).

Seawater intrusion is not likely to occur due to seasonal fluctuation of groundwater levels, because seasonal fluctuations are temporary, and seasonal decreases are compensated for by seasonal increases (Kennedy/Jenks 2012c). Seasonal fluctuations may result in a wider seawater/fresh water transition zone, as mentioned above. This wider transition zone may result in elevated chloride concentrations near the coast. However, such a wider transition zone is not an indicator of ongoing seawater intrusion.

Groundwater Flux

The flux of groundwater moving towards the ocean or bay represents the amount of water discharging from the aquifer. The flux values are representative of the groundwater basin as a whole and indicate total discharge along the coast; this means that localized changes in flux that could allow localized seawater intrusion to occur would not be identified in this analysis. However, calculating flux values provides a gross evaluation of the amount of water discharging from the aquifer. A positive flux indicates a lower potential for seawater intrusion to occur, although a positive flux value does not necessarily preclude seawater intrusion from occurring because the seawater wedge could still enter the lowest part of the freshwater aquifer. Rather, the calculated flux is used as an indication of whether seawater intrusion is expected to be a substantial concern.

Groundwater Contours

Groundwater contours were used to evaluate groundwater elevations and flow directions in the shallow water bearing zone and Shallow Aquifer throughout the basin. In general, groundwater levels estimated to be above sea level and groundwater flow directions estimated to be directed toward the ocean or bay indicate that there is a low potential for seawater intrusion to occur.

Significance Threshold

As previously discussed, the recommended secondary MCL for chloride is 250 mg/L and the upper limit is 500 mg/L. An increase in chloride concentrations above these concentrations could render at least part of the groundwater basin unsuitable for use as a drinking water source. Therefore, this analysis considers that impacts related to seawater intrusion would be significant if chloride concentrations exceeded 250 mg/L at one of the monitoring locations along the Pacific Coast or San Francisco Bay.

Impact Discussion and Significance Determination

Potential for Seawater Intrusion in the North Westside Groundwater Basin

<u>Shallow Aquifer</u>

The results from the Westside Basin Groundwater Model predict that, in the North Westside Groundwater Basin, average groundwater levels in the Shallow Aquifer due to the Project would be equal to or higher than the average groundwater levels without the Project, that is, under modeled existing conditions (Kennedy/Jenks 2012c). As a result of the higher future groundwater levels that would accumulate through operation of the Project, seawater intrusion would tend to be impeded or prevented. The average rise in groundwater levels in the Shallow Aquifer, modeled at monitoring well clusters in the Basin, would be between 0 and 1.6 feet. The Model results predict that the Project's average groundwater levels would never be below the exclusion head for the Shallow Aquifer.

The average groundwater flux from the Westside Groundwater Basin to the Pacific Ocean is predicted to be 17 af per month (afm) higher under Project conditions than under modeled existing conditions. This increased flux would tend to either push the seawater wedge further seaward and west of the coast or allow less seawater intrusion into the Westside Groundwater Basin, although a positive flux value does not necessarily preclude seawater intrusion from occurring because the seawater wedge could still enter the lowest part of the freshwater aquifer. Although these increased flux estimates are not specific to the Shallow Aquifer, they do suggest that, generally, more groundwater flows towards the Ocean under Project conditions than under modeled existing conditions.

Groundwater contours for the Shallow Aquifer under Project conditions are predicted to be almost identical to groundwater contours for the Shallow Aquifer under modeled existing conditions (Kennedy/Jenks 2012c), except that during the design drought, groundwater levels south of Lake Merced are predicted to be up to 5 feet lower with the Project than without the Project. These predicted lower groundwater levels, however, represent conditions after the design drought and do not represent average conditions. Any seawater intrusion induced during the design drought would be pushed back out by the average groundwater levels associated with operation of the Project, which are predicted to be higher than those predicted under modeled existing conditions. Therefore, the Project would not cause lower groundwater levels that would induce seawater intrusion in the Shallow Aquifer of the North Westside Groundwater Basin.

<u>Primary Production and Deep Aquifers</u>

The results from the Westside Basin Groundwater Model predict that, in the North Westside Groundwater Basin, average groundwater levels with implementation of the proposed Project in the Primary Production and Deep Aquifers would be equal to or higher than the average groundwater levels without the Project. Average groundwater levels would be higher because they would rise during the Put Years during Project operations, and would remain high during the Hold Years. Only during Take Years would groundwater levels drop below the groundwater levels for the modeled existing conditions. The average rise in groundwater levels in the Primary Production Aquifer, estimated at monitoring well clusters in the North Westside Groundwater Basin, is expected to be between 0.1 and 3.3 feet. The average rise in groundwater levels in the Deep Aquifer, estimated at monitoring well clusters in the North Westside Groundwater Basin, is expected to be between 0.2 and 1.5 feet. These higher groundwater levels would impede seawater intrusion.

The Model results predict that the Project's groundwater levels in the Primary Production Aquifer would be below the exclusion head between 99 and 100 percent of the hydrologic sequence, taking into account the values at different locations. This is identical to the percent of time that groundwater levels in the Primary Production Aquifer are estimated to be below the exclusion head under modeled existing conditions. Therefore, the Project would not be expected to cause groundwater levels to be below the exclusion head more frequently than they would be under the modeled existing conditions.

The Westside Basin Groundwater Model results predict that the Project's groundwater levels in the Deep Aquifer would be below the exclusion head during 100 percent of the hydrologic sequence, which is the same as is expected to occur without the Project (i.e., modeled existing conditions).

Therefore, the Project would not induce seawater intrusion in the Primary Production or Deep Aquifers of the North Westside Groundwater Basin that is not anticipated under modeled existing conditions.

Impact Conclusion: Less than Significant

Potential for Seawater Intrusion in the South Westside Groundwater Basin

Shallow Water-bearing Zone

The results from the Westside Basin Groundwater Model predict that, under the proposed Project, simulated groundwater elevations in the South Westside Groundwater Basin would range between 0.2 feet below and 3.1 feet above modeled existing conditions. The average groundwater levels in the South Westside Groundwater Basin's shallow water bearing zone over the 47-year hydrologic modeling sequence due to the proposed Project are predicted to be equal to or higher than the average groundwater levels without the Project. These higher groundwater levels under the proposed Project would tend to impede seawater intrusion. The average rise in groundwater levels in the shallow water bearing zone groundwater levels, estimated at monitoring well clusters in the South Westside Groundwater Basin, is predicted to be between 0.8 and 2.0 feet over this time period.

The Westside Basin Groundwater Model results predict that the Project's groundwater levels in the shallow water bearing zone would be below the exclusion head during seven to 100 percent of the 47-year hydrologic sequence, taking into account multiple locations throughout the South Westside Groundwater Basin. Groundwater levels in the shallow water bearing zone would be below the exclusion head 10 to 100 percent of the time at those same locations under modeled existing conditions (i.e., without the Project). Therefore, the Project would not cause groundwater levels to be below the exclusion head more frequently than they would be under the modeled existing conditions.

Groundwater flux from the South Westside Groundwater Basin to the San Francisco Bay under Project conditions is predicted to range between 11 afm less to 8 afm more than what is predicted under modeled existing conditions. The average groundwater flux from the Westside Groundwater Basin to the San Francisco Bay is predicted to be 3 afm higher with the Project than without the Project. This increased flux would tend to either push seawater further towards San Francisco Bay or allow less seawater intrusion into the Westside Groundwater Basin. Although these increased flux estimates are not specific to the shallow water bearing zone, they do suggest that, generally, more groundwater would flow towards the Bay under Project conditions than under modeled existing conditions.

Therefore, the Project would not cause lower groundwater levels as compared to modeled existing conditions, such that seawater intrusion would be induced to a greater degree in the shallow water bearing zone of the South Westside Groundwater Basin.

Primary Production and Deep Aquifers

At the Burlingame-D monitoring well (located adjacent to San Francisco Bay in the South Westside Groundwater Basin Primary Production Aquifer), the Westside Basin Groundwater Model results predict that average groundwater levels with the proposed Project would be 1.3 feet higher than the average groundwater levels without the Project (Kennedy/Jenks 2012c). These higher groundwater levels would impede seawater intrusion.

The Westside Basin Groundwater Model results also predict that groundwater levels in the Primary Production Aquifer, measured at Burlingame-D monitoring well, would be below the exclusion head 100 percent of the hydrologic sequence under Project conditions. This is identical to the percent of time that groundwater levels in the Primary Production Aquifer are predicted to be below the exclusion head under modeled existing conditions. Therefore, the Project would not cause groundwater levels to be below the exclusion head more frequently than they would be under the modeled existing conditions.

Simulated groundwater elevations for the South Westside Basin Deep Aquifer are not readily available from the memoranda detailing the results of the Westside Basin Groundwater Model. However, the sediments present in the Deep Aquifer are not continuous to the Bay, being separated from it by deposits of low-permeability Bay Mud that likely stretch from the land surface to the bedrock surface below (Kennedy/Jenks 2012c). Therefore, any Deep Aquifer seawater intrusion would need to pass through the shallow water bearing zone and Primary Production Aquifer before reaching the Deep Aquifer. As discussed above, the Project would not induce seawater intrusion into either the shallow water bearing zone or Primary Production Aquifer. Therefore, given the lack of hydrologic connection between the Deep Aquifer and the bay, the Project would not induce seawater intrusion into the Deep Aquifer.

In summary, the Project would not cause lower groundwater levels that would induce seawater intrusion in either the North or South Westside Groundwater Basin; therefore, the potential impact on groundwater relative to seawater intrusion would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HY-9: Project operation could have a substantial, adverse effect on water quality that could affect the beneficial uses of Lake Merced. (Less than Significant with Mitigation)

Description of Groundwater/Surface Water Interactions

The Project has the potential to affect Lake Merced due to groundwater/surface water interactions. The phrase "groundwater/surface water interactions" refers to the movement of water beneath the land surface (groundwater) to or from water bodies on the ground surface, such as streams, lakes, and wetlands (surface water). Several general conditions are required for groundwater/surface water interactions to occur. First, the depth to groundwater (the water table) has to be sufficiently shallow in relation to the bottom of the surface water body. While the water table does not have to connect with the surface water for interactions to occur, there cannot be a substantial distance between the two, and separations of tens or hundreds of feet would generally preclude groundwater/surface water interactions. There must also be a relatively permeable pathway (such as a sandy lakebed) between the groundwater and surface water for interactions to occur.

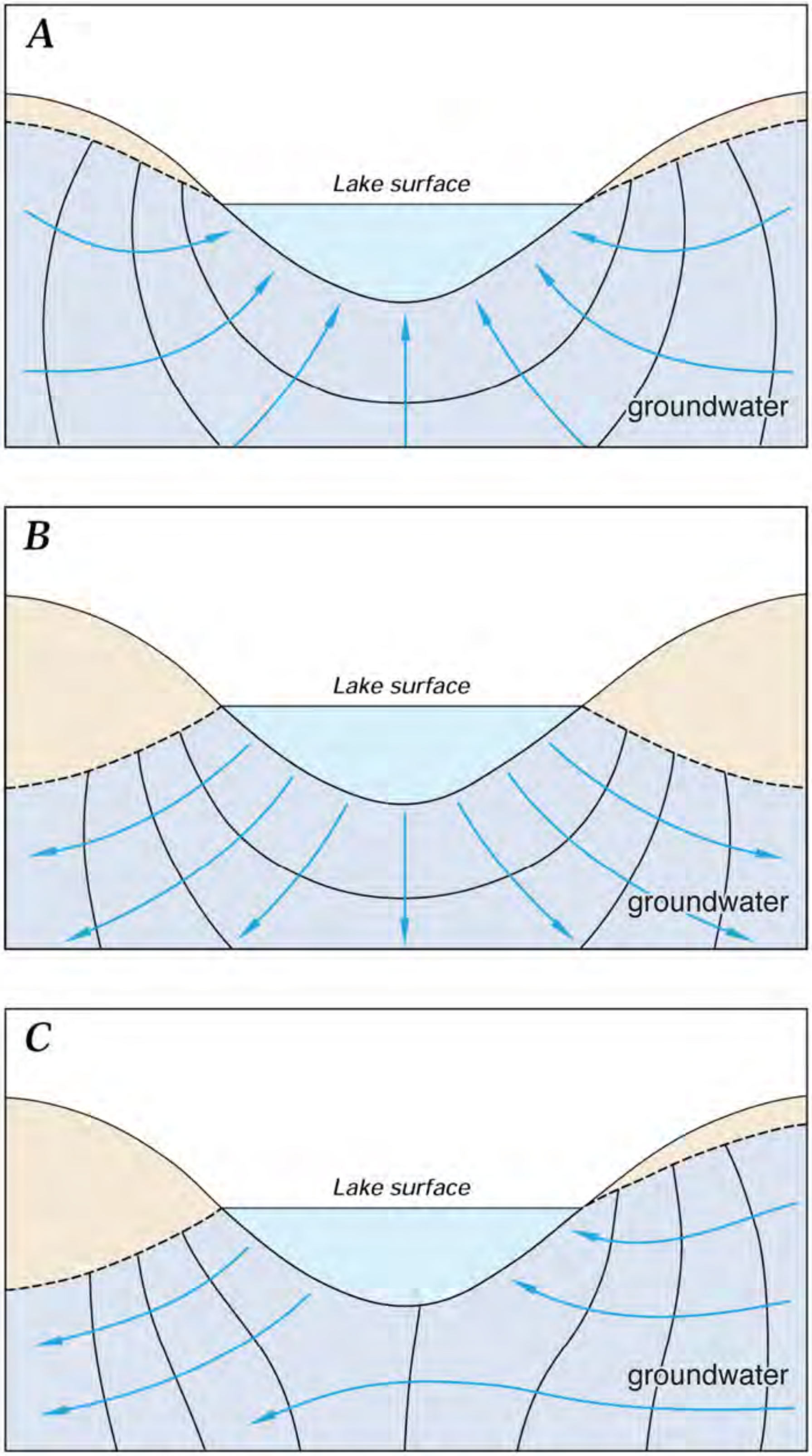
The presence of a clay layer or other low-permeability layer could preclude groundwater/surface water interactions, even if the water table were sufficiently shallow to otherwise allow interactions. Even with a natural sand lakebed, the settling of silt and organic-rich sediments from the lake water could reduce the permeability of the lake bottom, often restricting groundwater/surface water interactions to the areas along the sides of the lake where fine sediments would not have accumulated.

Surface water bodies such as lakes and streams can interact with groundwater in three basic ways (Kennedy/Jenks 2012d). They can gain water from the inflow of groundwater through the lakebed or streambed when the groundwater level is higher than the water level in the surface water body; this is referred to as a gaining system (illustration "A" on Figure 5.16-10 [Interaction of Groundwater and Lakes]). Surface water bodies can also lose water to the groundwater through the lakebed or streambed when the groundwater level is lower than the water level in the surface water body; this is referred to as a losing system (illustration "B" on Figure 5.16-10). In many cases, surface water bodies can both gain and lose water (e.g., during different seasons of the year), depending on the relative elevations of the groundwater table, the water level in the surface water body, as well as the groundwater flow direction in the aquifer (illustration "C" on Figure 5.16-10). The seepage rate between the lakebed or streambed and groundwater system is controlled by the permeability of the subsurface geology and the characteristics of the lakebed or streambed. In both gaining and losing systems, surface water levels can be affected by changes in groundwater elevations. Where the groundwater and surface water systems are disconnected, changes in groundwater elevations would not affect surface water levels.

To evaluate the potential for adverse effects on surface water bodies, it is important to understand changes in groundwater levels and related changes in surface water levels, as well as potential water quality effects related to changes in surface water levels. In general, a decrease in surface water levels would not be substantial unless the beneficial uses of the surface water were adversely affected.

Approach to Analysis

This impact analysis evaluates whether the proposed Project would result in significant changes in water quality due to changes in lake levels, which could in turn affect the beneficial uses of Lake Merced. This analysis is based on understanding the relationship of lake levels to water quality. It describes Lake Merced water levels predicted under the modeled existing conditions and then compares those levels with the projected lake water levels that are predicted to occur with implementation of the Project. Then, based on the magnitude, frequency, and duration of predicted changes in lake levels resulting from the Project, the analysis identifies the potential for water quality impacts that could affect beneficial uses.



Lakes can receive groundwater inflow (A), lose water as seepage to groundwater (B), or both (C). From Winter et al. (1998).

Interaction of Groundwater and Lakes

Regional Groundwater Storage and Recovery Project

Figure 5.16-10

Source: Kennedy/Jenks 2012 TM 10.2

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As discussed above in Section 5.16.1.4 (Groundwater-Surface Water Interactions), under the sub-heading "Lake Merced Water Quality", the relationship between water quality and lake levels varies, with no substantial correlations observed at lake levels between 0 and 7 feet City Datum, which is the range of lake levels observed between 1997 and 2009. Since 2003, Lake Merced has been maintained at a water surface elevation of at least 3 feet City Datum, and this level has increased to at least 5 feet City Datum since early 2006. At approximately 4 feet City Datum, all of the individual lakes are hydraulically connected, which is assumed to allow circulation between the four water bodies that comprise the lake, which would be expected to enhance water quality in the lake, as a result. Based on this, if Lake Merced water levels were to remain at or above 0 feet[26] City Datum (consistent with the water levels observed since 1997) under the Project, it can be expected that the current water quality conditions observed in the lake would continue. Therefore, increases in lake levels are not expected to cause water quality degradation.

Water quality monitoring between 1997 and 2009 indicates that water quality parameters in the lake have generally achieved the water quality objectives specified in the Basin Plan, with the exception of some occurrences of dissolved oxygen levels less than the warmwater habitat criterion of 5 mg/L during the summer and late fall in the deeper portions of the lake (Kennedy/Jenks 2010a). Based on a review of available water quality data, the water quality conditions of Lake Merced remained relatively constant from 1997 to 2009, with a slight improvement in lake clarity (secchi depth) during this period.

No historic data are available to determine whether lake levels below 0 feet would cause water quality degradation. Given this lack of historic data, if Project-related groundwater pumping (rather than hydrologic or other factors) were to result in lake levels below 0 feet City Datum, the potential for water quality impacts is unknown. As a conservative assumption, the approach to this analysis assumes that water quality impacts could occur when lake levels are below 0 feet City Datum, including changes in the pH and dissolved oxygen levels, the parameters that are responsible for the listing of Lake Merced as an impaired water body (see discussion in Section 5.16.1.4 [Groundwater-Surface Water Interactions], under the sub-heading "Lake Merced Water Quality"). For the purposes of this EIR, this would be considered a significant impact.

To evaluate changes in Lake Merced water levels, the Westside Basin Groundwater Model (Kennedy/Jenks 2012a) was used to estimate Project-related groundwater-level changes in the vicinity of Lake Merced and to derive the magnitude and direction of the flux of the groundwater/surface water interactions at Lake Merced. Because this model does not take into account the site-specific geometry of the lakebed, the simulation of Lake Merced surface water levels is not always accurate. Therefore, the output from the groundwater flow model was used as input to the Lake-level Model (a spreadsheet-based mass balance model calibrated to 70 years of historical water levels in Lake Merced) to provide a more accurate estimate of Lake Merced water levels in response to changes in groundwater levels and groundwater flux. Use of the Lake-level Model allows for changes in the surface area of Lake Merced as a function of lake level, a dynamic simulation of changes in lake volume, a more complete evaluation of

[26] At a lake level of 0 feet City Datum, the depth of Lake Merced would range from approximately 6 to 17 feet of water, depending on the location in the lake.

stormwater runoff, and an evaluation of flooding events resulting from overflows of the Vista Grande Drainage Canal.

The modeled groundwater elevations from the following four monitoring well clusters in the vicinity of Lake Merced (see Figure 5.16-11 [Simulated Lake Merced Level Changes]) were used for the analysis of changes in groundwater levels:

- LMMW-1, located along the west shore of South Lake;
- LMMW-2, located between North and South Lakes;
- LMMW-3, located adjacent to the west shore of Impound Lake; and
- LMMW-4, located north of North Lake.

Lake Merced Water Levels under Modeled Existing Conditions

Figure 5.16-12 (Simulated Lake Merced Levels Relative to Modeled Existing Conditions) shows the estimated Lake Merced water levels over the 47-year simulation period under modeled existing conditions. The modeled existing conditions respond directly to the assumed hydrologic sequence and existing groundwater practices described in Section 5.1, Overview, Section 5.1.6 (Groundwater Modeling Overview). Lake levels increase during years 1 to 4, which are years of above-average precipitation, followed by a decline in lake levels in years 4 through 16, which are years of a dry period, to a low of 1.5 feet City Datum during a dry period. From years 16 to 36, lake levels fluctuate with climatic conditions, but show an overall increasing trend to over 11 feet City Datum. The model also simulates the hypothetical design drought in years 36 to 44, during which the lake levels decline sharply to -0.8 feet, then recover to about 5 feet City Datum. Over the simulation period, the mean monthly lake level is 6.3 feet City Datum and the estimated mean annual range is 1.6 feet (see Figure 5.16-12). The mean monthly lake levels are below an elevation of 1 foot City Datum for four percent of the simulation period. (Kennedy/Jenks 2012d)

Under modeled existing conditions, estimated Shallow Aquifer groundwater levels in the nearby monitoring wells also indicate a response to climatic conditions, but groundwater levels in the Primary Production Aquifer show less variability than in the Shallow Aquifer. Characteristic of the Westside Groundwater Basin, the estimated groundwater levels are generally higher for locations to the north of Lake Merced and lower for locations to the south. This difference reflects the influence of existing groundwater pumping in the South Westside Groundwater Basin. For Lake Merced, this means that under modeled existing conditions, there could be a higher net outflow of lake water to groundwater from the South and Impound Lakes, while there could be more inflow of groundwater to the North and East Lakes. (Kennedy/Jenks 2012d)

The overall pattern of estimated flux (i.e., groundwater flow into or out of Lake Merced), indicates that under the modeled existing conditions, there is net inflow of groundwater to the lake during periods of higher precipitation and a net outflow of lake water to groundwater during dry periods when groundwater levels decline. (Kennedy/Jenks 2012d)

Effects of Project-related Pumping on Lake Merced Water Levels

Figure 5.16-11 (Simulated Lake Merced Level Changes) shows the estimated Lake Merced water levels over the 47-year simulation period under Project conditions. The effects of Project-related pumping would be observed in groundwater levels in both the Shallow and Primary Production aquifers. In the Shallow Aquifer, groundwater levels during Project operation, at the LMMW-3 location (to the south of Lake Merced), are predicted to be generally higher than is predicted to be the case without the Project, as indicated by the modeled existing conditions. However, following the design drought, groundwater levels at the LMMW-3 location are predicted to be about 2 feet lower with operation of the Project than they are predicted to be under the modeled existing conditions, and at LMMW-4 to the north they are predicted to be about 1 foot lower than they are predicted to be under the modeled existing conditions. Groundwater levels in the Shallow Aquifer, with operation of the Project, are estimated to recover in one to two years following the design drought. (Kennedy/Jenks 2012d)

In the Primary Production Aquifer, groundwater levels are also predicted be higher with operation of the Project than is predicted to be the case under modeled existing conditions throughout most of the 47 years of the modeled simulation. However, at the end of the design drought, the groundwater levels at LMMW-3 are predicted to be about 2 feet lower with operation of the Project than they are predicted to be under the modeled existing conditions. At LMMW-4 to the north, the Primary Production Aquifer groundwater levels are predicted to be about 2 feet lower with operation of the Project than they are predicted to be under the modeled existing conditions. Groundwater levels at this location in the Primary Production Aquifer, with operation of the Project, are estimated to partially recover to pre-design-drought levels in three to four years following the end of the design drought. (Kennedy/Jenks 2012d)

The Lake Merced lake levels under Project conditions are predicted to be similar to the modeled existing conditions for the first two years of the simulation, but are then predicted to rise rapidly from approximately 9 feet to approximately 11 feet by year 10, as a result of higher precipitation and concomitant higher groundwater levels in the Shallow Aquifer. During years 44 to the end of the simulation, after the design drought, lake levels under Project conditions are still predicted to be about 4 feet below what they are predicted to be under the modeled existing conditions at the end of the simulation. (Kennedy/Jenks 2012d)

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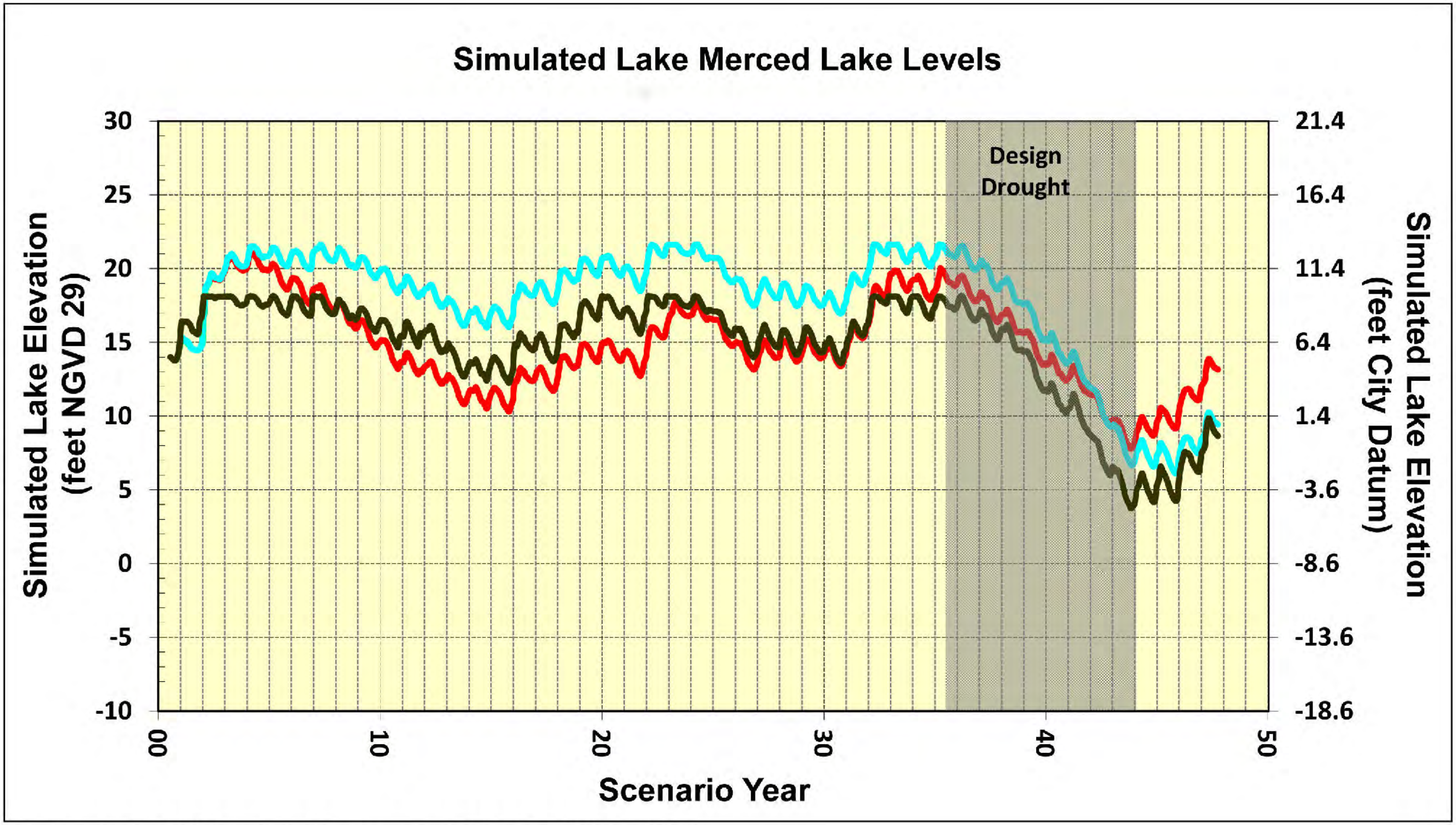

Note: Zero elevation NGVD is equivalent to mean sea level. City Datum = NGVD - 8.62 feet.

Lake Levels:

- Modeled Existing Conditions
- GSR Project
- Cumulative Conditions

Simulated Lake Merced Level Changes

Regional Groundwater Storage and Recovery Project

Figure 5.16-11

Source: Kennedy/Jenks 2012d (TM 10.2)

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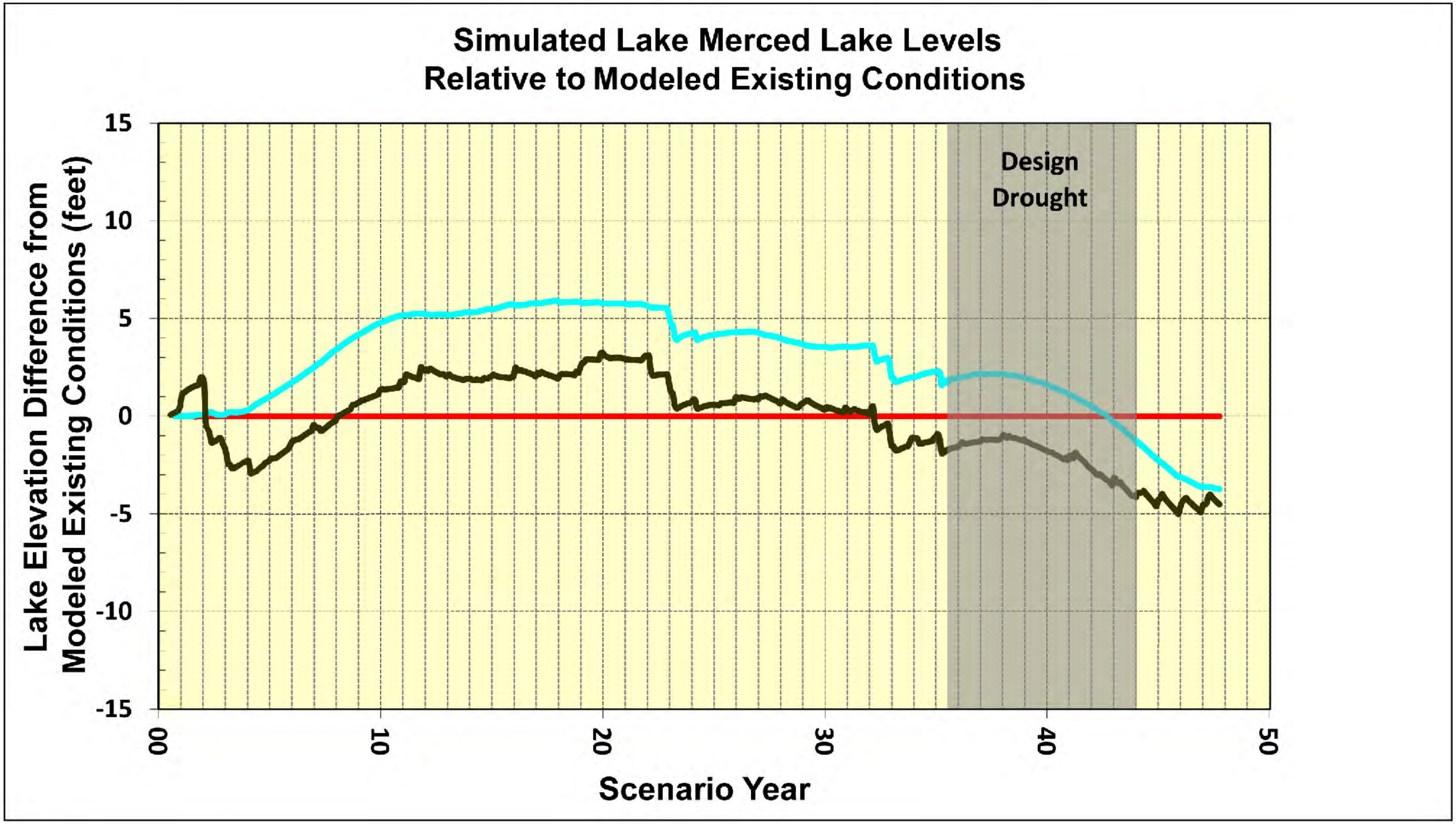

Lake Levels:

- Modeled Existing Conditions
- GSR Project
- Cumulative Conditions

Simulated Lake Merced Levels Relative to Modeled Existing Conditions

Regional Groundwater Storage and Recovery Project

Figure 5.16-12

Source: Kennedy/Jenks 2012d (TM 10.2)

The lowest predicted lake level with operation of the Project, which is expected at the end of the design drought, is approximately -2 feet City Datum (compared to approximately -1.5 feet City Datum under modeled existing conditions; i.e., without the Project), which would leave approximately 4 feet of water in Impound Lake and about 9 feet of water in East Lake. (Kennedy/Jenks 2012d)

The predicted mean monthly lake level with operation of the Project is 9.1 feet City Datum (compared to approximately 6.3 feet City Datum under modeled existing conditions). Lake levels with operation of the Project are predicted to be below 5 feet for 14 percent of the simulation period, whereas lake levels are predicted to be below 5 feet for 33 percent of the simulation period under the modeled existing conditions. Lake levels with operation of the Project are predicted to be below 1 foot for 10 percent of the simulation period, whereas lake levels are predicted to be below 1 foot for four percent of the simulation period under the modeled existing conditions. Overall, lake levels are predicted to be higher under the Project conditions than under the modeled existing conditions for approximately 90 percent of the time during the 47-year simulation, but lake levels are predicted to be lower than modeled existing conditions during and after the design drought for approximately 10 percent of the 47-year simulation. (Kennedy/Jenks 2012d)

Relative to the modeled existing conditions, the estimated outflow from Lake Merced to the groundwater under the proposed Project is predicted to be generally lower due to the higher groundwater levels associated with operation of the Project for most of the 47-year simulation period, although groundwater inflows to the lake are predicted to be reduced relative to the modeled existing conditions during and after the design drought. (Kennedy/Jenks 2012d)

Impact Discussion and Significance Determination

Although Lake Merced lake levels are predicted to be higher under the Project than under modeled existing conditions for approximately 90 percent of the time, as shown in Figure 5.16-12 (Simulated Lake Merced Levels Relative to Modeled Existing Conditions), Lake Merced water levels are also predicted to be lower than modeled existing conditions during and after the design drought. Following the design drought, water levels in Lake Merced are predicted to decrease due to the Project by about 4 feet more than under modeled existing conditions for at least three years. If water levels are reduced to this extent during and after the design drought, more of the lake bed would be exposed, making it susceptible to erosion and associated sedimentation of the lake, and the four individual lakes would separate hydraulically. Groundwater inflows to the lake are also predicted to be reduced relative to the modeled existing conditions during and after the design drought.

As described in Section 5.16.1 (Setting), Lake Merced is currently affected by periods of weak stratification and there have been episodes of low dissolved oxygen noted between 1997 and 2009. When the lake stratifies during the summer, dissolved oxygen levels are typically near saturation (approximately 10 mg/L) at the surface, with hypoxic (dissolved oxygen levels of less than 5 mg/L) or anoxic (dissolved oxygen levels of less than 2 mg/L) conditions in the bottom. The lake usually “turns over,” or mixes, in the fall and stays well-mixed throughout the winter. When the lake is mixed, dissolved oxygen levels are typically consistent throughout the entire water column, but these levels tend to be below saturation (approximately 8 mg/L, with a range of 6 to 10 mg/L). The lake is listed by the RWQCB as impaired for pH and dissolved oxygen.

Reduced lake levels and groundwater flows into the lake could also increase eutrophication of the lake because nutrients discharged to the lake would be concentrated in a smaller lake volume. Also, with a smaller volume, the lake would likely mix more frequently, and as a result (based on the patterns described above) this would likely increase dissolved oxygen levels at the bottom while decreasing dissolved oxygen levels at the surface. Therefore, depending on conditions, increased pumping under the proposed Project during Take Periods could increase the episodic occurrences of low dissolved oxygen and could also affect the pH of the lake water, potentially exacerbating the conditions that are responsible for the listing of Lake Merced as an impaired water body. Reduced groundwater inflows during and after Take Periods could affect nitrogen inflow to the lake from groundwater and also result in the increased concentration of suspended solids, metals, hydrogen sulfide, and bacteria already present in the lake, and less dilution of these constituents if they are discharged to the lake from stormwater flows.

As discussed in Section 5.16.2.1 (Federal and State Regulations) under the sub-heading "Regional Water Quality Control Board, Beneficial Uses," the Basin Plan identifies existing beneficial uses of Lake Merced as body contact recreation (e.g., fishing), noncontact recreation (e.g., picnicking, sightseeing, rowing), warm freshwater habitat, cold freshwater habitat, fish spawning, and wildlife habitat. Municipal and domestic supplies are also potential beneficial uses of Lake Merced. Adverse changes in water quality parameters such as dissolved oxygen and pH, as well as increased algal levels, could adversely affect the identified beneficial uses of Lake Merced that are related to warm freshwater habitat, cold freshwater habitat, and fish spawning, which, depending on the magnitude, duration, and frequency of such changes, could be considered a significant impact on water quality.

Because the Project is predicted to result in the lowering of Lake Merced water levels to below 0 feet City Datum somewhat more frequently than is predicted to occur under modeled existing conditions (from four percent of the 47-year simulation to 10 percent of the simulation), there is the potential for the Project to result in water quality changes that would compromise water quality objectives related to warm and cold freshwater habitat (e.g., dissolved oxygen), which in turn could adversely affect associated beneficial uses. Changes in dissolved oxygen levels and pH could also exacerbate conditions responsible for listing Lake Merced as an impaired water body during and after the design drought. This would be a *significant* impact on water quality.

Although municipal and domestic supplies are listed as potential beneficial uses of Lake Merced, the City and County of San Francisco (CCSF) has not used the lake as a municipal supply since the 1930s, as discussed in Section 5.16.1.4 (Groundwater-Surface Water Interactions) under the sub-heading "Existing Uses of Lake Merced." Further, as discussed below, the SFPUC would implement corrective action to ensure that long-term changes in water quality do not occur. Short-term changes in water quality associated with lowered lake levels would not be expected to affect the potential beneficial use of Lake Merced as a municipal supply because the need to rely on Lake Merced for the CCSF's water supply would occur only during a catastrophic emergency, and the City would direct residents to boil tap water prior to its consumption if such an unlikely emergency usage were to occur. (SFPUC 2012d)

Impacts related to water quality and associated beneficial uses of Lake Merced would be reduced to a *less-than-significant* level with implementation of Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced). These measures require the SFPUC to implement lake level management procedures to maintain Lake Merced water levels above 0 feet City Datum. These procedures include the continuation of lake-level and groundwater monitoring; redistribution of pumping patterns or decreasing the Project pumping rate; or additions of supplemental water (either from the regional system water, treated stormwater, or recycled water), if available. Supplemental water would be supplied from the regional water system, dechlorinated, and introduced to Lake Merced at the existing Lake Merced pumping station, in the same manner that supplemental water has been added to Lake Merced several times in the past. However, in the event that surface water supplies were not available due to maintenance, drought, or a declared emergency resulting from an earthquake or other disaster, the SFPUC could add treated stormwater or recycled water, if available (SFPUC 2012f).

Implementation of these measures would ensure that any lake level declines to below 0 feet City Datum as a result of the Project would be avoided through redistribution of pumping patterns or decreasing the Project pumping rate, or potentially through the addition of supplemental water. Although redistribution of pumping and the addition of supplemental water may or may not be feasible and effective under all circumstances, a decrease in Project pumping would be feasible and effective at mitigating lake level declines below 0 feet City Datum in any case. As a result, the Project would not cause changes in water quality that would adversely affect the potential beneficial uses of Lake Merced and, therefore, would result in a *less-than-significant* impact on the water quality of Lake Merced.

Implementation of redistribution of Project pumping under Mitigation Measure M-HY-9b (Lake Level Management for Lake Merced) would not cause significant seawater intrusion or well interference impacts, because the SFPUC would be able to avoid such impacts through alteration or stopping redistribution of pumping as needed. (SFPUC 2012a)

The Project's effect on Lake Merced water levels could also affect the soil and sediments of Lake Merced near the former Pacific Rod and Gun Club on the western shore of South Lake. Lead and other metals as well as clay target fragments (including associated organic chemicals) have been identified in the soil and sediments in this area. However, the Project would not result in adverse water quality effects related to this site either due to increasing or decreasing Lake Merced lake levels. If the Project were to result in a decrease in Lake Merced water levels, it may expose portions of the lakebed to the air. However, these portions of the Lake Merced lakebed have been exposed in the past and subsequently refilled; water quality sampling of this portion of the lake indicates that no dissolved lead was detected after the lake refilled. Fluctuations of Lake Merced predicted to occur due to Project operations, including increases in lake levels, are similar to historic fluctuations that have occurred in Lake Merced. Even with these historic fluctuations, lead has not been found in the lake water, and, therefore, Project-related lake-level increases or decreases at Lake Merced are expected to have no impact on Lake Merced water quality relative to lead (SFPUC 2012g).

Mitigation Measure M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced

The SFPUC shall implement lake level monitoring and modeling in accordance with the process described below. The SFPUC will conduct monitoring to detect changes in lake level and water quality, as well as groundwater-level elevations. Implementation of this measure shall be coordinated with the SFPUC's ongoing Lake Merced lake-level, water quality, and groundwater monitoring programs to document and maintain the database of these parameters throughout Project operations.

The SFPUC shall continue to maintain the Lake-level Model so as to be able to evaluate what lake levels may have been without implementation of the Project based on the actual hydrology that occurs during Project implementation. As described below, the SFPUC shall use the model to determine the amount of lake-level change that is attributable to the Project rather than to hydrologic or other factors.

Mitigation Measure M-HY-9b: Lake Level Management for Lake Merced

Prior to beginning operation of the Project, the SFPUC shall implement this lake level management program as follows:

- If lake levels are within the range that would occur without the Project based on maintenance of the Lake-level Model, no corrective action shall be required.
- If lake levels are below the range that would have occurred without the Project, corrective action shall be implemented in time to prevent lake levels from declining as a result of Project-related pumping below 0 feet City Datum or the level that would occur without the Project, whichever is lower. One or both of the following corrective actions shall be implemented:
  - Redistribute pumping to decrease Project pumping rates in the vicinity of Lake Merced or decrease the overall Project pumping rate. However, in no case would redistribution be undertaken where groundwater levels would decline more than from the Project as originally predicted by modeling.
  - Augment lake levels through the addition of supplemental water (such as potable water that is dechloraminated at the Lake Merced Pump Station, stormwater from the Vista Grande Drainage Canal, recycled water, or stormwater diverted from other development in the Lake Merced watershed), if available.

Impact Conclusion: Less than Significant with Mitigation

Impact HY-10: Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Pine Lake. (Less than Significant)

As discussed in Section 5.16.1 (Setting) Pine Lake is incised in the Shallow Aquifer and, therefore, lake levels are directly affected by changes in groundwater levels in the Shallow Aquifer. While there are no designated uses for Pine Lake per the Basin Plan, the water quality of the lake could be affected by lake level decreases, similar to what could occur at Lake Merced. Therefore, if the Project causes the lake level to drop below the existing level of 40.1 feet NGVD 29, then water quality in the lake could decline.

The Westside Groundwater Basin Model does not simulate Pine Lake levels, or the shallowest groundwater levels in the Shallow Aquifer. However, lake losses to the groundwater aquifer are directly proportional to changes in groundwater levels. Therefore, changes in Pine Lake water levels can be inferred from changes in groundwater levels in monitoring well LMMW-5S, located near Pine Lake and which monitors groundwater in the deeper portion of the Shallow Aquifer. (Kennedy/Jenks 2012d)

The Westside Basin Groundwater Model for the Project scenario predicts a general increase in groundwater levels at monitoring well LMMW-5S of up to several feet above those expected under modeled existing conditions, until near the very end of the simulation period, when there is a slight reduction after the design drought. The absence of any extended periods of reduced groundwater levels indicates that the Project would have little or no effect on groundwater levels near Pine Lake. Therefore, the lake would be maintained at levels similar to those that are predicted under the modeled existing conditions. As a result, the Project would not cause any significant changes to water quality or to the health of the lake.

In addition, the San Francisco Park and Recreation Department maintains Pine Lake's level by pumping from the Stern Grove well. Further, the Westside Basin Groundwater Model incorporates a sufficient amount of pumping (up to 0.013 mgd [15 afy]) to maintain Pine Lake at the elevation of 40.1 feet NGVD 29; maintenance of the lake at this level would not result in any changes to water quality or the health of the lake. Therefore, water quality impacts related to potential adverse effects on Pine Lake water levels would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HY-11: Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Colma Creek, San Bruno Creek, Lomita Channel, or Millbrae Creek. (Less than Significant)

The Westside Basin Groundwater Model predicts that the average annual groundwater outflow to the three creeks together would increase from 94 afy under modeled existing conditions to 122 afy with the Project (Kennedy/Jenks 2012d). Based on these results from the model, which predict little effect on the creeks, and because of the limited hydrogeologic connection between the creeks and groundwater, it is unlikely that groundwater-surface water interaction processes are present to any measureable extent for Colma, San Bruno, or Millbrae creeks. The Lomita Channel is an improved earth channel with a small (0.65 square mile) drainage area. The existing groundwater level in the vicinity of the Lomita Channel is approximately 20 feet below ground surface and is not expected to increase as a result of the Project (Kennedy/Jenks 2012d). As a result, no effect on the exchange between surface water and shallow groundwater at the Lomita Channel is expected. Therefore, the impact of the Project on Colma, San Bruno, and Millbrae creeks, and the Lomita Channel relative to potential groundwater-surface water interactions would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HY-12: Project operation would not cause a violation of water quality standards due to mobilization of contaminants in groundwater from changing groundwater levels in the Westside Groundwater Basin. (Less than Significant)

Description of Water Quality Impacts

Operation of the Project could violate water quality standards or waste discharge requirements in two ways: 1) if the groundwater pumped as part of the Project, after proposed treatment and/or blending as described in Chapter 3, Project Description, would not meet drinking water standards; or 2) if Project operation would change groundwater levels or change groundwater flow patterns such that areas of existing contamination could be mobilized or spread in groundwater, or existing remediation activities could become substantially less effective.

Approach to Analysis

Groundwater Pumped by Project May Violate Drinking Water Standards

To determine whether groundwater pumped by the Project would meet drinking water standards, preliminary Drinking Water Source Assessment and Protection Program (DWSAP) reports have been prepared by the SFPUC for the wells proposed at Sites 1 through 16. Refer to Section 5.16.2 (Regulatory Framework) for a description of the DWSAP Program. Preliminary DWSAP reports have not been prepared for the proposed alternate sites at Site 17 (Alternate), 18 (Alternate), and 19 (Alternate); if wells at these alternate sites were selected for construction, DWSAP reports would be required. For the analysis, the information in the preliminary DWSAP reports for Sites 8, 10, and 12 are used to characterize the vulnerability of Sites 17 (Alternate), 18 (Alternate), and 19 (Alternate), respectively, because the close proximity of the referenced sites means that water quality parameters would likely be substantially similar.

The preliminary DWSAP reports approximate the size of the Groundwater Protection Zones for the wells representing the overlying areas where groundwater may be drawn into the well during two, five, and ten years of pumping. They also report on the degree that the wells would be protected from contamination based on the local hydrogeology and construction features (physical barrier effectiveness) and identify possible contaminating activities (PCAs) within the Groundwater Protection Zones established for the wells. Examples of PCAs are known contaminant plumes, leaking underground storage tanks, dry cleaners, and gas stations. Each PCA is assigned a risk score correlated to the potential for that PCA to contaminate groundwater, with the risk score being based on the land use type of the PCA, which Groundwater Protection Zone the PCA is located in, and the effectiveness of local hydrogeology and well construction methods to prevent potential contamination in groundwater from entering the well. The combined vulnerability score for a PCA can range from 3 to 17 points, and the CDPH considers water supply wells to be vulnerable to PCAs with a score of 8 or higher.

For this analysis, a Groundwater Protection Zone with a radius 2,000 feet was assigned for each SFPUC Project well and each Partner Agency well. This radius is greater than the 1,500 to 1,900 feet approximated by the preliminary DWSAP reports for Groundwater Protection Zones for ten years of pumping. PCAs within 2,000 feet of SFPUC Project wells and Partner Agency wells are identified as potential sources of contamination to the production wells. The likelihood of contamination migrating from the PCAs at or near the surface to the production wells is evaluated based on an assessment of vertical flow from the shallow groundwater zone to the Primary Production Aquifer that supplies the Project and Partner Agency wells.

Groundwater contamination that is not associated with specific PCAs is also identified and the likelihood of this contamination resulting in groundwater from production wells exceeding drinking water standards is evaluated based on modeled changes in groundwater contours due to the Project.

Any violation of drinking water standards at production wells resulting from Project operation would be addressed by proposed treatment and/or blending as described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types).

Project Operations May Mobilize or Spread Contamination in Groundwater or Cause Remediation Systems to Become Less Effective

To determine whether Project operations could mobilize or spread existing contamination in groundwater or cause remediation systems to become less effective, the analysis examines the extent to which the Project could increase shallow groundwater zone levels and change shallow groundwater zone flow directions. Areas where existing groundwater levels are predicted to be below a depth of 70 feet under modeled existing conditions are evaluated differently from areas where existing groundwater levels are above a depth of 70 feet. A depth of 70 feet is selected because contamination at PCAs is assumed to be limited to the top 50 feet below ground surface; the additional 20 feet serves as a buffer between the shallow groundwater zone level and contamination at the PCA to prevent mobilization of existing contaminants. (Kennedy/Jenks 2012e, SFPUC 2013b)

PCAs do not include nitrate contamination that occurs sporadically in the Westside Groundwater Basin at various depths. A discussion of nitrate contamination is included in the evaluation of Project impacts relative to drinking water standards.

Where existing groundwater levels are below a depth of 70 feet under modeled existing conditions, and groundwater levels are predicted to rise above a depth of 70 feet due to Project operations, PCA contamination could be mobilized or spread in groundwater. These groundwater level rises could potentially mobilize contaminants beyond the downward migration that could occur with recharge under modeled existing conditions. When groundwater levels are not predicted to increase to within 70 feet or are predicted to decrease, it is presumed that shallow contamination would not be mobilized and spread by the Project.

Where existing groundwater levels are above a depth of 70 feet under modeled existing conditions, it is assumed that PCA contamination is already mobilized and could spread in the shallow groundwater zone (unless there is an active remediation system). If groundwater levels increase enough due to the Project to saturate an area of contamination that is undergoing remediation with, for example, a vapor recovery program dependent upon unsaturated soils, then the effectiveness of the remediation efforts could be adversely affected. Likewise, changes in shallow groundwater zone flow directions due to the Project could adversely affect pump-and-treat remediation systems that would have been designed for flow directions assumed under modeled existing conditions. If predicted groundwater levels do not increase enough or predicted groundwater zone flow directions do not change substantially to adversely affect remediation systems under the Project, it is presumed that shallow contamination would not be mobilized by the Project.

<u>Physical Processes Affecting Water Quality in the South Westside Groundwater Basin</u>

South Westside Groundwater Basin geology and the related aquifer system are described in detail in Section 5.16.1.3 (Regional Groundwater Hydrology). The primary physical processes affecting water quality in the South Westside Groundwater Basin consist of 1) groundwater recharge and groundwater gradients, and 2) contaminant fate and transport processes.

Some components of groundwater recharge can transport contaminants from the surface to the underlying regional aquifer system. The primary sources of groundwater recharge are vertical percolation of rainfall, applied irrigation water, subsurface inflow from surrounding areas and leakage from water supply and sewer pipes (HydroFocus 2011). Horizontal and vertical groundwater gradients can transport contaminants laterally between areas and downward to the underlying aquifer systems assuming there is a hydraulic connection. Groundwater gradients are a function of the difference in groundwater elevations within the same groundwater zone (horizontal gradient) or between different groundwater zones or aquifers if there is a direct hydraulic connection (vertical gradient). Larger differences in groundwater elevations result in steeper gradients which in turn can accelerate groundwater flow. On the other hand, smaller differences in groundwater elevations result in shallower gradients which in turn can slow groundwater flow. The ability for contaminants to affect water quality is largely controlled by the chemical properties of the contaminants (e.g., solubility, vapor pressure, soil retardation density, and stability).

The Primary Production Aquifer is generally disconnected hydraulically from most occurrences of shallow groundwater zones in the bulk of the South Westside Groundwater Basin by an unsaturated zone and in most places by the presence of shallow fine-grained materials. The aggregate thickness of the fine-grained materials that make up discontinuous low permeability zones reduces the possibility for vertical migration of contaminants between the shallow groundwater zone and Primary Production Aquifer. These relatively low-permeability shallow sediments in the area from Daly City to South San Francisco are markedly different than the higher-permeability shallow sands found in the North Westside Groundwater Basin. (Kennedy/Jenks 2012e)

Even though permeability is reduced, the shallow water-bearing zone and Primary Production Aquifer have limited hydraulic connectivity, and the GSR Project would therefore affect downward gradients and flow. The downward gradient with the GSR Project would be smaller on average because the time-averaged water levels in the Primary Production Aquifer would be higher (Kennedy/Jenks 2012a). Consequently, the downward movement of contaminated groundwater from the shallow water-bearing zone would generally be less than under existing conditions. The vertical permeability of the sediments between the two zones is low, which means that downward movement of groundwater and contaminants is expected to be relatively slow. This low rate of movement would provide more time to detect and remediate contamination from surface sources before it reaches the Primary Production Aquifer.

At a number of PCA sites, groundwater is encountered at depths more shallow than groundwater levels in the shallow groundwater zones. These groundwater occurrences represent localized perched groundwater that is not hydraulically connected with the shallow groundwater zone. When there is no hydraulic connection, the migration of contaminants from the localized perched groundwater or the soils above the localized perched groundwater to the shallow groundwater zone is limited by recharge rates.

Known Areas of Contamination

An inventory of existing PCAs, such as known contaminant plumes, leaking underground storage tanks, dry cleaners, and gas stations, was compiled and evaluated as part of preliminary DWSAP reports prepared for the proposed wells at Sites 1 through 16. In addition, records of known PCAs within a 2,000-foot radius of wells proposed at Sites 1 through 16 were compiled from the following sources (Kennedy/Jenks 2012e):

- Known contaminating activities from GeoTracker;
- Known historical land disposal sites;
- Records of DTSC sites; and
- Records of SLIC sites (Spills, Leaks, Investigations, and Cleanup).

In addition, environmental cases and spill sites located within 0.25 mile of proposed well facility sites are summarized in Table 5.17-1 (Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area) in Section 5.17, Hazards and Hazardous Materials.

A total of 153 PCAs were identified within the 2,000-foot-radius zones surrounding the proposed well sites. Of the 153 PCAs, 51 were reported to be open, and the remaining 102 were reported closed under regulatory oversight. The PCA sites that are reported to be closed under regulatory oversight are not anticipated to pose a groundwater quality risk given that cleanup at these sites has been completed and residual contamination, if any, is assumed to be low. Among the 51 PCAs reported to be open, several are reported to have affected soil only with no groundwater contamination, and the majority of the remaining sites are related to shallow groundwater contamination underlain by low permeability fine-grained materials. Contaminants at these sites occur at the surface and tend to remain near the surface due to the chemical properties of the contaminants and the geologic conditions that slow the migration of these contaminants into the deeper underlying Primary production Aquifer. Contaminants can occur in soil above shallow groundwater encountered at the site or in the groundwater encountered at the site. The shallow groundwater encountered at the site may be localized perched groundwater or part of a larger shallow groundwater zone. The encountered depth to water at each PCA site is an estimate of the maximum depth of soil contamination or the depth of contamination in perched groundwater, if applicable. The reported depths to water were shallower than 50 feet below ground surface in nearly all the active and inactive regulated sites. The one exception that has been identified is the Arco#465 site where groundwater was encountered 56 feet below ground surface; this site is discussed specifically below. (Kennedy/Jenks May 2012e)

Only two of the 51 open PCAs within the 2,000-foot radius zones surrounding the proposed GSR well sites were characterized in the SWRCB's GeoTracker database system as potentially affecting aquifer media used for drinking water supply (Kennedy/Jenks May 2012b). These two PCAs, discussed below, are located in proximity to Sites 2, 3, and 4. One additional PCA, which was not identified as potentially affecting a drinking water aquifer, is also described below due to its proximity to the proposed well at Site 16. A fourth PCA was identified as having an active remediation system and is within the 2,000-foot radius of the San Bruno #17 production well. The remaining PCAs with contaminated soil and/or shallow water-bearing zones are not summarized in detail below given the shallow nature of the contamination at the sites and the hydraulic separation provided by the aggregate thicknesses of intervening clay and sand layers. For additional information about these sites, refer to Table 5.17-1 (Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area) in Section 5.17, Hazards and Hazardous Materials.

Arco #0465 (T0608100027) – Located within 2,000 feet of Sites 2, 3 and 4

This PCA is listed as an active ARCO gasoline station with underlying soil and shallow groundwater affected with petroleum hydrocarbons. This site is located on the southern corner of the intersection of Southgate Avenue and Lake Merced Boulevard in Daly City, about 700 feet northeast of the existing Daly City Westlake production well and about 1,000 feet northwest of Sites 2, 3, and 4. Based on the 2009 monitoring report available at the GeoTracker website, on-site monitoring wells were screened from 39 to 70 feet below ground surface. Data available at the GeoTracker website indicate a shallow depth to groundwater at approximately 56 feet below ground surface, based on data measured in 2002. (Kennedy/Jenks 2012e)

A deep on-site monitoring well installed to a depth of 220 feet below ground surface (below an approximate 10-foot-thick clayey silt to silt clay zone) observes groundwater levels at much lower depths (approximately 154 feet below ground surface), which may represent the intermediate regional drinking water aquifer (i.e., Primary Production Aquifer). Groundwater sampling conducted in 2009 at the intermediate on-site monitoring well and off-site shallow monitoring well (screened from 39 to 49 feet below ground surface) detected no petroleum hydrocarbons. On-site shallow monitoring wells showed plume concentrations to be either stable or declining over time, with the contaminant plumes being contained on site. (Kennedy/Jenks 2012e)

Gas and Wash Partners (T10000003031) - Located within 2,000 feet of Sites 2, 3 and 4

This PCA is listed as a LUST cleanup site and is located approximately 1,900 feet east of Sites 2, 3, and 4, and about 470 feet north of Daly City Well No. 4. Contamination at this site was discovered in February 2011, when the current property owner conducted sampling beneath three underground storage tanks that were proposed to be converted to use for storage of recycled water. Sampling indicated a historical release of gasoline, benzene, toluene, and xylene from two of the three storage tanks and one of the fuel dispensers. Based on the particular contaminants encountered in the sampling, consultants for the site have speculated that the petroleum hydrocarbon release occurred before the introduction of oxygenated gasoline in the late 1970s to late 1980s; the fuel storage tanks were lined in early 1999. The investigation was limited to soil sampling and did not sample deeper than just below the USTs; groundwater was not encountered or sampled. The detected concentrations of petroleum hydrocarbons were above the Environmental Screening Levels (ESLs) mandated for shallow soil at a commercial property over a potential drinking water source. Consultants for the site noted that a nearby LUST site (approximately 500 feet to the east) had groundwater depths no shallower than 160 feet below the ground surface. Based on the current information available from the site investigation report, there is no supporting data indicating this site has affected the drinking water supply aquifer. (Kennedy/Jenks 2012e)

Olympic Service Station (T0608121993) - Located within 2,000 feet of Site 16

This PCA is listed as an existing service station located about 980 feet upgradient and west of Site 16. During the course of aquifer tests at the Project monitoring well at Site 16, the water level in a shallow monitoring well (Olympian MW-3, located at the Olympic Service Station) about 950 feet west of Site 16 was monitored. This was done to determine whether the pumping at Site 16 would affect any surrounding wells in the shallow groundwater zone. The pumping at Site 16 resulted in no discernible effects on the groundwater levels at the Olympic Service Station monitoring wells. (Kennedy/Jenks 2012e)

Based on the review of the Pangea Environmental Services, Inc., 2008 Groundwater Monitoring Report (Pangea Environmental Services, Inc., 2008) available on the GeoTracker website, concentrations of total petroleum hydrocarbons as gasoline (TPHg) and benzene detected in on-site monitoring wells are on long-term declining trends, while total petroleum hydrocarbons as diesel (TPHd) have been generally stable. No methyl tert-butyl ether (MTBE) was detected in the easternmost downgradient monitoring well (MW-3), which is the closest well, at a distance of 950 feet from Site 16. Soil sampling indicates that MTBE attenuated to a concentration of approximately 0.88 parts per billion (ppb). (Kennedy/Jenks 2012e)

The compounds detected at the Olympic Service Station site appear restricted to the shallow groundwater zones, based on data from the well log for Site 16. This is supported by depth to water data available at the GeoTracker website indicating shallow depth to groundwater conditions at approximately 17.5 feet below ground surface, based on data measured in 2003. The shallow groundwater zone is underlain by clay/Bay Deposits from about 100 feet to 170 feet below ground surface. (Kennedy/Jenks 2012e)

Chevron 9-5584 (T0608179897) – Located within 2,000 feet of San Bruno #17

This was a former Chevron station. Currently, a strip mall and parking lot occupy the site. It is located on the northeastern corner of the intersection of El Camino Real and San Benito Avenue, about 1,700 feet south of the existing San Bruno production well No.17. Site monitoring data indicate shallow depth to water, with water levels ranging from about 20 feet to 60 feet below ground surface. This is consistent with data available at the GeoTracker website indicating a shallow depth to water table at approximately 34 feet below ground surface, based on data measured in 2003, as reported by the GeoTracker records. The site has both soil vapor and groundwater extraction wells. The most recent monitoring event in March 2010 shows a benzene and TPH plume mostly contained on site. (Kennedy/Jenks 2012e)

As discussed under the "Groundwater Quality" sub-heading in Section 5.16.1.3 (Regional Groundwater Hydrology), isolated occurrences of elevated nitrate concentrations in groundwater above the primary drinking water MCL of 45 mg/L occur in portions of Daly City and South San Francisco. These include occurrences in the Primary Production Aquifer. Also discussed is the potential presence of VOCs in the Primary Production and Deep Aquifer monitoring wells at Site 1 in Daly City and Site 11 in South San Francisco.

Impact Discussion and Significance Determination

Groundwater Pumped by Project May Violate Drinking Water Standards

The results of the preliminary DWSAP reports for each proposed Project well identified PCAs within Groundwater Protection Zones resulting in vulnerability scores of 8 and higher (Kennedy/Jenks 2009a through 2009g, 2010a through 2010k). As noted in Section 5.16.3.3 (Approach to Analysis of Operational

Impacts), these scores indicate that groundwater near these wells may be vulnerable to contamination from nearby land use activities. The types of PCAs identified in the Groundwater Protection Zones around the proposed wells are reflective of activities found in most urban settings, such as automobile gas stations, leaking underground tank sites, chemical/petroleum processing, sewer collection systems, and transportation corridors.

The proposed wells would extract water from the Primary Production Aquifer, in general from 340 feet to 700 feet below ground surface, except at Site 16 where the proposed screen would be from 240 feet to 410 feet below ground surface (Kennedy/Jenks 2012e). The Partner Agency production wells also extract water from the Primary Production Aquifer. As described in the Approach to Analysis above, under the sub-heading "Known Areas of Contamination," the PCAs identified within the delineated 2,000-foot radius Groundwater Protection Zones surrounding the SFPUC and Partner Agency well sites have been detected in soil only or in shallow groundwater on the order of 30 to 50 feet below ground surface (Kennedy/Jenks 2012e). As concluded in the preliminary DWSAP reports, because the proposed SFPUC wells would be drawing groundwater from the Primary Production Aquifer, the groundwater to be pumped is not considered to be particularly vulnerable to soil or groundwater contaminant plumes identified in the shallow soil or the uppermost shallow groundwater zones. The same conclusion applies for Partner Agency wells.

There is known contamination in the shallow groundwater zone at PCAs where shallow groundwater zone levels are within 56 feet of the surface or shallower. In addition, there is the potential for contamination in shallow soil or localized perched groundwater to migrate down to the Primary Production Aquifer with groundwater recharge. This potential exists under modeled existing conditions and under the Project. However, the presence of an aggregate thickness of fine-grained materials (which make up discontinuous low permeability zones underlying the shallow and perched groundwater zones with unsaturated zones that overlie the Primary Production Aquifer in most areas of the basin) reduces the possibility for vertical migration of contaminants from the perched or shallow groundwater zone to the underlying Primary Production Aquifer.

The existing and potential shallow groundwater zone contamination would need to migrate down to the Primary Production Aquifer to affect the ability of SFPUC and Partner Agency wells to meet drinking water standards. The shallow groundwater zone and Primary Production Aquifer are generally disconnected hydraulically in most areas; however, in those areas where there may be some level of connection, the Project would affect downward gradients and flow. The downward gradient with the Project would be smaller on average than predicted under modeled existing conditions, because the water levels in the Primary Production Aquifer would be higher (LSCE 2010). Consequently, the downward movement of contaminated groundwater from the shallow water-bearing zone would generally be less than under existing gradients in those areas where there may be some level of hydraulic connection. The vertical permeability of the sediments between the two zones is low, which means that downward movement of groundwater and contaminants is expected to be relatively slow. This low rate of movement would provide more time to detect and remediate contamination from surface sources before it reaches the Primary Production Aquifer.

Finally, each proposed well would be protected against contamination by the construction of an annular seal composed of sand/cement grout (see Chapter 3, Project Description, Section 3.5.1.1 [Construction

Methods for Production Wells]). For the above reasons, potential impacts on groundwater from PCAs would be *less than significant* for all proposed sites.

Elevated nitrate concentrations, especially in the Daly City and South San Francisco area where elevated levels occur in the Primary Production Aquifer, could be affected by Project pumping and in-lieu recharge. Nitrates in soils in the Project area are currently percolating towards the shallow groundwater. The Project would neither increase nor decrease the amount of nitrates that reach the shallow groundwater, because the Project would not change the amount of recharge from rainfall or the percolation rate of the soils. However, the Westside Basin Groundwater Model predicts that Project pumping and in-lieu recharge could result in changes in groundwater flow directions in areas where nitrate concentrations are currently elevated, which could transport nitrate in groundwater to production wells (Kennedy/Jenks May 2012e). If the location of nitrate concentrations changes such that nitrate concentrations in Project wells or Partner Agency wells increases above drinking water standards, this would be addressed through treatment, such as blending, to ensure that all drinking water standards for nitrate are met, as described in Chapter 3, Project Description, Section 3.4.2 (Production Wells and Associated Facilities).

Potential elevated VOC concentrations (i.e., PCE and TCE) in the Primary Production Aquifer and Deep Aquifer at monitoring wells located near Site 1[27] in Daly City and Site 11 in South San Francisco could be affected by Project pumping and in-lieu recharge. The Westside Basin Groundwater Model predicts that Project pumping and in-lieu recharge could result in changes in groundwater flow contours in areas and zones where VOC concentrations may currently be elevated (Kennedy/Jenks 2012e), which could transport VOCs in groundwater to Project or Partner Agency wells. Raw groundwater produced at Sites 1 and 11 would be the most likely to exceed drinking water standards due to the sites' co-location with detected contamination and the increase in groundwater flow to the Sites during Project Take Years. VOCs at these sites could also migrate towards other production wells such as Partner Agency wells in Daly City and South San Francisco as a result of changes in groundwater flow directions during Put and Hold Years. If the location of VOC concentrations were to change due to the Project such that VOC concentrations in Project wells or Partner Agency wells increase above target levels, this would be addressed through treatment, such as blending, to ensure that all drinking water standards for VOCs are met, as described in Chapter 3, Project Description, Section 3.4.2 (Production Wells and Associated Facilities).

Therefore, no violations of water quality standards would occur due to existing PCA contamination, nitrate concentrations, or elevated VOC concentrations, and the impact would be *less than significant*.

With respect to water quality concerns near the cemeteries, refer to Impact HY-14, relative to water quality degradation for constituents for which water quality standards do not exist.

[27] In October 2012, the monitoring well at Site 1 was resampled, and no VOCs were detected, indicating that the earlier detections may not be representative of the groundwater quality at Site 1 (SFPUC 2013c).

Project Operations May Mobilize or Spread Contamination in Groundwater or Cause Remediation Systems to Become Less Effective

This EIR evaluates the possibility of mobilizing or spreading existing areas of contamination due to increasing groundwater levels from in-lieu recharge of the Project. The in-lieu recharge that would occur during Put Years; i.e., reduced pumping on the part of the Partner Agencies in the Primary Production Aquifer at depths greater than 300 feet below ground surface is expected to indirectly lead to higher groundwater levels in the shallow, regionally continuous, groundwater zone (referred to as Model Layer 1 in the Westside Basin Groundwater Model). The Westside Basin Groundwater Model predicts that the maximum increase in groundwater levels is expected to occur at about Scenario Year 7 after several years of above-normal rainfall and at a time when the SFPUC Storage Account would be full. The Model identifies the Daly City and Colma areas as having shallow groundwater zone (Model Layer 1) levels well below 70 feet under modeled existing conditions. Although the Westside Basin Groundwater Model predicts that Primary Production Aquifer groundwater levels will rise up to 40 to 80 feet in the Daly City area and 5 to 40 feet in the Colma area due to the Project in Scenario Year 7, Primary Production Aquifer groundwater levels are predicted to remain below 70 feet, below where existing PCA contamination is located. Therefore, shallow PCA contamination in this area would not be mobilized or spread by the Project. (Kennedy/Jenks 2012e)

Table 5.16-16 (Predicted Groundwater Levels relative to Depth of Known Contamination) below lists existing municipal and proposed Project wells, together with the Primary Production Aquifer groundwater zone levels under modeled existing conditions (i.e., without operation of the Project) and with the Project, and the depth to water at PCAs within 2,000 feet of the wells. The depth-to-water values listed in the table have been rounded to the nearest 5 feet, to reflect accuracy of the topographic data on which they are based. The existing municipal and proposed Project wells in the Daly City and Colma areas have depths to water of at least 150 feet. The maximum increase in groundwater levels in the Primary Production Aquifer at the wells and PCAs in this area is estimated to be 70 feet or less. The deepest depth to waters at PCAs within 2,000 feet of these wells range from 21-56 feet indicating the presence of localized perched groundwater at these PCAs. The depth to water at the PCAs defines the maximum extent of soil contamination at the PCAs and the depth of any perched groundwater contamination at the sites. However, higher groundwater levels predicted to occur in the Primary Production Aquifer due to the Project would not rise to encountered depth to water at the PCAs and would not mobilize contamination at the PCAs.

This EIR also evaluates the possibility of the Project mobilizing or spreading existing areas of contamination by adversely affecting remediation systems due to changes in shallow groundwater zone levels. This could occur where shallow groundwater zone levels are shallower than 70 feet where remediation systems are assumed to operate. The Model identifies the South San Francisco, San Bruno, and Burlingame areas where this occurs. The Model predicts that shallow groundwater level zones would rise up to 10 feet in these areas with the Project (Kennedy/Jenks 2012e). These groundwater level increases would not substantially change the environment under which remediation is being undertaken and therefore would not be expected to affect the success of the remediation processes. Also, remediation systems typically are designed with some flexibility to accommodate natural fluctuations in groundwater levels. These areas also show no appreciable changes in shallow groundwater zone flow directions caused by the Project at either Scenario Year 7 when groundwater levels are predicted to be most shallow or at the end of the design drought when groundwater levels are predicted to be most deep

(Kennedy/Jenks May 2012e). Therefore, changing groundwater flow directions caused by the Project would not affect remediation processes.

Table 5.16-16 (Predicted Groundwater Levels relative to Depth of Known Contamination) below lists existing municipal and proposed Project wells and information about PCAs within 2,000 feet of the wells in the South San Francisco and San Bruno areas. Table 5.16-16 shows that modeled shallow groundwater zone levels have depths to water of less than 70 feet at a number of wells. The increases in shallow groundwater zone levels at these wells are approximately 5 feet in the South San Francisco area, and approximately 1 to 4 feet in the San Bruno area. Groundwater at PCAs within 2,000 feet of the wells is encountered at depths of 10 to 47 feet. These levels are close enough to modeled levels that groundwater encountered below the PCAs is considered part of the shallow groundwater zone. Therefore, contaminants in the shallow groundwater PCAs are already mobilized in the shallow groundwater zone. The concern is whether changing groundwater levels caused by the Project would adversely affect remediation systems in these areas, such as Chevron 9-8854 near the existing San Bruno well #17. Groundwater levels at this well are predicted to only increase 1 foot due to Project operations, which would not adversely affect remediation at this site.

Based on the above analyses, the potential impact from mobilization or spreading of contaminants in groundwater as a result of increased pumping would be *less than significant*.

TABLE 5.16-16
Predicted Groundwater Levels relative to Depth of Known Contamination

Nearby Well	Predicted Groundwater Levels at Full SFPUC Storage Account				Deepest depth to water at known PCA within this radius (feet)
	Modeled Existing Conditions Depth to Water (feet)[(a)]	Maximum Increase in Groundwater Level due to Project (feet)	Depth to Water with Project (feet) [(a)]	Are known PCAs present within 2,000-foot radius?	
Daly City Wells					
A Street Replacement	420	0	420	No	NA
4 Replacement	250	60	190	Yes	32.7
Vale	285	65	220	Yes	29.3
Jefferson	310	70	240	Yes	22
Junipero Serra	310	70	240	Yes	22
Westlake	190	40	150	Yes	56
Cal Water, South San Francisco District Wells	55-70	5	50-65	Yes	30.6
San Bruno Wells					
15	130	4	125	No	NA
16	65	3	60	Yes	16.2
17	10	1	10	Yes	47.2
18	100	3	95	No	NA

TABLE 5.16-16
Predicted Groundwater Levels relative to Depth of Known Contamination

Nearby Well	Predicted Groundwater Levels at Full SFPUC Storage Account: Modeled Existing Conditions Depth to Water (feet)[(a)]	Maximum Increase in Groundwater Level due to Project (feet)	Depth to Water with Project (feet) [(a)]	Are known PCAs present within 2,000-foot radius?	Deepest depth to water at known PCA within this radius (feet)
20	10	1	10	Yes	10.4
Proposed GSR Wells					
Site 1	220	47	175	Yes	12.8
Sites 2, 3, 4	200-220	50	150-170	Yes	56
Site 5	270	45	225	Yes	32.7
Site 6	260	37	225	Yes	21.8
Site 7	250	27	225	Yes	21.8
Site 8	200	15	185	No	NA
Site 9	150	5	145	No	NA
Site 10	190	5	185	No	NA
Site 11	95	5	90	Yes	30.6
Site 12	80	5	75	Yes	30.6
Site 13	45	5	40	Yes	45.6
Site 14	120	4	115	No	NA
Site 15	130	4	125	No	NA
Site 16	10	1	10	Yes	17.6

Source: Kennedy/Jenks 2012e

Note:

(a) Depth to water for both modeled existing conditions and the Project is rounded to the nearest five feet because the Westside Basin Groundwater Model is not as accurate for specific groundwater levels at specific sites as when it is used to calculate Project effects (see further explanation in Section 5.1, Overview, Section 5.1.6 [Groundwater Modeling Overview]). Therefore, the values in the columns, "Modeled Existing Conditions Depth to Water" and "Maximum Increase in Groundwater Level due to the Project" may not add up exactly to the "Depth to Water with Project."

Impact Conclusion: Less than Significant

Impact HY-13: Project operation would not result in degradation of drinking water quality or groundwater quality relative to constituents for which standards do not exist. (Less than Significant)

Description of Water Quality Degradation

Operation of the Project could substantially degrade water quality if the groundwater pumped by the Project, Partner Agencies, and irrigation pumpers, after proposed treatment and/or blending as described in Chapter 3, Project Description, were degraded by constituents for which water quality standards do not exist.

Approach to Analysis

To determine whether groundwater pumped by the Project, Partner Agencies, and irrigation pumpers would be affected by non-regulated constituents, existing groundwater quality data were reviewed and detected non-regulated constituents were evaluated based on known health effects.

Groundwater quality in the Westside Groundwater Basin is monitored by the SFPUC and Partner Agencies through a network of production and monitoring wells as part of the semi-annual monitoring program that was initiated throughout the Basin in 2000. This network of wells includes existing water quality monitoring wells that have been installed at Sites 1, 2, 5, 7, 8, 9, 10, 11, 12, 13, 15, and 16 (see Chapter 3, Project Description, Section 3.4.3 [Facility Sites]), which were installed and sampled in 2008 and 2009.

The first series of monitoring wells were installed and sampled at Sites 2, 5, 7, 8, 10, 12, and 13 between December 2008 and January 2009. During the initial sampling of these wells, the volatile organic compound (VOC) acetone was detected in the groundwater sampled from each monitoring well at concentrations ranging from 6.5 to 34 micrograms per liter (μg/L). No Primary or Secondary MCL has been established for acetone and it is not included in the CDPH list of contaminants found in Title 22 of the California Code of Regulations. To assess the validity of acetone presence in the native groundwater, the monitoring well at Site 7 was re-sampled in October 2009 at two separate aquifer depths. In addition, groundwater from the monitoring wells at Sites 7, 8, and 10 were analyzed for acetone as part of SFPUC's 2010 Annual Groundwater Monitoring Program for the Westside Groundwater Basin (SFPUC 2011b). Acetone was not detected in any of the subsequent groundwater samples. The second series of monitoring wells were installed and sampled at Sites 9, 15, and 16 between June and September of 2009, and acetone was not detected in any of the wells. To further assess the validity of acetone presence in the native groundwater, the monitoring wells at Sites 2, 5, 7, 8, 10, and 12 were re-sampled in November 2012 at multiple aquifer depths. Acetone was not detected in any of the groundwater samples (SFPUC 2013c).

One other non-regulated VOC detected in groundwater monitoring wells is chloromethane. It is estimated that up to 99 percent of chloromethane that is released to the environment comes from natural sources, including chemical reactions that occur in the oceans or from chemical reactions that occur when materials like grass, wood, charcoal, and coal are burned (Kennedy/Jenks May 2012b, ATSDR 1998). In the past, chloromethane was widely used as a refrigerant, and also as a foam-blowing agent and as a pesticide or fumigant (ATSDR 1998). Chloromethane was detected in one groundwater sample collected from the monitoring well at Site 2 in January 2009. The sample was collected at a depth of 620 feet below ground surface and had a concentration of 0.77 μg/L, which is slightly above the laboratory detection limit of 0.5 μg/L. Chloromethane was not detected in other monitoring wells sampled. To assess the validity of chloromethane presence in the native groundwater, the monitoring well at Site 2 was re-sampled at a depth of 620 feet below ground surface in November 2012. Chloromethane was not detected in the groundwater sample (SFPUC 2013c).

Groundwater monitoring has also been performed to evaluate groundwater quality conditions in the vicinity of cemeteries. The initial samples were taken in September, October, and November 2009 at three different monitoring locations near cemeteries. Locations sampled included a multi-level monitoring well at Site 15 (screened at five depths from 190 to 580 feet below ground surface and each screen depth was sampled) located in the Golden Gate National Cemetery, a multi-level monitoring well at Site 7 (two depths sampled at 230 and 490 feet below ground surface) located near Cypress Lawn Cemetery, and the Site 13 multi-level monitoring wells (screened at four depths from 120 to 530 feet below ground surface and each screen depth was sampled). Samples were analyzed for aldehydes, including acetaldehyde. Acetaldehyde occurs naturally in certain foods, such as ripe fruits and coffee, and green plants produce acetaldehyde as they break down food (U.S. EPA 1994b). Acetaldehyde is also produced industrially for companies that make acetic acid and related chemicals, and is released into air or wastewater from facilities producing or using the chemical, as well as from the combustion and photo-oxidation of hydrocarbons (U.S. EPA 1994b).

Acetaldehyde was detected in two of the groundwater samples at concentrations of 1.0 and 2.0 μg/L, which were slightly above the laboratory detection limit of 1.0 μg/L. There is no established drinking water standard or health advisory for acetaldehyde. The Clean Air Act Amendments of 1990 list acetaldehyde as a hazardous air pollutant. The U.S. EPA has enacted restrictions for certain waste streams containing the chemical, and occupational exposure to acetaldehyde is regulated by the Occupational Safety and Health Administration, with a permissible exposure limit of 200 parts per million of air (U.S. EPA 1994a).

Specific groundwater sampling was undertaken in 2010 by the SFPUC to determine existing formaldehyde concentrations near cemeteries. No MCL has been established for formaldehyde, but a Notification Level of 100 μg/L has been set by the CDPH. Refer to Section 5.16.2.1 (Federal and State Regulations) for an explanation of Notification Levels. Formaldehyde was not detected in samples taken from monitoring wells located at Sites 7, 8, 10, 13, and 15 (all samples were non-detect for formaldehyde, i.e., less than 5 μg/L). The monitoring wells at Sites 7 and 15 are located at or adjacent to cemeteries; the monitoring wells at Sites 8 and 10 are located near cemeteries; and the monitoring well at Site 13 is located about 2,000 feet from the closest cemetery. The results indicate that there is no apparent existing groundwater contamination from cemeteries in the South Westside Groundwater Basin (Kennedy/Jenks 2012e). To assess the validity of acetaldehyde presence in the native groundwater, the monitoring wells at Sites 7 and 15 were re-sampled in November 2012. Acetaldehyde was not detected in either of the groundwater samples (SFPUC 2013c).

Impact Discussion and Significance Determination

As described in the Approach to Analysis above, several non-regulated constituents were initially detected in groundwater samples from monitoring wells at the proposed well sites, including acetone, acetaldehyde, and chloromethane. However, based on subsequent resampling, these detections were not confirmed (SFPUC 2013c).

Research on the possible long-term health ingestion of acetone suggests that the reference dose (the amount at which a daily exposure would likely not have deleterious non-cancer effects over a lifetime) is 0.9 milligrams per kilogram (mg/kg) per day for humans (Kennedy/Jenks May 2012e). This reference dose corresponds to a concentration in water of 31.5 mg/L (or 31,500 μg/L), which is approximately 1,000 times higher than the highest detected acetone concentration (34 μg/L) (Kennedy/Jenks May 2012e). In addition, as described above, the previously detected acetone concentrations have not been repeatable in subsequent groundwater sampling, and they are not considered to be representative of water quality conditions in the Westside Groundwater Basin (Kennedy/Jenks May 2012e). As a result, the potential impact on drinking water quality degradation from acetone in groundwater would be *less than significant*.

For chloromethane, the U.S. EPA has established one-day and 10-day drinking water health advisories for children (U.S. EPA 2012a). Health advisories from the U.S. EPA's Office of Water serve as informal technical guidance to assist federal, State, and local officials responsible for protecting public health, as needed. A 10-day health advisory for children is the concentration of a chemical in drinking water that is not expected to cause any adverse non-carcinogenic effects for up to 10 days of exposure. The one-day health advisory of 9,000 μg/L is approximately 9,000 times higher than the detected concentration of chloromethane (0.77 μg/L), and the 10-day health advisory of 400 μg/L is approximately 400 times higher than the detected concentration of chloromethane. In addition, as described above, the previously detected chloromethane concentration has not been repeatable in subsequent groundwater sampling (SFPUC 2013c). As a result, the potential impact on drinking water quality degradation from chloromethane in groundwater would be *less than significant*.

For acetaldehyde, no established drinking water standards or health advisories have been established. Acetaldehyde was detected in two of the groundwater samples at concentrations of 1.0 and 2.0 μg/L, which are slightly above the reporting limit of 1.0 μg/L. These concentrations are low and at levels normally found in the environment (Kennedy/Jenks 2012e). According to the U.S. EPA, acetaldehyde by itself is not likely to cause environmental harm at levels normally found in the environment (U.S. EPA 1994b). In addition, as described above, the previously detected acetaldehyde concentrations have not been repeatable in subsequent groundwater sampling (SFPUC 2013c). As a result, the potential impact on drinking water quality degradation from acetaldehyde in groundwater would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HY-14: Project operation may have a substantial adverse effect on groundwater depletion in the Westside Groundwater Basin over the very long term. (Less than Significant with Mitigation)

Description of Groundwater Depletion

Impacts related to groundwater depletion would be significant if Project operations were to reduce groundwater supplies or interfere with groundwater recharge in a manner that would result in a substantial regional deficit in aquifer storage, and that deficit in aquifer storage would lead to insufficient water supply to support existing or planned land uses.

Approach to Analysis

To assess potential changes in the volume of groundwater stored in the Westside Groundwater Basin, the existing storage volume was estimated and then compared to the storage volume predicted at the end of the 47-year simulation period with Project operations. This analytical approach provides a conservative estimate of the magnitude of impacts from Project operation on overall long-term groundwater storage using the modeled data for the 47-year simulation period. A volumetric calculation was made to estimate the total volume of groundwater in the Westside Groundwater Basin in 2009, based on the volume of the aquifer from the Westside Basin Groundwater Model and an estimate of the available pore space, or porosity, within the aquifer to store water. The volume of the aquifer in the Westside Basin Groundwater Model was based on measured groundwater levels throughout the Basin (Kennedy/Jenks 2012b). The total storage volume calculated by the Westside Groundwater Basin Model is not intended to be the groundwater volume available for recovery, the sustainable yield of the Basin, or other functional definition of storage. Instead, a volumetric estimate of this type is intended to provide context for evaluating the scale of aquifer storage changes that could be caused by the Project. This analysis compares the total groundwater storage changes from the Project to the total groundwater in the Basin. The purpose of this comparison is to provide a sense of the scale of the potential aquifer storage changes relative to the size of the groundwater basin. It should be noted that the Westside Basin Groundwater Model, from which the groundwater storage volumes are derived, has a root mean square error[28] of four percent with respect to basin-wide groundwater levels (Kennedy/Jenks 2012b). Assuming that this root mean square error value also applies directly to modeled groundwater storage then it is possible that any predicted changes in groundwater storage of less than four percent may be attributable to the accuracy of the Model and may not necessarily indicate a change attributable to the modeling scenario being analyzed.

Groundwater depletion may have negative effects on the specific uses of groundwater to support existing or planned land uses; therefore, this EIR evaluates impacts separately on groundwater resources relative to well interference, subsidence, seawater intrusion, groundwater-surface water interactions, and water quality. Refer to Impacts HY-7 through HY-14 for specific evaluations of these other potential impacts.

Previous Analysis

Daly City conducted a model simulation (Version 3.1) consisting of a 51-year continuation of existing or anticipated land and water use conditions and Partner Agency pumping rates consistent with those used in the GSR Project-specific and cumulative model scenarios. The Hydrofocus study concluded that planned groundwater pumping, including the GSR Project, would not result in substantial long-term storage decline in the basin. (HydroFocus 2011)

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[28] Root mean square error is a statistical measure that evaluates the average difference (or residual) between modeled and observed parameters and provides a measure of the overall error in the model (Kennedy/Jenks 2012a).

Modeled Existing Conditions

Based on the Westside Basin Groundwater Model, the groundwater storage volume in the Westside Groundwater Basin was calculated based on June 2009 groundwater levels. To facilitate this calculation, the Westside Groundwater Basin was defined as three onshore subareas[29]. The volume of the offshore subareas of the Westside Groundwater Basin underlying the Pacific Ocean and San Francisco Bay were not included in the analysis conducted for this EIR. The results of the volumetric calculations for the three onshore subareas are summarized below (Kennedy/Jenks 2012b):

- The Serra Block subarea was defined as the portion of the Basin east of the Pacific coast and west of the Serra Fault (where it is located onshore). The total estimated groundwater volume in this subarea is 340,000 af.

- The North Westside Basin subarea was defined as the portion of the Basin north of the San Mateo-San Francisco County line and east of either Ocean Beach or the Serra Fault (where it is located onshore). The total estimated groundwater volume in this subarea is 223,000 af.

The South Westside Basin subarea was defined as the portion of the Basin east of the Serra Fault, south of the San Mateo-San Francisco County line and west of SFO. The total estimated groundwater volume in this subarea is 513,000 af. The total estimated groundwater volume in 2009 in the onshore Westside Groundwater Basin using this method is 1,076,000 af (Kennedy/Jenks 2012b).

Over the 47 years of the hydrologic modeling sequence, the predicted 28,000 af decline (which includes the hypothetical design drought) under the modeled existing conditions is 2.6 percent of the estimated total groundwater storage of 1,076,000 af in 2009. It should be noted that the estimated total groundwater storage of 1,076,000 af is not equivalent to the sustainable yield of the basin. Some of the water in the basin has not proven to be a resource, and the accessibility to the total storage amount is not known at this time.

The Westside Basin Groundwater Model predicts that under the modeled existing conditions (i.e., without the Project), groundwater storage in the groundwater basin is declining by approximately 597 afy, or approximately 28,000 af over the 47 years of the hydrologic modeling sequence. The predicted 28,000-af decline in groundwater storage is primarily a result of the assumptions used in the modeling, which conservatively included a design drought consistent with the hydrologic modeling assumptions included in the WSIP PEIR. The design drought used in the Westside Basin Groundwater Model was created for planning purposes and represents drought conditions that are worse than anything indicated in recent historic records, as discussed in Section 5.1, Overview, section 5.1.6 (Groundwater Modeling Overview). Over the 47 years of historic hydrologic records used to develop the model, no drought occurred that was as severe as the design drought. Incorporation of a design drought into the Westside Basin Groundwater Model results in approximately 20 inches of rainfall less in the simulation than

[29] The analysis of groundwater depletion is not intended to address sub-basin or site-specific changes in groundwater storage. Impacts that may potentially result from sub-basin or site-specific changes in groundwater storage are addressed under the other groundwater impact categories, such as well interference and seawater intrusion.

otherwise indicated by historic records, which is nearly equivalent to losing a full year of precipitation and its associated recharge for the entire Basin. The projected 597 af of annual average decline (which would result in 28,000 af of decline in storage over the 47-year hydrologic modeling period) in groundwater storage can largely be attributed to the conservative inclusion of the design drought into the Westside Basin Groundwater Model (Kennedy/Jenks 2012b, HydroFocus 2011). Nonetheless, with the conservative use of a design drought, as included in the Westside Basin Groundwater Model, the Westside Groundwater Basin is predicted under the modeled existing conditions to lose a small amount of storage over the long-term, as further discussed below.

Impact Discussion and Significance Determination

The total decrease in groundwater storage volumes due to Project operation is predicted to result in a decline of approximately 416 afy more than under the modeled existing conditions (that is, without the Project). Over the 47-year simulation period, the total decline in groundwater storage is predicted to be approximately 20,000 af. This decline can be attributed to the fact that the storage efficiency of the Basin is less than 100 percent, that is, the stored groundwater naturally moves to other locations within the basin and/or out of the basin (e.g., water might move from an area of high groundwater levels to an area of low groundwater levels). Such movement of groundwater out of the Basin is known as "leakage." As described by Kennedy/Jenks (2012b), leakage would be highest when groundwater levels are highest (such as would be the case during prolonged Hold Periods) and lowest when groundwater levels are lowest (such as would be the case during the design drought). The effect of these losses would be that not all of the water added into the SFPUC Storage Account during normal and wet periods would be available for pumping during dry periods. As described in Chapter 3, Project Description, Section 3.8.1 (Operating Agreement), this possibility would be accounted for under the proposed Operating Agreement, whereby the Operating Committee would monitor and track the SFPUC Storage Account, including any leakage from the Basin attributable to the Project pumping.

The predicted 20,000 af decline in groundwater storage due to Project operations, as compared to modeled existing conditions over the 47-year simulation, represents about 1.8 percent of the estimated total groundwater volume in the onshore portion of the Westside Groundwater Basin. Even though this decline is small, the Project is predicted to cause an incremental depletion of groundwater storage over the long-term, which is conservatively deemed a *significant* impact because over the very long-term this could result in a substantial regional deficit in aquifer storage that may not fully support existing or planned land uses, given the heavy reliance of local jurisdictions, golf clubs, and cemeteries within the study area on groundwater for their water supply.

Mitigation Measure M-HY-14 (Prevent Groundwater Depletion) requires thorough accounting methods for Basin losses based on actual experience operating the Project, and allows the SFPUC to convert Hold Years to additional Put Years when surplus surface water is available. Such accounting methods would ensure that any Basin losses caused by the Project would be adequately reflected in the SFPUC Storage Account. The provision in the mitigation measure for additional Put Years would at least partially offset the estimated losses from the Basin as a result of the Project by reducing Partner Agency pumping from their existing wells during those years. If, however, the additional in-lieu recharge is not sufficient to offset basin storage losses identified by the Operating Committee, Mitigation Measure M-HY-14 requires that the Project pumping be restricted to extract only the volume of water in the SFPUC Storage Account, which would be adjusted to account for Basin storage losses. Therefore, Mitigation Measure M-HY-14 would reduce impacts of the Project on long-term depletion of groundwater storage to *less-than-significant* levels.

Mitigation Measure M-HY-14 (Prevent Groundwater Depletion) would not cause impacts to groundwater beyond those already identified in this EIR, because additional Put Years would only replace small volumes of overall basin groundwater storage which may be lost and would neither increase nor decrease groundwater levels more than would occur under the Project as defined in Chapter 3, Project Description (SFPUC 2013a).

Mitigation Measure M-HY-14: Prevent Groundwater Depletion

The SFPUC, working in conjunction with the GSR Operating Committee, shall develop and adopt an SFPUC Storage Account monitoring program that will determine the amount of water available for extraction from the SFPUC Storage Account and develop accounting rules that will account for losses from the Basin due to leakage, consistent with the terms of the Operating Agreement between the SFPUC and the Partner Agencies. The SFPUC shall develop the SFPUC Storage Account monitoring program to determine the balance in the SFPUC Storage Account based on actual experience operating in the Westside Groundwater Basin as proposed under the GSR Project. The SFPUC Storage Account monitoring program will use data from metered SFPUC in-lieu water deliveries to the Partner Agencies and regularly measured changes in groundwater elevations during a series of Put and Hold Years to determine the volume of stored water while developing rules to account for losses in groundwater storage, based on generally accepted principles of groundwater management.

To replace water losses in the SFPUC Storage Account due to Basin losses, the SFPUC may deliver additional surface water to the Partner Agencies when surplus surface water is available, creating additional in-lieu recharge to the Westside Basin. This conversion of wet Hold Years to additional Put Years would offset the estimated losses from the Basin as a result of the Project by reducing Partner Agency pumping from their existing wells during those years. Such additional surface water deliveries to the Partner Agencies shall not increase storage in the SFPUC Storage Account above 60,500 af.

The GSR wells shall only be pumped when there is a positive balance in the SFPUC Storage Account, which will be adjusted for losses from the Basin due to leakage caused as a result of the Project. If the additional in-lieu recharge is not sufficient to offset losses identified by the Operating Committee as caused by storage losses from the basin, the GSR wells will only be operated to extract the volume of water in the SFPUC Storage Account.

Impact Conclusion: Less than Significant with Mitigation

5.16.3.8 Cumulative Impacts and Mitigation Measures

Impact C-HY-1: Project construction could result in a cumulatively considerable contribution to cumulative impacts on surface water hydrology and water quality. (Less than Significant with Mitigation)

The geographic scope for the analysis of potential cumulative surface water hydrology and water quality impacts in the study area, due to construction activities, consists of individual facility sites and the surrounding watershed lands. The analysis of potential cumulative impacts on surface water hydrology and water quality considers those cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) and shown on Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis). This analysis focuses on the other past, present, and reasonably foreseeable future projects that could adversely affect water quality during construction of the Project, but especially on activities that involve ground disturbing activities, the placement of fill or structures within the 100-year flood hazard zone, and an increase in impervious surfaces that could be occurring concurrently with construction of the Project.

Degradation of Water Quality

Construction activities associated with the GSR Project could result in the degradation of water quality from increased soil erosion and associated sedimentation of water bodies, as well as an accidental release of hazardous materials, as analyzed above in Impact HY-1. The discharged groundwater from GSR well development, well pumping tests, initial disinfection, and excavation dewatering could also result in increased sources of silt-laden runoff resulting in on- or off site erosion or siltation and/or the violation of water quality standards and degradation of water quality (Impact HY-2). It is assumed that several of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), particularly those projects located in close proximity to the proposed well sites, could adversely affect some of the same water bodies during construction. In particular, the proposed SFPUC Peninsula Pipelines Seismic Upgrade (PPSU) Project (cumulative project D-1 through D-3) includes seismic upgrades to SFPUC existing pipelines that deliver water from the Harry Tracy Water Treatment Plant to the regional water system. Pipeline work for the PPSU Project would occur within the construction boundaries of GSR Sites 8 and 17 (Alternate). Construction of the PPSU Project and the GSR Project would overlap geographically and may use some of the same staging areas during construction. Therefore, cumulative impacts from the proposed SFPUC PPSU Project related to surface water quality and sedimentation, such as potential erosion from vegetation removal, grading, and excavation, could be significant, and the GSR Project's contribution to this cumulative impact could be cumulatively considerable given that its construction has the potential to result in *significant* construction-related water quality impacts.

However, as discussed in Impact HY-1, the GSR Project's potential construction-related water quality impacts related to soil erosion and sedimentation and accidental releases of hazardous materials would be reduced to *less-than-significant* levels with implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan); this measure requires the preparation and implementation of a SWPPP for sites that would exceed one acre of land disturbance (i.e., Sites 3, 4, 5, 6, 7, 12, 13, and 14) and an erosion and sedimentation control plan for all other sites to protect water quality during construction. The plans would address erosion and sedimentation control measures, waste management, and hazardous materials pollution control, and the necessary inspection and reporting requirements to document compliance. In addition, Project-related water quality impacts related to discharges of dewatering effluent from well development and testing would be *less than significant* with implementation Mitigation Measure M-HY-2 (Management of Well Development and Pump Testing Discharges). This measure requires the preparation of a Project-specific dewatering plan specifying how the water would be collected, contained, treated, monitored, and discharged to the local storm drainage system or sanitary sewer system. Therefore, potential impacts related to discharges of treated water from newly installed wells and pipelines during construction into the storm drain or sanitary sewer system would also be *less than significant as mitigated*.

This analysis assumes that most of the cumulative projects in Table 5.1-3 (Projects Considered for Cumulative Impacts) would be subject to the NPDES construction general construction permit and would be required to implement BMPs to protect water quality during construction, including measures to avoid water quality impacts from dewatering discharges from excavation and from well testing discharges, such as the Daly City "A" Street Well Replacement Project (cumulative project C). Other SFPUC projects that would involve discharges of treated water from the regional water system, such as the San Francisco Groundwater Supply (SFGW) Project (cumulative project A-1 through A-6) and the PPSU Project (cumulative project D-1 through D-3), would be subject to the Waste Discharge Requirements for the SFPUC Drinking Water Transmission System. Because the NPDES construction general permit and the Waste Discharge Requirements for the SFPUC Drinking Water Transmission System were developed in consideration of regional water quality issues, compliance with regulatory requirements would serve to limit the potential for significant cumulative water impacts to result from the construction of these projects. With implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) and Mitigation Measure M-HY-2 (Management of Well Development and Pump Testing Discharges) and compliance with the Waste Discharge Requirements for the SFPUC Drinking Water Transmission System, the GSR Project's potential contribution to any such cumulative water quality impacts would therefore not be cumulatively considerable (*less than significant with mitigation*).

Increased Flood Hazard

None of the present or probable future projects considered in the cumulative impact analysis and listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would be located in a mapped flood hazard zone according to the FEMA Flood Insurance Rate Mapping (San Francisco 2008; San Mateo County 2012). As such, there would be no cumulative impacts from increased flood hazard. Although a portion of Site 9 would be located in the FEMA mapped 100-year flood hazard zone, the only impacts would be Project specific and would not combine with any potential impacts from the cumulative projects. As discussed in Impact HY-4, Site 9 would not exacerbate flooding as the building would be elevated above the 100-year flood zone and the at-grade parking area would have a negligible effect on impeding or redirecting flood flows (*no impact*).

New Impervious Surfaces

As discussed under Impact HY-4, the GSR Project would result in the creation of new impervious surfaces, which could increase erosion and siltation, or increase the rate or amount of stormwater runoff, or cause flooding on- or off-site. Other cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), including well facilities associated with the SFGW Project (cumulative project A-1 through A-6), residential and commercial facilities associated with the Mission & McLellan Project (cumulative project F) and the Centennial Village Project (cumulative project I), would also create new impervious surfaces and could result in the similar localized effects, resulting in a potentially *significant* cumulative impact on hydrology. However, due to the relatively minor increase in impervious surface areas (e.g., 205 feet to 3,675 square feet) associated with construction of individual GSR facilities, the GSR Project's contribution to this potential impact on hydrology would not be cumulatively considerable (*less than significant*).

Impact C-HY-2: Operation of the proposed Project would result in a cumulatively considerable contribution to cumulative impacts related to well interference. (Significant and Unavoidable with Mitigation)

The geographic scope for the analysis of potential cumulative impacts on well interference in the study area is the area within three miles of each of the GSR wells, because if an existing irrigation well were located within 1.5 miles of a GSR Project well on one side, and a cumulative project well within 1.5 miles on the other side of it, hypothetically, it could be affected by both. Table 5.1-3 (Projects Considered for Cumulative Impacts) and their locations are shown on Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis).

Two cumulative projects, the SFGW Project (cumulative project A1 to A6) and the Holy Cross Cemetery Expansion Project (cumulative project E) would increase pumping in the Westside Groundwater Basin, potentially leading to lower groundwater levels. One cumulative project, the Vista Grande Drainage Basin Improvement Project (cumulative Project B) would discharge treated stormwater to Lake Merced, which could – in turn – potentially increase groundwater levels near Lake Merced.

Additional drawdowns due to the proposed SFGW Project are estimated using the Westside Basin Groundwater Model. These potential drawdowns are combined with estimated groundwater levels for the GSR Project to estimate the combined effects of both projects (Fugro 2012a). Additional drawdowns due to the Holy Cross Cemetery Expansion Project are estimated to be negligible relative to well interference impacts (Fugro 2012c). The Vista Grande Drainage Improvements Project would not increase well interference, because it would not decrease groundwater levels. Because pumping under cumulative conditions would be at maximum levels during a drought, this analysis focuses on the well interference that could occur at the end of the design drought.

The San Francisco Golf Club, Olympic Club, and Lake Merced Golf Club wells are the only existing irrigation wells where both the SFGW Project wells and the GSR Project wells would result in combined groundwater level effects (Fugro 2012a). Table 5.16-17 (Estimated Static and Pumping Depth to Water at the End of the Design Drought with Cumulative Projects) shows the projected static and pumping depth to water at wells at these three golf clubs at the end of the design drought during pumping by the cumulative projects. When the wells at the three golf clubs are not being pumped (i.e., static condition), groundwater levels are projected to decrease about 4 to 6 feet more from the cumulative pumping than with the GSR Project pumping alone. When the wells are active (i.e., pumping condition), groundwater levels are projected to decrease about 6 feet more from the cumulative pumping than from the GSR Project pumping alone.

TABLE 5.16-17
Estimated Static and Pumping Depth to Water at the End of the Design Drought with Cumulative Projects

Existing Irrigation Well	Estimated Static Depth to Water (feet below ground surface)			Estimated Pumping Depth to Water (feet below ground surface)		
	With GSR Project	With Cumulative Projects	Difference	With GSR Project	With Cumulative Projects	Difference
SF Golf Club #2	196	202	6	228	234	6
Olympic Club #8	136	142	6	195	201	6
Olympic Club #9	136	142	6	164	170	6
Lake Merced Golf Club #3	358	362	4	INA	INA	INA

Source: Fugro 2012a

Note:

INA: Information on this existing irrigation well that would allow calculation of impacts of the Project on production capacity is not available.

Cumulative pumping and the resulting groundwater level decreases identified above in Table 5.16-17 are projected to affect the pump discharge rates of existing irrigation wells, as shown in Table 5.16-18 (Estimated Pump Discharge Rate at the End of the Design Drought with Cumulative Projects). Pump discharge rates at the three golf clubs are projected to decrease due to cumulative pumping approximately one to three percent more than from the GSR Project pumping alone.

TABLE 5.16-18
Estimated Pump Discharge Rate at the End of the Design Drought with Cumulative Projects

Existing Irrigation Well	With GSR Project (gpm)	With Cumulative Projects (gpm)	Percent Reduction Compared to GSR Project
San Francisco Golf Club #2	660	655	1
Olympic Club #8	935	910	3
Olympic Club #9	660	640	3
Lake Merced Golf Club #3	INA	INA	INA

Source: Fugro 2012a

Note:

INA: Information on this existing irrigation well that would allow calculation of impacts of the Project on pump discharge rate is not available.

Table 5.16-19 (Estimated Peak Demands and 12-Hour Production Capacities) compares 12-hour production capacities for each well potentially affected by the cumulative projects. Also included in calculations in Table 5.16-19 is the increased demand resulting from the reasonably foreseeable 30-acre expansion of Holy Cross Cemetery to a future total area of 180 acres. Production capacities of the existing wells at Holy Cross Cemetery are assumed to be the same in the future as they are now. As stated above, this increased demand at Holy Cross Cemetery does not result in additional drawdowns that cause well interference impacts, but the analysis evaluates whether well interference from the Project affects the ability of Holy Cross Cemetery to meet its expansion demand.

TABLE 5.16-19
Estimated Peak Demands and 12-Hour Production Capacities

Land Use	Estimated Peak Demand (af per 12-hour period)	Estimated 12-Hour Production Capacity for Primary, Active, and Secondary Wells (af)		
		Existing Conditions	With GSR Project	With Cumulative Projects
San Francisco Golf Club	0.3	1.5	1.5	1.4
Olympic Club	0.1	3.7	3.5	3.4
Lake Merced Golf Club	0.2	INA	INA	INA
Holy Cross Cemetery	2.6	3.5	2.9	2.9

Note:

INA: Information on the existing irrigation well that would allow calculation of impacts of the Project on production capacity is not available.

The wells at the Olympic Club and San Francisco Golf Club would likely meet their estimated peak demands even with maximum cumulative pumping at the end of the design drought. The pumping groundwater level under the cumulative effects of the projects is estimated to decrease below the top of the screen at Olympic Club Well #8, and dewatering the 400 feet of screen by 1 foot would have a negligible impact on well capacity, because the 1-foot drawdown below the top of well screen would be a small percentage of the screen interval. Nevertheless, there is a risk of well or pump damage from lowering groundwater levels below the top of the screen. However, this risk could be avoided by pumping only from Olympic Club Well #9 when groundwater levels are low during drought conditions. Well #9 has a 12-hour discharge capacity of 1.4 af that can meet peak groundwater demand of the Olympic Club. It is assumed that the entire Olympic Club irrigation system can be supplied by Well #9 alone because Well #8 and #9 are located near each other. Therefore, the cumulative projects would have *less-than-significant* cumulative impacts relative to well interference at the Olympic Club and San Francisco Golf Club.

The impacts of the cumulative projects on the Lake Merced Golf Club wells would be slightly greater than under the proposed Project. The cumulative impact of these projects together would be *significant* at the Lake Merced Golf Club, given that the GSR Project by itself would have *significant* impacts. The contribution of the GSR Project to this significant cumulative impact would, therefore, be considerable (*significant*).

The well interference water level and pump capacity impacts at Holy Cross Cemetery are the same with the GSR project and the cumulative projects. The well at Holy Cross Cemetery would meet peak demand even with its expansion. Therefore, there would be *less-than-significant* cumulative impacts relative to well interference at Holy Cross Cemetery.

With implementation of Mitigation Measure M-HY-6 (Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation), the potentially *significant* cumulative impact on well interference would be reduced in a similar manner as described above for the Project-specific impacts. Mitigation Action #6, Replace Irrigation Well, would be effective at reducing the Project's contribution to cumulative impacts to less-than-considerable levels, because the replacement well could be constructed deep enough to access an aquifer with sufficient water to meet peak irrigation demand while simultaneously avoiding any cumulative effects related to well interference (SFPUC 2012c). Therefore, Mitigation Measure M-HY-6 would reduce the impacts of well interference to a level where existing and planned land uses would be supported, except that the feasibility of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property. Because such assurance has not yet been provided, Impact C-HY-2, with implementation of Mitigation Measure H-HY-6, is conservatively deemed to be cumulatively considerable (*significant and potentially unavoidable with mitigation)*.

Impact C-HY-3: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to subsidence. (Less than Significant)

The geographic scope for the analysis of potential cumulative impacts on subsidence in the study area is the entire Westside Groundwater Basin as shown on Figure 2-1 (Project Vicinity Map). Table 5.1-3 (Projects Considered for Cumulative Impacts) and their locations are shown on Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis).

Two cumulative projects, the SFGW Project (cumulative project A-1 to A-6) and the Holy Cross Cemetery Expansion Project (cumulative project E) would increase pumping in the Westside Groundwater Basin, potentially leading to lower groundwater levels. One cumulative project (the Vista Grande Drainage Basin Improvement Project [cumulative project B]) would discharge treated stormwater to Lake Merced, which could – in turn – potentially increase groundwater levels near Lake Merced. Each of these cumulative projects, together with the continuation of existing pumping in the Westside Groundwater Basin, have been included in the Westside Basin Groundwater Model (described in Section 5.1, Overview, Section 5.1.6 [Groundwater Modeling Overview]), so predicted groundwater levels for the cumulative conditions scenario include the effects from operation of the cumulative projects.

The difference in predicted groundwater levels between the modeled existing conditions and the cumulative conditions scenario would be up to 61 feet lower at Lake Merced[30], up to 25 feet lower at the Sunset area of San Francisco, up to 146 feet lower at GSR Site 8, and up to 151 feet lower at GSR Site 13.

Table 5.16-20 (Estimated Subsidence Due to Cumulative Projects and the GSR Project) lists estimates of land subsidence due to the cumulative conditions scenario, as well as the portion of the subsidence due to the GSR Project, at the four selected locations. The subsidence estimates are taken from the Westside Basin Groundwater Model results relative to the difference in groundwater levels between the modeled existing conditions scenario and the cumulative conditions scenario.

[30] The lower groundwater levels at Lake Merced are reported from the Primary Production Aquifer, not the Shallow Aquifer. The Primary Production Aquifer at Lake Merced is not in direct hydrologic connection with the lake.

TABLE 5.16-20
Estimated Subsidence Due to Cumulative Projects and the GSR Project (in inches)

Site ID	Estimated Subsidence from Cumulative Projects	Estimated Subsidence from GSR Project
San Francisco, eastern Lake Merced	2.8	1.0
San Francisco, Sunset area	1.6	— (a)
Colma, GSR Site 8	2.7	2.7
South San Francisco, GSR Site 13	3.5	3.4

Source: Fugro 2012b

Note:

(a) The contribution of the GSR Project to subsidence in the Sunset area of San Francisco would be so small that it cannot be reliably estimated.

The estimated subsidence due to the cumulative projects ranges between 1.6 and 3.5 inches. Estimated subsidence due to the cumulative projects at each of the locations is less than the significance threshold of six inches for structures, pipelines, and drainage patterns. Estimated subsidence due to operation of the cumulative conditions scenario (i.e., the cumulative projects plus the GSR Project) at each of the four locations is also less than the significance threshold of 1 foot set for flooding impacts on land within a 100-year flood zone. For these reasons, the potential cumulative impact on subsidence from operation of the cumulative projects would be *less than significant* for structures, changes to drainage patterns, and flooding *(less than significant)*.

Impact C-HY-4: Operation of the proposed Project would not have a cumulatively considerable contribution to seawater intrusion. (Less than Significant)

The geographic scope for the analysis of potential cumulative impacts relative to seawater intrusion in the study area is the entire Westside Groundwater Basin as shown in Figure 2-1 (Project Vicinity Map). Table 5.1-3 (Projects Considered for Cumulative Impacts) and their locations are shown on Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis).

Two cumulative projects, the SFGW Project and the Holy Cross Cemetery Expansion Project (cumulative project A-1 to A-6 and E, respectively) would increase pumping in the Westside Groundwater Basin, potentially leading to lower groundwater levels. One cumulative project, the Vista Grande Drainage Improvements Project (cumulative project B) would discharge treated stormwater to Lake Merced, which could – in turn – potentially increase groundwater levels near Lake Merced. Each of these cumulative projects, together with the continuation of existing pumping in the Westside Groundwater Basin, have been included in the Westside Basin Groundwater Model, so that groundwater levels are also predicted for the effects from operation of the cumulative projects.

The Westside Basin Groundwater Model cumulative simulation shows that groundwater levels in the South Westside Groundwater Basin are predicted to be similar to those of the GSR Project scenario. Because the SFGW Project would be located in the North Westside Groundwater Basin, the overall effect of the SFGW Project on the South Westside Groundwater Basin is expected to be minimal. However, the SFGW Project includes substantial pumping that would lower groundwater levels in the North Westside Groundwater Basin.

Potential for Cumulative Seawater Intrusion in the North Westside Groundwater Basin

Shallow Aquifer

The Westside Basin Groundwater Model predicts that the cumulative projects would result in average groundwater levels in the Shallow Aquifer that would be generally lower than the average groundwater levels under modeled existing conditions (Kennedy/Jenks 2012c). These lower groundwater levels would tend to promote seawater intrusion. The estimated change in groundwater levels, measured at monitoring well clusters in the North Westside Groundwater Basin, ranges between a rise of 0.3 feet and a drop of 20.3 feet. The average predicted drop in groundwater levels, estimated at monitoring well clusters in the North Westside Groundwater Basin, are groundwater drops of between 1.4 and 10.4 feet.

The Westside Basin Groundwater Model results also show that groundwater levels in the Shallow Aquifer are predicted to be below the exclusion head between 0 and 86 percent of the time for different locations during the hydrologic sequence under the cumulative scenario. Estimated groundwater levels in the Shallow Aquifer would never be below the exclusion head under modeled existing conditions (i.e., without the cumulative projects). Therefore, the cumulative scenario is expected to result in substantially more time when groundwater levels would be below the exclusion head.

Under the cumulative conditions scenario, the average groundwater flux from the Westside Groundwater Basin to the Pacific Ocean is predicted to be 103 afy, which is 153 afm lower than predicted under modeled existing conditions (Kennedy/Jenks 2012c). This decreased flux would tend to reduce the amount of groundwater outflow to the Pacific Ocean or allow incipient or additional seawater intrusion into the Westside Groundwater Basin. Although these decreased flux estimates are not specific to the Shallow Aquifer, they suggest that, generally, less groundwater would flow out to the ocean under the cumulative scenario than under modeled existing conditions.

The Westside Basin Groundwater Model predicts that groundwater level contours for the Shallow Aquifer under the cumulative scenario in western San Francisco (around the SFGW Project's West Sunset Playground well) would likely have an increased potential for seawater intrusion (Kennedy/Jenks 2012c). South of the West Sunset Playground well, the groundwater level contours suggest a smaller, although still measurable, potential for increased seawater intrusion compared to modeled existing conditions.

Primary Production and Deep Aquifers

The Westside Basin Groundwater Model predicts that the cumulative conditions scenario would result in average groundwater levels in the Primary Production and Deep Aquifers lower than the average groundwater levels under modeled existing conditions (Kennedy/Jenks 2012c). These lower groundwater levels could lead to seawater intrusion. The range of groundwater elevation changes in the Primary Production Aquifer, estimated at monitoring wells in the North Westside Groundwater Basin, is between a rise of 2.3 feet and a drop of 16 feet. The average drop in Primary Production Aquifer groundwater levels, estimated at monitoring well clusters in the North Westside Groundwater Basin, would be between 4.0 and 8.5 feet at various locations. The range of groundwater elevation changes in the Deep Aquifer, estimated at monitoring wells in the North Westside Groundwater Basin, is between a rise of 1.1 feet and a drop of 16.9 feet. The average drop in Deep Aquifer groundwater levels is predicted to be between 1.3 and 3.9 feet at the various locations.

The Westside Basin Groundwater Model results predict that the cumulative conditions scenario would cause groundwater levels in the Primary Production Aquifer to be below the exclusion head 100 percent of the hydrologic sequence. This is slightly greater than the 99 to 100 percent of time that groundwater levels in the Primary Production Aquifer are predicted to be below the exclusion head under modeled existing conditions. As a result, the cumulative scenario is expected to cause a small increase in time when groundwater levels would be below the exclusion head.

Groundwater levels in the Deep Aquifer are also predicted to be below the Deep Aquifer exclusion head 100 percent of the hydrologic sequence under cumulative conditions, which would be the same as predicted under modeled existing conditions.

Therefore, in the North Westside Groundwater Basin, the cumulative scenario is predicted to decrease groundwater levels on average, creating an increased risk of seawater intrusion, which would be a *significant* cumulative impact on groundwater quality. However, the GSR Project is not predicted to cause decreased average groundwater levels in the North Westside Groundwater Basin in excess of those predicted under modeled existing conditions. Therefore, the GSR Project would not have a considerable contribution to the cumulative impact relative to seawater intrusion in the North Westside Groundwater Basin (*less than significant*).

Potential for Cumulative Seawater Intrusion in the South Westside Groundwater Basin

Shallow groundwater zone

The Westside Basin Groundwater Model results predict that average groundwater levels in the shallow groundwater zone under the cumulative conditions scenario would be equal to or higher than the average groundwater levels predicted under modeled existing conditions (Kennedy/Jenks 2012c). These higher groundwater levels under the cumulative scenario would better impede seawater intrusion as compared to modeled existing conditions. The change in groundwater levels, estimated at monitoring well clusters in the South Westside Groundwater Basin range between a rise of 3.0 feet and a drop of 0.2 feet. The average rise in groundwater levels is predicted to be between 0.7 and 2.0 feet at various locations.

Groundwater levels in the shallow groundwater zone under the cumulative conditions scenario are predicted to be below the exclusion head seven to 100 percent of the time during the 47-year hydrologic sequence. Simulated groundwater levels in the shallow groundwater zone are predicted to be below the single aquifer exclusion head 10 to 100 percent of the hydrologic sequence under modeled existing conditions. Therefore, the cumulative scenario is not predicted to result in additional time when groundwater levels would be below the exclusion head.

The Westside Basin Groundwater Model also predicts that the average groundwater flux from the Westside Groundwater Basin to the San Francisco Bay would be 13 afm lower under the cumulative scenario than under the modeled existing conditions (i.e., without any of the cumulative projects). The model predicts that outflow to the San Francisco Bay under the cumulative scenario may vary over the hydrologic period from 4 afm greater than modeled existing conditions to 35 afm lower under cumulative conditions than under modeled existing conditions (Kennedy/Jenks 2012c). This decreased average flux would tend to allow incipient or additional seawater intrusion into the Westside Groundwater Basin.

These decreased flux estimates are not specific to the shallow groundwater zone, but suggest that, generally, more groundwater would flow in from the bay under cumulative conditions than under modeled existing conditions.

Primary Production and Deep Aquifers

At the Burlingame-D monitoring well (located adjacent to the San Francisco Bay in the south Westside Groundwater Basin Primary Production Aquifer), the Westside Basin Groundwater Model results predict that the change in groundwater levels due to the cumulative conditions scenario would range between a rise of 2.2 feet and a drop of 0.7 feet during the 47-year hydrologic sequence. Average groundwater levels at the Burlingame-D monitoring well under the cumulative scenario are predicted to be 1.2 feet higher than the average groundwater levels under modeled existing conditions during the 47-year hydrologic sequence. (Kennedy/Jenks 2012c)

Simulated groundwater levels at the Burlingame-D monitoring well are predicted to be below the exclusion head 100 percent of the hydrologic sequence under the cumulative scenario, which is the same as it is predicted to be under the modeled existing conditions.

The Westside Basin Groundwater Model does not provide data for the South Westside Basin Deep Aquifer. However, the sediments present in the Deep Aquifer are not continuous to the Bay, being separated from it by deposits of low-permeability Bay Mud that likely stretch from the land surface to the bedrock surface below (Kennedy/Jenks 2012c). Therefore, any Deep Aquifer seawater intrusion under the cumulative scenario would need to pass through the Shallow and Primary Production Aquifers before reaching the Deep Aquifer. Because the cumulative projects are not expected to induce seawater intrusion greater than that expected under modeled existing conditions in the Shallow or Primary Production Aquifers, there would be no additional seawater intrusion that could reach the Deep Aquifer.

As indicated by the modeled decrease in average groundwater flux from the Westside Groundwater Basin to the San Francisco Bay, the cumulative scenario may induce seawater intrusion. Therefore, in the South Westside Groundwater Basin, the cumulative scenario is predicted to cause an increased risk of seawater intrusion, which would be a *significant* cumulative impact relative to the potential for seawater intrusion. However, the GSR Project is not predicted to cause decreased average groundwater levels in the South Westside Groundwater Basin adjacent to the San Francisco Bay in excess of those under modeled existing conditions and thereby is not predicted to have a substantial adverse effect on average groundwater flux from the Westside Groundwater Basin to the bay (Kennedy/Jenks 2012c). Therefore, the GSR Project would not have a considerable contribution to the cumulative impact relative to seawater intrusion in the South Westside Groundwater Basin (*less than significant*).

Impact C-HY-5: Operation of the proposed Project could have a cumulatively considerable contribution to cumulative impacts on beneficial uses of surface waters. (Less than Significant with Mitigation)

The geographic scope for the analysis of potential cumulative impacts relative to the water quality of surface water bodies in the study area in the study area is the entire Westside Groundwater Basin as shown on Figure 2-1 (Project Vicinity Map). Table 5.1-3 (Projects Considered for Cumulative Impacts) and their locations are shown on Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis).

Two cumulative projects, the SFGW Project and the Holy Cross Cemetery Expansion Project (cumulative projects A-1 to A-6 and E, respectively) would increase pumping in the Westside Groundwater Basin, potentially leading to lower groundwater levels. One cumulative project, the Vista Grande Drainage Basin Improvement Project (cumulative project B) would discharge treated stormwater to Lake Merced, which could – in turn – potentially increase groundwater levels near Lake Merced. Each of these cumulative projects, together with the continuation of existing pumping in the Westside Groundwater Basin, have been included in the Westside Basin Groundwater Model and the Lake Merced Lake-level Model, so that groundwater levels are also predicted for the effects from operation of the cumulative projects.

Lake Merced

As discussed above, Daly City's proposed Vista Grande Drainage Basin Improvement Project (cumulative project B) would include the addition of stormwater to Lake Merced. For the purposes of the cumulative analysis, the groundwater model assumes that the Vista Grande Drainage Basin Improvement Project would lower the Lake Merced spillway to an elevation of approximately 9.5 feet City Datum from its current elevation of 13 feet City Datum. The cumulative analysis also assumes that Vista Grande Drainage Canal stormwater flows in excess of 75 cubic feet per second (cfs) that meet applicable water quality criteria would be discharged to Lake Merced as a part of that project, and the total resulting annual additions to Lake Merced would range from 19 to 681 af, and the average annual addition would be 209 afy. In addition, the baseflow[31], in the Vista Grande Drainage Canal would likely be diverted to an onsite engineered wetland for treatment and then discharged to Lake Merced on an ongoing basis. The resulting annual additions to Lake Merced would range from 78 to 277 af, with a long-term average of 220 af. Using these assumptions, the mean lake level would be 7.5 feet City Datum as a result of additions to Lake Merced under the Vista Grande Drainage Basin Improvement Project, without influences from the GSR Project or other potentially cumulative projects (Kennedy/Jenks 2012f).

As shown on Figures 5.16-11 (Simulated Lake Merced Level Changes) and 5.16-12 (Simulated Lake Merced Levels Relative to Modeled Existing Conditions), the estimated cumulative Lake Merced water levels are higher than estimated under the modeled existing conditions for much of the 47-year hydrologic modeling period, largely as a result of the GSR Project and Vista Grande Drainage Basin Improvement Project. However, the estimated lake levels are predicted to be below the modeled existing conditions for years two through eight of the simulation period and after year 32 during the modeled design drought conditions. The estimated cumulative lake levels are also consistently lower than are predicted to occur under the GSR Project alone for the entire simulation period, except for a brief period at the beginning of the simulation. Cumulatively, the estimated mean monthly water level in Lake Merced would be 6.1 feet, and the estimated mean annual range would be 1.6 feet. This cumulative estimated mean monthly lake level is 1.4 feet lower than it would likely be under the Vista Grande Drainage Basin Improvement Project alone, and 3 feet lower than it would likely be under the GSR Project alone (Kennedy/Jenks 2012d).

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[31] Baseflow is the minimum flow in the Vista Grande Drainage Canal that would be present year-round.

As noted above, the estimated lake levels would be below the modeled existing conditions for years two through eight of the simulation period and after year 32. The estimated cumulative lake levels would be below 1 foot for 13 percent of the simulation period compared to four percent under the modeled existing conditions. The minimum monthly lake level would be -4.9 feet City Datum at the end of the design drought. Therefore, cumulative impacts on Lake Merced water levels could be *significant* because water-level declines below the significance threshold of 0 feet are likely to occur. These water-level declines could cause decreased circulation between lakes and related deterioration of water quality, such as increased eutrophication and decreased dissolved oxygen levels, resulting in *significant* cumulative water quality impacts that could adversely affect the beneficial uses of the lake. The GSR Project's contribution to this impact would be cumulatively considerable, because the lake-level declines due to the Project would likely result in lake levels below 0 feet during, and for a period of time after, the design drought. However, similar to and for the reasons discussed under the analysis for the GSR Project alone, the contribution to this impact would be reduced to a less-than-cumulatively considerable level (*less than significant*) with implementation of Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced), because, in accordance with these measures, its implementation would ensure that any lake level declines to below 0 feet as a result of the Project would be avoided due to the required reduction in pumping, the alteration of pumping patterns, and/or the addition of supplemental water. Therefore, with implementation of this measure, the Project would not result in long-term changes in water quality that would affect the potential beneficial use of Lake Merced (*less than significant with mitigation*).

As discussed in Section 5.1, Overview, Section 5.1.6 (Groundwater Modeling Overview), the final design of Daly City's proposed Vista Grande Drainage Improvements Project (cumulative project B) has not been determined. Options under consideration include diverting a broad range of stormwater flows to Lake Merced from the Vista Grande Drainage Canal, ranging from diversion of flows above 35 cfs, or 357 afy, to diversion of flows above 170 cfs, or 66 afy (Daly City 2011). Under this range, the baseflow to Lake Merced from the engineered wetland would range from an average of 203 afy to 233 afy, resulting in total diversions to Lake Merced ranging from 299 afy to 560 afy (Kennedy/Jenks 2012f). The values on either end of the range are within 30 percent of the 429-afy volume used in the cumulative analysis. While the specific option selected for the Vista Grande Drainage Basin Improvement Project could result in a different amount of stormwater discharged to Lake Merced than is considered in the cumulative modeling scenario, the resulting mean lake-level range for each of the Vista Grande options is estimated to be 6.7 to 7.9 feet (Kennedy/Jenks 2012f) compared to 6.3 feet City Datum predicted under the modeled existing conditions. Therefore, any additions to Lake Merced would result in an increase in mean lake levels relative to the modeled existing conditions.

Pine Lake

Under cumulative conditions, in addition to the GSR Project, it is assumed that the SFPUC SFGW Project (cumulative project A-1 through A-6), Holy Cross Cemetery Expansion Project (cumulative project E) and Vista Grande Drainage Basin Improvement Project (cumulative project B) would be implemented.

The estimated average modeled groundwater level in monitoring well LMMW-5S, completed in the deeper portion of the Shallow Aquifer, is 26.5 feet NGVD 29 under cumulative conditions, or 13.7 feet lower than the SFRPD lake elevation of 40.1 feet NGVD 29 and 6.7 feet lower than what is estimated under the modeled existing conditions. Based on this potential decrease in groundwater levels, groundwater outflows from the lake would be increased, and an additional 0.0085 mgd (9.5 afy) would be required from the existing Stern Grove well to maintain Pine Lake at the 40.1 feet NGVD 29 lake level. This represents an increase of 0.0042 mgd (5 afy) over the modeled existing conditions.

While additional groundwater would be required to maintain Pine Lake water levels, the estimated amount of additional groundwater pumping is within the 250-gpm (0.36-mgd) capacity of the Stern Grove well. Further, the Westside Basin Groundwater Model incorporates a sufficient amount of pumping (0.013 mgd [15 afy] under cumulative conditions) to maintain Pine Lake at an elevation of 40.1 feet NGVD 29. Therefore, the lake would be maintained at similar levels to those under the modeled existing conditions without adverse effects on the Shallow Aquifer, and maintenance of the lake at this level would not result in any changes to water quality or the health of the lake. Therefore, cumulative water quality impacts on Pine Lake water levels would be *less than significant* (*less than significant*).

Impact C-HY-6: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality standards. (Less than Significant)

The geographic scope for the analysis of potential cumulative impacts relative to water quality standards in the study are is the entire Westside Groundwater Basin as shown in Figure 2-1 (Project Vicinity Map). Cumulative projects are listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) and their locations are shown on Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis).

Two cumulative projects, the SFGW Project (cumulative project A-1 to A-6) and the Holy Cross Cemetery Expansion Project (cumulative project E), would increase pumping in the Westside Groundwater Basin, potentially leading to lower groundwater levels. One cumulative project, the Vista Grande Drainage Improvements Project (cumulative project B), would discharge treated stormwater to Lake Merced, which could – in turn – potentially increase groundwater levels near Lake Merced. Each of these cumulative projects, together with the continuation of existing pumping in the Westside Groundwater Basin, have been included in the Westside Basin Groundwater Model so that estimated future groundwater levels are predicted for the effects from operation of the cumulative projects.

The results of the Westside Basin Groundwater Model cumulative conditions scenario predict that groundwater levels in the South Westside Groundwater Basin would be similar to those of the GSR Project scenario. The Model results also predict that the overall effect of the SFGW Project on the South Westside Groundwater Basin would be minimal.

Model-simulated groundwater levels for the cumulative conditions scenario south of Lake Merced and near Daly City primarily show the effects of the GSR Project, with slightly lower groundwater levels than the GSR Project alone due to the combined pumping effects of the cumulative conditions scenario (including the GSR Project). This difference is attributed to the SFGW Project extracting and intercepting groundwater that would otherwise flow from the North Westside Groundwater Basin south into the Daly City area. Groundwater levels in the cumulative simulation mimic the trends seen in the modeled simulation of the GSR Project in the remainder of the South Westside Groundwater Basin. Near South San Francisco and San Bruno, the effects of the SFGW Project would be minimal due to the intervening distance; the groundwater levels under the cumulative scenario reflect conditions similar to the GSR Project impacts. (Kennedy/Jenks 2012e).

Because groundwater level impacts from the cumulative projects would be similar to the groundwater level impacts for the GSR Project alone, potential cumulative impacts related to water quality standards would be *less than significant* for the same reasons that the GSR Project-specific impacts would be less than significant. As summarized in Impact HY-12 above, contaminants reported at PCA sites in soil or in shallow or perched groundwater zones are not anticipated to be mobilized during well pumping. This conclusion is based on the reported shallow nature of contamination at the PCAs and the aggregate thicknesses of intervening clay and sand layers between the shallower parts of the aquifer and the Primary Production aquifer from which the GSR Project would pump (see analysis of Impact HY-12). Therefore, the potential impact on drinking water standards from mobilization and spreading of contaminants in groundwater, changes in flow direction, or changes to operating conditions for remediation systems as a result of cumulative pumping would be *less than significant*. Consequently, there would be no such significant cumulative impact to which the GSR Project would contribute (*less than significant*).

Impact C-HY-7: Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality degradation. (Less than Significant)

The geographic scope for the analysis of potential cumulative impacts on water quality degradation in the study area is the entire Westside Groundwater Basin as shown in Figure 2-1 (Project Vicinity Map). Table 5.1-3 (Projects Considered for Cumulative Impacts) and their locations are shown on Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis).

Two cumulative projects, the SFGW Project (cumulative project A-1 to A-6) and the Holy Cross Cemetery Expansion Project (cumulative project E), would increase pumping in the Westside Groundwater Basin, potentially leading to lower groundwater levels. One cumulative project, the Vista Grande Drainage Basin Improvement Project (cumulative project B), would discharge treated stormwater to Lake Merced, which could – in turn – potentially increase groundwater levels near Lake Merced.

Increased pumping in the Westside Groundwater Basin by the SFGW Project and the Holy Cross Cemetery Expansion Project could potentially encounter very low levels of chemicals for which no regulatory standards exist, just as the proposed GSR Project monitoring wells have (see the discussion of Impact HY-14, above). However, groundwater quality monitoring by the SFPUC, Partner Agencies, and the GAMA program throughout the Westside Groundwater Basin indicates that groundwater quality in the Basin is generally very good. The SFPUC's monitoring program has identified VOCs in the Primary Production and Deep Aquifers in the Westside Groundwater Basin (Kennedy/Jenks 2012e). The GAMA groundwater quality monitoring program (described above under Water Quality Standards) sampled 11 wells within the Westside Groundwater Basin. Pesticides, pharmaceutical compounds, and wastewater indicator compounds – including those for which no regulatory standards have been established – were not detected in any of the 11 wells within the Westside Groundwater Basin (Ray et al. 2009).

Therefore, increased pumping in the Westside Groundwater Basin due to the cumulative projects is not likely to encounter chemicals in groundwater that would present substantial health risks.

The Vista Grande Drainage Improvements Project would potentially degrade the water quality in Lake Merced, if untreated stormwater were discharged to the Lake. However, groundwater quality below

Lake Merced would not be substantially affected by such discharges due to percolation of lake water through sediment, soils, and geological formations before reaching the aquifer, which has the effect of filtering the stormwater before it reaches the groundwater. As a result, these cumulative projects would not cause significant degradation of groundwater quality in the Westside Groundwater Basin. Therefore, potential cumulative impacts relative to the degradation of drinking water quality or groundwater quality for constituents for which standards do not exist would be *less than significant*. Consequently, there would be no such significant cumulative impact to which the GSR Project would contribute (*less than significant*).

Impact C-HY-8: Operation of the proposed Project would have a cumulatively considerable contribution to a cumulative impact related to groundwater depletion effect. (Less than Significant with Mitigation)

The geographic scope for the analysis of potential cumulative impacts relative to groundwater depletion in the study area is the entire Westside Groundwater Basin is shown in Figure 2-1 (Project Vicinity Map). Table 5.1-3 (Projects Considered for Cumulative Impacts) and their locations are shown on Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis).

Two cumulative projects, the SFGW Project (cumulative project A-1 to A-6) and the Holy Cross Cemetery Expansion Project (cumulative project E), would increase pumping in the Westside Groundwater Basin and potentially lead to less groundwater storage. One cumulative project, the Vista Grande Drainage Basin Improvement Project (cumulative project B), would discharge treated stormwater to Lake Merced, which could – in turn – potentially increase groundwater storage near Lake Merced. Each of these cumulative projects, together with the continuation of existing pumping in the Westside Groundwater Basin, have been included in the Westside Basin Groundwater Model (described in Kennedy/Jenks 2012a), so that future predicted groundwater volumes for the cumulative conditions scenario include the effects from operation of the cumulative projects.

Groundwater storage under the cumulative scenario is estimated to be less than estimated groundwater storage under the modeled existing conditions; the projected decline is predicted to be approximately 970 afy, which would represent a decline in storage over the 47-year simulation period of approximately 45,000 af more than under the modeled existing conditions. This change in groundwater storage represents about 4.2 percent of the total groundwater volume in the entire onshore portion of the Westside Basin. Even though this decline is small, the results of the Westside Basin Groundwater Model regarding groundwater storage volumes for the cumulative condition indicate an incremental depletion of groundwater storage over the long-term, which is a *significant* cumulative impact. The GSR Project's contribution to this impact would be cumulatively considerable, because the groundwater storage volume would decline due to the Project. However, similar to and for the reasons discussed in the analysis for the GSR Project alone, the contribution to this impact would be reduced to a less-than-cumulatively considerable level (*less than significant*) with implementation of Mitigation Measure M-HY-14 (Prevent Groundwater Depletion), because additional in-lieu recharge would be allowed, and Project pumping would be restricted to extract only the volume of water in the SFPUC Storage Account, which would be adjusted to account for Basin losses. Therefore, with implementation of this measure, the Project would not result in a considerable contribution to any potential long-term cumulative depletion of groundwater storage (*less than significant with mitigation*).

5.16.3.9 Impacts of Mitigation Measures

Well Interference

This section provides an evaluation of whether there would be any significant impacts in addition to those identified for the Project due to implementation of Mitigation Measure M-HY-6 (Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation). This mitigation measure lists a number of mitigation actions that may be undertaken by the SFPUC to meet the performance standard established in the mitigation measure. Nine mitigation actions are listed in the mitigation measure as examples of the types of actions that could result in a reduction of impacts from well interference, as follows:

1. Improve irrigation efficiency
2. Modify irrigation operation
3. Redistribute GSR pumping
4. Reduce GSR pumping
5. Lower pump in irrigation well
6. Lower and change pump in irrigation well
7. Add storage capacity for irrigation supply
8. Replace irrigation well
9. Replace irrigation water source

These nine mitigation actions are described below in detail; mitigation actions with similar effects are discussed together.

M-HY-6 Mitigation Action #1: Improve Irrigation Efficiency, and Mitigation Action #2: Modify Irrigation Operations

M-HY-6 Actions #1 and #2 could improve irrigation efficiency and reduce water needs if irrigation pumping is anticipated to decline as a result of Project pumping. Conservation practices would be designed to help control water losses due to evaporation, deep percolation, and runoff. The measures could result in changes to the irrigation schedule (i.e. use of longer irrigation cycles or use of evapotranspiration data to modify irrigation schedules), which may lead to changes to the irrigation timing and amount of water applied to the golf clubs and cemeteries to improve water application efficiency while satisfying turfgrass water needs. Minor physical modifications could include replacing sprinkler nozzles, replacement and/or additional sprinklers to redistribute irrigation more evenly, or installation of soil-moisture sensors to aid irrigation scheduling. (SFPUC 2012c)

M-HY-6 Mitigation Action #3: Redistribute GSR Pumping

M-HY-6 Action #3 would keep the overall Project pumping at up to 7.2 mgd during a Take Year, but redistribute Project pumping so that Project wells that were causing well interference with an existing irrigator's well would be pumped less, and other Project wells that were demonstrating less drawdown than predicted by the groundwater modeling would be pumped more. Pumping would be redistributed only if there are GSR wells where groundwater levels are higher than predicted. This mitigation action would not require any construction, but could temporarily and/or occasionally change the pumping rate at one or more of the Project wells. (SFPUC 2012c)

M-HY-6 Mitigation Action #4: Reduce GSR Pumping

M-HY-6 Action #4 would reduce Project pumping. Reduced pumping would not require any construction or operational changes, and therefore no construction or operational impacts would occur due to reduced pumping.

M-HY-6 Mitigation Action #5: Lower Pump in Irrigation Well and Mitigation Action #6: Lower and Change Pump in Irrigation Well

If needed as a mitigation action, the existing irrigation pump affected by Project pumping would be modified to allow irrigation pumping to continue. The modification would include lowering the pump deeper in the existing well and may include a change in the size and characteristics of the pump to accommodate pumping from deeper water levels. (SFPUC 2012c)

M-HY-6 Mitigation Action #7: Add Storage Capacity for Irrigation Supply

If needed as a mitigation action, storage capacity to meet peak flow rates required for irrigation purposes may be added to offset reduced well capacity caused by Project pumping. Additional storage capacity could be added through installation of an above-ground storage tank with a capacity of 20,000 gallons or less, which could be up to 20 feet in height, and sized according to the peak flow needs. The tank would be painted to blend in with the surrounding area (SFPUC 2012c) (i.e., green for vegetative surroundings). It is assumed, for purposes of this analysis, that the storage would be located adjacent to the existing well that would be impacted by Project pumping and that the storage facility would connect directly to the existing irrigation system infrastructure. To install a typical tank, a site would be cleared and graded as needed to prepare the site. Depending on the size of the tank needed to supply the peak flow water quantities, either a tank may be constructed on the site or a pre-fabricated tank moved to the site. A concrete foundation may be required depending upon the type and size of the tank and the site characteristics. Equipment used for tank construction could include a bulldozer for earthwork and grading, crane, concrete trucks, delivery trucks, and roller compaction equipment. After construction is completed, the area around the new tank disturbed by its installation would be restored to its general pre-construction condition. (SFPUC 2012c)

M-HY-6 Mitigation Action #8: Replace Irrigation Well

If needed as a mitigation action, a replacement well at a cemetery or golf club could be constructed on the cemetery or golf club property. This analysis assumes that the irrigation well would be sited to avoid impacts on: waters of the United States or of the State of California; wetlands; other sensitive habitat; or cultural and historic resources. It also assumes that the new irrigation well would not be sited directly on land currently used for agriculture, or land that has a unique geologic feature, but it could be sited adjacent to such land.

To install a typical replacement well, a site would first be cleared and graded (as needed). A steel conductor casing would be installed to a minimum depth of 50 feet. A large diameter borehole would be drilled to a depth of approximately 550 to 700 feet. The well casing, consisting of a steel well casing and well screen, would be installed in the production borehole. After the well casing has been installed, well development would begin. Various well pumping tests would be performed after final well development. If the pumping test shows that water quality and production would meet the need of the landowner, then a pump, valves, flowmeter, and electrical connection would be installed. Equipment used for replacement well construction would likely include a truck-mounted drill rig, shale shaker, drilling fluid tanks, support trucks, Baker Tanks, forklift, and loader/backhoe. Approximately 45 working days would be required for well construction, development, and testing. After construction, the construction work area would be restored to its general pre-construction condition, including any golf course playing surfaces or other landscaping. (SFPUC 2012c)

M-HY-6 Mitigation Action #9: Replace Irrigation Water Source

In the event that the preceding options cannot be immediately implemented without causing an interruption in the irrigation supply, a temporary replacement water supply source would be provided until another mitigation option(s) is implemented. Water would be trucked to the site or would be provided via aboveground pipes from Partner Agency or SFPUC supply from distribution or transmission pipelines close to the location where additional irrigation supplies are needed. The SFPUC would verify that the water quality of the new irrigation source is acceptable. (SFPUC 2012c)

The effects of these mitigation actions are evaluated together under each environmental resource area. For the following three resource areas, none of the mitigation actions would result in additional impacts:

- **Population and Housing**. Implementation of M-HY-6 Actions #1 through #9 would not result in impacts related to population and housing, because these actions would not increase or displace existing population and do not include the construction of new, or displacement of existing, housing. Therefore, there would be no additional impact on the environment relative to the construction of new housing.
- **Wind and Shadow**. M-HY-6 Actions #1 through #6, and #8 and #9 do not include construction of new structures that could alter wind and shadow patterns. Action #7 includes the placement of a new storage tank, up to 20 feet tall, next to an existing irrigation well. The size of the storage tank would not be substantial enough to alter wind patterns or significantly alter shadow patterns such that enjoyment or use of the golf clubs or cemeteries would be affected. Therefore, there would be no additional impacts related to wind and shadow.
- **Public Services**. Implementation of M-HY-6 Actions #1 through #9 would not result in impacts related to public services because these actions would not increase population in the study area and therefore would not affect the ability of local jurisdictions to maintain service ratios, response times, or other performance objectives. Therefore, there would be no additional impact on the environment relative to public services.

The potential effects of the nine mitigation actions on the remaining resource areas are discussed below.

Land Use

Implementation of M-HY-6 Actions #1 through #4 would not result in impacts on land use, because these actions would not generate construction- or operation-related noise, dust, or exhaust emissions, and would not include construction equipment or permanent structures that would adversely affect the existing character of the land use. *No impact* would occur for M-HY-6 Actions #1 through #4.

While M-HY-6 Actions #5, #6, and #9 would require the use of construction equipment and vehicles, the scope of these construction activities would be similar to ongoing maintenance activities at the golf clubs and cemeteries. Therefore, construction impacts for M-HY-6 Actions #5, #6, and #9 would be *less than significant*. Depending on the placement of the pipelines, operation of M-HY-6 Action #9 may result in minor disruption to recreational uses at the golf clubs. The temporary placement of aboveground pipelines in golf clubs could result in golf carts needing to maneuver around pipelines while traveling within the golf club; however, aboveground pipelines would be placed and operated such that the golf club would remain available and useable to golfers. The temporary operational impacts of M-HY-6 Action #9 would not displace the land use and would therefore be *less than significant*.

M-HY-6 Actions #7 and #8 could result in temporary adverse impacts on land use due to substantial disruption of existing land uses or substantial interference with access to land uses during construction from the combination of temporary increases in noise and dust/exhaust emissions levels, traffic delays, and/or access disruption. Depending on the location of the storage tank or new well (i.e., whether visible from a publicly accessible vantage point), implementation of this mitigation action could temporarily degrade the visual quality of the site or scenic views during construction, and therefore temporarily affect the existing character of surrounding land uses. Therefore, these potential impacts could be *significant*. Implementation of Mitigation Measures M-NO-1 (Noise Control Plan), M-AQ-2a (BAAQMD Basic Construction Measures), M-TR-1 (Traffic Control Plan), and M-AE-1a (Site Maintenance) to reduce Project impacts would also reduce impacts from construction activities related to M-HY-6 Action #7 and #8 to *less-than-significant* levels by requiring measures to reduce construction-related noise, dust, emissions, and traffic access-related issues to *less-than-significant* levels It is unlikely that the wells would displace existing land uses because the new wells could be located at the same site as the existing wells, and no perceptible noise would be generated from the wells; therefore, there would be *no operational impacts* on existing land uses from M-HY-6 Action #8. Given the size of the properties involved and their open-space nature, this analysis assumes that a new storage tank could be sited in an area that would not conflict with existing land use where this mitigation might be required, even though the possible locations for a new tank have not been identified for each irrigator. Therefore, the potential land use impact associated with implementation of M-HY-6 Action #7 is assumed to be *less than significant*.

Aesthetics

Implementation of M-HY-6 Actions #1 through #4 would not result in additional impacts on visual resources, because these actions would not involve construction activities or new aboveground structures that would alter or impact the visual quality of the cemeteries or golf clubs as viewed from publicly accessible vantage points. Additionally, the purpose of these mitigation actions is to ensure continued adequate water for irrigation at the golf clubs or cemeteries, therefore the operation of these facilities would not be impacted by these mitigation actions. As a result, *no construction or operational impacts* related to aesthetics would occur for M-HY-6 Actions #1 through #4.

The implementation of M-HY-6 Actions #5 through #9 could result in minor additional aesthetic impacts during construction due to the presence of construction equipment and vehicles; these impacts could be *significant* if construction sites were visible from publicly accessible viewpoints. Implementation of

Mitigation Measures M-AE-1a (Site Maintenance) would reduce construction impacts to *less-than-significant* levels by keeping the area clean of debris. Construction-related aesthetic impacts from implementation of M-HY-6 Actions #5 through #9 would therefore be *less than significant with mitigation*.

M-HY-6 Actions #5 and #6 would not have operational impacts related to aesthetics, because they would not include any aboveground changes, therefore *no operational impact* would occur for Actions #5 and #6. However, M-HY-6 Actions #7 and #8 could result in additional aesthetic impacts during operation. Placement of a storage tank up to 20 feet tall (M-HY-6 Action #7) could affect the visual quality and character of the golf club or cemetery, however, SFPUC would work with the landowner to site the tank in a location that minimizes visual impacts from publicly accessible viewpoints. Certain factors such as the tank's proximity to other structures or the presence of natural screening (i.e., trees or topography) could limit impacts on the visual character of the site or its surroundings. Additionally, the storage tank would be painted to blend in with its surroundings (SFPUC 2012c) (i.e., green for areas with evergreen turf or vegetation). If significant aesthetic impacts would still result from the installation of a new water tank, per this measure, this analysis assumes that Mitigation Measure M-AE-3a (Implement Landscape Screening) could also be implemented, as necessary, to mitigate such impacts to *less-than-significant* levels. This would be accomplished by requiring the SFPUC to develop and implement a landscape screening plan to screen publicly accessible views of the new water storage tank(s), including the following:

- The landscape plan shall include native trees and shrubs common to the surrounding areas. The landscape plan shall include plant species, planting specifications, and irrigation requirements necessary to screen the new water storage tank(s). The SFPUC shall monitor landscape plantings annually for five years after project completion to ensure that sufficient ground coverage has developed and that the shrubs survive. If necessary, the SFPUC shall implement additional measures (e.g., replanting, temporary irrigation) to address continued survival of the plantings, and shall replant additional shrubs should a significant amount of the plantings do not survive during the monitoring period.

M-HY-6 Action #8 would construct a replacement irrigation well at a golf club or cemetery. However, the aesthetic impact of the well would be minor, because the well would extend approximately three feet above ground, which would not significantly affect viewsheds or the visual quality of the cemetery or golf clubs, as viewed from publicly accessible vantage points. M-HY-6 Action #9 would potentially affect the visual quality of the cemetery or golf club because the pipelines would be located above ground. However, this mitigation action is intended to be temporary in duration. For these reasons, operational impacts on aesthetics from M-HY-6 Actions #8 and #9 would be *less than significant*.

Cultural and Paleontological Resources

Implementation of M-HY-6 Actions #1, #2, #3, #4 #5, #6, and #9, would not result in additional impacts on cultural or paleontological resources, because these actions would not involve additional excavation, grading, or other ground disturbances. Implementation of these mitigation actions would also not involve new structures or changes to historical resources. As a result, *no impacts* would occur.

There are no historical resources identified at the golf clubs that could be affected by the Project, but several cemeteries within the study area include individual historic resources or the cemeteries are eligible for listing on the National Register. If historic resources are present at a golf club or cemetery where a storage tank or replacement well (M-HY-6 Actions #7 and #8) might be needed, the facilities would be sited to avoid impacts on these resources (i.e., sited where the storage tank and well are not visible in proximity to a historic resource), where feasible. Construction of the storage tank or well would be short in duration and impacts on the historic resources during construction would therefore be *less than significant*. Once in place, if a storage tank is within close proximity of a historic resource, the implementation of Mitigation Measures M-AE-3a (Implement Landscape Screening) would reduce impacts on historic resources by providing screening, as also described above to address any potential aesthetics impacts.

It is unknown whether M-HY-6 Action #7 or #8 would be implemented at a site that contains archaeological or paleontological resources. Damage to an archaeological or paleontological resource would be a *significant* impact. However, implementation of Mitigation Measures M-CR-2 (Discovery of Archaeological Resources), M-CR-3 (Suspend Construction Work if a Paleontological Resource is Identified), and M-CR-4 (Accidental Discovery of Human Remains) would adequately address any potential impacts related to the accidental discovery of these resources during construction by requiring adherence to appropriate procedures and protocols. Impacts on cultural and paleontological resources as a result of implementing M-HY-6 Action #7 or #8 would therefore be *less than significant with mitigation*.

Transportation and Circulation

Implementation of M-HY-6 Actions #1 through #4 would not impact transportation and circulation because no construction would be required, and therefore *no construction traffic impacts* would occur. Because these actions would not require additional maintenance vehicle trips, operation would not permanently impact the performance of the transportation circulation system or increase traffic hazards and *no operational impact* would occur.

Implementation of M-HY-6 Actions #5, #6, #7, #8, or #9 could result in additional impacts on transportation and circulation due to additional construction traffic on regional highways and local roadways. However, construction traffic from these mitigation actions would be minor and temporary (i.e., truck deliveries for well pump, storage tank, or piping). Because any storage tanks, replacement wells or irrigation piping would be located on existing golf club or cemetery property and connected to onsite irrigation plumbing (rather than periodically filled by delivery truck), implementation of M-HY-6 Actions #7, #8, or #9 would not permanently impact the performance of the transportation circulation system or increase traffic hazards. Therefore, operational impacts of M-HY-6 Actions #5, #6, #7, #8, or #9 would be *less than significant*.

Noise and Vibration

Implementation of M-HY-6 Actions #1 through #4 would not result in construction or operational noise impacts because these actions would not include construction activities or result in new sources of noise. *No noise or vibration impacts* would therefore occur.

Implementation of M-HY-6 Action #5, #6, and #9 would not generate significant noise impacts during construction. Lowering and/or replacing the pump, or installing aboveground pipelines would be similar in nature to other ongoing maintenance activities and would not substantially increase ambient noise levels at the golf clubs or cemeteries. Any related noise impacts would therefore be *less than significant*. *No* *operational impacts would occur*, because the changed pump and aboveground pipelines would not generate perceptible changes in ambient noise levels.

Implementation of M-HY-6 Action #7 would result in additional noise and vibration impacts during construction due to site grading and clearing, construction of a concrete foundation (if necessary), and the use of construction equipment and vehicles. Implementation of M-HY-6 Action #8 would also result in additional noise and vibration impacts during construction of the replacement irrigation well. If pipelines are required for the irrigation well, pipeline trench compaction during construction could cause ground-borne vibration, which would be potentially significant depending on the proximity to structures and sensitive receptors. While golf clubs are not considered sensitive noise receptors, cemeteries and places of residence, schools, and churches are considered sensitive to noise disturbances. Additionally, Daly City, Colma, and San Bruno have specific noise regulations for cemeteries and/or golf clubs. Construction of M-HY-6 Actions #7 or #8 could exceed local noise standards and temporarily increases ambient noise levels, which would be *significant*.

Mitigation Measures M-NO-1 (Noise Control Plan) would reduce construction-related noise impacts for M-HY-6 Actions #7 and #8. Mitigation Measure M-NO-2 (Reduce Vibration Levels during Construction of Pipelines) would reduce noise and vibration levels generated during well drilling and pipeline trench compaction. Implementation of M-NO-1 (Noise Control Plan) would reduce noise impacts from Action #7 to *less-than-significant* levels. However, Action #8 includes drilling, and as discussed in Section 5.7, Noise and Vibration, depending on the proximity of construction to a sensitive noise receptor (e.g., residences or schools), and depending on the local noise regulations for cemeteries and/or golf clubs, it is possible that even with the implementation of these mitigation measures, noise impacts related to noise standards and ambient noise levels from well drilling could be *significant and unavoidable*.

Operation of the storage tank (M-HY-6 Action #7) would not increase ambient noise levels at the golf clubs or cemeteries. Operation of the irrigation well (M-HY-6 Action #8) would not increase ambient noise levels because the pump would be located underground. *No operational noise impacts* would therefore occur.

Air Quality

Implementation of M-HY-6 Actions #1 through #4 would not require construction, and therefore would not result in the emission of criteria air pollutants or violation of air quality standards. *No impact* would occur. M-HY-6 Actions #5, 6, and #9 would require use of construction equipment and vehicles (but no ground disturbance), and would generate small amounts of exhaust emissions. M-HY-6 Actions # 7 and #8 would generate fugitive dust and other criteria air pollutants from construction activities such as grading and excavation, and the use of construction equipment and vehicles. These emissions could be *significant*. However, implementation of M-AQ-2a (BAAQMD Basic Construction Measures) would reduce impacts to *less-than-significant* levels by requiring measures to control dust and reduce idling. Post-construction, these mitigation actions would not emit criteria air pollutants. *No impact* from operations would therefore occur.

Greenhouse Gas (GHG) Emissions

Implementation of M-HY-6 Actions #1 through #4 would not require construction, and therefore would not generate greenhouse gases. *No impact* would occur. M-HY-6 Actions #5, 6, #7, #8, and #9 would generate a small additional amount of GHG emissions through the combustion of fossil fuels in mobile construction equipment and vehicles, and from the purchase of electricity to operate any electrical equipment for Project construction. However, due to the small scale of these mitigation actions, GHG emissions generated during construction would be *less than significant*. Operation of the Actions #5, #6, #7, and #9 would be similar in scope to existing maintenance activities. Action #8 would replace an existing well, so maintenance activities would be the same as for the existing well, and would not result in additional GHG emissions. Therefore, operational impacts associated with GHG emissions generated from worker trips and energy use would be *less than significant*.

Recreation

Implementation of M-HY-6 Actions #1 through #4 would not require construction. Operation of these mitigation actions would facilitate the continued recreational function of the golf clubs by providing irrigation water. *No impact* would therefore occur.

M-HY-6 Actions #5 and #6 would require the use of construction equipment and vehicles, and construction would be similar to ongoing maintenance activities at the golf clubs, because no ground disturbance would occur and significant noise or dust would not be generated. Therefore, impacts on recreational experience would be *less than significant*. No permanent changes to the recreational facilities would occur, so *no operational impacts* would occur.

Implementation of M-HY-6 Actions #7, #8, and #9 could result in additional impacts on recreation during construction. If M-HY-6 Action #7 is implemented at a golf club, the storage tank would likely be located immediately adjacent to the affected existing irrigation well. If M-HY-6 Action #8 is implemented at a golf club, the replacement irrigation well would likely be sited at the outer fringes of playing surfaces or in other non-playing areas, to minimize damage to playing surfaces. Implementation of M-HY-6 Action #9 could result in temporary impacts at golf clubs. Placement of aboveground pipelines could temporarily affect golf cart access between holes and may require golfers using golf carts to take alternative access routes if pipelines cross internal golf club roadways; otherwise pipeline placement would not prevent golfers from using the golf club or impact playing surfaces. Therefore, it is unlikely that the placement of the storage tank, irrigation well, or aboveground pipelines would substantially damage or displace existing playing surfaces.

Construction of these mitigation actions could temporarily affect the quality of the recreational experience or temporarily affect golf cart access within the golf club; these temporary impacts on recreational experience would be *less than significant* because disruption would be limited and short-term (typically less than one month), and because other recreational resources are available in the area.

Any golf club playing surfaces damaged during construction would be restored to their general pre-construction condition after construction is completed (pursuant to Chapter 3, Project Description, Section 3.5.1.3 [Construction Methods for Water Distribution and Utility Pipeline Installation], which specifies that areas disturbed during construction would be restored to pre-construction conditions). As stated earlier, it is unlikely that the storage tank or irrigation well would substantially displace existing playing surfaces. Depending on the placement of the pipelines, operation of M-HY-6 Action #9 may result in temporary and minor disruption of recreational uses at the golf clubs. Implementation of these actions would not result in population growth, and therefore would not increase the use, or require the expansion of existing parks or recreational facilities. Therefore, operational recreation impacts of M-HY-6 Actions #7, #8, and #9 would be *less than significant*.

Utilities and Service Systems

Implementation of M-HY-6 Action #1, #2, #3, #4, #5, #6, and #9 would not require trenching or other ground disturbances that could disrupt or damage existing utilities. These mitigation actions would not require additional water entitlements; generate additional solid waste or additional discharges to sanitary sewer or stormwater systems. *No such impacts* would therefore occur.

Implementation of M-HY-6 Actions #7 and #8 would result in additional potentially *significant* impacts on utilities and service systems by contributing small additions of solid waste generated during construction and potentially damaging or disrupting utilities during construction. However, as discussed in Section 5.12, Utilities and Service Systems, the Ox Mountain Landfill has a remaining capacity that is sufficient to accommodate the amount of solid waste that would be generated by implementation of M-HY-6 Actions #7 and #8. Additionally, Mitigation Measure M-UT-4 (Waste Management Plan) would require compliance with local solid-waste diversion goals and regulations. Implementation of Mitigation Measures M-UT-1a (Confirm Utility Line Information), M-UT-1b (Safeguard Employees from Potential Accidents Related to Underground Utilities), M-UT-1c (Notify Local Fire Departments), M-UT-1d (Emergency Response Plan), M-UT-1e (Advance Notification), M-UT-1f (Protection of Other Utilities during Construction), M-UT-1g (Ensure Prompt Reconnection of Utilities), M-UT-1h (Avoidance of Utilities Constructed or Modified by Other SFPUC Projects), and M-UT-1i (Coordinate Final Construction Plans with Affected Utilities) would adequately address impacts related to the potential disruption and relocation of utility operations or accidental damage to existing utilities by requiring the SFPUC and/or its contractor(s) to identify the potentially affected lines in advance, coordinate with utility service providers to minimize the risk of damage to existing utility lines, protect lines in place to the extent possible or temporarily re-route lines if necessary, and take special precautions when working near high priority utility lines (e.g., gas transmission lines). Construction impacts on utilities and service systems from M-HY-6 Actions #7, and #8 would therefore be *less than significant with mitigation*. Construction of M-HY-6 Action #8 would also discharge to the local sanitary sewer or storm drain system during well development pumping tests. However, as described in Section 5.12, Utilities and Service Systems, the sanitary sewer and storm drain systems in the Project area have sufficient capacity to handle the volume and rate of such discharges during well development.

Operation of M-HY-6 Actions #7 and #8 would not result in impacts on utilities or service systems. A new storage tank would not result in additional discharges to the storm drain or sanitary sewer system. Since Action #8 involves replacing an existing well, no additional discharges to the storm drain or sanitary sewer system would occur.

Biological Resources

Implementation of M-HY-6 Actions #1 through #4, and #9 would occur on existing golf club or cemetery property and would not modify existing habitats or require tree removal. Implementation of M-HY-6 Action #5 or #6 would not impact biological resources, because these actions would not require additional construction activities beyond lowering and/or changing the well pump. No trees would be removed and no surface ground disturbance would occur. Construction equipment and workers would be present, but would avoid any waters of the State or of the United States, wetlands, or sensitive habitat near or adjacent to the construction site, as discussed previously in the mitigation action descriptions. As a result, *no impacts* on biological resources from M-HY-6 Actions #1 through #6, and #9 would occur.

Implementation of M-HY-6 Actions #7 and #8 could result in additional potentially *significant* impacts on biological resources. Storage tanks would likely be located adjacent to existing irrigation wells. Storage tanks and replacement irrigation wells would be sited to avoid jurisdictional waters, wetlands, or other sensitive habitat. However, implementation of this mitigation action could potentially require the removal of trees to accommodate placement of a new tank depending on where the tank was constructed. Implementation of Mitigation Measures M-BR-1a (Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors), M-BR-1b (Protection Measures for Special-status Bats during Tree Removal or Trimming), M-HY-1 (Develop and Implement a Stormwater Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan), M-BR-4a (Identify Protected Trees), and M-BR-4b (Protected Tree Replacement) would reduce any such potential impacts to l*ess-than-significant* levels. These measures would require pre-construction surveys to determine whether special-status or migratory birds or bats (including their nests and roosts), or overwintering monarch butterflies are present at or near construction sites. These also include measures to protect nearby habitat from construction-related runoff and sedimentation, and require trees to be protected, avoided, and replaced in accordance with local tree protection ordinances if removed. Therefore, impacts on biological resources from M-HY-6 Actions #7 and #8 would be *less than significant with mitigation*.

Geology and Soils

Implementation of M-HY-6 Actions #1 through #6, and #9 would occur on existing golf club or cemetery property and would not include the construction of new structures that could expose people to seismic ground shaking or landslides. Implementation of Actions #1, #2, #5, #6, and #9 would be similar in nature to existing ongoing maintenance activities; Actions #3 and #4 would not result in physical changes, and therefore would not result in new or increased risk for landslides or other soil or geologic instability risks. As a result, *no impacts* would occur.

M-HY-6 Action #7 could potentially place a storage tank on unstable soil that could be susceptible to landslides, ground shaking, or settlement. The exposure of this structure to potentially adverse seismic effects that could lead to tank failure could be *significant*. However, implementation of Mitigation Measure M-GE-3 (Conduct Site-specific Geotechnical Investigations and Implement Recommendations) would require site-specific geotechnical investigations, and implementation of recommendations to protect against property loss, injury, or death from ground shaking or settlement that could result from the damage of a new water tank and would be reduced to *less-than-significant* levels. Installation and operation of a replacement irrigation well identified in M-HY-6 Action #8 would not include construction of structures intended for human occupancy; therefore, there would be no exposure of people or structures to the effects of landslides, ground shaking, or settlement.

Given that any storage tanks or replacement irrigation wells would be located within existing cemeteries or golf clubs, which are carefully landscaped and highly disturbed, it is unlikely that implementation of these mitigation actions would substantially change existing topography or unique geologic or physical features. If a replacement well were to be sited on the Holy Cross Cemetery property east of Hillside Boulevard, the well would likely be sited to avoid substantial changes to existing topography or unique geologic or physical features. Such potential impacts would be *less than significant*.

Hydrology and Water Quality

Implementation of the M-HY-6 Actions #1, #2, #4 #5, #6 and #9 would not include ground-disturbing construction activities and therefore these mitigation actions would not result in erosion or runoff that would impact water quality. Irrigation (Actions #1, #2, and #9) would follow standards necessary to reduce runoff to surface waters and percolation to groundwater. If a new well is drilled (Action #8), SFPUC would ensure that water quality of the new well is appropriate for irrigation use. Actions #5 and #6 would modify pumping to allow irrigation pumping to continue at existing levels. Action #4 would reduce Project pumping and not require any other construction or operational changes. Therefore, there would be *no impacts* on hydrology or water quality from these mitigation actions.

Implementation of M-HY-6 Actions #7 and #8 could require vegetation removal, grading, excavation, and soil stockpiling, which could result in erosion and sedimentation and impact water quality. This would be a *significant* impact. However, implementation of Mitigation Measure HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan), would reduce such potential impacts to *less-than-significant* levels by requiring stabilization and control measures during ground disturbing activities.

Redistribution of pumping under M-HY-6 Action #3 would not have the potential for additional well interference, subsidence, seawater intrusion, or Lake Merced water quality impacts, because Mitigation Measure M-HY-6 specifies that redistribution of pumping would not occur in a manner that would cause groundwater levels to drop below that caused by the Project.

If pumping were redistributed to a different well or wells, the increased pumping during Take Periods would not cause adverse water quality impacts related to drinking water standards, because the wells would still be operated by the SFPUC to meet such standards, as described in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types). If decreased pumping were to occur, groundwater levels in the shallow water-bearing zone could increase slightly, with the potential for interaction with existing contamination. However, such an increase in the shallow water-bearing zone is unlikely and would be very small if it were to occur. Therefore, such potential impacts on groundwater quality would be *less than significant.*

If pumping were redistributed to a different well or wells, the increase in pumping would not cause significant water quality degradation related to constituents for which regulatory standards do not exist, because such constituents occur at very low levels that are not likely to be injurious to health (refer to Impact HY-14). Therefore, *no additional impacts* on groundwater quality would occur.

If pumping were redistributed, the total volume of Project pumping would remain the same, and therefore, *no impact* would occur on overall groundwater storage volumes in the Westside Groundwater Basin, and Project impacts related to groundwater depletion would therefore not change.

Hazards and Hazardous Materials

Implementation of M-HY-6 Actions #1, #2 and #9 would occur on existing golf club or cemetery property and would be similar in scope to ongoing irrigation activities at these facilities. Implementation of these actions would not involve the transport, use, or disposal of hazardous materials. Actions #3 and #4 would not involve construction activities and would also not involve the transport, use, or disposal of hazardous materials. As a result, *no such impacts* would occur for M-HY-6 Actions #1 through #4, and #9.

Implementation of M-HY-6 Actions #5, #6, #7, and #8 could require the use of hazardous materials during construction. Impacts related to accidental releases of chemicals (including within proximity to a school) could be *significant*. However, any activities involving the use or transport of hazardous materials would require compliance with applicable hazardous materials laws and regulations. Implementation of Mitigation Measure M-HY-1 (Develop and Implement a Stormwater Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would lessen the potential for impacts to *less than significant with mitigation* related to an accidental release of hazardous materials (including within proximity to a school) by requiring specific practices for the safe storage and handling of chemicals.

M-HY-6 Actions #7 and #8 would not include new structures. It is unknown whether implementation of M-HY-6 Actions #7 and #8 would result in the siting of a storage tank or a replacement irrigation well near a hazardous materials site identified on the Cortese List (described in Section 5.17, Hazards and Hazardous Materials). Siting the well near a hazardous materials site could result in the potential to encounter hazardous materials in soil or groundwater, which would be a *significant* hazardous materials impact. However, if these facilities were to be located near a hazardous materials site, implementation of Mitigation Measures M-HZ-2a (Preconstruction Hazardous Materials Assessment), M-HZ-2b (Health and Safety Plan), and M-HZ-2c (Hazardous Materials Management Plan) would reduce the potential hazardous materials impact on the environment to *less-than-significant* levels by requiring a soil investigation to determine the presence of chemical residue, as well as a soil and groundwater management plan to ensure appropriate handling and disposal of excavated material containing hazardous materials. No hazardous materials would be required during operation of M-HY-6 Actions #7 and #8. *No such potential impacts* during operation would therefore occur.

Mineral and Energy Resources

A portion of the Olympic Golf Club is mapped as MRZ-3, which indicates areas that contain mineral deposits, but the significance is unknown (CGS 1987, 1996). All other golf club and cemetery properties within the study area that may be subject to well interference are mapped as MRZ-1, which are areas with no significant mineral deposits or little likelihood for their presence, or MRZ-4, which are areas where information is inadequate for assignment to another zone (CGS 1987, 1996).

Implementation of M-HY-6 Actions #1 through #6, and #9 would not change existing land uses or otherwise change the availability of a known mineral resource. Therefore, no such impacts would occur. Implementation of M-HY-6 Actions #1, #2, #5, #6, and #9 could result in a small change in the energy use required by the irrigation systems or wells at the golf clubs and cemeteries. However, any such changes would be negligible in the context of the overall energy use at these facilities, and may actually reduce energy use. As a result, *no impacts* on minerals or energy resources would occur.

Construction of storage tanks (M-HY-6 Action #7) or replacement irrigation wells (M-HY-6 Action #8) would require the use of fossil fuels. However, given the nature and scale of construction, construction of M-HY-6 Actions #7 or #8 would not require a large amount of fuel or energy usage because of the moderate number of construction vehicles and equipment, worker trips, and truck trips that would be required for a project of this scale. Therefore, construction would not encourage activities that would result in the use of large amounts of fuel and energy. The impact would be *less than significant.* A storage tank or replacement irrigation well could be sited within the Olympic Golf Club area mapped as MRZ-3. However, implementation of these mitigation actions would not result in the loss of a known or locally important mineral resource because the site is not currently mined, and the placement of an aboveground storage tank or small irrigation well would not preclude future access to this resource or result in a change in this site's resource designation. Impacts on mineral and energy resources from M-HY-6 Actions #7 or #8 would therefore be *less than significant with mitigation*.

Agriculture and Forest Resources

A portion of the Holy Cross Cemetery property (areas east and west of Hillside Boulevard) is mapped by the Farmland Mapping and Monitoring Program as Unique Farmland, and a portion of the undeveloped property east of Hillside Boulevard is mapped as Grazing Land (CDC 2011). The area east of Hillside Boulevard also contains a small portion of forest land, as defined in PRC § 12220(g).

M-HY-6 Actions #1 through #6, and #9 do not involve changes to existing zoning, land use, or other construction that would result in the loss of important farmland or forest land. As a result, *no impacts* on agriculture or forest resources from these mitigation actions would occur.

M-HY-6 Actions #7 and #8 would be implemented on existing golf club and/or cemetery property. If a storage tank or replacement irrigation well were constructed in the Holy Cross cemetery area mapped as Unique Farmland, land actively used for agriculture would likely be avoided to the extent feasible, but a small portion of land mapped as Unique Farmland or Grazing Land could be displaced. However, the area of impact would be small and would not result in a conversion of land designated as Unique Farmland or Grazing Land to non-agricultural use, given that the overall land use would not change as a result of these mitigation actions. The land is not under a Williamson Act contract, and the implementation of M-HY-6 Actions #7 or #8 would not preclude continued and future use for agriculture, or involve other changes that could result in the conversion of agriculture land to some other use given that this is an irrigation supply action. Therefore, impacts on agriculture resources would be *less than significant*.

The Holy Cross Cemetery parcel also contains a small portion of forest land, as defined in PRC § 12220(g). However, sufficient non-forested land exists such that storage tanks could easily be sited to avoid the loss of forest land. *No impacts* on forest land would therefore occur.

Adverse Effects on Beneficial Uses of Lake Merced

This section provides an evaluation of whether there would be any significant impacts in addition to those identified for the Project due to implementation of Mitigation Measure M-HY-9b (Lake Level Management for Lake Merced). This mitigation measure lists a number of mitigation actions that may be undertaken by the SFPUC to meet the performance standard established in the mitigation measure. Two corrective actions are listed in the mitigation measure as examples of the types of actions that could result in a reduction of impacts at Lake Merced, as follows:

- Redistribute pumping to decrease Project pumping rates in the vicinity of Lake Merced or decrease the overall Project pumping rate. However, in no case would redistribution be undertaken where groundwater levels would decline more than from the Project as originally predicted by modeling.
- Augment lake levels through the addition of supplemental water (such as potable water that is dechloraminated at the Lake Merced Pump Station, stormwater from the Vista Grande Drainage Canal, recycled water, or stormwater diverted from other development in the Lake Merced watershed), if available.

Impacts related to implementation of this mitigation measure would not include any construction–related impacts, but could include hydrology and water quality impacts as follows:

Well Interference

Redistribution of pumping under Mitigation Measure M-HY-9b (Lake Level Management for Lake Merced) would not have the potential for additional well interference, because Mitigation Measure M-HY-9b specifies that redistribution of pumping would not occur in a manner that would cause groundwater levels to decline more from the Project than originally predicted by modeling. Therefore, impacts related to well interference would be l*ess than significant*.

Subsidence

Increased pumping at a Project well as a result of redistributed pumping could cause increased subsidence. However, the estimated maximum subsidence based on the proposed pumping distribution is less than 60 percent of the significance threshold (3.4 inches at Site 13 as shown in Table 5.16-15 (Estimated Subsidence due to Project Operations) compared to the significance threshold of six inches). Therefore, increased pumping, even at the well where the potential for subsidence is the greatest, would not likely result in subsidence in excess of the significance threshold for subsidence. As a result, impacts related to subsidence would be *less than significant*.

Seawater Intrusion

Increased pumping at a Project well as a result of redistributed pumping could result in an increased potential for seawater intrusion. However, Mitigation Measure M-HY-9b (Lake Level Management for Lake Merced) prohibits redistribution from being undertaken where groundwater levels would decline more than from the Project as originally predicted by modeling. Therefore, Mitigation Measure M-HY-9b would not increase the potential for seawater intrusion as compared to the Project, and Project impacts are less than significant. As a result, impacts related to adverse effects from Mitigation Measure M-HY-9b caused by seawater intrusion would be *less than significant*.

Adverse Effects on Beneficial Uses of Lake Merced

Addition of supplemental water to Lake Merced to maintain lake levels to avoid impacts on water quality, biological resources, and recreational resources could affect water quality, and therefore affect the beneficial uses of the lake. However, the discharge of supplemental water to the lake would be subject to oversight by the RWQCB, which would ensure that the water quality is sufficient to protect the beneficial uses of the lake. Therefore, there would be *less-than-significant* impacts on the beneficial uses of Lake Merced as a result of supplemental water additions.

Water Quality Standards

Increased pumping at a Project well as a result of redistributed pumping under Mitigation Measure M-HY-9b (Lake Level Management for Lake Merced) could increase the size of the groundwater protection zone at that well, potentially introducing new potentially contaminating activities. However, the Primary Production and Deep Aquifers would be protected from surface-level contamination within this large groundwater protection zone in the same manner that they are under the Project groundwater protection zones. Therefore, implementation of Mitigation Measure M-HY-9b would have *less-than-significant* impacts to water quality of the groundwater in the Westside Groundwater Basin.

Groundwater Depletion

Redistribution of pumping would not affect total groundwater storage, and, therefore, impacts related to groundwater depletion would be *less than significant*.

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5.17 HAZARDS AND HAZARDOUS MATERIALS

This section describes hazardous materials and other hazards to public health and safety that could result from implementation of the proposed Project. It presents the potential construction and operational impacts of the Project related to hazards and hazardous materials, as well as mitigation measures as appropriate. This section also evaluates potential impacts from regional hazards including wildfire hazards, public use airports, and geologic units containing naturally occurring asbestos.

5.17.1 Setting

The study area for hazardous materials includes possible contaminating activities (e.g., known contaminant plumes, leaking underground storage tanks, dry cleaners, gas stations) within 0.25 mile of facility sites. The study area for the evaluation of airport and airstrip impacts is within two miles of each facility site and the study area for the evaluation of wildfires and emergency access is the facility site and the nearby areas surrounding the site. This section assesses the potential for hazardous materials to be present in the soil or groundwater as a result of a previously unidentified release of hazardous materials in the study area or a documented release of hazardous materials in or near the facility sites.

5.17.1.1 Definition of Hazardous Materials

The term "hazardous materials"[1] refers to both hazardous substances and hazardous wastes. Under federal and State laws, any material, including wastes, may be considered hazardous if it is specifically listed by statute as such or if it is toxic (causes adverse human health effects), ignitable (has the ability to burn), corrosive (causes severe burns or damage to materials), or reactive (causes explosions or generates toxic gases). The term "hazardous material" is defined as any material that, because of quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment.

In some cases, past industrial or commercial activities on a site could have resulted in spills or leaks of hazardous materials to the ground, resulting in soil and/or groundwater contamination. Hazardous materials may also be present in building materials and released during building demolition activities. Hazardous materials may also be required as part of the operation of a project, or may be naturally present in soils such as naturally occurring asbestos (NOA) found in serpentine minerals.

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[1] The California Health and Safety Code defines a hazardous material as "any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety, or to the environment. Hazardous materials include, but are not limited to, hazardous substances, hazardous waste, radioactive materials and any material which a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment" (Health and Safety Code, Section 25501).

If improperly handled, hazardous materials and wastes can cause public health hazards when released to the soil, groundwater, or air. The four basic exposure pathways through which an individual can be exposed to a chemical agent include: inhalation, ingestion, bodily contact, and injection. Exposure can come as a result of an accidental release during transportation, storage, or handling of hazardous materials. Disturbance of subsurface soil during construction can also lead to exposure of workers or the public from stockpiling, handling, or transportation of soils contaminated by hazardous materials from previous spills or leaks.

5.17.1.2 Potential Presence of Hazardous Materials in Soil and Groundwater

This evaluation of the potential to encounter hazardous materials in soil and groundwater is based on federal, State, and local regulatory database reviews conducted by Environmental Data Resources to identify permitted hazardous materials uses[2], environmental cases[3], and spill sites[4] within 0.25 mile of the facility sites (EDR 2008a-l). Additional information regarding identified cases was obtained from Preliminary Drinking Water Source Assessment and Protection[5] reports for facility sites, site investigation reports available from the State Water Resources Control Board (SWRCB) Geotracker database, as well as from the California Environmental Protection Agency (Cal/EPA) Department of Toxic Substances Control (DTSC) Envirostor online database (Kennedy/Jenks 2009a-g, 2010a-i; SWRCB 2012a; DTSC 2012). A list of the specific reports reviewed is provided in Section 5.17.4 (References).

Permitted hazardous material uses, environmental cases and spill sites identified within 0.25 mile of facility sites, including the well facility and associated pipelines, were characterized as to their potential to affect soil and groundwater that would be encountered during excavation for construction (i.e., subsurface conditions) at the facility sites according to the following classifications:

> **Low Potential.** Facilities that are permitted to use or store hazardous waste, but have not had a documented release, would be considered to have a low potential to affect facility sites. In addition, environmental cases that are listed as closed, because remediation or cleanup has been completed and approved by the regulatory agency, would be considered to have a low potential to affect proposed facility sites. The potential to affect subsurface conditions at a site would also be considered to be low if any of the following three factors is known to occur: (1) the direction of groundwater flow is away from the facility site construction area; (2) the lateral extent of contamination from the occurrence is known and is not present within the proposed facility site

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[2] Permitted hazardous materials uses are facilities that use hazardous materials or handle hazardous wastes and comply with current hazardous materials and hazardous waste regulations.

[3] Environmental cases are sites suspected of releasing hazardous substances or sites that have required hazardous materials investigations and are identified on regulatory agency lists. These are sites where soil and/or groundwater contamination is known or suspected to have occurred.

[4] Spill sites are locations where a spill has been reported to the State or federal regulatory agencies. Such spills do not always involve a release of hazardous materials.

[5] The potential for groundwater contamination to affect drinking water quality and the potential for pumping of project wells to affect the extent of groundwater contamination is evaluated in Section 5.16, Hydrology and Water Quality.

construction area; or (3) only soil was affected by the occurrence and the potentially contaminated site is not located within the proposed facility site or immediately adjacent to the site (i.e., within 200 feet of the construction area).

Moderate Potential. The potential to affect subsurface conditions within a facility site would be considered to be moderate, and further investigation might be necessary, if the following three factors occur: (1) an off-site occurrence was reported within 0.25 mile of the facility site, but does not occur within the construction area; (2) the extent of contamination and remedial status is not known; and (3) the occurrence has affected groundwater and is located up-gradient from the facility site.

High Potential. The potential to affect subsurface conditions within the facility site would be considered to be high and further investigation would be necessary, if either of the following two factors is known to occur: (1) an active on-site occurrence exists within the proposed facility site construction area; or (2) contamination from an off-site occurrence is known to be present within the proposed facility site construction area.

Environmental cases and spill sites within 0.25 mile of proposed facility sites and their potential to affect soil and groundwater conditions in the project area during excavation are summarized in Table 5.17-1 (Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area). Environmental cases where the reporting agency has determined no further action is necessary (case closed) are not included in the table unless located within the well facility or immediately adjacent (i.e., within 200 feet) of a facility site and associated pipelines. In addition, facilities that are permitted to use or store hazardous waste, but have not had a documented release are not included in the table.

5.17.1.3 Potential Presence of Hazardous Building Materials

Demolition or renovation of older structures that contain hazardous building materials could present a public health risk if such materials were released during construction. Hazardous building materials include asbestos-containing materials[6] in roofing, siding, walls, ceilings, floors, pipes and pipe fittings; certain electrical equipment, such as transformers and fluorescent light ballasts that contain polychlorinated biphenyls (PCBs)[7] or di(2-ethylhexyl) phthalate (DEHP)[8]; fluorescent lights containing

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[6] Asbestos-containing materials were commonly used until the 1970s as a component of numerous building materials. Long-term, chronic inhalation of asbestos can cause lung diseases. Asbestos may be present in numerous building materials, such as materials used to affix floor tiles, insulation materials, shingles, roofing materials, floor tiles and acoustical ceiling materials.

[7] PCBs are known carcinogens. They are mixtures of synthetic organic chemicals with physical properties ranging from oily liquids to waxy solids. Under the Toxic Substances Control Act, the US Environmental Protection Agency (U.S. EPA) began to impose bans on PCB manufacturing and sales on most PCB uses in 1978.

[8] Between 1979 and the early 1990s, DEHP was used in place of PCB as a dielectric fluid in some fluorescent light ballasts and other electrical equipment. DEHP is classified as a probable human carcinogen by the U.S Department of Health and Human Services and as a hazardous substance by the U.S. EPA. Ballasts containing DEHP must be legally disposed of.

mercury vapors[9]; and lead-based paints. If removed during demolition of a building, these materials would require special disposal procedures.

An existing concrete-block restroom building located within the construction area at Site 1 would be demolished as part of the Project. It is conservatively assumed for purposes of this analysis, that the restroom may contain hazardous building materials that could present a public health risk during demolition, such as asbestos and lead-based paint. The concrete block building includes sinks and toilets, plumbing, and electrical lighting materials. Internal and external building materials may contain asbestos in the flooring, roofing, pipes, and pipe fittings and the building may contain lead-based paint.

An existing well, concrete pump enclosure, steel tank, and above ground piping at Site 14 within the Golden Gate National Cemetery would be demolished as part of the Project. It is conservatively assumed for purposes of this analysis, that asbestos-containing materials may be present in the roofing, flooring, ceiling, and piping. The interior and exterior paint may also contain lead.

Building demolitions or renovations would not be needed at the other facility sites; therefore, hazardous building materials at sites other than Sites 1 and 14 would not be encountered.

5.17.1.4 Potential Presence of Naturally Occurring Asbestos

Asbestos is a common name for a group of naturally occurring fibrous silicate minerals that are made up of thin, but strong, durable fibers. Asbestos is a known carcinogen and presents a public health hazard if it is present in the friable (easily crumbled) form. Naturally occurring asbestos would most likely be encountered in Franciscan ultramafic rock (primarily serpentinite) or Franciscan mélange.

As discussed in Section 5.15, Geology and Soils, the underlying geology of the facility sites consists primarily of the Colma formation, with small pockets of alluvium deposits, slope debris/ravine fill and artificial fill. Franciscan ultramafic rock, including serpentinite, is not mapped in the vicinity of the proposed facility sites. In addition, Open File Report 2000-19, entitled *A General Location Guide for Ultramafic Rocks in California - Areas More Likely to Contain Naturally Occurring Asbestos*, was reviewed (CDC 2000). This report shows the areas more likely to contain natural occurrences of asbestos in California. According to this map, no ultramafic rock units occur in the areas of the proposed facility sites; therefore, naturally occurring asbestos is not likely to be encountered.

[9] Spent fluorescent lamps and tubes commonly contain mercury vapors and are considered a hazardous waste in California (California Code of Regulations [CCR], Title 22, Section 66261.50). In 2004, new regulations classified all fluorescent lamps and tubes in California as a hazardous waste, because they contain mercury. All fluorescent lamps and tubes must be recycled or taken to a universal waste handler.

TABLE 5.17-1
Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area

Site	Environmental Case within 0.25 Mile	Approximate Distance from Facility Site Construction Area	Regulatory List[(a)]	Environmental Case Summary	Potential to Affect Facility Site
Site 1	Tosco #3816 101 South Mayfair Avenue Daly City	1,000 feet northwest of Site 1	LUST	As of March 2012, the Tosco facility, located on the southwest corner of South Mayfair Avenue and Poncetta Drive, is undergoing soil investigation and remediation related to a former waste oil tank. Cleanup actions have included over excavation[(b)] and disposal of contaminated soil during tank removal as well as soil vapor extraction[(c)] for hydrocarbon removal (SWRCB 2012b). Sampling indicates that soil contamination is limited to the area surrounding the former and current tanks (no off-site migration). Only soil is affected, which, unlike contaminated groundwater, does not spread unless disturbed.	Low
Site 1	Pacific Plaza III 2099-2147 Junipero Serra Boulevard Daly City	1,200 feet southeast of Site 1	LUST	Pacific Plaza III is located on two parcels, one south of the intersection of Junipero Serra Boulevard and Westlake Avenue and another on the north side of the intersection. As of March 2012, the facility is undergoing soil investigation and remediation for arsenic, mercury and cadmium at isolated spots (SWRCB 2012c). Sampling indicates that soil contamination is limited to the area surrounding the release (minimal off-site migration) (Envirometrix 2009). Only soil is affected, which, unlike contaminated groundwater, does not spread unless disturbed.	Low
Site 2, Site 3 and Westlake Pump Station	Arco #0465 151 Southgate Avenue Daly City	1,200 feet northwest of Sites 2 and 3; 500 feet northeast of Westlake Pump Station	LUST	This facility, located at the southwest corner of Lake Merced Boulevard and Southgate Avenue, is an active gas station undergoing soil investigation and remediation as of March 2012. Cleanup actions have included overexcavation and disposal of contaminated soil during tank removal and soil vapor extraction for hydrocarbon removal (SWRCB 2012d). The documented groundwater flow direction at the Arco site varies from the northeast to south-southwest generally away from Sites 2 and 3 and the Westlake Pump Station (Stantec 2012). Sampling indicates that contamination is limited to the area surrounding the release (no off-site migration).	Low

TABLE 5.17-1
Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area

Site	Environmental Case within 0.25 Mile	Approximate Distance from Facility Site Construction Area	Regulatory List[(a)]	Environmental Case Summary	Potential to Affect Facility Site
Site 2, Site 3 and Westlake Pump Station	Southgate Cleaners 183 Southgate Avenue Daly City	1,200 feet northwest of Sites 2 and 3; 500 feet northeast of Westlake Pump Station	LUST	Southgate Cleaners, located at the southwest corner of Lake Merced Boulevard and Southgate Avenue near the Arco Station described above, is a former dry cleaning site undergoing soil and groundwater investigation for tetrachloroethylene (also known as perchloroethylene or PCE). As of March 2012, ongoing investigation work includes sub-slab soil and groundwater sampling on-site and in the vicinity of North Coronado Boulevard (SWRCB 2012e). The documented groundwater flow direction at the Arco #0465 site, which is adjacent to the Southgate Cleaners site, is toward the northeast to east, away from Sites 2 and 3 and the Westlake Pump Station (Treadwell & Rollo 2010). Sampling indicates that soil contamination is limited to the area surrounding the release (no off-site migration).	Low
Site 5	BP #11202 (Former) 3001 Junipero Serra Boulevard Daly City	450 feet north of Site 5	LUST	As of March 2012, this BP facility, located at the northeast corner of Junipero Serra Boulevard and San Pedro Road, is an active gas station undergoing soil investigation and remediation. Cleanup actions have included overexcavation and disposal of contaminated soil during tank removal as well as pumping and treatment of groundwater from an on-site monitoring well (SWRCB 2012f). The documented groundwater flow direction is to the north-northeast, away from Site 5 (Antea Group 2011). Sampling indicates that the groundwater plume is stable and limited to the area surrounding the release (no off-site migration).	Low
Site 5	Exxon 7-0207 1690 Sullivan Avenue Daly City	850 feet northwest of Site 5	LUST	Exxon 7-0207, located at the northwest corner of Sullivan Avenue and Pierce Street on the west side of I-280, is an active gas station undergoing soil investigation and remediation as of March 2012. Cleanup actions to date have included overexcavation and disposal of contaminated soil during tank removal and soil vapor extraction for hydrocarbon removal (SWRCB 2012g). The documented groundwater flow direction across the site is east to east-northeast , away from Site 5 (Cardno ERI 2011; SWRCB 2012g). Sampling indicates that soil and groundwater contamination is limited to the area surrounding the release (no off-site migration).	Low

TABLE 5.17-1
Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area

Site	Environmental Case within 0.25 Mile	Approximate Distance from Facility Site Construction Area	Regulatory List[(a)]	Environmental Case Summary	Potential to Affect Facility Site
Site 6	L. Bocci and Sons 7778 Mission Street Colma	800 feet east of Site 6	LUST	This facility, located near the Colma BART station at the intersection of Mission Street and Albert M. Tegla Boulevard, is a manufacturer of cemetery memorial monuments and is undergoing soil and groundwater investigation as of March 2012. Cleanup actions to date have included overexcavation and disposal of contaminated soil during tank removal (SWRCB 2012h). The documented groundwater flow direction is to the west-northwest and northwest, toward the Site 6 water connection pipeline. Sampling indicates that soil and groundwater contamination is limited to the area surrounding the release (minimal off-site migration) (TEC Environmental 2010a).	Low
Site 9	Treasure Island Trailer Court 1609 Old Mission Road South San Francisco	At least 50 feet northwest of Site 9; actual location of contaminant release within the trailer court is unknown	LUST	The trailer court, located on the west side of Mission Road, is a former LUST case site that has been closed since 1993, indicating that cleanup has been completed and residual contamination, if any, is low. Cleanup actions included overexcavation and disposal of contaminated soil during tank removal in 1991 (SWRCB 2012i). Database information regarding the environmental case indicates that only soil was affected, which, unlike contaminated groundwater, does not spread unless disturbed.	Low
Site 10 and Site 18 (Alternate)	WESCO Management 117 Hickey Boulevard South San Francisco	150 feet east of Site 10 and 1,200 feet northeast of 18 (Alternate)	LUST	The WESCO facility, located near Hickey Boulevard and Camaritas Avenue, is a former LUST case site that has been closed since 2000, indicating that cleanup has been completed and residual contamination, if any, is low. Cleanup actions included overexcavation and disposal of contaminated soil during tank removal in 1989 (SWRCB 2012j). Database information regarding the environmental case indicates that only soil was affected, which, unlike contaminated groundwater, does not spread unless disturbed.	Low
Site 11	Contreras Painting 1090 Grand Avenue South San Francisco	1,000 feet north of Site 11	Cortese	Contreras Painting, located near Grand Avenue and Mission Road, is a former residence that underwent soil and groundwater investigation for alleged unauthorized discharges of paint and solvent onto the exposed ground surface (SWRCB 2012k). Cleanup actions included excavating a trench alongside a house and in other hot spot areas on the property. The case site has been closed since June 2011, indicating that cleanup has been completed and residual contamination, if any, is low.	Low

TABLE 5.17-1
Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area

Site	Environmental Case within 0.25 Mile	Approximate Distance from Facility Site Construction Area	Regulatory List[(a)]	Environmental Case Summary	Potential to Affect Facility Site
Site 12 and Site 19 (Alternate)	Chevron, Former Standard Oil 972 El Camino Real South San Francisco	600 feet northeast of Site 12 and Site 19 (Alternate)	LUST	This facility, located on the east side of El Camino Real south of Westborough Boulevard, is a former gas station that underwent soil and groundwater investigation. No cleanup actions have been completed at the facility to date (SWRCB 2012l). The documented groundwater flow direction was to the east, away from Sites 12 and 19 (Alternate). Sampling indicates that soil and groundwater contamination was limited to the area surrounding the release (no off-site migration). The case site has been closed since March 2012, indicating that cleanup has been completed and residual contamination, if any, is low (San Mateo County Health System 2012).	Low
Site 12	Chevron 9-5669 698 El Camino Real South San Francisco	250 feet southeast of water connection pipeline for Site 12	LUST	This facility, located at the southeast corner of El Camino Real and West Orange Avenue, is a former LUST case site that was closed in 2007, indicating that cleanup has been completed and residual contamination, if any, is low. Cleanup actions have included overexcavation and disposal of contaminated soil during tank removal in 1994 (SWRCB 2012m).	Low
Site 12	Chevron 9-0248 687 El Camino Real South San Francisco	150 feet south of water connection pipeline for Site 12	LUST	This facility, located at the southwest corner of El Camino Real and West Orange Avenue, is a former LUST case site that was closed in 2001, indicating that cleanup has been completed and residual contamination, if any, is low. Information on cleanup actions was not documented in available database information (SWRCB 2012n).	Low
Site 13	Pacific Bell 1465 Huntington Avenue South San Francisco	<50 feet east of water connection pipeline along Huntington Avenue for Site 13	LUST	Pacific Bell, located on the east side of Huntington Avenue, is a former LUST case site that has been closed since 2010, indicating that cleanup has been completed and residual contamination, if any, is low. Cleanup actions included overexcavation and disposal of contaminated soil during tank removal in 1985, as well as soil vapor and dual phase extraction[(d)] for removal of hydrocarbons from soil and groundwater (SWRCB 2012o). The documented groundwater flow at the Pacific Bell site is toward the northeast, away from the water connection pipeline along Huntington Avenue for Site 13, as well as away from Site 13 itself (San Mateo County Health System 2010). The westernmost monitoring well at the Pacific Bell site nearest Huntington Avenue was historically non-detect for hydrocarbons. According to the case closure letter for the facility, the shallowest groundwater depth recorded at the site was approximately 21 feet below ground surface (bgs), which is below the depth of the proposed well facility pipeline trench (San Mateo County Health System 2010).	Low

TABLE 5.17-1
Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area

Site	Environmental Case within 0.25 Mile	Approximate Distance from Facility Site Construction Area	Regulatory List[(a)]	Environmental Case Summary	Potential to Affect Facility Site
Site 13	UNOCAL #6980 192 El Camino Real South San Francisco	1,000 feet west of water connection pipeline along Huntington Avenue for Site 13	LUST	The UNOCAL site, located at the northeast corner of El Camino Real and South Spruce Boulevard, is a former gas station undergoing soil and groundwater investigation and remediation as of March 2012. Cleanup actions to date have included overexcavation and disposal of contaminated soil during tank removal in 1992 (SWRCB 2012p). The documented groundwater flow direction in 2010 ranged from south to southwest, away from Site 13 (Arcadis 2010). Sampling indicates that soil and groundwater contamination is limited to the area surrounding the release (no off-site migration).	Low
Site 13	Tony's Services 209 El Camino Real South San Francisco	1,200 feet west of water connection pipeline along Huntington Avenue for Site 13	LUST	This facility, located at the northwest corner of El Camino Real and Hazelwood Drive, is a gas station undergoing soil and groundwater investigation and remediation as of March 2012. Cleanup actions to date have included overexcavation and disposal of contaminated soil during tank removal, soil vapor extraction, and pumping and treatment of groundwater (SWRCB 2012q). The documented groundwater flow direction is toward the west, away from Site 13 (AEI Consultants 2011).	Low
Site 13	Spruce Car Wash 246 South Spruce Avenue South San Francisco	650 feet northeast of Site 13	LUST	Spruce Car Wash, located on the north side of South Spruce Avenue near Myrtle Avenue, is an operating fuel service station and car wash undergoing soil and groundwater investigation and remediation as of March 2012 (SWRCB 2012r). Cleanup actions to date have included free product removal and pilot testing of vacuum enhanced groundwater extraction (GES 2011). Sampling indicates that soil and groundwater contamination is limited to the area surrounding the release with some off-site migration beneath Sneath Lane. The documented groundwater flow direction is toward the southeast away from Site 13 (GES 2010).	Low
Site 13	Coyne Cylinder Company 224 Ryan Way South San Francisco	1,000 feet east of Site 13	LUST	This facility, located on the north side of Ryan Lane near Victory Avenue, is undergoing soil and groundwater investigation related to a former acetone storage tank as of March 2012 (SWRCB 2012s). Cleanup actions to date have included overexcavation and disposal of contaminated soil during tank removal, as well as pumping and treating groundwater from an on-site well (Treadwell & Rollo 2008). Sampling indicates that soil and groundwater contamination is limited to the area surrounding the release (no off-site migration). The documented groundwater flow direction is toward the south, away from Site 13 (Treadwell & Rollo 2008).	Low

TABLE 5.17-1
Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area

Site	Environmental Case within 0.25 Mile	Approximate Distance from Facility Site Construction Area	Regulatory List[(a)]	Environmental Case Summary	Potential to Affect Facility Site
Site 13	Former Goss-Jewett Facility 416 Browning Way South San Francisco	650 feet east of water connection pipeline along Huntington Avenue for Site 13; 1,000 feet southeast of Site 13 well facility	CERCLA	This facility, located on the north side of Browning Way, is undergoing soil and groundwater investigation related to PCE contamination from a former dry cleaning business as of March 2012 (SWRCB 2012t). Based on monitoring data collected in October 2012, the groundwater flow direction appears to be to the north-northeast, which is away from Site 13 (KCE Matrix 2012). Recent sampling indicates that soil and groundwater contamination is limited to the area surrounding the release (minimal off-site migration) and appears to be essentially defined (KCE Matrix 2012). The PCE plume is heading to the north and northeast, away from Huntington Avenue and Site 13, in part due to the higher elevation of the existing trail to the west of the facility that prevents off-site flow to the west (RWQCB 2012).	Low
Site 13	290 South Maple Avenue South San Francisco	850 feet east of water connection pipeline along Huntington Avenue for Site 13; 1,200 feet southeast of Site 13 well facility	LUST CERCLIS	This facility, located on the northwest corner of South Maple Avenue and Browning Way, is undergoing soil and groundwater investigation related to PCE contamination from a former dry cleaning business as of March 2012. Cleanup actions to date have included excavation and disposal of contaminated soil (SWRCB 2012u). The documented groundwater flow direction at the site in September 2012 was toward the northeast, away from Huntington Avenue and Site 13 (GEI 2012).	Low
Site 13	Pellegrini Bros Wines Inc. 272 South Maple Avenue South San Francisco	1,000 feet east of water connection pipeline along Huntington Avenue for Site 13	LUST	This facility, located on the west side of South Maple Avenue, is undergoing soil and groundwater investigation and remediation related to hydrocarbons released from a former gasoline tank as of March 2012 (SWRCB 2012v). Cleanup actions to date have included overexcavation and disposal of contaminated soil during tank removal, as well as installation of an ozone and hydrogen peroxide injection remediation system (TEC Environmental 2011). The documented groundwater flow direction is toward the northeast, away from Site 13. Sampling indicates that soil and groundwater contamination is limited to the area surrounding the release (no off-site migration) (TEC Environmental 2011).	Low
Site 15	Golden Gate National Cemetery 1300 Sneath Lane San Bruno	100 feet north of pipeline connection for Site 15	LUST	This facility, located on the north side of Sneath Lane at the Cemetery Operation and Maintenance Facility, is a former LUST case site that was closed in 2005, indicating that cleanup has been completed and residual contamination, if any, is low. Cleanup actions included overexcavation and disposal of contaminated soil during tank removal in 1989 (San Mateo County Health Department 2005). Database information regarding the environmental case indicates that only soil was affected, which, unlike contaminated groundwater, does not spread unless disturbed (SWRCB 2012w).	Low

TABLE 5.17-1
Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area

Site	Environmental Case within 0.25 Mile	Approximate Distance from Facility Site Construction Area	Regulatory List[(a)]	Environmental Case Summary	Potential to Affect Facility Site
Site 16	Olympian Service Station 1009 El Camino Real Millbrae	200 feet west of the western end of the alternate water connection pipeline for Site 16	LUST	The Olympian Service Station, located on the northwest corner of El Camino Real and Meadow Glen Avenue, is undergoing soil and groundwater investigation and remediation related to former gasoline and diesel tanks. As of March 2012, cleanup actions to date have included overexcavation and disposal of contaminated soil during tank removal, and dual phase water and vapor extraction (SWRCB 2012x). A work plan for enhanced interim remediation using a bio-organic catalyst to enhance contaminant removal rates and accelerate contaminant bioattenuation is currently under review. The documented groundwater flow at the service station primarily is toward the southeast (on the service station property) to the east-northeast off-site, in the general direction of the proposed alternate water connection at Site 16 (Pangea 2011). Sampling indicates that the methyl tert-butyl ether (MTBE) plume in shallow groundwater extends across the intersection of El Camino Real to within approximately 200 feet of the western end of the alternate water connection pipeline for Site 16 (Pangea 2011). During the most recent site investigations, groundwater was encountered across El Camino Real to the west of the alternate water connection at depths ranging from 5.6 to 11.8 feet bgs. The site has moderate potential because the site is located within 0.25 miles of Site 16, the extent of contamination is not known, and the occurrence up gradient of Site 16.	Moderate
Site 16	San Francisco Water Department (SFWD) 1000 El Camino Real Millbrae	500 feet north of pipeline connections for Site 16	LUST	As of March 2012, the SFWD facility, located on the northeast corner of El Camino Real and Meadow Glen Lane, is undergoing soil and groundwater investigation and remediation related to an unintentional release of diesel from a backup generator in September 2010 (SWRCB 2012y). The majority of the spill was contained within the SFWD's corporation yard property, with approximately 10 to 15 gallons of diesel migrating onto the Caltrain right of way (GRI 2011). Cleanup actions to date have included removal and disposal of spilled diesel, storm drain cleaning and soil excavation in the Caltrain right of way. Sampling indicates that soil contamination is limited to a depth of eight feet in the area surrounding the release, approximately 500 feet from the well facility site.	Low
Site 16	Jiffy Cleaners 512 Magnolia Avenue Millbrae	1,200 feet south of alternate water connection pipeline for Site 16	LUST	As of March 2012, the Jiffy Cleaners facility, located at the northeast corner of Magnolia Avenue and Taylor Boulevard, is undergoing soil and groundwater investigation and remediation related to PCE contamination from a former dry cleaning facility (SWRCB 2012z). The documented groundwater flow direction at the cleaners is toward the east, away from Site 16. (TRC 2009).	Low

TABLE 5.17-1
Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area

Site	Environmental Case within 0.25 Mile	Approximate Distance from Facility Site Construction Area	Regulatory List[(a)]	Environmental Case Summary	Potential to Affect Facility Site
Site 16	Jerair Shell Station 491 El Camino Real Millbrae	1,200 feet south-southeast of alternate water connection pipeline for Site 16	LUST	As of March 2012, this facility, located on the southwest corner of EI Camino Real and Taylor Boulevard, is undergoing soil and groundwater investigation and remediation related to hydrocarbons released from former tanks. Cleanup actions to date have included overexcavation and disposal of contaminated soil during tank removal (SWRCB 2012aa). The documented groundwater flow is toward the east-southeast, away from Site 16 (TEC Environmental 2010b).	Low

Notes:

(a) Regulatory Lists: LUST (Leaking Underground Storage Tank List); Cortese (Cal/EPA List); CERCLIS (Comprehensive Environmental Response, Compensation, and Liability Information System). These lists are described in more detail in Section 5.17.2 (Regulatory Framework). Regulatory lists searched in April and May 2011, and again in March 2012.

(b) Overexcavation is a technique for the expedited corrective action of a limited release from an underground storage tank. Specifically, if a release is identified during the removal of a tank, the soil surrounding the tank pit area is often excavated to remove the contaminated materials.

(c) Soil vapor extraction is a remedial technology that reduces concentrations of volatile constituents in petroleum products adsorbed to soils in the unsaturated (vadose) zone.

(d) Dual phase extraction is a remedial technology that uses pumps to remove various combinations of contaminated groundwater, separate-phase petroleum product and hydrocarbon vapor from the subsurface.

5.17.1.5 Fire Hazards

The California Department of Forestry and Fire Protection (CAL FIRE) identifies fire hazard areas and fire-threatened communities at the wildland urban interface. The facility sites are located on urban land in non-fire hazard severity zones (CAL FIRE 2008).

The SFPUC maintains Lake Merced as a nonpotable emergency water supply for the City and County of San Francisco (CCSF) to be used for firefighting or sanitation purposes if no other sources of water are available (SFPUC 2011). In the event of a major disaster (i.e., catastrophic earthquake), Lake Merced water could be pumped into the City's drinking water distribution system to maintain firefighting, basic sanitary (e.g., toilet flushing), and other critical needs. In the event of such an emergency, residents would be directed to boil tap water before consuming it.

5.17.1.6 Airports

The nearest public airport to the facility sites is San Francisco International Airport (SFO), located approximately 1,600 feet northeast from Site 16 in Millbrae as measured from the proposed well facility to the SFO property boundary. In addition to Site 16, all proposed well facility sites in South San Francisco and San Bruno are within two miles of SFO and are located within an area covered by the San Mateo County Airport Land Use Plan. As a result, the well facility sites in Millbrae, South San Francisco and San Bruno would be subject to airport related height limitations and other airspace protection concerns for SFO. The other facility sites are not located within an area covered by an airport land use plan or within two miles of a public airport. No private airstrips occur in the project vicinity.

5.17.1.7 Hazardous Chemicals

Hazardous materials, such as fuels, motor oils, paints, and compressed gases, would be used during construction. While these are commonly used materials, if handled improperly, they could endanger workers and the public. In addition, a variety of commonly used chemicals would be used during operation of the chemical and filtration system for disinfection and water treatment; see Table 3-4 (Maximum Volume of Chemical Storage) in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types).

5.17.2 Regulatory Framework

Hazardous materials and hazardous wastes are subject to numerous federal, State, and local laws and regulations intended to protect public health and safety and the environment. The U.S. Environmental Protection Agency (U.S. EPA), Cal/EPA, DTSC, Regional Water Quality Control Boards (RWQCB), and Bay Area Air Quality Management District (BAAQMD) are the primary agencies that enforce these regulations. The main focus of the federal Occupational Safety and Health Administration (Fed/OSHA) and California Occupational Safety and Health Administration (Cal/OSHA) are to prevent work-related injuries and illnesses, including those from exposures to hazardous materials. CAL FIRE implements fire safety regulations. In accordance with Chapter 6.11 of the California Health and Safety Code (CHSC, Section 25404, et seq.), local regulatory agencies enforce many federal and State regulatory programs through the Certified Unified Program Agency (CUPA) program, including:

- Hazardous Materials Business Plans (HMBPs) (Chapter 6.95 of the Health and Safety Code, Sections 25501 et seq.);
- State Uniform Fire Code requirements (Section 80.103 of the Uniform Fire Code as adopted by the State Fire Marshal pursuant to Health and Safety Code Section 13143.9);
- Underground storage tanks (Chapter 6.7 of the Health and Safety Code, Sections 25280 et seq.);
- Aboveground storage tanks (Health and Safety Code Section 25270.5[c]); and
- Hazardous waste generator requirements (Chapter 6.5 of the Health and Safety Code, Sections 25100 et seq.).

The San Mateo County Health Department, Environmental Health Division, is the CUPA agency for oversight of hazardous materials storage and cleanup of underground fuel leaks in San Mateo County.

5.17.2.1 Use and Storage of Hazardous Materials and Fuels

State and federal laws require detailed planning and management to ensure that hazardous materials are properly handled, used, stored, and disposed of, and, in the event that such materials are accidentally released, to reduce risks to human health and the environment. Businesses that handle specified quantities of chemicals are required to submit a HMBP in accordance with community right-to-know laws. This plan allows local agencies to plan appropriately for a chemical release, fire, or other incidents. Hazardous waste regulations establish criteria for identifying, packaging, and labeling hazardous wastes; dictate the management of hazardous waste; establish permit requirements for hazardous waste treatment, storage, disposal and transportation; and identify hazardous wastes that cannot be disposed of in landfills.

Chapter 6.95 of the CHSC (§ 25503 et seq.) and Title 19 of the California Code of Regulations (CCR) (§ 2729 et seq.), require any business that handles a hazardous material or mixture containing a hazardous material in reportable quantities to establish and implement a HMBP for emergency response to a release or threatened release of a hazardous material. The minimum reportable quantities are 500 pounds for a solid, 55 gallons for a liquid, and 200 cubic feet for a gas at standard temperature and pressure. Some acutely hazardous materials are reportable at much decreased quantities. Businesses in the Project area submit their plans to the appropriate CUPA. The HMBP must identify the type of business, location, emergency contacts, emergency procedures, mitigation plans, and chemical inventory at each location.

Certain chemicals that could be released to the environment and might affect surrounding communities are regulated by California's Accidental Release Prevention Law (CalARP). This State law and similar federal laws (i.e., the Emergency Preparedness and Community Right-to-Know Act [EPCRA], the Clean Air Act) allow local oversight of both the State and federal programs. The State and federal laws are similar in their requirements; however, the California threshold planning quantities for regulated substances are lower than the federal values. Local agencies may set lower reporting thresholds or add additional chemicals to the program. Beginning in 1997, CalARP has been implemented by the local CUPAs. Any business where the maximum quantity of a regulated substance exceeds the specified threshold quantities must register with the CUPA as a manager of regulated substances.

Ammonia is a regulated substance under State and federal risk management regulations. In accordance with CalARP regulations, preparation of a risk management plan (RMP) is required for the storage of regulated substances above threshold quantities. The listed CalARP threshold value for ammonia is 500 pounds (solid form). The ammonia component of the maximum volume of aqueous ammonia that would be stored at the proposed well facilities is below the CalARP threshold[10]. Therefore, storage of the ammonia at the facility sites would not be regulated under CalARP. Sod.ium hypochlorite, sodium hydroxide, and sodium fluoride are not regulated substances under CalARP.

The Construction General Permit which is issued under State Water Resources Control Board Order No. 2009-0009-DWQ, Waste Discharge Requirements for Discharges of Storm Water Runoff Associated with Construction and Land Disturbance Activities, applies to construction that in total disturbs one or more acres. This permit includes specific requirements for the safe storage and handling of chemicals. The best management practices (BMPs) required by the permit include protection measures for the temporary onsite storage of diesel fuels or other hazardous materials used during construction, including requirements for secondary containment and berming to contain a potential release and to prevent any such release from reaching an adjacent waterway or stormwater collection system. All equipment and materials storage would need to be routinely inspected for leaks and records maintained for documenting compliance with the storage and handling of hazardous materials. In addition, the Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP) for project-related construction activities at construction sites that disturb one or more acre of land.

Aboveground Storage of Petroleum Products

The Aboveground Petroleum Storage Act of 1990 requires facilities storing petroleum products in a single tank greater than 1,320 gallons, or facilities storing petroleum in aboveground tanks or containers with a cumulative storage capacity of greater than 1,320 gallons, to file a storage statement with the SWRCB and prepare a spill prevention, control, and countermeasure plan. The plan must identify appropriate spill containment or equipment for diverting spills from sensitive areas, as well as discuss facility-specific requirements for the storage system, inspections, recordkeeping, security, and personnel training. The SWRCB requires registration of an aboveground fuel storage tank at a construction site only if the tank is 20,000 gallons or larger, or if the aggregate volume of aboveground petroleum storage is over 100,000 gallons, which would not be applicable to the Project, since no fuel storage tanks are proposed as part of the Project. For smaller temporary tanks used during construction, methods to control releases and measures to clean up an accidental release and prevent degradation of water quality are included in

[10] Maximum of 116 gallons aqueous ammonia x 8.35 pounds per gallon (weight of water) x 0.93 (specific gravity of aqueous ammonia solution) x 0.19 (19% ammonia in solution) = 171 pounds of Ammonia.

Mitigation Measure HY-1 (Develop and Implement an Erosion and Sediment Control Plan) as described in Section 5.16, Hydrology and Water Quality.

Underground Storage Tanks

State laws governing underground storage tanks (USTs) specify requirements for permitting, monitoring, closure, and cleanup of these facilities. Regulations set forth construction and monitoring standards for existing tanks, reporting requirements for any releases, and closure requirements. In the Project area, the San Mateo County Environmental Health Division has regulatory authority for permitting, inspection, and removal of USTs. Any entity proposing to remove a UST must submit a closure plan to the County prior to tank removal. Upon approval of the UST closure plan, the County would issue a permit, oversee removal of the UST, require additional subsurface sampling if necessary, and issue a site closure letter when the appropriate removal and/or remediation has been completed. No USTs are proposed as part of the Project; however, these regulations are relevant due to the number of USTs in the vicinity of the Project with the potential to affect subsurface conditions at project sites.

5.17.2.2 Hazardous Materials Transportation

Caltrans regulates hazardous materials transportation on all interstate roads. Within California, the State agencies with primary responsibility for enforcing federal and State regulations and for responding to transportation emergencies are the California Highway Patrol (CHP) and Caltrans. Together, federal and State agencies determine driver-training requirements, load labeling procedures, and container specifications for vehicles transporting hazardous materials.

5.17.2.3 Hazardous Structural and Building Components

Numerous State and federal laws and regulations control exposure to hazardous building components, including asbestos and lead-based paint.

Lead in Construction

Cal/OSHA's Lead in Construction Standard (8 CCR 1532.1) requires project proponents to develop and implement a lead compliance plan when lead-based paint would be disturbed during construction. The plan must describe activities that could emit lead, methods for complying with the standard, safe work practices, and a plan to protect workers from exposure to lead during construction activities. Cal/OSHA requires 24-hour notification if more than 100 square feet of lead-based paint would be disturbed.

Abatement of Asbestos in Buildings and Structures

Regulatory requirements for asbestos abatement are set forth in CHSC Section 19827.5, as well as Title 8 of the CCR, Sections 341.6 through 341.14 and 1529. The BAAQMD also provides requirements for abatement of asbestos-containing materials.

CHSC Section 19827.5, adopted January 1, 1991, requires that local agencies not issue demolition or alteration permits until an applicant has demonstrated compliance with notification requirements under applicable federal regulations regarding hazardous air pollutants in the Bay Area, including asbestos. BAAQMD is vested by the California legislature with authority to regulate airborne pollutants, including asbestos. BAAQMD regulations pertaining to abatement of asbestos-containing materials are specified in Regulation 11, Hazardous Pollutants, Rule 2, Asbestos Demolition, Renovation, and Manufacture.

In accordance with this regulation, BAAQMD must be notified 10 days in advance of any proposed demolition or abatement work. This notification must include the names and addresses of operations and persons responsible; description and location of the structure to be demolished/altered, including size, age and prior use; approximate amount of friable asbestos; scheduled starting and completion dates of demolition or abatement; nature of planned work and methods to be employed; procedures to be employed to meet BAAQMD requirements; and the name and location of the waste disposal site to be used. In accordance with this regulation, a survey must be conducted to identify asbestos-containing materials prior to demolition. Containment must be provided during work that disturbs asbestos-containing materials and there must be no visible emissions to the outside air from demolition operations that involve asbestos-containing materials. The contractor must use methods specified in the regulations for control of emissions, such as wetting of exposed asbestos-containing materials; use of a high-efficiency particulate air (HEPA) filter within an exhaust, ventilation, and control system; or removal in an entirely contained chute. In addition, asbestos-containing materials must be removed prior to demolition and the work site must be cleaned of asbestos materials.

Contractors who conduct asbestos related work activities (including abatement) in buildings and structures must follow State regulations contained in 8 CCR Section 1529 and 8 CCR Sections 341.6 through 341.14 where the work would involve 100 square feet or more of asbestos-containing material. Specifically, under 8 CCR Section 341.6, Cal/OSHA must be notified of asbestos-related work activities to be performed. Contractors must be licensed as an Asbestos Qualified Contractor by the Contractors Licensing Board of the State of California, and registered as such with Cal/OSHA. In addition, a one-time report of the use of carcinogens must be made to Cal/OSHA under 8 CCR Chapter 4, Section 5203. The owner of the property where abatement is to occur must have a Hazardous Waste Generator Number assigned by and registered with the DTSC. The contractor and hauler of the material are required to file a Hazardous Waste Manifest that details the hauling of the material from the site and its disposal. Title 8 CCR Section 1529(b) defines asbestos-containing material as any material that contains more than one percent asbestos.

PCBs and Universal Wastes

Regulatory requirements for disposal of PCB wastes are set forth in 40 CFR Part 761. These requirements include identifying and labeling PCB-contaminated equipment prior to demolition, completion of a Notification of PCB Activity Form, obtaining a PCB disposal identification number, and disposing of waste at an approved PCB waste disposer under hazardous waste manifests. Regulatory requirements for disposal of universal wastes, such as mercury-containing non-incandescent lamps, batteries and other hazardous wastes commonly found in building components and equipment, are set forth in the Department of Toxic Substance Control's Universal Waste Rule (22 CCR Sections 66261.9 and 66273.1

thru 66273.90). These requirements include guidelines for removing and recycling or disposing of such wastes.

5.17.2.4 *Soil and Groundwater Contamination*

In San Mateo County, remediation of contaminated sites is generally performed under the oversight of the San Mateo County Environmental Health Division, or in some instances, the RWQCB and/or the DTSC. At sites where contamination is suspected or known to have occurred, the site owner is required to perform a site investigation and conduct site remediation, if necessary. Site remediation or development may also be subject to regulation by other agencies. For example, if a project required dewatering near a hazardous waste site, the project sponsor might be required to obtain a permit from the municipal sewer agency before discharging the water to the sewer system, or a National Pollutant Discharge Elimination System (NPDES) permit from the RWQCB before discharging to the storm water collection system.

5.17.2.5 *Worker Safety Requirements*

Fed/OSHA and Cal/OSHA are the agencies responsible for assuring worker safety in the handling and use of chemicals in the workplace. The federal regulations pertaining to worker safety are contained in Title 29 of the Code of Federal Regulations (CFR), as authorized in the Occupational Safety and Health Act of 1970. They provide standards for safe workplaces and work practices, including standards relating to hazardous materials handling. In California, Cal/OSHA assumes primary responsibility for developing and enforcing workplace safety regulations; Cal/OSHA standards are generally more stringent than federal regulations.

The State regulations concerning the use of hazardous materials in the workplace are included in Title 8 of the CCR, which contain requirements for safety training, availability of safety equipment, accident and illness prevention programs, hazardous substance exposure warnings, and emergency action and fire prevention plan preparation. Cal/OSHA also enforces hazard communication program regulations, which contain worker safety training and hazard information requirements, such as procedures for identifying and labeling hazardous substances, communicating hazard information related to hazardous substances and their handling, and preparation of health and safety plans to protect workers and employees.

At sites known or suspected to have soil or groundwater contamination, construction workers must receive training in hazardous materials operations and a site health and safety plan must be prepared. The health and safety plan establishes policies and procedures to protect workers and the public from exposure to potential hazards at the contaminated site.

5.17.2.6 *Control of Asbestos during Construction*

The California Air Resources Board (CARB) has adopted an asbestos Airborne Toxic Control Measure (ATCM) for construction and grading operations (CARB 2002). The ATCM requires the use of best available dust mitigation measures to prevent offsite migration of asbestos-containing dust from road construction and maintenance activities, construction and grading operations, and quarrying and surface mining operations in areas of ultramafic rock, serpentine, or asbestos. The regulation is implemented by the BAAQMD.

For construction projects located in areas where ultramafic rock (primarily serpentinite) is mapped and that would disturb one acre or less of land, the ATCM requires the site operator to implement standard dust mitigation measures before construction begins, and to maintain each measure throughout the duration of the construction project. For construction activities that would disturb more than one acre of asbestos-containing materials, project sponsors are required to prepare an asbestos dust mitigation plan specifying measures that would be taken to ensure that no visible dust crosses the property boundary. The asbestos dust mitigation plan must be submitted to and approved by the BAAQMD prior to the beginning of construction. The site operator must ensure the implementation of all measures throughout the construction project. In addition, the BAAQMD could require air monitoring for offsite migration of asbestos dust during construction activities and might change the plan on the basis of the air monitoring results. As discussed in Section 5.17.1.4 (Potential Presence of Naturally Occurring Asbestos) mapping does not indicate the presence of ultramafic rock units in the areas of the proposed facility sites; therefore, the Asbestos ATCM would not apply to the proposed Project.

5.17.2.7 Risk of Fires

The California Public Resources Code (PRC) sets forth fire safety regulations that include the following:

- Earthmoving and portable equipment with internal combustion engines must be equipped with a spark arrestor to reduce the potential for igniting a wildland fire (PRC Section 4442).
- Appropriate fire suppression equipment must be maintained during the highest fire danger period – from April 1 to December 1 (PRC Section 4428).
- On days when a burning permit is required, flammable materials must be removed to a distance of 10 feet from any equipment that could produce a spark, fire, or flame, and the construction contractor would maintain the appropriate fire suppression equipment (PRC Section 4427).
- On days when a burning permit is required, portable tools powered by gasoline-fueled internal combustion engines must not be used within 25 feet of any flammable materials (PRC Section 4431).

As noted in Section 5.17.1.5 (Fire Hazards), the proposed Project would be located on urban land in zones designated as "Non-Fire Hazard" by CAL FIRE (CAL FIRE 2008).

5.17.2.8 Uniform Fire Code

The Uniform Fire Code, Article 80, includes specific requirements for the safe storage and handling of hazardous materials. These requirements are intended to reduce the potential for a release of hazardous materials and for mixing of incompatible chemicals and specify the following specific design features to reduce the potential for a release of hazardous materials that could affect public health or the environment:

- Separation of incompatible materials with a noncombustible partition;
- Spill control in all storage, handling, and dispensing areas; and
- Separate secondary containment for each chemical storage system. The secondary containment must hold the entire contents of the tank, plus the volume of water needed to supply the fire suppression system for a period of 20 minutes in the event of catastrophic spill.

5.17.2.9 Emergency Response

California has developed an emergency response plan to coordinate emergency services provided by federal, State, and local government, and private agencies. Responding to hazardous materials incidents is a part of this plan. The plan is administered by the State Office of Emergency Services (OES), which coordinates the responses of other agencies. The San Mateo County Emergency Response Team (ERT) coordinates response to hazardous materials emergencies within the project area. ERT members respond and work with local fire and police agencies, emergency medical providers, CHP, the California Department of Fish and Wildlife, and Caltrans. San Mateo County, Daly City, Colma, South San Francisco, San Bruno, and Millbrae all have adopted emergency response plans. The emergency response plans do not designate specific evacuation routes within these cities (Colma Fire Department 2012; NCFA 2012; San Mateo County Sherriff's Office of Emergency Services 2012; RWQCB 2012; South San Francisco Fire Department 2012).

5.17.2.10 Airport Operations

The Federal Aviation Administration (FAA) has jurisdiction over airspace in the U.S. FAA requirements as they relate to land uses near SFO are described below.

The Federal Aviation Regulations (FAR) provide criteria for evaluating the potential effects of obstructions on the safe and efficient use of navigable airspace within approximately two to three miles of airport runways and approximately 9.5 miles from the end of high-traffic runways that have a precision instrument approach. FAA requires notification of proposed construction or alteration projects identified by the following airspace obstruction criteria provided in FAR Part 77:

- Any construction or alteration of more than 200 feet in height above the ground level at its site.
- Any construction or alteration of greater height than an imaginary surface extending outward 100 feet and upward one foot for a horizontal distance of 20,000 feet from the nearest point of the nearest runway of an airport with at least one runway more than 3,200 feet in actual length.
- Any construction or alteration of greater height than an imaginary surface extending outward 50 feet and upward one foot for a horizontal distance of 10,000 feet from the nearest point of the nearest runway of an airport with its longest runway no more than 3,200 feet in actual length.

Under the California State Aeronautics Act, local governments have the authority to protect airspace as defined by criteria provided in FAR Part 77. The City/County Association of Governments of San Mateo is the Airport Land Use Commission (ALUC) and has adopted the San Mateo County Comprehensive Airport Land Use Plan, which incorporates and in some cases exceeds the criteria provided in FAR Part 77 (C/CAG 1996). Other airspace protection concerns described in FAR Part 77 include avoiding land uses in the airport vicinity that would create hazards to flight such as electrical interference, lighting, glare, smoke, and bird strikes.

5.17.3 Impacts and Mitigation Measures

5.17.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant impact on hazards and hazardous materials if it were to:

- Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials.
- Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment.
- Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within 0.25 mile of an existing or proposed school.
- Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would create a significant hazard to the public or the environment.
- Be located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, and would result in a safety hazard for people residing or working in the project area.
- Be located within the vicinity of a private airstrip and would result in a safety hazard for people residing or working in the project area.
- Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.
- Expose people or structures to a significant risk of loss, injury, or death involving fires.

5.17.3.2 Approach to Analysis

This impact analysis focuses on the potential to encounter hazardous substances in soil and groundwater during construction and the potential to discharge hazardous materials during Project operations.[11] The evaluation was performed in light of current conditions at the proposed facility sites, information in the environmental database, site investigation reports, applicable regulations and guidelines, and proposed construction activities and operations. The analysis also addresses the potential for the Project to encounter hazardous materials during building demolition activities; result in a release of hazardous materials from construction equipment; interfere with an adopted emergency response plan or emergency evacuation plan; create fire hazards; or result in a release of hazardous materials during operation. Each potential impact is assessed in terms of the applicable regulatory requirements, and mitigation measures are identified as appropriate.

Areas of No Project Impact

As explained below, the Project would not result in impacts related to three of the above-listed significance criteria. These significance criteria are not discussed further in the impact analysis for the following reasons:

Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would create a significant hazard to the public or the environment. According to the environmental database review, Project facilities are not included on any lists of hazardous materials sites compiled pursuant to Government Code Section 65962.5. Therefore, this criterion is not applicable to the proposed Project and is not discussed further.

Be located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, and would result in a safety hazard for people residing or working in the project area. This significance criterion is intended to address facility siting and design impacts and does not apply to temporary construction impacts. Therefore, this significance criterion is not applicable to Project construction activities and is only discussed below as it relates to long-term operational impacts.

Be located within the vicinity of a private airstrip and would result in a safety hazard for people residing or working in the project area. Proposed well facilities would not be located within the vicinity of a private airstrip. Therefore, this significance criterion is not applicable to construction or operation of the Project.

Impair implementation of, or physically interfere with, an adopted emergency response plan or emergency evacuation plan. San Mateo County, Daly City, Colma, South San Francisco, San Bruno, and

[11] Potential effects of exhaust emission from construction activities in the vicinity of schools and other sensitive receptors is described in Section 5.8, Air Quality, Impact AQ-3.

Millbrae all have adopted emergency response plans. The emergency response plans do not designate specific evacuation routes or sites within the cities (Colma Fire Department 2012; NCFA 2012; San Mateo County Sherriff's Office of Emergency Services 2012; RWQCB 2012; South San Francisco Fire Department 2012). Therefore, neither Project construction nor operation, including pipeline installations that would extend into adjacent roadways, would impair implementation of or physically interfere with any adopted emergency response or evacuation plan. Section 5.6, Transportation and Circulation, further discusses anticipated lane closures that would be required during construction.

5.17.3.3 Summary of Impacts

For the significance criteria that have not already been deemed "not applicable" in the Approach to Analysis section above, the specific impact analyses below are divided into two subsections: (1) construction impacts (short-term) and (2) operational impacts (long-term). Table 5.17-2 (Summary of Impacts – Hazards and Hazardous Materials) provides a summary of potential impacts from the proposed Project.

TABLE 5.17-2
Summary of Impacts – Hazards and Hazardous Materials

	Construction			Operations				Cumulative
Sites	**Impact HZ-1: The Project would not create a significant hazard to the public or the environment related to transport, use or disposal of hazardous materials during construction.**	**Impact HZ-2: The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction.**	**Impact HZ-3: The Project would result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during construction.**	**Impact HZ-4: The Project would not create a hazard to the public or environment from the routine transport, use, or disposal of hazardous materials or accidental release of hazardous materials during operation.**	**Impact HZ-5: The Project would not result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during operation.**	**Impact HZ-6: The Project would not result in a safety hazard for people residing or working in the vicinity of a public use airport.**	**Impact HZ-7: The Project would not expose people or structures to a significant risk of loss, injury, or death involving fires.**	**Impact C-HZ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials.**
Site 1	LS	LSM	NI	LS	NI	NI	LS	LSM
Site 2	LS	LSM	LSM	NI	NI	NI	LS	LSM
Site 3	LS	LSM	LSM	NI	NI	NI	LS	LSM
Site 4	LS	LSM	LSM	NI	NI	NI	LS	LSM
Westlake Pump Station	LS	LSM	LSM	LS	LS	NI	LS	LSM
Site 5 (Consolidated Treatment at Site 6)	LS	LSM	LS	NI	NI	NI	LS	LSM
Site 5 (On-site Treatment)	LS	LSM	LS	LS	LS	NI	LS	LSM
Site 6	LS	LSM	LS	LS	NI	NI	LS	LSM

TABLE 5.17-2
Summary of Impacts – Hazards and Hazardous Materials

	Construction			Operations				Cumulative
Sites	**Impact HZ-1: The Project would not create a significant hazard to the public or the environment related to transport, use or disposal of hazardous materials during construction.**	**Impact HZ-2: The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction.**	**Impact HZ-3: The Project would result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during construction.**	**Impact HZ-4: The Project would not create a hazard to the public or environment from the routine transport, use, or disposal of hazardous materials or accidental release of hazardous materials during operation.**	**Impact HZ-5: The Project would not result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during operation.**	**Impact HZ-6: The Project would not result in a safety hazard for people residing or working in the vicinity of a public use airport.**	**Impact HZ-7: The Project would not expose people or structures to a significant risk of loss, injury, or death involving fires.**	**Impact C-HZ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials.**
Site 7 (Consolidated Treatment at Site 6)	LS	LSM	NI	NI	NI	NI	LS	LSM
Site 7 (On-site Treatment)	LS	LSM	NI	LS	NI	NI	LS	LSM
Site 8	LS	LSM	NI	LS	NI	NI	LS	LSM
Site 9	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 10	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 11	LS	LSM	NI	LS	NI	LS	LS	LSM
Site 12	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 13	LS	LSM	LS	LS	LS	LS	LS	LSM

TABLE 5.17-2
Summary of Impacts – Hazards and Hazardous Materials

	Construction			Operations				Cumulative
Sites	**Impact HZ-1: The Project would not create a significant hazard to the public or the environment related to transport, use or disposal of hazardous materials during construction.**	**Impact HZ-2: The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction.**	**Impact HZ-3: The Project would result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during construction.**	**Impact HZ-4: The Project would not create a hazard to the public or environment from the routine transport, use, or disposal of hazardous materials or accidental release of hazardous materials during operation.**	**Impact HZ-5: The Project would not result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during operation.**	**Impact HZ-6: The Project would not result in a safety hazard for people residing or working in the vicinity of a public use airport.**	**Impact HZ-7: The Project would not expose people or structures to a significant risk of loss, injury, or death involving fires.**	**Impact C-HZ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials.**
Site 14	LS	LSM	NI	NI	NI	LS	LS	LSM
Site 15	LS	LSM	NI	LS	NI	LS	LS	LSM
Site 16	LS	LSM	NI	LS	NI	LS	LS	LSM
Site 17 (Alternate)	LS	LSM	NI	LS	NI	NI	LS	LSM
Site 18 (Alternate)	LS	LSM	LS	LS	LS	LS	LS	LSM
Site 19 (Alternate)	LS	LSM	LSM	NI	NI	LS	LS	LSM

Notes:

NI = No Impact

LS = Less than Significant Impact

LSM = Less than Significant with Mitigation

5.17.3.4 Construction Impacts and Mitigation Measures

Impact HZ-1. The Project would not create a significant hazard to the public or the environment related to transport, use, or disposal of hazardous materials during construction. (Less than Significant)

<u>All Sites</u>

Project construction activities would include the use of hazardous materials such as fuels, lubricants, paints, and solvents. Numerous laws and regulations ensure the safe transportation, use, storage, and disposal of hazardous materials (see Section 5.17.2, Regulatory Framework). Routine transport of hazardous materials to and from proposed facility sites could result in an incremental increase in the potential for accidents; however, Caltrans and CHP regulate the transportation of hazardous materials and wastes, including container types and packaging requirements, as well as licensing and training for truck operators, chemical handlers, and hazardous waste haulers. Worker safety regulations cover hazards related to the prevention of exposure to hazardous materials and a release to the environment from hazardous materials use. Regulations and criteria for the disposal of hazardous materials mandate disposal at an appropriate landfill. Cal-OSHA also enforces hazard communication program regulations, which contain worker safety training and hazard information requirements, such as procedures for identifying and labeling hazardous substances, communicating hazard information related to hazardous substances and their handling, and preparation of health and safety plans to protect workers and employees.

Therefore, because the SFPUC and its contractors would be required to comply with existing and future hazardous materials laws and regulations covering the transport, use, and disposal of hazardous materials, the impacts associated with the potential to create a significant hazard to the public or the environment would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HZ-2. The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction. (Less than Significant with Mitigation)

Accidental Release of Hazardous Chemicals during Construction

<u>All Sites</u>

There are two types of accidental releases that could occur during construction. Hazardous materials are routinely used during construction activities and there is a potential for an accidental release associated with this routine use during construction. In addition, construction involves excavation that could encounter contaminated soil or groundwater that are already present at the construction site. Each type of accidental release is discussed below.

Hazardous materials assumed by this analysis to be used during construction activities include fuels, lubricants, paints, and solvents. Storage and use of hazardous materials at construction sites and staging areas could potentially result in the accidental release of small quantities of hazardous materials, which could pose a risk to construction workers and the environment, such as degradation of soil and groundwater quality and/or surface water quality.

The greatest potential for encountering contaminated soil and groundwater during construction would be in areas where past or current land uses may have resulted in leaking fuel or chemical storage tanks or other releases of hazardous materials. Properties with known soil and/or groundwater contamination are referred to as "environmental cases." As identified in Section 5.17.1 (Setting) and Table 5.17-1 (Hazardous Materials Release Sites Identified within 0.25 Mile of a Facility Site Construction Area), 26 environmental cases included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 are located within 0.25 mile of proposed facility sites and have some potential to affect subsurface conditions at project locations.

No active environmental cases were identified within 0.25 mile of Sites 4, 7, 8, 9, 14, and 17 (Alternate). In addition, no closed environmental cases were located on site or immediately adjacent to these sites. Therefore, the potential to encounter hazardous materials in soil or groundwater at these sites would be low. Although the potential to encounter hazardous materials in soil or groundwater at these sites arising from off-site sources is low, site conditions could change prior to construction if new contaminated sites are identified in the vicinity of these proposed well facilities. If new contamination sites were located at or near these sites, the potential hazardous materials impact would be *significant.*

Several environmental cases included on a list of hazardous materials sites are located within 0.25 mile of Sites 1, 2, 3, 5, 6, 10, 11, 12, 13, 15, 18 (Alternate), 19 (Alternate), and the Westlake Pump Station. The potential to encounter hazardous materials in soil or groundwater at these proposed facility sites is low because hazardous material release sites have not resulted in soil or groundwater contamination in the immediate vicinity of the well facilities. Similar to the findings above, although the potential to encounter hazardous materials in soil or groundwater at these sites arising from off-site sources is low, site conditions could change prior to construction if new contaminated sites are identified in the vicinity of proposed well facilities or if there are substantial changes in the extent of contamination at known release sites. Therefore, the potential hazardous materials impact would be *significant*.

Four environmental cases are located within 0.25 mile of Site 16. The Jiffy Cleaners and Jerair Shell Station cases are at least 1,200 feet (0.23 mile) away from the nearest excavation area associated with Site 16 and have a low potential to affect subsurface excavations at Site 16 because the direction of groundwater flow is away from Site 16 (TRC 2009; TEC Environmental 2010b). Also, the San Francisco Water Department case is at least 500 feet (0.095 mile) away from Site 16 and has a low potential to affect potential subsurface excavations associated with Site 16 because remedial action is underway and sampling indicates that soil contamination is limited to the area surrounding the release (GRI 2011). Off-site contamination from the Olympian Service Station case is located within approximately 200 feet from the alternate water connection for Site 16 and has a moderate potential to affect subsurface excavations in the area. The potential for this impact is considered moderate because the documented occurrence of contamination is in close proximity to the alternate water connection pipeline route and the extent of contamination from the case has not been laterally delineated, the groundwater flow is in the general direction of the construction area, and the most recent data about off-site depth to groundwater in the vicinity of the alternate water connection pipeline indicates groundwater could be encountered during trenching (i.e., less than six feet bgs) (Pangea 2011). Therefore, given that the potential to encounter hazardous materials in soil or groundwater at Site 16 is moderate, and due to the proximity and nature of construction activities, construction of the Project at this location could cause a significant hazardous materials impact on the public or the environment by exposing people to contaminated soil or groundwater or soil vapors during excavation and other ground-disturbing pipeline construction activities. As a result, the potential hazardous materials impact on the environment from constructing the alternate water connection for Site 16 would be *significant*.

The potential impact associated with construction at all the above sites would be reduced to a *less-than-significant* level with implementation of Mitigation Measures M-HZ-2a (Preconstruction Hazardous Materials Assessment), M-HZ-2b (Health and Safety Plan), and M-HZ-2c (Hazardous Materials Management Plan). These measures require: (1) a preconstruction hazardous materials assessment within three months of construction to identify new hazardous materials sites or substantial changes in the extent of contamination at known groundwater contamination sites that could affect subsurface conditions at proposed well facility sites; (2) preparation of a site health and safety plan to protect construction worker health and safety; and (3) a hazardous materials management plan to ensure that appropriate procedures are followed in the event that hazardous materials, including unanticipated hazardous materials, are encountered during project construction, and to ensure that hazardous materials are transported and disposed of in a safe and lawful manner.

In addition, the implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan), which is required to reduce potential impacts on water quality during Project construction (see Impact HY-1 in Section 5.16, Hydrology and Water Quality), would also reduce this potential hazardous materials impact to a *less-than-significant* level. While this mitigation measure is presented in Section 5.16, Hydrology and Water Quality, and primarily addresses potential water quality impacts, it also contains measures for controlling non-stormwater (i.e., excavation dewatering), waste, and potential hazardous materials pollution, which would also reduce the potential for the accidental release of hazardous construction chemicals. The Erosion and Sediment Control Plan requires specific practices for the safe storage and handling of chemicals. The BMPs required to be in the plan include protection measures for the temporary on-site storage of diesel fuels or other hazardous materials used during construction, including requirements for secondary containment to contain a potential release and to prevent any such release from reaching an adjacent waterway or stormwater collection system. All equipment and materials storage would need to be routinely inspected for leaks and records maintained for documenting compliance with the storage and handling of hazardous materials. With the incorporation of these BMPs, the potential hazardous materials impact on the public or environment from an accidental release of hazardous materials during construction would be *less than significant with mitigation*.

Mitigation Measure M-HZ-2a: Preconstruction Hazardous Materials Assessment (All Sites)

Within three months prior to construction, the SFPUC shall retain a qualified environmental professional to conduct a regulatory agency database review to update and identify hazardous materials sites within 0.25 mile of a well facility site and to review appropriate standard information sources to determine the potential for soil or groundwater contamination at the project sites. Should this review indicate a high likelihood of encountering contamination at the proposed facility sites, follow-up sampling shall be conducted to characterize soil and groundwater quality prior to construction to provide necessary data for the site health and safety plan (Mitigation Measure M-HZ-2b) and hazardous materials management plan (Mitigation Measure M-HZ-2c). If needed, site investigations or remedial activities shall be performed at facility sites in accordance with applicable laws and regulations.

Mitigation Measure M-HZ-2b: Health and Safety Plan (All Sites)

The construction contractor shall, prior to construction, prepare a site-specific health and safety plan in accordance with federal OSHA regulations (29 CFR 1910.120) and Cal-OSHA regulations (8 CCR Title 8, Section 5192) to address worker health and safety issues during construction. The health and safety plan shall identify the potentially present chemicals, health and safety hazards associated with those chemicals, all required measures to protect construction workers and the general public from exposure to harmful levels of any chemicals identified at the site (including engineering controls, monitoring, and security measures to prevent unauthorized entry to the work area), appropriate personal protective equipment, and emergency response procedures. The health and safety plan shall designate qualified individuals responsible for implementing the plan and for directing subsequent procedures in the event that unanticipated contamination is encountered.

Mitigation Measure M-HZ-2c: Hazardous Materials Management Plan (All Sites)

The contractor shall, prior to construction, prepare a hazardous materials management plan that specifies the method for handling and disposal of both chemical products and hazardous materials during construction and contaminated soil and groundwater, should any be encountered during construction. Contract specifications shall mandate full compliance with all applicable local, State, and federal regulations related to identifying, transporting, and disposing of hazardous materials, including hazardous building materials (i.e., asbestos containing materials, lead-based paint, and electrical equipment) and any hazardous wastes encountered in excavated soil or groundwater. The contractor shall provide the SFPUC with copies of hazardous waste manifests documenting that disposal of all hazardous materials has been performed in accordance with the law.

If contaminated soil or groundwater is encountered, the SFPUC shall require the construction contractor to prepare and implement a construction Soil and Groundwater Management Plan. The contractor shall submit the Plan to the SFPUC and the San Mateo County Department of Health Services, Groundwater Protection Program, for review and approval. Elements of the plan shall include:

- Measures to address hazardous materials and other worker health and safety issues during construction, including the specific level of protection required for construction workers.

- Provisions for excavation of soil, stockpiling, dust, and odor control measures.

- Measures to prevent off-site migration of contaminated soil and groundwater.

- Location and final disposition of all soil and groundwater removed from the site.

- All other necessary procedures to ensure that excavated materials are stored, managed, and disposed of in a manner that is protective of human health and in accordance with applicable laws and regulations.

Mitigation Measure M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan (All Sites)
(See Impact HY-1 in Section 5.16, Hydrology and Water Quality, for description.)

Impact Conclusion: Less than Significant with Mitigation

Hazardous Building Materials

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 16, 17 (Alternate), 18 (Alternate), 19 (Alternate), and the Westlake Pump Station</u>

Construction at these facility sites would not result in exposure of construction workers or the public to hazardous building materials because building demolition would not occur at any of these sites. Therefore, there would be *no impact* at these sites relative to the potential to create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment from hazardous building materials.

Impact Conclusion: No Impact

<u>Sites 1 and 14</u>

At Site 1, an existing concrete restroom building would be demolished. At Site 14, an existing well, concrete pump enclosure, steel tank, and aboveground piping would be demolished. Lead-based paint may be present on the interior of the restroom building at Site 1, as well as on the exterior and interior of the concrete pump enclosure at Site 14. In addition, asbestos-containing materials could be present in the roofing, flooring, ceiling, and piping (i.e., transit pipe and fittings) at the sites. PCB-containing electrical equipment, fluorescent light ballast containing DEHP, and fluorescent light tubes containing mercury could also be present in electrical equipment at either Site 1 or Site 14.

Cal/OSHA's Lead in Construction Standard, described above in Section 5.17.2.3 (Hazardous Structural and Building Components), addresses the safe handling of lead-based paint during demolition. The SFPUC would sample the lead content in the paint at both demolition sites to determine whether the Standard applies. If lead were detected, the construction contractor would be required to comply with the standard. The standard requires that a contractor develop and implement a lead compliance plan, which must include a description of the activities that could emit lead, methods that will be used to meet the safe work practices, Cal/OSHA notification requirements, and a plan to protect workers from lead exposure during construction activities. Therefore, compliance with the regulations and procedures already established would ensure that potential impacts due to disturbance of lead-based paint during demolition would be *less than significant*.

There are well-established regulatory requirements for asbestos abatement in structures, described above in Section 5.17.2.3 (Hazardous Structural and Building Components). For example, in accordance with BAAQMD Regulation 11, Rule 2 (Asbestos Demolition, Renovation and Manufacture), a survey must be conducted to identify asbestos-containing materials prior to demolition, and the BAAQMD must be notified 10 days in advance of any proposed demolition or abatement work. Containment must be provided during work that disturbs asbestos-containing materials and there must be no visible emissions to the outside air from demolition operations that involve asbestos-containing materials. The contractor must use methods specified in the regulations for control of emissions, such as wetting of exposed asbestos-containing materials; use of a high-efficiency particulate air (HEPA) filter within an exhaust, ventilation and control system; or removal in an entirely contained chute. The contractor and hauler of the material are required to file a Hazardous Waste Manifest that details the hauling of the material from the site and its disposal. Therefore, compliance with the required handling and disposal procedures already established would ensure that potential impacts due to disturbance of asbestos during demolition would be *less than significant*.

The U.S. EPA's PCB regulations (40 CFR Part 761) regulates the disposal of PCB wastes generated or encountered during construction, including PCB-contaminated soils or equipment discovered during demolition. The SFPUC would be required to identify and label PCB-contaminating equipment prior to demolition. The EPA must be notified prior to disposal through completion of a Notification of PCB Activity Form, which would include establishing an ID number for activities involving PCBs. The regulations require that the waste be disposed of at an approved PCB waste disposer under a hazardous materials manifest. In addition, the Department of Toxic Substance Control's Universal Waste Rule (22 CCR Sections 66261.9 and 66273.1 thru 66273.90) provides guidelines for removal and recycling / disposal of universal wastes, such as mercury-containing non-incandescent lamps, batteries and other hazardous wastes commonly found in building components and equipment. Therefore, compliance with the regulations and procedures already established would ensure that potential impacts due disposal of PCB-containing equipment or other universal wastes during demolition would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HZ-3. The Project would result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during construction. (Less than Significant with Mitigation)

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts, and sites with significant impacts.

During construction, potentially hazardous materials could be used or stored near a school. As shown in Table 5.17-3 (Schools within 0.25 Mile of a Proposed Facility Site Construction Area), 10 schools are located within approximately 0.25 mile of a proposed facility site. Potentially hazardous materials typically used for construction would include lubricants, degreasers, paints, solvents, and fuels. The impacts of construction-related truck and vehicle emissions in proximity to schools (and other sensitive receptors) are discussed in Section 5.8, Air Quality, Impact AQ-3.

TABLE 5.17-3
Schools within 0.25 Mile[(a)] of a Proposed Facility Site Construction Area

Schools	Sites within 0.25 Mile
Ben Franklin Intermediate School	• Site 2 is approximately 60 feet (0.01 mile) east of the school property, across Park Plaza Drive. • Site 3 is located within the school property. • Site 4 is approximately 100 feet (0.02 mile) southeast of the school property. • The Westlake Pump Station is immediately adjacent to a school playing field.
Garden Village Elementary School	• Site 2 is approximately 30 feet (0.006 mile) north of the school property. • Site 3 is approximately 330 feet (0.06 mile) west of the school property. • Site 4 is located immediately adjacent to the school playing field.
Margaret Brown Elementary School	• Site 5 is approximately 1,200 feet (0.23 mile) east of the school, across Interstate Highway 280 (I-280).
Hope Lutheran Elementary School	• Site 5 is approximately 1,200 feet (0.23 mile) northeast of the school, across I-280. • Site 6 is approximately 1,050 feet (0.20 mile).
Holy Angeles Elementary School	• Site 5 is approximately 475 feet (0.09 mile) southwest of the school, across the BART tracks.
El Camino High School	• Site 9 is approximately 1,100 feet (0.21 mile) northwest of the school.
Alta Loma Middle School	• Site 9 is approximately 1,275 feet (0.24 mile) northeast of the school, across El Camino Real. • Site 10 is approximately 950 feet (0.18 mile) northwest of the school. • Site 18 (Alternate) is approximately 170 feet (0.03 mile) northwest of the school.
R.W. Drake Preschool	• Site 12 is 100 feet (0.018 mile) south of the school. • Site 19 (Alternate) is immediately adjacent to the school.
Baden High School	• Site 12 is 920 feet (0.17 mile) northeast of the school. • Site 19 (Alternate) is 900 feet (0.17 mile) northeast of the school.
Los Cerritos Elementary School	• Site 12 is 930 feet (0.17 mile) northwest of the school, across El Camino Real. • Site 19 (Alternate) is 1,250 feet (0.23 mile) northwest of the school, across El Camino Real.
South San Francisco High School	• Site 12 is approximately 1,000 feet (0.19 mile) northwest of the school, across El Camino Real. • Site 13 is approximately 900 feet (0.17 mile) south of the school.

Note:

(a) Measurements are taken from the closest boundary of the construction zone to the closest edge of the land use, including school parking areas.

Sites 1, 7, 8, 11, 14, 15, 16, and 17 (Alternate)

Because no schools are located within a 0.25 mile of these sites, *no impact* would occur related to the emission or use of hazardous materials within 0.25 mile of a school during construction.

Impact Conclusion: No Impact

Sites 5, 6, 9, 10, 12, 13, and 18 (Alternate)

As shown on Table 5.17-3 (Schools within 0.25 Mile of a Proposed Well Facility Site Construction Area), Schools located within 0.25 mile of these sites include: Margaret Brown Elementary School (Site 5); Holy Angels Elementary School (Site 5); Hope Lutheran Elementary School (Sites 5 and 6); El Camino High School (Site 9); Alta Loma Middle School (Sites 9, 10, and 18 [Alternate]); R.W. Drake Preschool, Baden High School, and Los Cerritos Elementary School (Site 12); and South San Francisco High School (Sites 12 and 13).

Project construction activities are assumed by this analysis to include the use of hazardous materials such as fuels, lubricants, degreasers, paints, and solvents. These materials are commonly used during construction, are not acutely hazardous, and would be used in small quantities. Numerous laws and regulations ensure the safe transportation, use, storage, and disposal of hazardous materials (see Section 5.17.1 [Regulatory Framework]). Routine transport of hazardous materials to and from facility sites could result in an incremental increase in the potential for accidents. However, Caltrans and the CHP strictly regulate the transportation of hazardous materials and wastes, including container types and packaging requirements, as well as licensing and training for truck operators, chemical handlers, and hazardous waste haulers. Worker safety regulations cover hazards related to the prevention of exposure to hazardous materials and a release to the environment from hazardous materials use. Regulations and criteria for the disposal of hazardous materials mandate disposal at an appropriate landfill. Cal-OSHA also enforces hazard communication program regulations, which contain worker safety training and hazard information requirements, such as procedures for identifying and labeling hazardous substances, communicating hazard information related to hazardous substances and their handling, and preparation of health and safety plans to protect workers and employees.

These types of hazardous materials are commonly used at facilities such as gasoline stations and dry cleaners, and at construction areas. Although construction activities could result in the inadvertent release of small quantities of hazardous construction chemicals, a spill or release at a well facility construction area is not expected to endanger individuals at nearby schools given the nature of the materials and the small quantities that would be used. Therefore, because the SFPUC and its contractors would be required to comply with existing and future hazardous materials laws and regulations covering the transport, use, and disposal of hazardous materials, and because of the nature and quantity of the hazardous materials, the potential impact on schools related to the use of hazardous materials at these sites that are within 0.25 miles would be *less than significant.* In addition, although the impact is considered less than significant, the standard BMPs that would be implemented under the required erosion and sediment control plan (see Impact HY-1 in Section 5.16, Hydrology and Water Quality) would require specific preventative practices for safe storage and handling of chemicals, as well as secondary containment to contain a potential release. These standard BMPS would further serve to prevent and contain inadvertent releases of hazardous materials at construction sites.

Impact Conclusion: Less than Significant

Sites 2, 3, 4, 19 (Alternate), and the Westlake Pump Station

As shown on Table 5.17-3 (Schools within 0.25 Mile of a Proposed Facility Site Construction Area), Sites 2, 3, 4, and 19 (Alternate) are located within 0.25 miles of several schools, including: Ben Franklin Intermediate School (Sites 2, 3, 4, and Westlake Pump Station); Garden Village Elementary School (Sites 2, 3, 4); and R.W. Drake Preschool, Baden High School, and Los Cerritos Elementary (Site 19 [Alternate]).

Site 19 (Alternate) is located approximately 900 feet away from Baden High School, 1,250 feet away from Los Cerritos Elementary School, and immediately adjacent to R.W. Drake Preschool. As discussed previously, well facility construction activities are assumed by this analysis to include the use of hazardous materials such as fuels, lubricants, degreasers, paints, and solvents, which are commonly used during construction, are not acutely hazardous, and would be used in small quantities. The SFPUC and its contractors would be required to comply with existing and future hazardous materials laws and regulations covering the transport, use, and disposal of hazardous materials. These types of hazardous materials are commonly used at gasoline stations, dry cleaners, and other construction areas. Although construction activities could result in the inadvertent release of small quantities of hazardous construction chemicals, a spill or release at a well facility construction area is not expected to endanger individuals Baden High School or Los Cerritos Elementary School given the nature of the materials and the small quantities that would be used. Therefore, because of anticipated regulatory compliance and the nature and small quantity of the materials used and stored, an accidental spill or release would be unlikely to result in significant hazardous materials impacts on these schools. Therefore, the potential impact related to the use of hazardous materials within 0.25 miles of Baden High School and Los Cerritos Elementary School, would be *less than significant.*

However, several well facility site construction and staging areas would be located on, or immediately adjacent to, several schools. Site 2 is immediately adjacent to Garden Village Elementary School; Site 3 is located on Ben Franklin Intermediate School property; Site 4 is located on Garden Village Elementary School property; Westlake Pump Station is immediately adjacent to Ben Franklin Intermediate School; and Site 19 (Alternate) is immediately adjacent to R.W. Drake Preschool. Because of this close proximity, the potential for an adverse effect at Ben Franklin Intermediate School, Garden Village Elementary School, and R.W. Drake Preschool due to accidental spill or release of hazardous materials at Sites 2, 3, 4, 19 (Alternate), and the Westlake Pump Station could potentially be *significant*, even after considering the nature and quantity of the chemicals to be used and stored and compliance with laws and regulations.

However, implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) and Mitigation Measure M-HZ-2c: (Hazardous Materials Management Plan) would reduce this potential hazardous materials impact to a *less-than-significant* level. While Mitigation Measure M-HY-1 is presented in Section 5.16, Hydrology and Water Quality, and primarily addresses water quality impacts, it also contains measures for controlling non-stormwater (i.e., equipment maintenance and servicing requirements and equipment fueling requirements), waste, and potential hazardous materials pollution, which would also reduce the potential for the accidental release of hazardous construction chemicals. The Erosion and Sediment Control Plan requires specific practices for the safe storage and handling of chemicals. The BMPs required to be in the plan include protection measures for the temporary on-site storage of diesel fuels or other hazardous materials used during construction, including requirements for secondary containment of a potential release and to prevent any such release from reaching an adjacent waterway or stormwater collection system. All equipment and materials storage would need to be routinely inspected for leaks and records maintained for documenting compliance with the storage and handling of hazardous materials. In addition, Mitigation Measure M-HZ-2c would require that the contractor prepare a Hazards Materials Management Plan to ensure proper handling of all hazardous substances that are used during construction. With the incorporation of these measures, the potential hazardous materials impact on Ben Franklin Intermediate School, Garden Village Elementary School, and R.W. Drake Preschool, due to emission or use of hazardous materials during construction of Sites 2, 3, 4, 19 (Alternate), and the Westlake Pump Station, would be *less than significant with mitigation*.

> ***Mitigation Measure M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan (All Sites)***
> (See Impact HY-1 in Section 5.16, Hydrology and Water Quality, for description.)

> ***Mitigation Measure M-HZ-2c: Hazardous Materials Management Plan (All Sites)***
> (See Impact HZ-2 above for description.)

Impact Conclusion: Less than Significant with Mitigation

5.17.3.5 Operation Impacts and Mitigation Measures

Impact HZ-4. The Project would not create a hazard to the public or environment from the routine transport, use, or disposal of hazardous materials or accidental release of hazardous materials during operation. (Less than Significant)

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 2, 3, 4, 5 (Consolidated Treatment at Site 6), 7 (Consolidated Treatment at Site 6), 14, and 19 (Alternate)</u>

Because these well facilities would not store or use chemicals for disinfection or water treatment, accidental releases from stored chemicals would not occur. Therefore, *no impact* would occur relative to transport, use, or disposal of hazardous materials or an accidental release during operation of these sites.

Impact Conclusion: No Impact

Sites 1, 5 (On-site Treatment), 6, 7 (On-site Treatment), 8, 9, 10, 11, 12, 13, 15, 16, 17 (Alternate), 18 (Alternate), and the Westlake Pump Station

Attainment of water quality goals may require disinfection, treatment, or filtration prior to distribution of water into the regional water system or Partner Agency distribution systems. The primary chemicals needed at facility sites are sodium hypochlorite and ammonia for disinfection. Sodium hydroxide would be added if necessary to adjust the pH. Sodium fluoride would be required if the fluoride concentration in the blended water in the local water distribution system is below the respective water agency's identified fluoride levels (see Chapter 3, Project Description, Section 3.4.2.2 [Well Facility Types]).

As discussed in Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types), the chemical storage tanks would be placed on a pedestal and above a grate-covered chemical containment pit. The depth of the pit would be sized to provide 110 percent of the total storage volume in the event of a spill. A hatch on the grate would allow access for a sump pump to remove any spilled chemicals. Each tank is intended to provide a chemical storage capacity of 14 to 21 days (with an additional 15 percent safety factor). The proposed storage capacity allows for the frequency of chemical delivery to occur every two- to three weeks.

As described above, Project operation would involve regular transportation of hazardous materials. However, Caltrans and the CHP strictly regulate the transportation of hazardous materials and wastes, including container types and packaging requirements, as well as licensing and training for truck operators, chemical handlers, and hazardous waste haulers (see Section 5.17.1, Regulatory Framework). Vehicle and equipment inspection, shipment preparation, container identification, and shipping documentation are the responsibility of CHP, which conducts regular inspections of licensed transporters to assure regulatory compliance. Caltrans has emergency chemical spill identification teams at locations throughout the State that can respond quickly in the event of a spill.

The Uniform Fire Code, Article 80, includes specific requirements for the safe storage and handling of chemicals. These requirements are intended to reduce the potential for an accidental release and for mixing of incompatible chemicals. Design of chemical storage facilities at the well facilities and storage of chemicals for the Project at the Westlake Pump Station would comply with the current Uniform Fire Code requirements and other applicable federal, State, and local regulations, including design features (including noncombustible partitions, spill control features and separate secondary containment, as described above in Section 5.17.2.8 [Uniform Fire Code]) that would reduce the potential for a release of hazardous materials that could affect public health or the environment. The SFPUC would be required by the local CUPA agency (San Mateo County Health Department) to prepare an HMBP for the well facilities that store hazardous chemicals, as well as update the existing HMBP for the Westlake Pump Station facility to reflect the changes in hazardous materials storage.

The SFPUC would also be required to comply with existing and future hazardous materials laws and regulations covering the transport, use, and disposal of hazardous materials. In addition, the SFPUC would be required to incorporate legally mandated design features into the facilities and prepare HMBPs for chemical storage. Therefore, because the SFPUC would be required to comply with these laws and regulations that are designed to protect the public against potential impacts associated with the use of chemicals and accidental chemical releases, potential hazardous materials impacts during operation would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HZ-5. The Project would not result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during operation. (Less than Significant)

This impact discussion considers the potential for operational impacts due to the use of chemicals and other hazardous materials. Potential impacts related to operational pollutant emissions are discussed in Section 5.8, Air Quality, Impact AQ-6.

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 1, 2, 3, 4, Site 5 (Consolidated Treatment at Site 6), 6, 7, 8, 11, 14, 15, 16, 17 (Alternate), and 19 (Alternate)</u>

Because no schools would be located within a 0.25 mile of Sites 1, 6, 7, 8, 11, 14, 15, 16, and 17 (Alternate), *no impact* would occur related to emission or use of hazardous materials within 0.25 mile of a school during operation of these sites.

Sites 2, 3, 4, Site 5 (Consolidated Treatment at Site 6), and 19 (Alternate) would be located within a 0.25 mile of schools; however, these well facilities would not store or use chemicals for disinfection or water treatment. As a result, there would be *no impact* related to emission or use of hazardous materials within 0.25 mile of a school during operation of these sites.

Impact Conclusion: No Impact

<u>Sites 5 (On-site Treatment), 9, 10, 12, 13, 18 (Alternate), and Westlake Pump Station</u>

These well facilities, where chemicals would be stored on the site during Project operations, would be located within a 0.25 mile of schools and may store and use sodium hypochlorite, ammonia, sodium hydroxide, and sodium fluoride. The well facility building at Site 5 would be located approximately 475 feet from Holy Angels Elementary School, 1,200 feet from Hope Lutheran Elementary School, and 1,200 feet from Margaret Brown Elementary School. The well facility building at Site 9 would be located approximately 1,100 feet from El Camino High School and 1,275 feet from Alta Loma Middle School. Site 10 would be located approximately 950 feet from Alta Loma Middle School, and Site 18 (Alternate) would be located about 170 feet from the school. Site 12 would be located approximately 920 feet from Baden High School, 1,000 feet from South San Francisco High School, and 930 feet from Los Cerritos Elementary School. Site 13 would be located about 900 feet from South San Francisco High School. The parcel where the Westlake Pump Station is located is immediately adjacent to schoolyard athletic fields at Ben Franklin Intermediate School.

The potential for emissions of chemicals from an accidental release is discussed under Impact HZ-5. As stated there, incorporation of legally required design features and development of HMBPs for chemical storage would maintain the potential impact from increased use of chemicals and potential for accidental release at less-than-significant levels. This includes the potential for emission or use of hazardous materials within 0.25 mile of a school. Therefore, the potential for hazardous materials impacts related to emissions resulting from chemical storage and use to affect schools within 0.25 mile would also be *less than significant*.

Impact Conclusion: Less than Significant

Impact HZ-6. The Project would not result in a safety hazard for people residing or working in the vicinity of a public use airport. (Less than Significant)

The evaluation of impacts that follows discusses sites with no impacts first, followed by sites with less-than-significant impacts.

<u>Sites 1, 2, 3, 4, 5, 6, 7, 8, 17 (Alternate), and the Westlake Pump Station</u>

These sites are not located within an area covered by an airport land use plan or within two miles of a public airport. Therefore, *no impact* per this criterion would occur at these sites.

Impact Conclusion: No Impact

<u>Sites 9, 10, 11, 12, 13, 14, 15, 16, 18 (Alternate), and 19 (Alternate)</u>

These sites are located within an area covered by the San Mateo County Airport Land Use Plan for the SFO. Site 19 (Alternate) would be a well-only facility and surrounded by an 8-foot tall fence. The remaining well facilities would include buildings for treatment and/or filtration that would be a maximum of 15.5 feet above finished grade. As a result, the heights of the well facility buildings would be well below FAR Part 77 airport related height limitations and the land surrounding the well facility sites is almost entirely developed with urban uses that include structures as tall or taller than the proposed well facilities. In addition, the well facilities would not direct lights toward, or cause sunlight to be reflected toward, an aircraft, would not generate smoke or rising columns of air, would not attract large concentrations of birds, and would not cause electrical interference. Therefore, operation of the Project would not result in a safety hazard for people residing or working in the project area. As a result, this potential hazards impact would be *less than significant*.

Impact Conclusion: Less than Significant

Impact HZ-7: The Project would not expose people or structures to a significant risk of loss, injury, or death involving fires. (Less than Significant)

Exposure of people or structures to risk of loss, injury, or death involving fire could occur if the Project sites were located in areas susceptible to risk from fire. As discussed in the setting section, the SFPUC maintains Lake Merced as a nonpotable emergency water supply for the CCSF to be used for firefighting if no other sources of water are available (SFPUC 2011). Impact HY-10 in Section 5.16, Hydrology and Water Quality, discusses the effects of Project operations on Lake Merced lake levels.

<u>All Sites</u>

The facility sites would be located on urban land in zones designated as "Non-Fire Hazard" (CAL FIRE 2008). Therefore, the risk of fires from is considered very low and *no impact* would occur.

As discussed in Impact HY-10 in Section 5.16, Hydrology and Water Quality, water levels in Lake Merced would increase during wet and normal years and decrease during dry years ("Take Periods") (see Impact HY-10 in Section 5.16, Hydrology and Water Quality for an evaluation of the Lake Merced water level and modeled operational scenarios). Despite the increases and decreases in water levels in Lake Merced, water would be present in the lake and available for emergency use during Project operations. Therefore, impacts on the exposure of people or structures to fire risk due to changes in Lake Merced water levels would be *less than significant*.

Impact Conclusion: Less than Significant

5.17.3.6 Cumulative Impacts and Mitigation Measures

Impact C-HZ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials. (Less than Significant with Mitigation)

The geographic scope for the analysis of cumulative impacts relating to hazards and hazardous materials consists of each proposed GSR facility site (including the construction area for the well, the well facility, and the proposed or alternate pipelines) and the area surrounding the sites where an adverse effect could occur.

Construction

Use of Hazardous Materials

All of the cumulative projects listed in Table 5.1-3 (Project Considered for Cumulative Impacts) in Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, Section 5.1, Overview, would result in the use, transport, and disposal of hazardous materials during construction within the cumulative impacts study area.

As described in Impact HZ-1, the GSR Project would have less-than-significant impacts associated with the potential to create a significant hazard, because the SFPUC and its contractors would be required to comply with the existing and future laws and regulations governing the use, transport, and disposal of hazardous materials.

Depending on the extent of overlap between the construction schedules for the projects listed in Table 5.1-3 (Project Considered for Cumulative Impacts), implementation of these projects together with the proposed GSR Project could result in a cumulative impact associated with increased hazards; however, each of the cumulative projects would need to comply with existing and future laws and regulations governing the hazardous materials, similar to the GSR Project. For this reason, the potential cumulative impact from the use, transport, and disposal of hazardous materials during construction would be less than significant. As a result, there would be no significant cumulative impact associated with increased hazards relative to the use, transport, or disposal of hazardous materials during construction to which the proposed Project would contribute (*less than significant*).

Accidental Release of Hazardous Chemicals or Building Materials

All of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) in Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, Section 5.1 (Overview), are likely to use fuels and other flammable materials during construction within the cumulative impacts study area. The PG&E Transmission Pipeline Replacement Project (cumulative project H) would be located 160 feet south of the pipeline construction area for GSR Site 11 in Chestnut Avenue and adjacent to the pipeline construction area for GSR Sites 12 and 19 (Alternate) along El Camino Real. In addition, a number of the cumulative projects would involve demolition of existing structures (e.g., the Centennial Village Project [cumulative project I], which is adjacent to the pipeline construction area for GSR Site 13, and would demolish the existing commercial businesses on the site), which could release asbestos, lead, or other hazardous building materials into the environment.

As identified above in Impact HZ-2, the GSR Project could cause significant impacts on workers and the environment, if accidental release of hazardous materials were to occur during construction or if contaminated soil or groundwater were encountered during construction. In addition, demolition of existing structures is proposed at GSR Sites 1 and 14, which could release hazardous building materials into the environment. Therefore, cumulative impacts related to accidental release of hazardous chemicals or building materials during construction could be *significant* and the GSR Project's contribution to this cumulative impact could be cumulatively considerable.

However, as discussed in Impact HZ-2, the GSR Project's impacts related to release of hazardous chemicals during construction would be reduced to *a less-than-significant* level with implementation of Mitigation Measure M-HZ-2a (Preconstruction Hazardous Materials Assessment), Mitigation Measure M-HZ-2b (Health and Safety Plan), and Mitigation Measure M-HZ- 2c (Hazardous Materials Management Plan),which require preconstruction hazardous materials assessments, site health and safety plans, and hazardous materials management plans. In addition, Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan), would require specific preventive practices for safe storage and handling of chemicals, as well as secondary containment to contain a potential release (see Impact HZ-2, above, for description). With regard to potential release of hazardous building materials from demolition, impacts at GSR Sites 1 and 14 would be *less than significant* due to compliance with applicable laws and regulations that provide procedures for identification and legal disposal of hazardous building materials. Therefore, with implementation of Mitigation Measure M-HZ-2a, Mitigation Measure M-HZ-2b, Mitigation Measure M-HZ-2c, and M-HY-1 at all GSR facility sites, the GSR Project's contribution to cumulative impacts related to compliance with hazards due to accidental release of hazardous chemicals or building materials during construction, would not be cumulatively considerable (*less than significant*).

Exposure of Schools to Hazardous Materials

The following cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would be located within 0.25 mile of a school that could be potentially affected by a proposed GSR facility site, and would be likely to use hazardous chemicals (e.g., fuels, lubricants, and paints) during construction:

- Cumulative project C, the Daly City "A" Street Well Replacement Project, would be within 0.25 mile of Holy Angels Elementary School, which would also be near GSR Site 5.
- Cumulative project D-2, the South San Francisco site for the Peninsula Pipelines Seismic Upgrade Project (PPSU), would be within 0.25 mile of Baden High School, which would also be near GSR Sites 12 and 19 (Alternate).
- Cumulative project E, Holy Cross Cemetery Expansion Project, would be within 0.25 mile of El Camino High School, which would also be near GSR Site 9.
- Cumulative project F, the Mission and McLellan Project, would be within 0.25 mile of El Camino High School and Alta Loma Middle School, both of which would also be near GSR Sites 9 and 10.
- Cumulative project H, the PG&E Transmission Pipeline Replacement Project, would be within 0.25 mile of Los Cerritos Elementary School, which would also be near GSR Sites 12 and 19 (Alternate).
- Cumulative project I, the Centennial Village Project, would be within 0.25 mile of South San Francisco High School, which would also be near GSR Site 13.

As identified in Impact HZ-3, this analysis presumes that some of the proposed GSR facilities would use hazardous materials such as fuels, lubricants, and paints during construction, which could cause a hazard at adjacent schools. Therefore, cumulative impacts related to an increased risk of exposure to hazardous materials to schools from use of hazardous chemicals during construction could be *significant*, and, for GSR Sites 2, 3, 4, 19 (Alternate), and the Westlake Pump Station, the GSR Project's contribution to this cumulative impact could be cumulatively considerable, given the close proximity of construction activities on or immediately adjacent to schools.

However, as discussed in Impact HZ-3, all of the above-listed projects would likely be using similar hazardous materials for the GSR Project (not acutely hazardous) and in non-industrial quantities. The transportation, use, and storage of these hazardous materials would be regulated by numerous laws and regulations, as described in Impact HZ-3. Additionally, for Sites 2, 3, 4, and 19 (Alternate), the GSR Project's impacts related to safety risks to nearby schools during construction would be reduced to *a less-than-significant* level with implementation of M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) (see Impact HZ-3, above, for description) and M-HZ-2c (Hazardous Materials Management Plan). Implementation of these mitigation measures would ensure that specific preventive practices for safe storage and handling of chemicals, as well as procedures for secondary containment to contain a potential release, would be implemented during construction of the GSR Project. With implementation of these mitigation measures, the GSR Project's contribution to cumulative impacts related to an increased risk of exposure to hazardous materials to schools from use of hazardous chemicals during construction would not be cumulatively considerable *(less than significant)*.

Operations

Use of Hazardous Materials

Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) may require the use, transport, and disposal of hazardous materials during operations. For example, the San Francisco Groundwater Supply Project (cumulative projects A-1 to A-6) and the Daly City "A" Street Well Replacement project (cumulative project C) could use, transport, and store common materials for water treatment if they include treatment facilities. The Mission & McLellan and Centennial Village development projects (cumulative projects F and I) could use, transport, and store common hazardous materials such as fuels, paints, and fertilizers for commercial operations, landscaping, and site maintenance.

As described in Impact HZ-4, the GSR sites with treatment facilities would use and store common materials for water treatment, and be required to incorporate legally required design features and HMBPs for chemical storage. These legal requirements are designed to protect the public against potential impacts associated with the use of chemicals and accidental chemical releases. Therefore, the Project would have *less-than-significant* impacts associated with the potential to create a significant hazard, because the SFPUC would be required to comply with the existing and future laws and regulations governing the use, transport, and disposal of hazardous materials.

For the projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), implementation of these projects together with the proposed GSR Project could result in a cumulative impact associated with increased hazards; however, each of the cumulative projects would need to comply with the existing and future laws and regulations governing hazardous materials, similar to the GSR Project. For this reason, the potential cumulative impact from the use, transport, and disposal of hazardous materials during operations would be *less than significant*. As a result, there would be no significant cumulative impact associated with increased hazards relative to the use, transport, or disposal of hazardous materials during operations *(less than significant*).

Exposure of Schools to Hazardous Materials

Some of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would be likely to use hazardous chemicals (e.g., paints, fertilizers) during operations. For example, the San Francisco Groundwater Supply Project (cumulative projects A-1 to A-6) and the Daly City "A" Street Well Replacement project (cumulative project C) could use, transport, and store common materials for water treatment if they include treatment facilities. The Mission & McLellan and Centennial Village development projects (cumulative projects F and I, respectively) could use, transport and store common hazardous materials such as fuels, paints, and fertilizers for commercial operations, landscaping, and site maintenance. Some of these cumulative projects would also be located within 0.25 mile of a school that could also be potentially affected by a proposed GSR facility site (see list under Exposure of Schools to Hazardous Materials during construction).

As identified in Impact HZ-5, some of the proposed GSR sites where treatment facilities would be built would store hazardous materials such as sodium hydroxide (for pH adjustment) and sodium hypochlorite (for disinfection) for use during operations. Such storage and use of these common water treatment chemicals would have less-than-significant impacts associated with the accidental release of chemicals near schools, because the storage amounts would be minimal (i.e., only enough for two to three weeks' supply would be stored on site when wells are operating), and the SFPUC would be required to comply with the existing and future laws and regulations governing the storage, use, transport, and disposal of such hazardous materials.

For the projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), operation of these projects together with the proposed GSR Project could nevertheless result in a cumulative impact associated with increased risk of accidental release near schools; however, each of the cumulative projects would need to comply with the existing and future laws and regulations governing hazardous materials, similar to the GSR Project. For this reason, the potential cumulative impact from the storage, use, transport, and disposal of these water treatment chemicals during operations would be *less than significant*. As a result, there would be no significant cumulative impact associated with increased hazards relative to the use, transport, or disposal of hazardous materials during operations (*less than significant*).

Safety Hazard near an Airport

Of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), cumulative projects D-1, and E through I would also be located within lands subject to the San Mateo County Airport Land Use Plan (ALUP). The Holy Cross Expansion Project and the California Water Service Company Water Well Replacement Project (cumulative projects E and G, respectively) are cemetery expansion and well replacement projects. The PPSU Colma site (cumulative project D-1) and PG&E Transmission Pipeline Replacement Project (cumulative project H) are infrastructure improvement projects that would not include new aboveground features. The Mission & McLellan Project (cumulative project F) has a maximum height of 50 feet above grade (Allison Knapp Wollam Planning & Environmental Consulting 2010). These cumulative projects would not likely be inconsistent with air space restrictions due to height, although lighting impacts are unknown. It is unknown if the Centennial Village Project (cumulative project I) would have elements that would be inconsistent with air space restrictions contained in the ALUP. As identified in Impact HZ-6, some of the proposed GSR sites (GSR Sites 9 through 16, 18 [Alternate], and 19 [Alternate]) would also be located within lands subject to the San Mateo County ALUP. However, the proposed GSR facilities would have *less-than-significant* impacts on safety hazards near an airport, because the GSR Project would not exceed FAR Part 77 airport-related height limitations. In addition, the well facilities would not direct lights toward, or cause sunlight to be reflected toward, an aircraft, and would not generate smoke or rising columns of steam.

For the projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), operation of these projects together with the proposed GSR Project could result in a cumulative impact associated with increased safety hazards near SFO because they could include new lighting or facilities that may be inconsistent with air space restrictions contained in the ALUP, such as airport-related height limitations, directing lights toward, or cause sunlight to be reflected toward an aircraft, or generate smoke or rising columns of steam. The cumulative impact would, therefore, be *significant*. However, as described in Impact HZ-6, the GSR Project well facility buildings would be well below FAR Part 77 airport-related height limitations, and the land surrounding the facility sites is almost entirely developed with urban uses that include structures as tall or taller than the proposed well facilities. Therefore, the GSR Project's contribution to potentially significant cumulative impacts from increased safety hazards near an airport would not be cumulatively considerable *(less than significant)*.

Exposure of People or Structures to Fire Risk

Some of the cumulative projects may be located on land designated as moderate fire hazard severity zones. None of the cumulative projects would be located on land designated as high to very high fire hazard severity zones. The GSR Project would be located in urban land in zones designated as "Non-Fire Hazard" and the risk from fire is considered very low (CAL FIRE 2008). Therefore, the GSR Project and the cumulative projects would not combine to create a significant cumulative effect related to risk from fire *(less than significant)*.

Additionally, the San Francisco Groundwater Supply Project (cumulative project A-1 through A-6) and the Vista Grande Drainage Basin Improvement Project (cumulative project B) could affect water levels in Lake Merced. Lake Merced water may be used for firefighting purposes in emergency situations, and a reduction of water levels could impact the availability water for firefighting purposes. However, water would still be present in the lake and available for emergency use even with implementation of the cumulative projects. Therefore, the anticipated cumulative impact would be *less than significant.*

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5.18 MINERAL AND ENERGY RESOURCES

This section analyzes the proposed Project's potential impacts on the use of non-renewable mineral and energy resources, as well as on water use, and the potential for Project implementation to adversely affect the availability of these resources. The study area for mineral and energy resources includes the facility sites and the nearby areas.

5.18.1 Setting

5.18.1.1 Mineral Resources

In accordance with the Surface Mining and Reclamation Act of 1975 (SMARA) (discussed below in Section 5.18.2.2 [State Regulations]), the California Department of Conservation, Division of Mines and Geology, currently known as the California Geological Survey (CGS), has mapped nonfuel mineral resources of the State to show where economically significant mineral deposits are either present or likely to occur based on the best available scientific data. These resources have been mapped using the California Mineral Land Classification System, which includes the following four Mineral Resource Zones (MRZs):

- **MRZ-1.** Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
- **MRZ-2.** Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood exists for their presence.
- **MRZ-3.** Areas containing mineral deposits, the significance of which cannot be evaluated.
- **MRZ-4.** Areas where available information is inadequate for assignment to any other zone.

The study area is mapped as MRZ-1, which indicates that the study area does not, or is unlikely to contain, significant mineral resources (CGS 1987, 1996).

5.18.1.2 California's Electricity Supply

California's electricity is generated by a number of sources, including natural gas (46 percent), coal (18 percent), large hydroelectric plants (11 percent), and nuclear (14 percent) (CEC 2009). The remaining 11 percent is supplied from geothermal, biomass, small hydroelectric, wind, and solar sources (CEC 2009). Established in 2002 under Senate Bill 1078 (SB 1078) and accelerated in 2006 under Senate Bill 107 (SB 107), California's Renewable Portfolio Standard (RPS) requires electric corporations to increase procurement from eligible renewable energy resources by at least one percent of their retail sales annually, until they reached 20 percent by 2010. On September 15, 2009, former Governor Schwarzenegger signed Executive Order S-21-09 directing the California Air Resources Board (CARB) to adopt regulations increasing California's RPS to 33 percent by 2020. In 2010, the three largest investor-owned utilities, including the Pacific Gas and Electric Company (PG&E), had reached 17.9 percent (CPUC 2011).

5.18.1.3 Current Energy Providers

SFPUC Power Enterprise

The San Francisco Public Utilities Commission (SFPUC) Power Enterprise would provide electrical power service for the Project facilities, primarily from power generated by the SFPUC's hydroelectric facilities in the Hetch Hetchy system. The system includes 401 megawatts (MW) of hydroelectric power generation plants on the Tuolumne River and 150 miles of high-voltage transmission lines that carry this power to California's electricity grid at Newark, California, where the Hetch Hetchy power system is linked to California's electricity grid. Energy production varies by season and by year depending on hydrologic conditions. The long-term annual average production is approximately 1.7 billion kilowatt-hours (kWh); historical production has ranged from a low of 1.2 billion kWh per year to a high of 2.2 billion kWh per year (SFPUC 2002). The total energy usage of existing facilities within the Water System Improvement Program (WSIP) regions is nearly 44 million kWh, less than four percent of the historical low production rate of the regional water system and less than three percent of the long-term annual average production rate (incorporated by reference from the WSIP Program EIR, Chapter 4, WSIP Facility Projects – Setting and Impacts, Section 4.15, Energy Resources, Section 4.15.1 Setting [San Francisco Planning Department 2008]).

The SFPUC Power Enterprise provides electricity to all City and County of San Francisco (CCSF) facilities (including tenants), including the San Francisco International Airport and its tenants, and would supply power for the proposed Project. The SFPUC Power Enterprise also sells electricity to Norris Industries (a federal defense contractor), provides electricity for the municipal and agricultural pumping loads of the Modesto and Turlock Irrigation Districts, and sells electricity to other public agency wholesalers. While the quantity of power produced exceeds San Francisco's municipal power needs on an annual basis, the CCSF must supplement its power sources to meet municipal demand and its contractual obligations during the summer and fall months, at which time power generation is reduced so that water can be stored. The SFPUC Power Enterprise load profile is relatively flat (i.e., not dramatically higher in the summer), because it is not driven by air conditioning use.

Pacific Gas and Electric Company

PG&E provides natural gas and electricity to most of Northern California. It provides the SFPUC Power Enterprise with transmission and distribution services from Newark, California, to points west, pursuant to an Interconnection Agreement regulated by the Federal Energy Regulatory Commission (FERC). Under this agreement, PG&E transmits and distributes electricity to the SFPUC Power Enterprise customers and would provide power distribution services for the proposed Project.

5.18.1.4 Existing Energy Use and Distribution

The SFPUC annual energy demand for operation of the regional water system was approximately 35 million kWh in 2009 when the system delivered 219 million gallons per day (mgd); none of this energy demand came from pumping groundwater.

Based on the volume of existing groundwater supply of 6.8 mgd, the Partner Agencies' annual energy demand is estimated to be approximately 16 million kWh[1] to pump, treat and distribute water from their existing groundwater facilities (see Appendix I [Calculations for GSR Energy Use Impacts]).

Because the proposed Project affects energy demand of the regional water system as well as the Partner Agencies' groundwater systems, existing energy use collectively is estimated to be 51 million kWh.[2]

5.18.2 Regulatory Framework

5.18.2.1 Federal Regulations

National Energy Policy Act of 2005

The National Energy Policy Act of 2005 sets equipment energy-efficiency standards and seeks to reduce reliance on nonrenewable energy resources and provide incentives to reduce current demand on these resources. For example, under the Act, consumers and businesses can attain federal tax credits for purchasing fuel-efficient appliances and products, including hybrid vehicles, constructing energy-efficient buildings, and improving the energy efficiency of commercial buildings. Additionally, tax credits are available for the installation of qualified fuel cells, stationary microturbine power plants, and solar power equipment.

5.18.2.2 State Regulations

Surface Mining and Reclamation Act of 1975

In accordance with SMARA and as discussed above in Section 5.18.1.1 (Mineral Resources), the State has established the California Mineral Land Classification System to help identify and protect mineral resources in areas that are subject to urban expansion or other irreversible land uses that would preclude mineral extraction. Protected mineral resources include construction materials, industrial and chemical mineral materials, metallic and rare minerals, and nonfluid mineral fuels.

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[1] Energy demand for the Partner Agencies' groundwater supply systems was estimated by multiplying the volume of Partner Agency pumping (6.8 mgd) by the projected unit energy demand for the proposed Project's new well facilities (6.4 million kWh per mgd). This calculation is appropriate, because the Partner Agencies are likely using the same general type of equipment and pumping from the same groundwater basin as the proposed new well facilities. However, the calculation is expected to overestimate energy demand somewhat, because some of the Partner Agencies are pumping from shallower aquifers, and the unit energy demand of the proposed new well facilities is based on design loads rather than actual loads (e.g., the new well facilities would not actually operate 24 hours a day in a dry year, but the calculation of the unit energy demand makes this assumption). See Appendix I (Calculations for GSR Energy Use Impacts).

[2] Existing energy use of 51 million kWh is the sum of regional water system 2009 annual energy demand of approximately 35 million kWh, plus the Partner Agencies' 2009 annual energy demand of approximately 16 million kWh.

The Surface Mining and Reclamation Act of 1975 (Chapter 9, Division 2, Section 2710 et seq. of the Public Resources Code) requires the State Mining and Geology Board to adopt State policies for reclaiming mined lands and conserving mineral resources. Title 24 of the California Code of Regulations, Division 2, Chapter 8, Subchapter 1, contains these policies.

2005 California Energy Action Plan II and 2008 Update

The Energy Action Plan II, and subsequent update in 2008, is the State's principal energy planning and policy document (CEC and CPUC 2005, 2008). The plan continues the goals of the original Energy Action Plan, describes a coordinated implementation plan for State energy policies, and identifies specific action areas to ensure that California's energy is adequate, affordable, technologically advanced, and environmentally sound. In accordance with this plan, the first-priority actions to address California's increasing energy demands are energy efficiency and demand response (i.e., reduction of customer energy usage during peak periods in order to address system reliability and support the best use of energy infrastructure). Additional priorities include the use of renewable sources of power and distributed generation (i.e., the use of relatively small power plants near or at centers of high demand). To the extent that these actions are unable to satisfy the increasing energy and capacity needs, clean and efficient fossil-fired generation is supported. At the beginning of 2008, the California Energy Commission (CEC) and California Public Utilities Commission (CPUC) determined it was not necessary or productive to create a new Energy Action Plan. The State's energy policies have been significantly influenced by the passage of Assembly Bill 32, the California Global Warming Solutions Act of 2006. So rather than produce a new Energy Action Plan, the CEC and CPUC prepared an "update" that examines the State's ongoing actions in the context of global climate change.

The Energy Action Plan II includes the following energy efficiency actions specific to water supply systems: Identify opportunities and support programs to reduce electricity demand related to the water supply system during peak hours, as well as opportunities to reduce the energy needed to operate water conveyance and treatment systems. Because much of electricity demand growth is expected to be met by increases in natural-gas-fired generation, reducing consumption of electricity and diversifying electricity generation resources are significant elements of plans to reduce natural gas demand.

Building Energy Efficiency Standards

The Energy Efficiency Standards for Residential and Nonresidential Buildings, as specified in Title 24, Part 6, of the California Code of Regulations (CCR), were established in 1978 in response to a legislative mandate to reduce California's energy consumption. The standards are updated periodically to allow consideration and possible incorporation of new energy efficiency technologies and methods. The CEC adopted the 2008 Standards on April 23, 2008, and the Building Standards Commission approved them for publication on September 11, 2008. The 2008 Non-residential Compliance Manual was adopted January 14, 2009. The new standards went into effect January 1, 2010, and were updated again in 2011.

5.18.2.3 Local

San Francisco Sustainability Plan

The San Francisco Board of Supervisors endorsed the San Francisco Sustainability Plan in 1997, although the Board has not committed the CCSF to perform the actions addressed in the plan. The plan addresses a broad scope of environmental issues such as air quality, human health, biodiversity, and solid waste management to promote sustainability. The major energy goals expressed in the plan are: reduction of overall power use through maximizing energy efficiency; maintaining an energy supply based on renewable, environmentally sound resources; elimination of climate-changing and ozone-depleting emissions, and toxics associated with energy production and use; and basing energy decisions on the goal of creating a sustainable society (San Francisco 1997).

San Francisco Electricity Resource Plan

The 2002 Electricity Resource Plan for San Francisco presented the initial action plan to meet the City's growth in demand for electricity using renewable energy resources. Goals included in this plan were: assure reliable power; maximize energy efficiency; develop renewable power; increase local control; affordable electric bills; improve air quality; support environmental justice; and promote economic opportunities. One of the primary goals of the plan, to facilitate the shutdown of two of the older fossil-fueled power plants located in the City on Hunters Point and in Potrero Hill, was achieved in 2006 and 2011, respectively (SFPUC 2002). The *2011 Update of the San Francisco Electricity Resource Plan* reaffirms the on-going goals of the 2002 Electricity Resource Plan and details the next steps to help San Francisco achieve its goal of generating all of its energy needs from renewable and zero-greenhouse gas (GHG) electric energy sources by 2030. The updated plan is designed to cover all electrical energy needs in San Francisco, not just the electrical energy needs provided by the SFPUC to serve municipal facilities. The updated plan proposes three broad strategies to reduce GHG emissions from electricity:

- Empower San Francisco citizens and businesses to cost-effectively reduce GHG emissions associated with their own electric energy usage;
- Increase the amount of zero-GHG electricity supplied to the City's customers from the wholesale energy market; and
- Continue and expand the SFPUC electric service to guarantee reliable, reasonably-priced and environmentally sensitive service to its customers.

The 2011 Electricity Resource Plan includes recommendations for implementation of each of these strategies (SFPUC 2011).

5.18.3 Impacts and Mitigation Measures

5.18.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on minerals and energy resources if it were to:

- Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the State.
- Result in the loss of availability of a locally important mineral resource recovery site delineated on a local general plan, specific plan, or other land use plan.
- Encourage activities which result in the use of large amounts of fuel, water, or energy, or use these in a wasteful manner.

5.18.3.2 Approach to Analysis

This analysis evaluates the potential Project-related loss of availability of locally or regionally important mineral resources based on mapping conducted under the CGS Mineral Land Classification System. Impacts related to the loss of mineral resources would be considered significant if construction activities would make known mineral resources temporarily unavailable, or if the construction of new facilities would make these resources permanently unavailable.

This analysis also evaluates the use of energy resources (e.g., fuel and electricity) and the use of water associated with the construction and operation of the Project. For construction, the analysis considers whether construction activities would use large amounts of fuels, water, or energy, and whether they would be used in a wasteful manner. For energy, water, and fuel used during operation and maintenance, the analysis identifies the average annual increase in energy and fuel use that would occur with implementation of the Project to determine whether large amounts would be used and whether they would be used in a wasteful manner.

Natural gas would not be required for Project construction or operation and is not discussed further in this section.

With respect to water use, the Project would supply, treat, and distribute groundwater for use during a dry year. The additional water supply would supplant an existing source of water, but it would not increase demand (as, for example, a residential project would). Project construction techniques, such as watering exposed surfaces, would not result in the wasteful use of water or encourage activities using large amounts of water given that a water truck has a limited volume and it is to the benefit of the contractor not to water the site excessively. For these reasons, water usage is not discussed further in this section.

Areas of No Project Impact

The Project would not result in impacts related to the first and second significance criteria. These criteria are not discussed further in this section for the following reasons:

Result in the loss of availability of a known mineral resource of value to the region or State. As noted in Section 5.18.1.1 (Mineral Resources), the study area is mapped as MRZ-1, which means that no known mineral resources pursuant to SMARA were identified within the study area (CGS 1987, 1996). Therefore, the Project would not result in the loss of known mineral resources or make them inaccessible. As a result, this significance criterion would not be applicable to the Project.

Result in the loss of availability of a locally important mineral resource recovery site. As noted in Section 5.18.1.1 (Mineral Resources), the study area is mapped as MRZ-1, which means that no known mineral resources pursuant to SMARA were identified within the study area (CGS 1987, 1996). There are no locally important mineral resource recovery sites identified on a local general plan, specific plan, or other land use plan within the Project area (Colma 1999; Daly City 1987; Millbrae 1998; San Bruno 2009; San Mateo County 1986a, 1986b; South San Francisco 1999). Therefore, the Project would not impact the accessibility of a locally important mineral resource recovery site. As a result, this significance criterion would not be applicable to the Project.

5.18.3.3 Impact Summary

Table 5.18-1 (Summary of Impacts – Mineral and Energy Resources) provides a summary of potential impacts to energy resources and significance determinations.

TABLE 5.18-1
Summary of Impacts – Mineral and Energy Resources

Impact ME-1: The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during construction.	**Impact ME-2: The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during operation.**	**Impact C-ME-1: Construction and operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to mineral and energy resources.**
LS All Sites	LS All Sites	LS All Sites

Notes:

LS = Less than Significant

LSM = Less than Significant with Mitigation

5.18.3.4 Construction Impacts and Mitigation Measures

Impact ME-1: The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during construction. (Less than Significant)

<u>All Sites</u>

Construction of the Project would require the use of fossil fuels (primarily gas, diesel, and motor oil) for a variety of activities, including well drilling, excavation, grading, demolition, generator use, and vehicle travel. The precise amount of construction-related energy consumption is uncertain. However, given the nature and scale of Project construction (i.e., potentially up to 19 wells drilled, with operation of only 16), construction would not require a large amount of fuel or energy usage because of the moderate number of construction vehicles and equipment, worker trips, and truck trips that would be required for a project of this scale (see Table 3-8 [Estimated Daily Worker and Construction Equipment Trips for Well Facilities Construction], in Chapter 3, Project Description, Section 3.5.1.2 [Construction Methods for Well Facilities]). Therefore, Project construction would not encourage activities that would result in the use of large amounts of fuel and energy in a wasteful manner. The impact would be *less than significant.*

Impact Conclusion: Less than Significant

5.18.3.5 Operation Impacts and Mitigation Measures

Impact ME-2: The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during operation. (Less than Significant)

<u>All Sites</u>

The production of groundwater requires electricity to pump the groundwater from the wells, convey it to a water treatment system, treat the groundwater, and convey the treated water to the potable water distribution system. The amount of energy required would depend on the efficiency of the pumping equipment, the depth to groundwater, the distance to the treatment facility, the type of treatment required, and the distance to the distribution system. The proposed Project, during dry years, would increase energy demand associated with the pumping of accumulated water in the southern portion of the Westside Groundwater Basin; dry years are projected to occur in approximately 23 percent of the years (see Appendix I [Calculations for GSR Energy Use Impacts]). The proposed well facilities have been designed and sited so that wells would be close to treatment systems and close to existing distribution systems (the local distribution systems of the Partner Agencies and the regional water system), which would support an efficient use of energy (see Chapter 3, Project Description, Section 3.4.2 [Production Wells and Associated Facilities]). In accordance with the WSIP Greenhouse Gas Reduction Actions, the SFPUC would consult with its Power Enterprise's Energy Efficiency Group to incorporate applicable energy efficiency measures into the Project design, would attempt to maximize efficiency by exceeding Title 24 minimum requirements by at least 20 percent, and would attempt to meet or exceed LEED Silver certification. At a minimum, the proposed well facilities would be designed to meet California's energy efficiency standards outlined in Title 24 of the California Code of Regulations (see Chapter 3, Project Description, Section 3.7 [Greenhouse Gas Reduction Actions] and Section 3.4.2.2 [Well Facility Types]).

The proposed Project's energy demand would be the result of three operational components as discussed in Chapter 3, Project Description, Section 3.8 (Operations and Maintenance) and as shown on Figure 3-2 (Source of Proposed Water Supply for Partner Agencies). This includes operation of the new well facilities and pump station, operation of the Partner Agency wells, and operation of the regional water system. Each of these operational components is discussed below; refer to Appendix I (Calculations for GSR Energy Use Impacts) for additional information and assumptions.

New Well Facilities and Westlake Pump Station Upgrade

Most of the Project's energy demand would be due to pumping at the new wells; however, a small amount of energy would be required to operate the well facility buildings and treatment systems. The energy demand from the new well facilities and the Westlake Pump Station upgrade from pumping 7.2 mgd during a dry year (i.e., Take Year) would be approximately 17 million kWh (see Appendix I [Calculations for GSR Energy Use Impacts]). This would be the maximum annual demand, since the pumping volume would be greatest and the groundwater levels would be lowest during a dry year, thereby requiring more energy to pump the water to the surface (see Appendix I [Calculations for GSR Energy Use Impacts]). In other words, a greater volume of water would be pumped a greater distance.

Energy demand at the proposed well facilities in normal or wet years (i.e., Put or Hold Years) would be negligible, as the well pumps would only be turned on approximately four hours per month to exercise the wells and keep them from fouling (see Chapter 3, Project Description, Section 3.8.3 [Maintenance]).

Taking into account the projected frequency of dry, normal, and wet years, the long-term average annual energy demand of the proposed new well facilities and the Westlake Pump Station upgrade would be approximately four million kWh (see Appendix I [Calculations for GSR Energy Use Impacts]).

Partner Agency Wells

During dry years (i.e., Take Years), and in accordance with the proposed Operating Agreement (see Chapter 3, Project Description, Section 3.8.1 [Operating Agreement]), Partner Agency pumping would be 6.9 mgd, a slight increase over existing pumping, as calculated over a five-year averaging period; the estimated annual energy demand would increase only slightly.

During wet and normal years when the SFPUC Storage Account is full (i.e., Hold Years), the Partner Agencies could pump groundwater at the 6.9 mgd rate, as calculated over a five-year averaging period; the estimated annual energy demand would increase over the existing demand (at the 6.8 mgd pumping rate) only slightly. Under the proposed Operating Agreement, the Partner Agencies would be allowed to increase pumping by 10 percent over the 6.9 mgd, or a total of 7.6 mgd for a short period, but the five-year average pumping rate would still need to be maintained at 6.9 mgd. Therefore, any increased energy demand due to this possibility of short-term increased pumping by the Partner Agencies would be offset by decreased energy demand from reduced pumping required to maintain the 6.9 mgd five-year average pumping rate.

During normal and wet years when the SFPUC Storage Account is not full (i.e., Put Years), pumping by the Partner Agencies would be reduced substantially to 1.4 mgd. Estimated annual energy demand for the Partner Agencies' well facilities would decrease accordingly from 16 to 3 million kWh in normal and wet years (see Appendix I [Calculations for GSR Energy Use Impacts]).

Taking into account the projected frequency of dry, normal, and wet years, the long-term average annual energy demand of the Partner Agency's well facilities would decrease by approximately four million kWh (see Appendix I [Calculations for GSR Energy Use Impacts]).

Regional Water System

Under the proposed Project and in accordance with the proposed Operating Agreement, the SFPUC would decrease surface water deliveries to retail and wholesale customers by 7.2 mgd during dry years (i.e., Take Years), when water supply from groundwater would increase, resulting in energy savings to the regional water system of approximately one million kWh (see Appendix I [Calculations for GSR Energy Use Impacts]).

During normal and wet years when the SFPUC Storage Account is full (i.e., Hold Years), no changes would occur to deliveries from the regional water system due to the Project.

However, during normal and wet years when the SFPUC Storage Account is not full (i.e., Put Years), the SFPUC would increase surface water deliveries to the Partner Agencies by 5.5 mgd, when groundwater pumping would decrease to allow the southern portion of the Westside Groundwater Basin to recharge naturally. This increase in surface water deliveries would result in additional energy use by the regional water system of approximately one million kWh (see Appendix I [Calculations for GSR Energy Use Impacts]).

Taking into account the projected frequency of dry, normal, and wet years, the long-term average annual energy demand for the regional water system would not change substantially from the existing energy demand as a result of the proposed Project (see Appendix I [Calculations for GSR Energy Use Impacts]).

New Well Facilities, Partner Agency Wells, and Regional Water System

Thus, the collective change in energy demand of the new well facilities and Westlake Pump Station (increase of four million kWh), the Partner Agencies' wells (decrease of four million kWh) and the regional water system (no change) would be negligible, and the proposed Project would not cause a substantial increase in energy use on a long-term basis (see Appendix I [Calculations for GSR Energy Use Impacts]).

The Project also would use a small amount of fuel for worker trips to perform routine equipment checks at each well facility site. Each well station would be visited daily when wells are operating. During normal and wet years, the wells normally would be turned off, but regular exercising would be conducted. At these times, the wells would be visited on a weekly basis or at a frequency determined by on-site conditions (see Chapter 3, Project Description, Section 3.8.3 [Maintenance]).

Impact Conclusion

Therefore, because (1) the necessary power for the Project is already produced and distributed through existing infrastructure, (2) the Project is designed to be energy efficient and not waste energy, and (3) the proposed Project would not increase energy demands, the potential impacts associated with energy resources during operation of the Project would be *less than significant*. The energy resources that would be consumed by the Project would be for the public benefit and would not be wasteful, because the Project serves to increase water delivery reliability, meet customer water supply needs, and increase regional operational flexibility.

Impact Conclusion: Less than Significant

5.18.3.6 Cumulative Impacts and Mitigation Measures

Impact C-ME-1: Construction and operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to mineral and energy resources. (Less than Significant)

The geographic scope for the analysis of potential cumulative mineral and energy resources impacts consists of the proposed GSR facility sites, and the general vicinity (for mineral resources), and service area for the SFPUC Power Enterprise (for energy resources), as described in Section 5.18.1.3 (Current Energy Providers).

Construction

Mineral Resources

Because construction of the GSR Project would not result in Project-specific impacts related to mineral resources, implementation of the Project would not result in cumulative impacts to these resources (*no impact*).

Energy Resources

The cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) and the proposed GSR Project (see Impact ME-1) would all use energy during construction, which could result in a *significant* cumulative energy impact. However, the GSR Project's contribution to this cumulative impact would not be cumulatively considerable, given that construction of the Project as proposed would use a small amount of fuel and energy in an efficient manner for the public benefit. Therefore, the GSR Project's contribution to a significant cumulative impact on energy resources would not be cumulatively considerable (*less than significant*).

Operation

Mineral Resources

Because operation of the GSR Project would not result in Project-specific impacts related to mineral resources, implementation of the Project would not result in cumulative impacts to these resources (*no impact*).

Energy Resources

Most of the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts) would result in incremental increases in energy demand during long-term operation. The San Francisco Groundwater Supply Project (cumulative projects A-1 to A-6) would use the SFPUC Power Enterprise electricity to pump up to 4 mgd of groundwater for potable water supply. Expansion of the Holy Cross Cemetery (cumulative project E) would increase energy use to pump an additional 0.04 mgd of groundwater for cemetery operations. The Mission & McLellan Project (cumulative project F) would increase energy demand to supply power to 20 new condominium units. Lastly, the Centennial Village Project (cumulative project I) would increase energy demand with a new shopping center and 132 new apartment units.

As described in Impact ME-2, the GSR Project would have *less-than-significant* impacts on energy demand during operation, because it would not increase the long-term use of energy, it would not use energy in a wasteful manner, and the long-term energy demand for maintenance would be small.

Nevertheless, implementation of the proposed GSR Project, together with the cumulative projects listed in Table 5.1-3 (Projects Considered for Cumulative Impacts), could result in a *significant* cumulative impact on energy use. However, as discussed above, operation of the proposed GSR Project would not increase energy use in the long-term and would not be wasteful of energy resources. As a result, the GSR Project's contribution to a cumulative impact on energy resources would not be cumulatively considerable (*less than significant*).

5.18.4 References

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5.19 AGRICULTURE AND FOREST RESOURCES

This section describes existing agricultural and forest resources at each facility site and analyzes the potential for Project construction or operation to affect such resources through displacement or conversion of these uses.

5.19.1 Setting

The proposed Project would be located in northern San Mateo County in unincorporated San Mateo County, the Town of Colma, and the cities of Daly City, South San Francisco, San Bruno, and Millbrae. The proposed Project would be located in areas characterized primarily by developed urban/suburban landscapes, and within the Golden Gate National Cemetery and Lake Merced Golf Club. No proposed well facility sites would be located in areas zoned for, or used for, agricultural or forestry purposes. The study area for potential impacts to agriculture and forest resources is the construction area boundary of the individual facility sites.

5.19.1.1 Agricultural Resources

Farmland Classifications

Farmland Mapping and Monitoring Program

The California Natural Resources Agency's Department of Conservation (CDC), Division of Land Resource Protection, maps important farmlands throughout California. Important farmlands are classified into the categories listed below on the basis of soil conditions (their suitability for agriculture) and current land use.

- **Prime Farmland.** This category represents farmland with the best combination of physical and chemical characteristics for long-term agricultural production. It has the soil quality, growing season, and moisture supply needed to produce sustained high yields of crops when treated and managed. In addition, the land must have been used for irrigated agricultural production in the last four years to qualify under this category.
- **Farmland of Statewide Importance**. Farmland of Statewide Importance is similar to Prime Farmland in that it has a good combination of physical and chemical characteristics for crop production, but with minor shortcomings, such as greater slopes and less ability to store moisture.
- **Unique Farmland**. This land does not meet the criteria for Prime Farmland or Farmland of Statewide Importance, but is land that has been used for the production of the State's leading agricultural crops. This land is usually irrigated, but may include non-irrigated orchards or vineyards, as found in some climatic zones of California. Unique Farmland must have been cropped at some time during the four years prior to the mapping date.

- **Farmland of Local Importance**. This category applies to land of importance to the local agricultural economy, as determined by the county. This land is either currently producing crops or has the capability of production, but does not meet the criteria of the preceding categories.
- **Grazing Land.** Grazing Land is land on which the vegetation is suited to the grazing of livestock.
- **Urban and Built-up Land**. This land is occupied by structures with a building density of at least one unit to 1.5 acres, or approximately six structures on a 10-acre parcel. This land generally provides unfavorable conditions for agricultural production.
- **Other Land**. This is land that is not included in any of the categories above and may include brush, timber, wetlands, confined livestock areas, strip mines, and gravel pits, among other land types.

Farmland Designations in the Project Area

All of the proposed Project facility sites are mapped as Urban and Built-up Land (CDC 2011). No farmland is mapped in the study area (CDC 2011).

Williamson Act Program

As described below in Section 5.19.2.2 (State Regulations), the California Land Conservation Act (commonly referred to as the Williamson Act) is the State's primary program for the conservation of private land for agricultural and open space uses. The CDC prepares countywide maps of lands enrolled in Williamson Act contracts and classifies them into the categories described below.

- **Prime Agricultural Land**. This category represents the State's highest quality agricultural land. Land under this category is typically used for the production of irrigated crops or to support livestock.

- **Non-prime Agricultural Land**. This category represents Open Space Land of Statewide Significance, as defined under the California Open Space Subvention Act. Most land under this category is in agricultural uses such as grazing or non-irrigated crops and may also include other open space uses that are compatible with agriculture and consistent with local general plans.

- **Land in Non-renewal**. This category represents land under contracts that are being terminated at the option of the landowner or local government.

Williamson Act Contracts in the Study Area

No lands in the study area are enrolled in the Williamson Act program (CDC 2007).

5.19.1.2 Forest Resources

Section 12220(g) of the California Public Resources Code defines forest land as "land that can support 10 percent native tree cover of any species, including hardwoods, under natural conditions, and that allows for management of one or more forest resources, including timber, aesthetics, fish and wildlife, biodiversity, water quality, recreation and other public benefits." Timberland is land that is available for and capable of growing a crop of trees of any commercial species used to produce lumber and other forest products (Public Resources Code Section 4526). Under this definition, timberland does not include land owned by the federal government and land designated by the California Board of Forestry and Fire Protection as experimental forest land. There is no forest land within the study area.

5.19.2 Regulatory Framework

5.19.2.1 Federal Regulations

The Farmland Protection and Policy Act (FPPA) requires an evaluation of the relative value of farmland that could be affected by decisions sponsored in whole or part by the federal government. The FPPA is intended to minimize the impact federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses. It assures that, to the extent possible, federal programs are administered to be compatible with State, local units of government, and private programs and policies to protect farmland (USDA 2011). For the purpose of FPPA, farmland includes prime farmland, unique farmland, and land of statewide or local importance. Farmland subject to FPPA requirements includes forest land, pastureland, cropland, or other land, but not water or urban built-up land. The FPPA does not apply to the proposed Project, because lands in the study area are mapped as Built-up Lands.

5.19.2.2 State Regulations

As noted in Section 5.19.1.1 (Agricultural Resources), the California Land Conservation Act of 1965, commonly referred to as the Williamson Act, is the State's primary program aimed at conserving private land for agricultural and open space use. It is a voluntary, locally-administered program that offers reduced property taxes on lands whose owners place enforceable restrictions on land use through contracts between the individual landowners and local governments. As also indicated in Section 5.19.1.1 (Agricultural Resources), there are no lands in the study area that are enrolled in the Williamson Act program. Therefore, land use restrictions imposed by the Williamson Act are not applicable to the proposed Project.

5.19.2.3 Local Regulations

Local planning agencies regulate land uses, including agricultural uses, through general plan policies and zoning designations, which specify allowable uses within their jurisdictions. The San Francisco Public Utilities Commission (SFPUC) is not subject to local land use policies and zoning ordinances (refer to Chapter 4, Plans and Policies), although it seeks to work cooperatively with local jurisdictions to avoid conflicts. However, none of the facility sites would be located on land designated by a local general plan or zoned for agriculture or forestry (Colma 2009, 2010; Daly City 1987, 2003; Millbrae 1998, 2012; San Bruno 2007, 2009; San Mateo County 1986a, 1986b, 1999, n.d.; South San Francisco 1999, 2010).

5.19.3 Impacts and Mitigation Measures

5.19.3.1 Significance Criteria

For the purposes of this EIR, the Regional Groundwater Storage and Recovery Project would have a significant effect on agriculture and forest resources if it were to:

- Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as shown on maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Natural Resources Agency, to non-agricultural use.
- Conflict with existing zoning for agricultural use or a Williamson Act contract.
- Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code Section 12220[g]) or timberland (as defined by Public Resources Code Section 4526).
- Result in the loss of forest land or the conversion of forest land to non-forest use.
- Involve other changes in the existing environment, which, due to their location or nature, could result in the conversion of farmland to non-agricultural use or forest land to non-forest use.

5.19.3.2 Approach to Analysis

Due to the location of the Project, no impacts would occur related to the five impact criteria listed above; therefore, no impact discussion is provided for these topics for the reasons presented below:

Convert mapped farmland to non-agricultural use. The proposed Project's facility sites are not located on or in the vicinity of land mapped as farmland. Therefore, the first significance criterion listed above is not applicable to the Project and is not discussed further.

Conflict with zoning for agricultural use or with a Williamson Act contract. The proposed Project's facility sites are not located on land zoned for agricultural uses or subject to a Williamson Act contract. Therefore, the second significance criterion listed above is not applicable to the Project and is not discussed further.

Conflict with existing zoning for, or cause rezoning of, forest land, or result in the loss of forest land or the conversion of forest land to non-forest use. No land in the study area is either zoned for forestry or meets the definition of forest land. Thus, neither construction nor operation of the proposed Project would conflict with zoning regulations for forest land, result in the loss of forest land, or result in the conversion of forest land to non-forest use. Therefore, the third and fourth significance criteria listed above are not applicable to the proposed Project and are not discussed further.

Involve other changes in the existing environment, which, due to their location or nature, could result in the conversion of farmland to non-agricultural use or forest land to non-forest use. The facility sites would be located on land designated as Urban and Built-up Land. The proposed Project would install and operate improvements (well facilities and an upgrade at the Westlake Pump Station) for water supply and, therefore, would not involve changes that would result in conversion of farmland to non-agricultural use or forest land to non-forest use. Thus, the fifth criterion listed above is not applicable to the proposed Project and is not discussed further.

5.19.3.3 Construction and Operational Impacts and Mitigation Measures

As discussed above, the Project would not cause impacts to agriculture or forest resources. Therefore, no mitigation measures related to this resource topic are required.

5.19.3.4 Cumulative Impacts and Mitigation Measures

Because the GSR Project would not result in Project-specific impacts related to agriculture or forest resources, implementation of the Project would not result in cumulative impacts to these resources.

5.19.4 References

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6 OTHER CEQA ISSUES

Sections	Tables
6.1 Growth Inducement 6.2 Summary of Cumulative Impacts 6.3 Significant Environmental Effects that Cannot be Avoided if the Proposed Project is Implemented 6.4 Significant Irreversible Environmental Changes 6.5 References	6-1 Summary of Significant Cumulative Impacts

6.1 GROWTH INDUCEMENT

6.1.1 Introduction and Overview

This chapter analyzes the growth inducement potential and associated secondary effects of growth impacts of the proposed Project, as required by the California Environmental Quality Act (CEQA). CEQA requires that an Environmental Impact Report (EIR) evaluate the growth inducing impacts of a proposed Project. A growth-inducing impact is defined as follows:

> "[T]he ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects which would remove obstacles to population growth… It must not be assumed that growth in any area is necessarily beneficial, detrimental, or of little significance to the environment" (CEQA Guidelines Section 15126.2[d]).

As described in Chapter 2 Introduction and Background, Section 2.2 (Project Background), the San Francisco Planning Department prepared a Program Environmental Impact Report (PEIR) on the San Francisco Public Utilities Commission's (SFPUC) Water System Improvement Program (WSIP), which was certified in October 2008 (San Francisco Planning Department 2008). The PEIR includes a detailed analysis of the growth inducement potential of the overall WSIP water supply strategy and concluded that "The WSIP would support planned growth in the existing SFPUC service area (WSIP PEIR, Volume. 4, Chapter 7, Impact 7-1)."

The proposed GSR Project, as a dry-year supply project of the WSIP, would be a contributing factor in that growth inducement potential and associated indirect effects of growth. By removing the lack of a reliable water supply and supply system as one potential obstacle to growth within the SFPUC service area, the WSIP, and thus the proposed Project, would have an indirect growth-inducing effect according to the CEQA definition above[1]. This EIR tiers from the WSIP PEIR, and the growth inducement analysis contained in PEIR Chapter 7 and PEIR Appendix E are incorporated by reference into this EIR. All impacts related to the WSIP water supply strategy to which the Project contributes have been examined at a sufficient level of detail in the PEIR and no additional review is necessary in this EIR. The significant environmental effects have been adequately addressed in the PEIR and the SFPUC has adopted the CEQA Findings on the PEIR related to the growth inducing impacts of the WSIP. A summary of the growth inducement analysis in the PEIR is provided below.

6.1.2 Summary of PEIR Growth Inducement Analysis

Implementation of the WSIP would achieve the WSIP goals and objectives, including the water supply goal through the year 2018. It would allow the SFPUC to: (1) meet its customer water needs in non-drought periods through the year 2018 and (2) limit rationing to a maximum of 20 percent reduction in water service system-wide during extended droughts. Achieving the WSIP water supply goal would increase the reliability of water service to existing customers and provide water to serve planned growth of additional residential and business customers in the existing SFPUC service area.

A variety of factors influence new development or population growth in the area served by the SFPUC's water, including economic conditions of the region, adopted growth management policies in the affected communities and the availability of adequate infrastructure (e.g., water service, sewer service, public schools and roadways), with economic factors generally the leading driver. While water service is only one of many factors affecting the growth potential of a community, it is one of the chief public services needed to support urban development, and lack of a reliable water supply as well as a service capacity deficiency could constrain future development.

Pursuant to CEQA, growth per se is not assumed to be necessarily beneficial, detrimental, or of little significance to the environment; it is the secondary, or indirect, effects of growth that can cause adverse changes to the physical environment. The indirect effects of population and/or economic growth and accompanying development can include increased demand on community services and public service infrastructure; increased traffic and noise; degradation of air and water quality; and conversion of agricultural land and open space to urban uses. Local land use plans (e.g., general plans and specific plans) of the jurisdictions served by the SFPUC establish land use development patterns and growth policies that are intended to allow for the orderly expansion of urban development supported by adequate public services, including water supply, roadway infrastructure, sewer service and solid waste service. Local jurisdictions conduct CEQA environmental review on their general and specific plans to assess the secondary effects of their planned growth and to identify feasible mitigation for significant, adverse effects. A project that would induce growth and is inconsistent with local land use plans and policies could indirectly cause adverse environmental impacts, as well as impacts on public services; this

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[1] The WSIP would not *directly* induce growth as it does not involve the development of new housing to attract additional population, nor would it indirectly induce growth by establishing substantial permanent or even short term construction employment opportunities that could stimulate population growth. Construction of the WSIP projects is not expected to involve employment opportunities substantially beyond what would normally be available to construction workers in the area, and workers are expected to be drawn from the local labor pool.

could occur if the local land use jurisdictions have not previously addressed these issues in the CEQA review of their land use plans and development proposals.

By removing the lack of a reliable water supply and water system (as one potential obstacle to growth within the SFPUC service area), providing and assisting in the development of additional water supply sources (such as recycled water and groundwater projects) and promoting of more efficient use of water through conservation measures, the WSIP would have an indirect growth-inducing effect according to the CEQA definition. The WSIP would support growth in the SFPUC service area through 2018; although it appears that some growth would occur irrespective of the WSIP due to increased water delivery efficiencies (e.g., plumbing code changes), conservation and other water supply sources. Growth would in turn result in indirect effects. In most cases, the effects of population and employment growth have been identified and addressed in the EIRs for the general plans and associated area plans and specific plans adopted by the jurisdictions in the service area. Some of the identified indirect effects of growth are significant and unavoidable; others are significant, but can be mitigated.

Potentially significant and unavoidable impacts as a result of growth in the SFPUC service area have been identified by the local jurisdictions in the following areas: traffic congestion, air pollution, traffic noise, construction noise, increased demand for public schools and other public services, loss of recreational opportunities and impacts on visual quality resulting from the loss of open space, cumulative effects on over-utilized parks, loss of wildlife habitat and wetlands and impacts on other biological resources, cumulative impacts on cultural resources, increased flooding potential, increased urban runoff pollutants, seismic hazards, induced population growth, failure to meet housing demand for projected population growth, exposure of new development to contaminated soil or groundwater, insufficient water supply, insufficient wastewater disposal capacity, loss of agricultural resources, land use conflicts, conflicts with existing land use plans or policies, and changes in density, scale and character of an area.

The adopted WSIP would have growth-inducement potential through 2018 because the SFPUC (with the cooperation of the wholesale customers) would provide the additional water supply to meet purchase requests through 2018. The WSIP would support much of the growth through 2018 in the jurisdictions served by the regional water system. In general, development that was planned and approved through the general plan process in the SFPUC service area would have environmental impacts. The environmental consequences of this planned growth have been largely addressed in local plans and the associated CEQA review, as well as in other, project-specific documentation. In a number of jurisdictions, negative declarations or mitigated negative declarations were prepared for general plans and related planning documents that were found not to have significant environmental effects.

The PEIR does not identify any mitigation measures for implementation by the SFPUC that could substantially decrease or eliminate growth-inducing impacts. This is because the SFPUC does not have control over the decisions that each local agency will make with respect to growth in their jurisdictions. Individual agencies' general plans and environmental documents contain actions, limitations and mitigation measures that will be implemented in the individual jurisdictions with local development project or program approvals. These types of mitigation measures were identified in the PEIR (see PEIR Chapter 7 and PEIR Appendix E, which are incorporated by reference into this EIR) (San Francisco Planning Department 2008).

To assess the growth inducement potential of the WSIP and characterize the secondary effects of growth, the PEIR investigates the following questions:

- What assumptions did the SFPUC and its wholesale customers make regarding growth (population and employment) in projecting future (2030) total water demand and customer purchases from the SFPUC?
- Are these assumptions consistent with forecasts prepared and used by local and regional planning agencies (e.g., Association of Bay Area Governments [ABAG], counties, and cities) within the service area? What are the growth trends in the Bay Area region?
- Are there any notable inconsistencies between the population and employment forecasts used by the SFPUC and the wholesale customers, and those of the local and regional planning agencies that suggest that the water supply planning efforts are inconsistent with land use planning efforts?
- Is the level of growth projected for 2030 consistent with that identified and planned for in existing adopted general plans?
- What are the potential environmental impacts (i.e., secondary effects) associated with growth projected to occur in the service area? Have these impacts been evaluated in previous CEQA review documents on existing general and specific plans?
- What mitigation measures and findings have the local jurisdictions adopted as part of approving their future growth plans?

  The issues raised in these questions are summarized below and addressed in detail in PEIR Chapter 7 (Volume 4) and supplemented by PEIR Appendix E (Volume 5).

- **SFPUC Projections (PEIR Section 7.2).** Accurate demand projections are important in ensuring that future water supplies will be adequate while not surpassing the needs of planned growth. The SFPUC and its customers used computer models to forecast future water demand. PEIR Section 7.2 presents an overview of the SFPUC water service area and describes key factors (assumptions, inputs and methodologies) used in estimating future demand that relate to growth and inform comparisons between water demand and land use planning projections. These factors include baseline population, methodology used to determine existing water usage by land use/account type, the current water supply agreement between the SFPUC and its wholesale customers, and assumptions regarding future land use patterns, water conservation and recycling, and water from other (non-SFPUC) sources through 2030. The demand estimates, in conjunction with estimates of savings from conservation and use of other water sources, provide the basis for the 2030 purchase estimates.
- **Growth Inducement Potential (PEIR Section 7.3).** This section analyzes the WSIP's growth inducement potential: whether the demand to be met by the WSIP would be consistent with local plans and policies or could contribute to growth in the service area beyond that called for in the existing general plan. To gauge the consistency of the WSIP with growth planned in the jurisdictions served by the SFPUC, the analysis compares the growth assumed in the SFPUC projections with growth forecasts (a) developed by ABAG and (b) reflected in

adopted land use plans in the service area. With respect to ABAG, this section also describes ABAG's changing expectations about growth as reflected in its updated projections issued in 2002, 2003, and 2005.

- **Indirect Effects of Growth (PEIR Section 7.4).** Growth (whether planned or unplanned) can cause environmental impacts. Section 7.4 of the PEIR describes the potential impacts of growth that could be supported, in part, by implementation of the WSIP. This section also identifies measures adopted to reduce, eliminate or otherwise mitigate the impacts of planned growth.

6.1.3 Summary of Conclusions

A review of historical growth trends of a selection of jurisdictions in the service area, based primarily on information in general plans and Bay Area Water Supply and Conservation Association profiles, shows that:

- Cities in the service area are largely urbanized, most having experienced their most rapid growth in the postwar decades through the 1970s.
- Milpitas and East Palo Alto have experienced high rates of growth more recently.
- San Francisco's population fluctuated somewhat, but on average has been essentially stable over the past 50 years.
- Many jurisdictions cannot grow laterally and their general plans include policies to manage growth. Many general plans identify strategies consistent with "smart growth" principles, such as encouraging infill development and the redevelopment of previously developed areas, as means to accommodate future growth.
- The SFPUC's wholesale customers vary widely, in a variety of ways: by size; overall demand projected for 2030; the change that the 2030 demand represents in absolute terms and as a percentage of 2001 demand; and the degree to which the customers depend on the SFPUC for their water supply. As such, the WSIP would remove growth obstacles to varying degrees within the service area.

As stated above, the complete growth inducement analysis is included in PEIR Chapter 7 and PEIR Appendix E, which are incorporated into this EIR by reference.

6.1.4 Indirect Effects of Growth

The indirect effects of growth expected in the general plans of jurisdictions in the service area have been identified in the EIRs prepared for those plans. Impacts commonly identified as significant and unavoidable and those commonly identified as significant, but mitigable, are presented in PEIR Section 7.4 and summarized briefly.

- The most commonly identified significant and unavoidable impacts of growth are:
  - Increased traffic congestion,
  - Deterioration of air quality, and
  - Cumulative effects of increased air pollutant emissions and noise.
- Mitigation measures have been adopted by local jurisdictions as part of their general plan approval processes to address the secondary effects of planned growth. These measures are summarized in PEIR Appendix E.
- Two cities, Foster City and City of San Mateo, identified increased demand for potable water supply as a significant and unavoidable effect of growth; the WSIP would address this issue in those two cities.
- Overriding considerations commonly adopted by the decision-making bodies in adopting their general plans include the following:
  - Accommodation of growth in an orderly, fiscally sound manner
  - Economic diversification and job generation
  - Creation of housing, furtherance of regional housing share objectives, and provision of affordable housing
  - Improvements of the local jobs/housing balance
  - Increased sales revenue and positive fiscal impact
  - Promotion of alternative modes of travel to reduce reliance on private vehicles
  - Establishment of policies to preserve natural areas and open space lands
- For many cities that receive water from the regional water system, the supply to be provided under the WSIP supports and is consistent with the planned growth reflected in their existing adopted general plans. For other communities, it appears that the WSIP supply (in combination with other supply sources available to those communities), could serve a level of growth beyond that identified in the existing general plans. In those cases, secondary effects of such growth could include impacts related to increased density and impacts related to development of new land areas.
  - Density related impacts could include increased traffic congestion, air pollution, traffic noise, construction noise and demand on public services.
  - Land area related impacts could include loss of open space and agricultural land, as well as loss of and degradation of water quality due to increases in impervious surface area.

The proposed GSR Project would not directly induce population or economic growth, nor would it tax existing community service facilities or encourage other activities that could significantly affect the environment. However, as described above, the GSR Project is one of the groundwater projects that comprise the WSIP and, therefore, its implementation would contribute to the growth inducement potential of the WSIP and the associated indirect effects of growth. Implementation of the GSR Project would thus contribute to an incremental portion of the growth inducement impacts and associated indirect impacts of growth of the WSIP. See Chapter 7 of the PEIR for a detailed analysis of the WSIP's growth inducement effects (San Francisco Planning Department 2008).

6.2 SUMMARY OF CUMULATIVE IMPACTS

As described in Chapter 5 Environmental Setting, Impacts, and Mitigation Measures, Section 5.1.7 (Cumulative Impacts), cumulative impacts are defined as "two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts" (CEQA Guidelines Section 15355). Cumulative impacts can result from individually minor, but collectively significant actions when added to those of other closely related past, present or reasonably foreseeable future projects. The cumulative impacts from several projects are the change in the environment that results from the incremental impact of the project when added to other closely related past, present and reasonably foreseeable future projects. The cumulative analysis in this EIR identifies Project impacts that would be individually limited, but when viewed in connection with the effects of other past, present and reasonably foreseeable future projects, could be "cumulatively considerable" with regard to the Project's contribution to a cumulative impact.

In Chapter 5 Environmental Setting, Impacts, and Mitigation Measures, cumulative impacts are discussed and analyzed under each resource area immediately following the description of the direct impacts of the proposed Project and the identified mitigation measures for that resource area. The analyses of cumulative impacts are based on the same setting, regulatory framework and significance criteria as the direct impacts, and it applies the results of the project-level, direct impact analysis within the context of the identified geographic scope of the area affected by the cumulative effect. Table 5.1-3 (Projects Considered for Cumulative Impacts) lists the relevant past, present and reasonably foreseeable future projects proposed by the SFPUC and other jurisdictions that are considered in the cumulative impact analysis. Figure 5.1-3 (Location of Projects Considered in the Cumulative Analysis), shows the location of the cumulative projects.

Table 6-1 (Summary of Significant Cumulative Impacts), provides a summary of the cumulative impacts associated with the GSR Project that are significant. All significant cumulative impacts could be reduced to less-than-significant levels with implementation of mitigation measures identified in Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, except for unavoidable noise, and well interference impacts. See Chapter 5 for a detailed discussion of cumulative impacts by resource topic, and where appropriate, a description of mitigation measures that would avoid or lessen the cumulative impacts.

TABLE 6-1
Summary of Significant Cumulative Impacts

Impact	Significance Determination
Impact C-LU-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to land use.	SUM
Impact C-AE-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to scenic resources and visual character.	LSM
Impact C-CR-1: Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains.	LSM
Impact C-TR-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to transportation and circulation.	LSM
Impact C-NO-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to noise.	SUM
Impact C-AQ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality.	LSM
Impact C-UT-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to utilities and service systems.	LSM
Impact C-BR-1: Construction and operation of the proposed Project could result in significant cumulative impacts related to biological resources.	LSM
Impact C-BR-2: The Project would result in cumulative construction or operational impacts related to special-status species, riparian habitat, sensitive communities, wetlands, or waters of the United States, or compliance with local policies and ordinances protecting biological resources at Lake Merced.	LSM
Impact C-HY-1: Project construction could result in a cumulatively considerable contribution to cumulative impacts on hydrology and water quality.	LSM
Impact C-HY-2: Operation of the proposed Project would result in a cumulative considerable contribution to cumulative impacts related to well interference.	SUM
Impact C-HY-5: The proposed Project, in combination with past, present, and reasonably foreseeable future projects, could have a substantial adverse effect on water quality that could affect the beneficial uses of surface waters.	LSM
Impact C-HY-8: Operation of the proposed Project would have a cumulatively considerable contribution to a cumulative impact related to groundwater depletion effect.	LSM
Impact C-HZ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials.	LSM

Notes:

LSM = Less than Significant with Mitigation

SUM = Significant and Unavoidable with Mitigation

6.3 SIGNIFICANT ENVIRONMENTAL EFFECTS THAT CANNOT BE AVOIDED IF THE PROPOSED PROJECT IS IMPLEMENTED

In accordance with Section 21100(b)(2)(A) of CEQA and with Sections 15126(b) and 15126.2(b) of the CEQA Guidelines, the purpose of this section is to identify project-related environmental impacts that could not be eliminated or reduced to a less-than-significant level with implementation of mitigation measures identified in Chapter 5 Environmental Setting, Impacts, and Mitigation Measures. The findings in this chapter are subject to final determination by the San Francisco Planning Commission as part of its certification of the EIR.

6.3.1 Significant and Unavoidable Effects of the Proposed Project

This section identifies Project impacts that, even with the implementation of all identified mitigation measures, would remain significant and are, therefore, considered *unavoidable*. All GSR Project impacts would either be less than significant or reduced to less-than-significant levels with implementation of the identified mitigation measures except for unavoidable land use, aesthetics, well interference, and noise impacts. The analysis presented in Chapter 5 Environmental Setting, Impacts, and Mitigation Measures, of this EIR concludes that implementation of the proposed Project would result in four significant and unavoidable impacts:

- Project construction would result in significant and unavoidable impacts associated with construction noise and the temporary increase in ambient noise levels and exceedance of local noise standards. Even with implementation of all feasible noise-reducing mitigation measures, a significant impact would remain with mitigation at Sites 1, 3, 4, 5 (On-site Treatment), 9, 12, 14, 16, 18 (Alternate), and 19 (Alternate) (see Section 5.7, Noise and Vibration, Impacts NO-1, NO-3, and C-NO-1).
- Similarly, Project construction would have a substantial temporary impact on the existing character of the area surrounding well facility sites and could substantially disrupt existing land uses near Sites 1, 3, 4, 5, (On-site Treatment), 9, 12, 14, 16, 18 (Alternate), and 19 (Alternate). These impacts would remain significant and unavoidable after implementation of mitigation measures (see Section 5.2, Land Use, Impacts LU-1 and C-LU-1).
- Project construction would result in a significant and unavoidable impact on the visual character of the area surrounding Site 7, related to the removal of trees. Even with implementation of all feasible mitigation measures, the significant impact would remain at Site 7 (see Section 5.3, Aesthetics, Impact AE-1).
- Operation of the project would decrease the production rate of existing wells due to localized groundwater drawdown within the Westside Groundwater Basin such that existing or planned land uses may not be fully supported. Mitigation could reduce impacts to less than significant. However, feasibility of mitigation would vary depending on the willingness of the well owner to allow the SFPUC to implement mitigation, which would have to take place on the property of existing irrigators. Because such assurance has not yet been provided, the

impact is considered significant and potentially unavoidable (see Section 5.16, Hydrology and Water Quality, Impacts HY-7 and C-HY-2).

6.3.2 Significant and Unavoidable Effects of the WSIP

The proposed Project is one of the groundwater projects that comprise the SFPUC's WSIP. Insofar as the proposed Project is a component of the WSIP, it would contribute to the WSIP's significant and unavoidable, and potentially significant and unavoidable water supply and growth-inducement impacts, as identified in the WSIP PEIR (San Francisco Planning Department 2008) and summarized below:

- By providing water to support planned growth in the SFPUC service area, the WSIP will result in significant and unavoidable growth inducement effects that are primarily related to secondary effects such as air quality, traffic congestion and water quality. These impacts were adequately addressed in the PEIR at a sufficient level of detail such that no further analysis is required in this EIR. The analysis contained in the PEIR is incorporated into this EIR by this reference (see PEIR Chapter 7).
- Based on the best available information at that time, the PEIR made the conservative determination that the WSIP could result in a significant and unavoidable impact on fishery resources in Crystal Springs Reservoir related to inundation of spawning habitat upstream of the reservoir (see PEIR Chapter 5, Section 5.5.5, Impact 5.5.5-1). The project-level fisheries analysis in the Lower Crystal Springs Dam Improvements Project EIR modifies certain PEIR impact determinations based upon more detailed site-specific data and analysis. These project-level conclusions supersede any contrary impact conclusions in the PEIR. Project-level review of updated, site-specific information that was developed following certification of the PEIR was incorporated into the project-level EIR for the Lower Crystal Springs Dam Improvements Project, and the project-level analysis determined that impacts on fishery resources due to inundation effects would be less than significant (San Francisco Planning Department 2010).
- Based on the best available information at that time, the PEIR made the conservative determination that the WSIP would result in a significant and unavoidable impact related to flow along Alameda Creek below the Alameda Creek Diversion Dam ("Alameda Creek Hydrologic Impact") (see PEIR Chapter 4, Section 5.4.1, Impact 5.4.1-2). The project-level analysis in the Calaveras Dam Replacement Project EIR modifies this PEIR impact determination to be less than significant based upon more detailed site-specific data and analysis (San Francisco Planning Department 2011). These project-level conclusions supersede the contrary impact conclusions in the PEIR.

6.4 SIGNIFICANT IRREVERSIBLE ENVIRONMENTAL CHANGES

In accordance with CEQA Section 21100(b)(2)(B) and CEQA Guidelines Sections 15126(c) and 15126.2(c), the purpose of this section is to identify significant irreversible environmental changes that would be caused by the proposed Project. Construction activities associated with the GSR Project would result in an irretrievable and irreversible commitment of natural resources through the use of power supply and construction materials. In addition, the construction of new facilities (e.g., new wells and water treatment facilities) would result in an irretrievable or irreversible commitment of land to water supply uses. However, these uses would take up limited land area and are compatible with adjacent land uses.

The proposed GSR Project would require the commitment of energy resources to fuel and maintain construction equipment (such as gasoline, diesel and oil) during the construction period. Project construction would commit resources, such as concrete and steel, to be used for the proposed facilities and related improvements.

6.5 REFERENCES

San Francisco Planning Department. 2008. *Final Program Environmental Impact Report for the San Francisco Public Utility Commission's Water System Improvement Program (*File No. 2005.0159E, State Clearinghouse No. 2005092026). Certified October 30, 2008.

San Francisco Planning Department. 2010. *Final Environmental Impact Report for the San Francisco Public Utilities Commission's Lower Crystal Springs Dam Improvements Project* (San Francisco Planning Department, File No. 2005.0161E, State Clearinghouse No. 2007012002). Certified October 7, 2010.

San Francisco Planning Department. 2011. *Final Environmental Impact Report for the San Francisco Public Utilities Commission Calaveras Dam Replacement Project* (San Francisco Planning Department, File No. 2005.0161E, State Clearinghouse No. 2005102102). Certified January 27, 2011.

7 ALTERNATIVES

Sections	Tables
7.1 Introduction 7.2 WSIP Alternatives 7.3 GSR Alternatives Analysis 7.4 Comparison of Alternatives 7.5 Environmentally Superior Alternative 7.6 Alternatives Considered but Rejected from Further Analysis 7.7 References	7-1 Selected CEQA Alternatives 7-2 Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

7.1 INTRODUCTION

This chapter presents the California Environmental Quality Act (CEQA) alternatives analysis for the Groundwater Storage and Recovery Project (GSR Project or Project). The CEQA Guidelines, Section 15126.6(a), state that an Environmental Impact Report (EIR) must describe and evaluate a reasonable range of alternatives to a project that would feasibly attain most of the project's basic objectives, but that would avoid or substantially lessen any identified significant adverse environmental effects of the project. Specifically, the CEQA Guidelines (Section 15126.6) set forth the following criteria for selecting and evaluating alternatives:

- **Identifying Alternatives**. The selection of alternatives is limited to those that would avoid or substantially lessen any of the significant effects of the project, are feasible, and would attain most of the basic objectives of the project. Among the factors that may be considered when addressing the feasibility of an alternative are site suitability, availability of infrastructure, general plan consistency, other plans or regulatory limitations, jurisdictional boundaries, economic viability, and whether the proponent can reasonably acquire, control, or otherwise have access to an alternative site. An EIR need not consider an alternative whose impact cannot be reasonably ascertained and whose implementation is remote and speculative. The specific alternative of "no project" must also be evaluated.
- **Range of Alternatives**. An EIR need not consider every conceivable alternative, but must consider and discuss a reasonable range of feasible alternatives in a manner that will foster informed decision-making and public participation. The "rule of reason" governs the selection and consideration of EIR alternatives, requiring that an EIR set forth only those alternatives necessary to permit a reasoned choice. The lead agency (the City and County of San Francisco [CCSF]) is responsible for selecting a range of project alternatives to be examined and for disclosing its reasons for the selection of the alternatives.

- **Evaluation of Alternatives**. EIRs are required to include sufficient information about each alternative to allow meaningful evaluation, analysis, and comparison with the proposed project. Matrices may be used to display the major characteristics and the environmental effects of each alternative. If an alternative would cause one or more significant effects that would not result from the project as proposed, the significant effects of the alternative must be discussed, but in less detail than the significant effects of the project.

This chapter is organized in the following sections, following this introductory section:

Section 7.2, WSIP Alternatives, summarizes the seven alternatives to the San Francisco Public Utilities Commission (SFPUC) Water System Improvement Program (WSIP) that were evaluated in the WSIP Program EIR (PEIR). As required by CEQA, the PEIR evaluated a range of alternatives to the WSIP. The GSR Project is the primary drought supply project under the WSIP.

Section 7.3, GSR Alternatives Analysis, describes the alternatives selection process and the objectives of the Project; summarizes the significant impacts of the Project; describes the alternatives selected for detailed analysis; and compares the environmental impacts of each alternative to those of the proposed Project.

Section 7.4, Comparison of Alternatives, provides a summary comparison of the alternatives, including the No Project Alternative, to the proposed Project. It includes a summary of environmental impacts, a discussion regarding the ability of each alternative to meet project objectives.

Section 7.5, Environmentally Superior Alternative, identifies the environmentally superior alternative.

Section 7.6, Alternatives Considered but Rejected from Further Consideration, includes a description of the alternatives that were considered for evaluation in this Draft EIR and the reasons they were rejected from further consideration. Alternatives were eliminated from detailed consideration in this Draft EIR where they failed to meet most of the basic project objectives, were infeasible, and/or would not avoid any significant environmental effects.

7.2 WSIP ALTERNATIVES

As discussed in Chapter 2, Introduction and Background, the SFPUC approved implementation of the Phased WSIP in October 2008. The WSIP is a comprehensive program to improve the reliability of the regional water system with respect to water quality, seismic response, and water delivery based on a planning horizon through the year 2030, as well as to improve the system with respect to water supply to meet water delivery needs in the service area through the year 2018. To the extent that the GSR Project would contribute to achieving the goals and objectives of the WSIP, the analysis of the WSIP alternatives applies to the alternatives analysis of the GSR Project.

The San Francisco Planning Department, Environmental Planning Division (EP) considered systemwide alternatives to the WSIP in the PEIR, which the San Francisco Planning Commission certified on October 30, 2008. The PEIR evaluated seven alternatives to the WSIP because of their apparent ability to meet most of the WSIP's goals, their ability to reduce one or more of the significant impacts associated with program implementation, their potential feasibility, and their collective ability to provide a reasonable range of alternatives to foster informed decision-making and public participation. Analysis of the No Program Alternative was included in the PEIR as required by CEQA.

The San Francisco Planning Commission certified the PEIR in October 2008 (Planning Commission Motion No. 17734). Thereafter, the SFPUC approved the Phased WSIP and adopted the CEQA Findings on the WSIP (SFPUC Resolution 08-0200). The Phased WSIP incorporates elements of three alternatives analyzed in the PEIR: the No Purchase Request Increase Alternative, the Aggressive Conservation/Water Recycling and Groundwater Alternative, and the Modified WSIP Alternative. Chapters 9 and 14 of the PEIR include more detailed descriptions of these WSIP alternatives and also present the associated program-level environmental analysis of these alternatives. Chapter 13 of the PEIR includes additional information about the adopted Phased WSIP. All three of these chapters are incorporated into this EIR by reference. For informational purposes, the WSIP and the alternatives examined in the PEIR are summarized below.

- **WSIP Proposed Program**. The proposed program described and analyzed in the PEIR would establish program goals and system performance objectives in the areas of water quality, seismic reliability, delivery reliability, and water supply. The WSIP would provide for water supplies to serve customer purchase requests during non-drought and drought periods through 2030, including increased average annual diversions from the Tuolumne River, and would implement all key regional facility improvement projects.
- **No Program Alternative**. Under the No Program Alternative, the SFPUC would implement only those facility improvement projects driven by regulatory requirements or existing agreements with regulatory agencies. It would meet only the water quality goals of the WSIP and would fail to meet the other goals and objectives. It would endeavor to meet increasing customer purchase requests through the year 2030 by diverting additional Tuolumne River water only when available under the CCSF's existing water rights.
- **No Purchase Request Increase Alternative**. The No Purchase Request Increase Alternative is designed to serve the wholesale customers the amount of water required under the Master Water Sales Agreement between the CCSF and each of the wholesale customers in effect in 2008. It would thereby limit the ability of the system to meet customer purchase requests through 2030, but would include implementation of all key regional facility improvement projects.
- **Aggressive Conservation/Water Recycling and Local Groundwater Alternative**. Under the Aggressive Conservation/Water Recycling and Local Groundwater Alternative, the SFPUC would implement all of the key regional facility improvement projects, but would endeavor to serve the projected increase in customer purchase requests through 2030 only through additional conservation, water recycling, and local groundwater projects.
- **Lower Tuolumne River Diversion Alternative**. Under the Lower Tuolumne River Diversion Alternative, the SFPUC would implement all of the key regional facility improvement projects and would serve the projected increase in customer purchase requests through 2030 through diversions from the lower Tuolumne River near its confluence with the San Joaquin

River. This alternative would include construction and operation of additional conveyance and treatment facilities to divert, transport, treat, and blend the new supply into the regional water system.

- **Year-round Desalination at Oceanside Alternative**. Under the Year-round Desalination at Oceanside Alternative, the SFPUC would implement all of the key regional facility improvement projects and would construct a 25-million-gallons-per-day (mgd) desalination plant in San Francisco to serve the projected increase in customer purchase requests through 2030.
- **Regional Desalination for Drought Alternative**. Under the Regional Desalination for Drought Alternative, the SFPUC would implement all of the key regional facility improvement projects and would partner with other San Francisco Bay Area (Bay Area) water agencies to construct and operate a regional desalination plant that would provide the SFPUC with supplemental supply during drought years.
- **Modified WSIP Alternative**. Under the Modified WSIP Alternative, the SFPUC would implement all of the key regional facility improvement projects, but would modify proposed system operations to minimize environmental effects. This alternative would include the implementation of key mitigation measures identified in the PEIR.

The alternatives analysis in the PEIR identified the Modified WSIP Alternative as the environmentally superior alternative. As described above, the Phased WSIP was ultimately adopted by the SFPUC, which incorporates elements of the No Purchase Request Alternative, the Aggressive Conservation/Water Recycling and Groundwater Alternative, and the Modified WSIP Alternative.

7.3 GSR ALTERNATIVES ANALYSIS

7.3.1 Approach to Alternatives Selection

Consistent with CEQA, the approach to alternatives selection for this Project EIR focused on identifying alternatives that: (1) could meet most of the basic objectives of the GSR Project while reducing one or more of its significant impacts, (2) could foster informed decision-making and public participation, and (3) were feasible. The planning effort for the Project entailed consideration of multiple alternatives by the SFPUC and EP. Certain alternatives were eliminated from consideration based on their inability to meet most of the Project's basic objectives, their lack of feasibility, or their inability to reduce the Project's environmental impacts. Those alternatives retained for consideration are presented in Section 7.3.4 (Selected CEQA Alternatives). The alternatives eliminated and the reasons for their elimination are discussed in Section 7.5 (Environmentally Superior Alternative).

The proposed Project would increase the volume of groundwater in storage by allowing the South Westside Groundwater Basin to recharge naturally during normal and wet years. The increased volume of groundwater in storage would occur through a reduction in groundwater pumping by the Partner Agencies; this reduction in groundwater pumping would be made possible by increased surface water deliveries to the Partner Agencies from the regional water system in those years. This "conjunctive," or cooperative, use of the basin would allow recapture of the naturally stored water during dry years.

As discussed in Chapter 3, Section 3.2 (Project Goals and Objectives) the primary goal for the Project is to provide an additional dry-year water supply for the SFPUC and Partner Agencies. Specific objectives of the Project are to:

- Conjunctively manage the South Westside Groundwater Basin through the coordinated use of SFPUC surface water and groundwater pumped by the Partner Agencies;
- Provide supplemental SFPUC surface water to the Partner Agencies in normal and wet years, with a corresponding reduction of groundwater pumping by these agencies, which would then allow for in-lieu recharge of the South Westside Groundwater Basin;
- Increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by 7.2 mgd; and
- Provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8.5-year design drought cycle[1].

These objectives support the goals and objectives of the SFPUC's WSIP (SFPUC Resolution No. 08-200). The Project is considered by the SFPUC to be a fundamental component of the WSIP; implementation of the proposed Project is one element of an overall program designed to achieve the established WSIP system performance objectives for delivery reliability and water quality.

7.3.2 Impacts of the Proposed Project

The proposed Project would have potentially significant impacts on land use, aesthetics, cultural and paleontological resources, transportation and circulation, noise, air quality, recreation, utilities and service systems, biological resources, geology and soils, hydrology and water quality, hazards and hazardous materials, and mineral and energy resources. These impacts are associated with construction and operation of the Project as discussed below:

Construction-related Impacts: With the exception of noise, land use, and aesthetics impacts during Project construction, all construction-related Project impacts were determined to have no impact (NI) or be less than significant (LS) or less than significant with mitigation (LSM). The Project's estimated construction-related noise levels at some of the sites were determined to result in significant impacts even with implementation of mitigation (SUM). Significant and unavoidable noise impacts would result from proposed nighttime well drilling that would conflict with local noise standards and/or exceed sleep interference thresholds and daytime construction that would exceed the speech interference thresholds at

[1] The SFPUC measures water supply reliability using an 8.5-year design drought for water supply planning purposes. The design drought is based on the hydrology of the six years of the worst historical drought (1987-1992) plus the 2.5 years of the 1976-1977 drought, for a combined total of an 8.5-year design drought sequence. For additional information on the design drought and its role in the environmental analysis in this EIR, refer to Section 3.2 in the Project Description.

the closest residential receptors (see Impacts NO-1 and NO-3 in Section 5.7, Noise and Vibration). Because of this temporary significant and unavoidable noise impact, temporary construction-related impacts on land use character were also considered to be significant and unavoidable (see Impact LU-1 in Section 5.2, Land Use).

Additionally, the Project would result in the removal of a portion of a locally-designated tree mass in the Town of Colma at Site 7 to accommodate construction of a well facility treatment building, and the impact was determined to be significant and unavoidable (for the preferred option of consolidated treatment at Site 6 and the on-site treatment option). Although a mitigation measure has been identified to potentially reduce the visual impacts associated with tree removal at this site, all trees in the construction area boundary may be removed due to construction safety concerns and trees may not be replanted in the SFPUC right-of-way in sufficient numbers and tree species following construction to reduce the aesthetic impacts to less than significant (see Impact AE-1 in Section 5.3, Aesthetics, Section 5.3.3.4 [Construction Impacts and Mitigation Measures]). All other construction-related significant impacts were determined to be *less than significant with mitigation* (LSM).

Operation-related Impacts: With the exception of hydrology and land use impacts during project operations, all operational-related impacts were determined to be less than significant or less than significant with mitigation. Potential impacts resulting from well interference during Project pumping were determined to be significant and potentially unavoidable because implementation of the identified mitigation would not be totally within the control of the SFPUC, and project operations could adversely impact existing irrigation wells in areas near GSR Project wells. Mitigation measures identified would effectively reduce impacts to existing irrigation wells to a less-than-significant level; however, since the successful implementation of the identified mitigation measure at all affected existing irrigation wells cannot be certain at this time (as it would depend on cooperation from existing irrigation well owners), the mitigation may not reduce all impacts to less-than-significant levels at all locations. Therefore, the potential impacts of well interference were determined to be significant and potentially unavoidable even with all feasible mitigation applied (see Impact HY-6 in Section 5.16, Hydrology and Water Quality). All other significant impacts related to Project operations were determined to be *less than significant with mitigation* (LSM).

All the impacts of the proposed Project, including the significance determination before and after mitigation, are listed in Table 1-1 (Summary of Impacts and Mitigation Measures) at the end of Chapter 1, Executive Summary, in Section 1.5 (Summary of Project Impacts and Mitigation Measures).

7.3.3 GSR Project Development and Site Screening

Prior to the start of the environmental review process, the SFPUC and the Partner Agencies (California Water Service Company [Cal Water], the City of Daly City, and the City of San Bruno) developed an Alternatives Analysis Report (AAR) to evaluate the potential to use the South Westside Groundwater

Basin[2] to store water in normal and wet years and develop in-lieu recharge of the Basin to increase the volume of water in storage that can be pumped in dry years (MWH 2007).

The AAR identifies and evaluates potential sites for the facilities needed to support the Project and achieve all the Project's goals and objectives. The AAR evaluated potential well and treatment facility sites based on evaluation criteria for identification of preferred facility locations.

The following is a list of evaluation criteria utilized in the AAR:

- **Well Site Suitability.** This evaluation included review of access to the site, the footprint of the site, underground obstructions, and horizontal setback distances.
- **Groundwater System Considerations.** This evaluation included review of potential well yield, groundwater quality, well interference, and geologic stability.
- **Distribution System Considerations.** This evaluation included proximity to existing Partner Agency and SFPUC conveyance and treatment facilities.
- **Land Use Considerations.** This evaluation included a review of land ownership, property acquisition, ease of permitting, and local acceptance.

Candidate well sites were identified, screened for suitability, displayed on maps, and evaluated with respect to the evaluation criteria. Preferred well sites were selected and analyzed using a hydraulic model of the water distribution system to evaluate whether the respective water systems would accommodate the estimated additional water at each proposed location.

The SFPUC developed the Project in conjunction with the Partner Agencies and other stakeholders with impact avoidance or reduction in mind. The SFPUC participated in a multi-agency collaborative effort to identify and rank new groundwater well locations; 48 potential well sites were identified and evaluated according to the criteria listed earlier in this section. The 48 potential well sites were reduced to 14 well sites through application of the evaluation criteria (MWH 2007). The SFPUC completed groundwater modeling for the 14 wells identified and found that the pumping rates needed to reach the desired 7.2 mgd could result in well interference and other potential well interference effects at the Partner Agency wells and among the 14 Project wells. As a result, the SFPUC increased the proposed number of wells to 16 wells to redistribute the required pumping over a larger geographic area and thereby reduce the potential for well interference. The SFPUC also has identified three alternate well sites to be implemented in the instance where up to three of the 16 preferred well facilities cannot be constructed due to infeasibility. Some well sites include alternate connections to the SFPUC or Partner Agency distribution systems. Also, the Project includes alternate treatment configurations for wells at Sites 5, 6, and 7; treatment may be located on site for each of these three, or consolidated for all three of these sites at Site 6 (MWH et al. 2008).

[2] The Westside Groundwater Basin has been administratively divided at the San Francisco-San Mateo County line.

7.3.4 Selected CEQA Alternatives

In accordance with CEQA requirements, an alternative must meet the following three criteria: 1) the alternative would attain most of a project's basic objectives; 2) the alternative would avoid or substantially reduce the significant environmental impacts of the proposed project; and 3) the alternative must be feasible. An EIR need not analyze an alternative whose impact cannot be reasonably ascertained and whose implementation is remote and speculative. Furthermore, an EIR need not consider every conceivable alternative, but must consider a reasonable range of alternatives that will foster well-informed decision-making and public participation.

This section describes the project alternatives that were selected and analyzed in accordance with CEQA Guidelines Section 15126.6(a). The five alternatives to the proposed Project selected for detailed analysis in this EIR are:

- **Alternative 1: No Project Alternative.** The SFPUC would not conjunctively manage the South Westside Groundwater Basin with the Partner Agencies and the basin would continue to be operated as it is now. The 16 wells and well facilities would not be constructed or operated, the Westlake Pump Station would not be upgraded, and a new drought water supply would not be developed. The six test wells installed at Sites 2 (Park Plaza Meter), 5 (Right-of-way at Serra Bowl), 6 (Right-of-way at Colma BART), 8 (Right-of-way at Serramonte Boulevard), 10 (Right-of-way at Hickey Boulevard), and 13 (South San Francisco Linear Park) would be abandoned in accordance with regulatory standards or converted to monitoring wells[3].
- **Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield.** This alternative would reduce impacts on Lake Merced associated with declining lake levels by reducing Project pumping near the lake by approximately 54 percent by eliminating construction and operation of Sites 1 (Lake Merced Golf Club) and 4 (Garden Village Elementary School)[4], but redistributing that pumping to wells located away from Lake Merced to maintain Project yield at 7.2 mgd. The Project has the potential to affect Lake Merced by both increasing lake levels during extended Put and Hold Periods and decreasing lake levels during and after a design drought. There is no alternative that can reduce the extent of both lake level increases and lake level declines. Declining lake levels cause a more extensive set of impacts, including impacts to water quality and wetlands, so this alternative was developed to address declining lake levels, as was Alternative 2B, which is described below.
- **Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield.** This alternative would reduce impacts on Lake Merced associated with declining lake levels by reducing Project pumping near the lake by approximately 54 percent (by eliminating construction and operation of Sites 1 and 4), thereby reducing Project yield from 7.2 mgd to approximately 6.2 mgd.

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[3] Sites 2, 5, and 6 are located in Daly City. Site 8 is located in the Town of Colma and Sites 10 and 13 are located in South San Francisco.

[4] Site 1 is located in Daly City and Site 4 is located in Broadmoor, in unincorporated San Mateo County.

- **Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield.** This alternative would reduce impacts on existing irrigation wells in the Colma area by reducing Project pumping near Colma by approximately 32 percent (by eliminating construction and operation of Sites 7 [Right-of-way Colma Boulevard][5] and 8), but also by redistributing that pumping to wells located away from Colma to Daly City, unincorporated Broadmoor, and San Bruno, to maintain Project yield at 7.2 mgd. Alternative 3A represents an alternative that could be developed to decrease well interference for wells in a particular geographic area near proposed well facility sites while maintaining the overall project yield.
- **Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield.** This alternative would reduce impacts on existing irrigation wells in the Colma area by reducing Project pumping near Colma by approximately 32 percent (by eliminating construction and operation of Sites 7 and 8), thereby reducing Project yield from 7.2 mgd to approximately 6.0 mgd. Alternative 3B represents an alternative that could be developed to decrease well interference for wells in a particular geographic area near proposed well facility sites while reducing overall project yield.

Table 7-1 (Selected CEQA Alternatives) provides a brief description of these alternatives and highlights how they differ from the proposed Project. Sections 7.3.4.1 through 7.3.4.5, below, include an evaluation of the impacts of the five selected alternatives relative to those of the proposed Project. Because the alternatives are conceptual, the evaluation is based on the available information and reasonable assumptions about how each alternative would be implemented. Each project alternative presented below has been developed only for the Project's preferred 16 sites and does not include analysis of the proposed alternate sites; the proposed alternate sites are included in the Project Description and have been evaluated as part of the Project. For each project alternative, Sections 7.3.4.1 through 7.3.4.5 present the following:

- A description of the alternative, including the rationale for its selection. Each description discusses feasibility issues as well as assumptions regarding the construction methods likely to be used.
- An evaluation of the alternative's ability to meet project goals and objectives. Evaluation of hydrologic and water quality impacts of the alternatives is, in part, dependent upon the groundwater modeling undertaken for the evaluation of the Project. Refer to Chapter 5, Environmental Setting, Impacts, and Mitigation Measures, Section 5.1.6 (Groundwater Modeling Overview) for an explanation of the groundwater model and its assumptions and limitations.
- Analysis of the environmental impacts of each alternative compared to those of the proposed Project.

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[5] Site 7 is located in Colma.

The significant impacts of the proposed Project and the alternatives are presented in Table 7-2 (Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project), which follows discussion of each of the alternatives in Section 7.4 (Comparison of Alternatives).

TABLE 7-1
Selected CEQA Alternatives

Alternative	How Does the Alternative Differ from the Proposed Project?
Alternative 1: No Project. The SFPUC would not conjunctively manage the South Westside Groundwater Basin with the Partner Agencies and the basin would continue to be operated as it is under existing conditions.	• The 16 wells and well facilities would not be constructed or operated. The Westlake Pump Station would not be upgraded. • A new drought water supply may not be developed unless the SFPUC or its wholesale customers pursue other projects.
Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield. The SFPUC would not construct or operate Sites 1 and 4, two of the four wells proposed to be located near Lake Merced. The SFPUC would instead increase Project pumping at Sites 5 through 15 by approximately 20 percent each, to maintain overall yield at 7.2 mgd.	• Pumping near Lake Merced would be reduced by approximately 54 percent compared to the Project. • 14 well facilities would be constructed, rather than 16 wells proposed by the Project. • No well or well facility would be constructed or operated at Sites 1 or 4, and approximately 1.0 mgd of Project pumping proposed at these two wells would not occur. • Approximately 1.0 mgd of Project pumping would be redistributed to wells at Sites 5 through 15. • Pumping at Sites 5 through 15 would increase by approximately 20 percent each compared to the proposed Project. • Well interference impacts on some existing irrigators' wells would be increased.
Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield. The SFPUC would not construct or operate wells at Sites 1 and 4, two of the four sites proposed to be located near Lake Merced. Overall yield would be approximately 6.2 mgd.	• Pumping near Lake Merced would be reduced by approximately 54 percent compared to the Project. • 14 well facilities would be constructed, rather than 16 wells described in the Project. • No well or well facility would be constructed or operated at Sites 1 and 4, and approximately 1.0 mgd of Project pumping proposed at these two wells would not occur. • Overall yield would be reduced from 7.2 mgd to 6.2 mgd, approximately a 14 percent decrease compared to the proposed Project.

TABLE 7-1
Selected CEQA Alternatives

Alternative	How Does the Alternative Differ from the Proposed Project?
Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield. The SFPUC would not construct or operate wells at Sites 7 and 8, two of the seven wells proposed to be located near existing irrigation wells for cemeteries in Colma. The SFPUC would instead increase Project pumping at Sites 1 through 4 and 11 through 15 by approximately 31 percent each, to maintain overall yield at 7.2 mgd.	• Pumping near the existing irrigation wells for cemeteries in Colma would be reduced by approximately 32 percent compared to the Project. • 14 well facilities would be constructed, rather than 16 wells proposed in the Project. • No well or well facility would be constructed or operated at Sites 7 or 8, and approximately 1.2 mgd of Project pumping proposed at these two wells would not occur. • Approximately 1.2 mgd of Project pumping would be redistributed to wells at Sites 1 through 4 and 11 through 15 to maintain yield at 7.2 mgd. • Lake Merced impacts would be increased.
Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield. The SFPUC would not construct or operate wells at Sites 7 and 8, two of the seven sites proposed to be located near existing irrigation wells for cemeteries in Colma. Overall yield would be approximately 6.0 mgd.	• Pumping near the existing irrigation wells for cemeteries in Colma would be reduced by approximately 32 percent compared to the Project. • 14 well facilities would be constructed, rather than 16 wells proposed in the Project. • No well or well facility would be constructed or operated at Sites 7 or 8, and approximately 1.2 mgd of Project pumping proposed at these two wells would not occur. • Overall yield would be reduced from 7.2 mgd to approximately 6.0 mgd, approximately a 16 percent decrease compared to the proposed Project.

7.3.4.1 Alternative 1: No Project Alternative

CEQA Guidelines Section 15126.6(e) requires that EIRs include an evaluation of the No Project Alternative to provide decision-makers the information necessary to compare the relative impacts of approving a project to not approving a project. The No Project Alternative is defined as a continuation of existing conditions, as well as conditions that are reasonably expected to occur in the event that a proposed project is not implemented.

Description of Alternative

In the event that the SFPUC does not implement the GSR Project, no Project facilities would be constructed and the conjunctive use of the South Westside Groundwater Basin, as proposed under the Project, would not occur. Under the No Project Alternative, a GSR dry-year water supply would not be available to the SFPUC, its wholesale customers, or the Partner Agencies, as planned for and approved in the Phased WSIP.

The SFPUC would continue to operate the regional water system, but it would have reduced water supply reliability during dry years under the No Project Alternative compared to the proposed Project. Under the No Project Alternative, regional water system customers would experience water shortages -- and the need to implement water rationing -- more frequently, and water rationing would be more severe; i.e., exceeding 20 percent systemwide rationing, based on hydrologic modeling (San Francisco Planning Department 2008).

In the absence of reliable water service from the SFPUC during dry years, the wholesale customers may pursue other projects, either individually or collectively, to meet their dry-year water needs. However, numerous factors would inhibit the ability of the wholesale customers to address the decreased supply during dry years associated with this alternative, including the following:

- Water demand among all customers is highest when supplies are most constrained, i.e., during dry years, and therefore dry-year water supply is more difficult to secure. Securing water supplies in California is increasingly difficult, particularly in dry years, as overall demand increases and conflicts among competing interests for water supply arise (San Francisco Planning Department 2008).
- A major new water supply project can take as many as 20 to 25 years to complete (Johnson and Loux 2004).
- The SFPUC wholesale customers already have planned for and adopted increased water conservation and recycling initiatives (San Francisco Planning Department 2008).

The ability of the wholesale customers to develop additional dry-year water supplies is uncertain, and further studies would be required to evaluate technical and institutional feasibility. Determining (a) the specific projects that each wholesale customer would pursue, and (b) the likelihood that the wholesale customers could successfully implement the projects is speculative and largely outside the control of the SFPUC.

The basic water management strategies that the wholesale customers could pursue to offset the reduced dry-year water supply under the No Project Alternative involve increasing supply and decreasing demand or increasing rationing during dry years. Potential options associated with these strategies are water purchases or transfers, increased groundwater use, more aggressive water conservation or water recycling, and desalination. However, each of the wholesale customers has already planned for their water supply taking into consideration such programs, and further development of these programs by the wholesale customers may or may not occur for the sake of dry-year supply management.

The WSIP PEIR evaluated water purchases or transfers, increased groundwater use, additional water conservation and water recycling as part of the WSIP and evaluated even further expansion of these programs and local and regional desalination as part of the WSIP alternatives. The WSIP PEIR provides additional detail on supplemental supply options and their associated environmental impacts (San Francisco Planning Department 2008).

Ability of Alternative to Meet Project Objectives

The No Project Alternative would not meet any of the project objectives as it would not result in the coordinated use of SFPUC surface water and groundwater by the Partner Agencies or the in-lieu recharge of the South Westside Groundwater Basin, and it would not provide a new dry-year groundwater supply for SFPUC customers.

Without the Project, the South Westside Groundwater Basin would not be conjunctively managed and the coordinated use of SFPUC surface water and groundwater pumped by the Partner Agencies would not occur. The existing municipal groundwater use by the Partner Agencies would likely continue under the No Project Alternative.

The No Project Alternative would also not support the WSIP goals because it would not provide a dry-year supply to increase water delivery reliability nor would it meet customer water supply needs. The No Project Alternative would not allow the operational flexibility and delivery reliability goals of the WSIP to be met, as fulfillment of the WSIP goals is reliant upon the proposed Project providing 7.2 mgd for up to 7.5 years during a drought.

Environmental Impacts of No Project Alternative Compared to Those of the Proposed Project

The No Project Alternative would avoid all of the construction impacts identified for the GSR Project. The No Project alternative would eliminate the need for construction activities at the GSR facility sites, thereby avoiding all construction impacts identified for the proposed Project, including the significant and unavoidable impacts associated with noise, land use, aesthetics, and hydrology, which, in some instances, may be at least partially reduced by mitigation where feasible (in other instances, feasible mitigations may not exist for reducing some of the impacts identified) (See Section 7.3.2 [Impacts of the Proposed Project]). Other proposed future projects in the GSR Project area may still be implemented. The San Francisco Groundwater Supply (SFGW) Project (cumulative project A-1 through A-6) is one of the projects approved by the SFPUC in 2008 as part of the WSIP, and is currently undergoing project-level environmental review. In addition, the SFPUC Peninsula Pipelines Seismic Upgrade Project (cumulative projects D-1 through D-3), which is also proposed to be implemented under the WSIP and undergoing environmental review, and the PG&E Transmission Pipeline Replacement Project (cumulative project H) could be implemented. While cumulative construction impacts could still occur from these projects, there would be no contribution to the cumulative impacts from the No Project Alternative.

The significant environmental impacts of the No Project Alternative are presented in Table 7-2 (Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project). Because alternatives in general have been selected to reduce groundwater impacts, a more detailed analysis of groundwater impacts is provided than for other impacts.

Indirect or Secondary Impacts. Under the No Project Alternative, the SFPUC could not meet dry-year water supply goals. To meet the dry-year water supply goals, the SFPUC and/or its wholesale customers would likely take action to secure supplemental dry-year supply to make up for drought period supply shortfalls, which could have similar or additional secondary environmental effects. Supplemental dry-year supply options include additional Tuolumne River diversions and water transfers from the Turlock Irrigation District or the Modesto Irrigation District. The WSIP PEIR provides additional detail on supplemental dry-year supply options and their associated environmental impacts (San Francisco Planning Department 2008).

The No Project Alternative could result in secondary effects related to development of drought water supplies. Supplemental water supply options include, for example, water transfers. If the SFPUC and/or its wholesale customers were to pursue supplemental water supplies to compensate for the dry-year shortfall due to the No Project Alternative being selected, the secondary effects could include any or all of the following: construction impacts and operational impacts such as groundwater overdraft, subsidence, seawater intrusion, and water quality effects associated with development of groundwater sources; impacts on fisheries and biological resources, including sensitive species, associated with additional Tuolumne River diversions; and construction impacts and operational impacts on land use, aesthetics, hydrology and water quality, air quality, hazards, and energy associated with development of desalinated water supplies.

7.3.4.2 Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield

Description of Reduce Lake Merced Impacts and Maintain Project Yield Alternative

Alternative 2A was selected for analysis because it would reduce potentially significant biological and water quality impacts associated with declining lake levels at Lake Merced due to Project pumping during dry years, although these impacts have been determined to be less than significant, or less than significant with mitigation (see Impact RE-6 in Section 5.11, Recreation; Impacts BR-6, BR-7, BR-8, BR-9, and C-BR-2 in Section 5.14, Biological Resources; and Impacts HY-9 and C-HY-5 in Section 5.16, Hydrology and Water Quality). Under Alternative 2A, the SFPUC would construct only 14 wells and well facilities (instead of 16 wells under the proposed Project). The 14 wells would be located at the same preferred sites as the Project; however, Alternative 2A would not include a well or well facility at Site 1 in Daly City or Site 4 in unincorporated Broadmoor. Without wells at Sites 1 and 4, pumping would be reduced by approximately 1.0 mgd. To maintain the overall yield at 7.2 mgd, pumping would be redistributed to 11 wells at Sites 5 through 15. Pumping at each of Sites 5 through 15 would increase by approximately 20 percent compared to the proposed Project and production rates of wells at Sites 5 through 15 could support this increased pumping (SFPUC 2012b, 2012c). Pumping at Sites 2 and 3 would not increase under this alternative, because these would become the closest Project wells to Lake Merced and the goal of this alternative is to minimize impacts on Lake Merced, as compared to the proposed Project. Pumping at Site 16 would also not increase under this alternative, as compared to the Project, because groundwater availability is restricted at this location (compared to the other preferred sites). As a result, this alternative would decrease Project pumping near Lake Merced by approximately 54 percent when compared to the Project proposal.

Ability of the Reduce Lake Merced Impacts and Maintain Project Yield Alternative to Meet Project Objectives

Alternative 2A would fully meet the Project objectives. The overall yield would remain at 7.2 mgd, which would meet the Project goal to increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by an average annual 7.2 mgd in the event that the 8.5-year design drought was to happen.

Environmental Impacts of the Reduce Lake Merced Impacts and Maintain Project Yield Alternative (Alternative 2A) Compared to Those of the Proposed Project

Construction-related Impacts. Alternative 2A would result in all of the same construction-related impacts as the proposed Project, except for the construction-related impacts associated with construction at Sites 1 and 4. Elimination of Site 1 would eliminate the SU and SUM impacts relative to noise and the SUM impacts relative to land use, as well as all other LSM and LS impacts at that site (see Impacts NO-1 and NO-3 in Section 5.7, Noise and Vibration, and Impact LU-1 in Section 5.2, Land Use). Elimination of Site 4 would eliminate SUM impacts relative to noise and land use (see Impacts NO-1 and NO-3 in Section 5.7, Noise and Vibration, and Impact LU-1 in Section 5.2, Land Use), as well as all other LSM and LS impacts at the site. All other SU and SUM impacts related to noise, land use, and aesthetics would remain as described for the proposed Project. These impacts are described in Chapter 5, Environmental Setting, Impacts and Mitigation Measures. Construction impacts at the remainder of the sites related to cultural resources, transportation and circulation, recreation, utilities and service systems, geology and soils, water quality, and hazards and hazardous materials would be the same as those of the proposed Project, and the same mitigation measures would be required to reduce these impacts to less-than-significant levels.

Operational Impacts. The significant environmental impacts of Alternative 2A are presented in Table 7-2 (Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project). However, because Alternative 2A was selected to reduce groundwater impacts, a more detailed analysis of operational groundwater impacts is provided than for other impacts as compared to the proposed Project. The operational groundwater impacts of the alternatives as compared to the proposed Project are presented below. The information provided comes from the groundwater modeling analysis and other technical studies, as identified below (Kennedy/Jenks 2012b, 2012c).

Production rate of preexisting wells. A 54 percent reduction in pumping near Lake Merced would reduce well interference impacts on the irrigation wells at the Lake Merced Golf Club. This reduced interference, however, would be partially offset by increased pumping at Sites 5, 6, and 7. The 54 percent pumping reduction near Lake Merced attributable to the elimination of Sites 1 and 4, however, would not provide enough change to maintain water levels above the well screens at the Lake Merced Golf Club. As a result, static water levels at the Lake Merced Golf Club wells would still decrease to below the top of the well screen, increasing the risk of well or pump damage. Therefore, the well interference impact on the Lake Merced Golf Club wells would be significant under Alternative 2A, as it would be for the proposed Project. The elimination of pumping at Sites 1 and 4 would have a beneficial effect on the Olympic Club wells and the San Francisco Golf Club wells, compared to the proposed Project because, similar to the proposed Project, both static and pumping groundwater levels would remain above the top of the well screen at these wells under Alternative 2A. Furthermore, these wells have the capacities to meet their peak demand (Fugro 2012b). Therefore, the well interference impact on the Olympic Club wells and the San Francisco Golf Club wells would be less than significant under Alternative 2A, as it would be for the proposed Project.

Increasing pumping at Sites 5 through 15 by 20 percent would increase well interference impacts on the wells at the Colma cemeteries and at the California Golf Club. Under the proposed Project, all irrigation wells at the nine Colma area cemeteries and the California Golf Club would be subject to significant well interference impacts. The increased pumping at Sites 5 through 15 would increase such impacts at these wells by approximately 20 percent. Therefore, the well interference impacts on the Colma cemetery wells and on the California Golf Club wells would be significant and slightly greater under Alternative 2A, than they would be for the proposed Project. Mitigation Measure M-HY-6 (Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation) would reduce the impacts of well interference to *less-than–significant* levels, except that the implementation of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property, thereby potentially resulting in a *significant and unavoidable impact with mitigation*. Refer to the discussion of Impact HY-6 in Section 5.16, Hydrology and Water Quality, Section 5.16.3.7 (Operation Impacts and Mitigation Measures – Groundwater) where this impact analysis is presented in greater detail.

Land Subsidence. A 54 percent reduction in pumping near Lake Merced would reduce the risk of subsidence near Daly City and the unincorporated community of Broadmoor. A 20 percent increase in pumping at Sites 5 through 15 would increase the risk of subsidence slightly, but would not result in significant impacts, because estimated subsidence would remain below the established thresholds of six inches for structures and drainage patterns, and one foot for floodplains. The maximum expected subsidence under the proposed Project would be 3.4 inches; approximately half of the six-inch threshold. The 20 increase in pumping at Sites 5 through 15 would result in a 20 percent increase in groundwater elevation decline compared to the proposed Project. The method for calculating subsidence indicates that subsidence changes would be proportionately smaller than groundwater elevation changes and, therefore, a 20 percent increase in groundwater level decline would not be expected to increase subsidence to significant levels, because to do so would require almost doubling the amount of subsidence anticipated for the proposed Project (Fugro 2012a). Therefore, subsidence impacts would be slightly greater for Alternative 2A when compared to the proposed Project; however, the impacts would be *less than significant* for both Alternative 2A and the proposed Project.

Seawater Intrusion. Decreasing pumping in the Lake Merced area by 54 percent may reduce the risk of seawater intrusion from the Pacific Ocean slightly. Increasing pumping at Sites 5 through 15 by 20 percent would increase the risk of seawater intrusion from San Francisco Bay. Seawater intrusion has been observed in sediments adjacent to the Bay and is expected to continue into the future. The proposed Project would reduce the risk of seawater intrusion a small amount. Over a long-term average, estimated groundwater elevations at the Bay rise slightly and approximately three acre-feet (af) per year more groundwater is predicted to flow out to the Bay, as compared to modeled existing conditions. (Kennedy/Jenks 2012c)

While there would be an incremental increase in the potential for seawater intrusion due to the 20 percent increase in pumping in Colma, South San Francisco, and San Bruno areas, the magnitude of the increase would be relatively small based on two lines of evidence. First, in general, the San Francisco Bay coast is not particularly susceptible to seawater intrusion due to the presence of the Bay Mud and a subsurface bedrock ridge, both of which provide some protection to the southern portion of the South Westside Basin from potential seawater intrusion from San Francisco Bay (Kennedy/Jenks 2012c). Second, the proposed Project is estimated to increase groundwater flows to the Bay (due to the increase of in-lieu recharge) on the order of two to three af per month at the end of the design drought. For this alternative, the increase in pumping from GSR wells south of Daly City would slightly increase the potential for seawater intrusion from San Francisco Bay as compared to the proposed Project. This is not expected to result in a seawater intrusion impact because it would be similar to the amount of seawater intrusion predicted under modeled existing conditions (SFPUC 2012a). Therefore, potential seawater intrusion impacts would be slightly greater under Alternative 2A; however, the potential impact for both Alternative 2A and the proposed Project would be *less than significant.*

Adverse Effects on Beneficial Uses at Lake Merced. A 54 percent reduction in pumping in the Lake Merced area would result in a 54 percent decrease in the decline of Lake Merced lake levels at the end of the design drought. The proposed Project is expected to result in lake levels that are one foot lower than is predicted to occur under modeled existing conditions at the end of the design drought; under Alternative 2A, this impact would be reduced to approximately 0.5 feet instead of one foot, due to the reduced pumping under this alternative. Because the lake levels under the proposed Project recover more slowly than under modeled existing conditions, the difference between the proposed Project and modeled existing conditions is actually greater several years after the drought than at the end of the drought. Thus, the proposed Project is expected to result in lake levels about four feet lower than under modeled existing conditions after the end of the design drought. With the proposed Project, the lake is expected to recover to a lake level of 0 feet City Datum within 37 months after the drought. Under Alternative 2A, the decline in lake levels (as compared to modeled existing conditions) would be reduced to approximately 2 feet City Datum (instead of 4 feet City Datum under the proposed Project), due to the reduced pumping under this alternative, and the recovery period is expected to be shorter (SFPUC 2012b). During the period following the design drought, when Lake Merced lake levels are recovering, the impact of Alternative 2A on water quality would be *significant*, as it would be for the proposed Project, because, monthly lake level averages would decline below 0 feet City Datum under both the proposed Project (a minimum of -2.5 feet) and this alternative (a minimum of -0.5 feet). Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) would require the SFPUC to develop and implement a lake level monitoring and management program to maintain Lake Merced at water levels similar to conditions that would occur without the Project. The mitigation measures would be effective at reducing impacts of the alternative to less than significant, as it would be for the Project, because it requires the SFPUC to implement lake level management procedures to maintain Lake Merced water levels above 0 feet City Datum. These procedures include continuation of lake-level and groundwater monitoring, additions of supplemental water, if available, or alteration of pumping patterns. Implementation of this measure would ensure that any lake level declines to below 0 feet City Datum as a result of this alternative are short-term and, with the addition of supplemental water or alteration of pumping patterns, this alternative would not result in long-term changes in water quality that would adversely affect the potential beneficial uses of Lake Merced.

Water Quality Standards. A reduction in pumping in the Lake Merced area and an increase in pumping away from Lake Merced would not affect the ability of the SFPUC to provide drinking water that meets drinking water quality standards, because the SFPUC would treat or blend groundwater as necessary to meet primary and secondary water quality standards and because the groundwater to be pumped is not considered vulnerable to soil or groundwater contamination due to the depth of pumping proposed. Therefore, the potential impact of Alternative 2A on drinking water quality would be the same as the proposed Project, which would be *less than significant.*

Under either the Project or Alternative 2A, the SFPUC would supply supplemental surface water to Daly City, and Daly City would decrease groundwater pumping during put years. However, with the reduction in pumping during take years under this alternative, in-lieu recharge could increase compared to the proposed Project, potentially resulting in increased groundwater elevations in the Daly City area after a drought (i.e., Take Years). Such increased groundwater levels would not be expected to rise to the level where existing contaminated plumes are located, because the existing groundwater levels in the Daly City area are very low and would stay very low even with the increased in-lieu recharge. Therefore, the impact of Alternative 2A relative to the potential to mobilize existing areas of contamination due to increasing groundwater levels from in-lieu recharge would be the same as the proposed Project, which would be *less than significant.*

Water Quality Degradation. Decreasing pumping in the Lake Merced area and increasing pumping to the south would not degrade water quality in relation to constituents not currently regulated, because the existing concentration of such non-regulated constituents in the groundwater is lower than what would be likely to cause environmental harm and decreased pumping would not increase or decrease these concentrations. Therefore, potential impacts of Alternative 2A relative to this type of water quality degradation would be *less than significant*, as they would be for the proposed Project.

Groundwater Depletion. Because the overall yield from the Westside Groundwater Basin would be maintained at 7.2 mgd under Alternative 2A, potential impacts on groundwater depletion would be the same as they would be for the proposed Project, which would be *less than significant with mitigation.* Both the proposed Project and Alternative 2A would have the potential to result in depletion of the basin if losses from the SFPUC Storage Account were not considered in the management of pumping. With implementation of Mitigation Measure M-HY-14 (Prevent Groundwater Depletion), pumping would be managed to ensure that GSR wells would only be pumped when there is a positive balance in the SFPUC Storage Account, which would be adjusted for losses from the basin due to leakage.

Reduce Lake Merced Impacts and Maintain Project Yield Alternative Conclusions

Alternative 2A would fully meet the Project objectives and meet the Project goal to increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by 7.2 mgd. This alternative would have the same construction-related impacts as the proposed Project, except impacts associated with construction at Sites 1 and 4 would not occur. Operational impacts would be nearly the same as those expected for the proposed Project. A 54 percent reduction in pumping near Lake Merced would reduce well interference on the irrigation wells at the Lake Merced Golf Club; however the reduced well interference at the golf club would be partially offset by increased pumping at Sites 5, 6, and 7, which are within the vicinity of the Lake Merced Golf Club. Increasing pumping at Sites 5 through 15 by 20 percent would increase the potential well interference impacts on the wells at the Colma cemeteries and at the California Golf Club. As a result, well interference impacts would be *significant and potentially unavoidable with mitigation* for both the alternative and the Project, although well interference impacts at some existing wells would be greater under Alternative 2A than the Project. The potential for subsidence impacts and for seawater intrusion would be slightly greater for Alternative 2A when compared to the proposed Project; however impacts would be less than significant for both the alternative and the proposed Project. Declines in water levels in Lake Merced would be slightly less under this alternative; however impacts for both this alternative and the proposed Project would be less than significant with mitigation. Eliminating other wells would not further reduce impacts on Lake Merced water levels because other wells are too far from the lake to have a substantial influence on the lake. Potential impacts on groundwater quality and groundwater depletion would be the same for the proposed Project and this alternative. In any case, this alternative would support the WSIP goals and objectives to provide dry-year and emergency water pumping capacity.

7.3.4.3 Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield

Alternative 2B was selected for analysis because it would reduce significant biological and water quality impacts associated with declining lake levels at Lake Merced due to Project pumping during dry years, but would not include any redistribution of pumping as Alternative 2A does. Under Alternative 2B, the SFPUC would construct only 14 wells and well facilities (instead of 16 wells under the proposed Project). The 14 wells would be located at the same preferred sites as the Project; however, Alternative 2B would not include a well or well facility at Site 1 in Daly City or at Site 4 in unincorporated Broadmoor. Without wells at Sites 1 and 4, Project pumping would be reduced by approximately 1.0 mgd and the overall Project yield would be 6.2 mgd. The alternative would also decrease pumping near Lake Merced by approximately 54 percent (as would Alternative 2A).

Ability of Alternative to Meet Project Objectives Compared to the Proposed Project

Alternative 2B would reduce pumping by 1.0 mgd; therefore, the alternative would meet most, but not all, of the Project objectives. This alternative would allow for the conjunctive use of the South Westside Groundwater Basin, and it would provide supplemental SFPUC surface water to Partner Agencies during normal and wet years to allow for in-lieu recharge of the Basin, albeit reduced by 1 mgd, as compared to the proposed Project. The alternative would not meet the objective of increasing the SFPUC's dry-year and emergency pumping capacity by 7.2 mgd; it would provide a new dry-year groundwater supply though not at the same volume as described in Section 7.3.1 (Approach to Alternatives Selection) or in the adopted WSIP goals. Therefore, in order to meet the WSIP goal of limiting rationing to a systemwide maximum of 20 percent during an 8.5-year drought, if this alternative were implemented, the SFPUC or its wholesale customers could decide to pursue additional projects such as water transfers to increase dry-year and emergency pumping capacity by 7.2 mgd.

The alternative would also not meet the project objective of providing an emergency supply, to be used in the event of a catastrophic emergency that would affect the other sources of supply for the regional water system. Therefore, the reduction in yield with Alternative 3B would limit the regional water system's ability to meet the WSIP goal of seismic and delivery reliability, adopted as part of approval of the WSIP under SFPUC Resolution 08-0200. Per the adopted resolution, the SFPUC will reevaluate 2030 demand projections, regional water system purchase requests, and water supply options by 2018. If this alternative were adopted, the up to 1.2-mgd reduction in drought-year water supply would be included as part of the reevaluation and taken into consideration as a part of the separate SFPUC decision regarding water deliveries after 2018. With the reduction in yield from this alternative, the SFPUC may need to revise the WSIP goals and objectives or develop additional water supply projects depending on demand projections.

Environmental Impacts of Alternative 2B

The significant environmental impacts of Alternative 2B are presented in Table 7-2 (Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project). However, because Alternative 2B was evaluated for its ability to reduce groundwater impacts, a more detailed analysis of operational groundwater impacts is provided than for other impacts, as compared to the proposed Project. The operational groundwater impacts of this alternative, as compared to the proposed Project, are presented below. The information provided comes from the groundwater modeling analysis and other technical studies, as identified below (Kennedy/Jenks 2012a, 2012b).

Production rate of preexisting wells. A 54 percent reduction in pumping near Lake Merced would reduce well interference impacts on the irrigation wells at the Lake Merced Golf Club. The Project is predicted to lower static water levels in the Lake Merced Golf Club Well #3 by 85 feet at the end of the design drought, from 271 feet below ground surface (bgs) to 356 feet bgs (see Table 5.16-11 [Estimated Static and Pumping Depth to Water Level at the End of the Design Drought] in Section 5.16, Hydrology and Water Quality). Assuming a linear relationship between pumping and water level, a 54 percent reduction in nearby pumping would lower static water levels by 46 percent of 85 feet (i.e., by 39 feet). The static water level in the Lake Merced Golf Club Well #3 at the end of the design drought is therefore estimated to be 310 feet bgs, which would be below the top of the screen at 294 feet bgs. Therefore, even with the 54 percent pumping reduction at Sites 1 and 4, static water levels at the Lake Merced wells would decrease to below the top of the well screen (albeit approximately 39 feet higher than is predicted to result with the proposed Project), which would reduce but not eliminate the risk of well or pump damage. Therefore, the well interference impact on the Lake Merced Golf Club wells would also be *significant* under Alternative 2B, as it would be for the proposed Project.

The elimination of pumping at Sites 1 and 4 would reduce the Project's potential well interference impacts on the Olympic Club wells and the San Francisco Golf Club wells. The Project would lower static water levels in both Olympic Club Well #8 and Olympic Club Well #9 by 14 feet, from 122 feet bgs to 136 feet bgs at the end of the design drought (see Table 5.16-11 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought] in Section 5.16, Hydrology and Water Quality). Assuming a linear relationship between pumping and water level, a 54 percent reduction in nearby pumping would lower static water levels by 46 percent of 14 feet (i.e., by 6 feet). The static water level in both of the Olympic Club Wells at the end of the design drought is therefore estimated to be 128.4 feet bgs, which would be above the top of the screen at 260 feet bgs. Table 5.16-12 (Estimated Pump Discharge Rate at the End of the Design Drought) shows that the Project is expected to lower static water levels in the San Francisco Golf Club Well #2 by 14 feet, from 182 feet bgs to 196 feet bgs. Assuming a linear relationship between pumping and water level, a 54 percent reduction in nearby pumping would lower static water levels by 46 percent of 14 feet (i.e., by 6 feet). The static water level in both of the Olympic Club Wells at the end of the design drought is therefore estimated to be 188 feet bgs, which would be above the top of the screen at 360 feet bgs. Therefore, similar to the proposed Project, both static and pumping groundwater levels would remain above the top of the well screen at these wells under Alternative 2B. Furthermore, these wells have the capacities to meet peak their demand (see Impact HY-6 in Section 5.16, Hydrology and Water Quality). Therefore, the potential well interference impact on the Olympic Club wells and the San Francisco Golf Club wells would also be *less than significant* under Alternative 2B, as it would be for the proposed Project.

Land Subsidence. A 54 percent reduction in pumping near Lake Merced would reduce the risk of subsidence near Daly City and the unincorporated community of Broadmoor, as compared to the proposed Project. Because pumping would not be increased in Colma, South San Francisco and San Bruno, this alternative would not change subsidence impacts in these areas. Therefore, subsidence impacts would also be *less than significant* under Alternative 2B, as they would be for the proposed Project.

Seawater Intrusion. Decreasing pumping in the Lake Merced area by 54 percent would correspondingly reduce the risk of seawater intrusion from the Pacific Ocean, as compared to the Project. Therefore, seawater intrusion impacts would also be *less than significant* under Alternative 2B, as they would be for the proposed Project.

Adverse Effects on Beneficial Uses at Lake Merced. A 54 percent reduction in pumping in the Lake Merced area would result in a 54 percent decrease in the decline of Lake Merced lake levels at the end of the design drought. The proposed Project is expected to result in lake levels that are 1 foot lower than predicted under modeled existing conditions at the end of the design drought; under Alternative 2B, this impact would be reduced by 54 percent to approximately 0.5 feet instead of 1 foot, given that the pumping from Sites 1, 2, 3, and 4 would be within 1.3 miles of Lake Merced, whereas the next closest Project well would be over 2 miles from the lake, and Sites 1 and 4 constitute 54 percent of the proposed pumping at Sites 1, 2, 3, and 4 (SFPUC 2012b, 2012c). Because the lake levels under the proposed Project recover more slowly than under modeled existing conditions, the difference between the proposed Project and modeled existing conditions is actually greater several years after the drought than at the end of the drought. Thus, the proposed Project is also expected to result in lake levels about 4 feet lower than predicted under modeled existing conditions after the design drought, with lake levels gradually increasing over the 37-month period during which the lake is recovering from the drought; under Alternative 2B, the decline in lake levels (as compared to modeled existing conditions) would be reduced to approximately 2 feet instead of 4 feet (SFPUC 2012b, 2012c). Minimum monthly average lake levels are predicted to be -2.5 feet City Datum due to the Project, and approximately -0.5 feet for the alternative, both of which are below 0 feet, which is the threshold used by this EIR for determining significant water quality impacts on Lake Merced. Therefore, during the period following the design drought, until Lake Merced lake levels recover to a level of 0 feet City Datum, the impact of Alternative 2B on water quality would be *significant*, as it would be for the proposed Project. However, implementation of Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced)would reduce the water quality impact of this alternative on Lake Merced to *less-than-significant* levels, as it would for the Project, through development and implementation of lake level monitoring and management procedures to maintain Lake Merced at water levels similar to conditions that are predicted to occur without the Project.

Water Quality Standards. A reduction in pumping in the Lake Merced area would not affect the ability of the SFPUC to provide drinking water that meets drinking water quality standards, because the SFPUC would treat or blend groundwater as necessary to meet primary and secondary water quality standards and because the groundwater to be pumped is not considered vulnerable to soil or groundwater contamination due to the depth of pumping proposed. Therefore, the impact of Alternative 2B on drinking water quality would be *less than significant*, as it would be for the proposed Project.

Because groundwater levels that would result from this alternative would not be expected to rise more than they would from the proposed Project, due to the reduced pumping, the impact of Alternative 2B on the potential to mobilize existing areas of contamination would be *less than significant*, as it would be for the proposed Project.

Water Quality Degradation. Decreasing pumping in the Lake Merced area would not affect water quality degradation from constituents not currently regulated because the existing concentration of such non-regulated constituents in the groundwater is lower than what would be likely to cause environmental harm and decreased pumping would not increase or decrease these concentrations. Therefore, potential impacts of Alternative 2B relative to water quality degradation would be *less than significant*, as they would be for the proposed Project (Kennedy/Jenks 2012d).

Groundwater Depletion. Because the overall yield from the Westside Groundwater Basin would be reduced to 6.2 mgd, potential impacts on groundwater depletion resulting from Alternative 2B would be less than expected for the proposed Project. However, impacts on groundwater depletion under both the alternative and the proposed Project would be *less than significant with mitigation.* Both the proposed Project and Alternative 2B would have the potential to result in depletion of the basin if losses from the SFPUC Storage Account were not considered in the management of pumping. With implementation of Mitigation Measure M-HY-14 (Prevent Groundwater Depletion), pumping would be managed to ensure that GSR wells would only be pumped when there is a positive balance in the SFPUC Storage Account, which would be adjusted for losses from the basin due to leakage.

Reduce Lake Merced Impacts and Reduce Project Yield Alternative Conclusions

Alternative 2B would meet most, but not all, of the Project goals and objectives. It would provide for the conjunctive management of the South Westside Groundwater Basin, and it would provide supplemental SFPUC surface water to Partner Agencies in normal and wet years, albeit reduced by 1 mgd, as compared to the proposed Project. Alternative 2B would also provide a new dry-year groundwater supply though not at the same volume as described in Section 7.3.1 (Approach to Alternatives Selection) or in the adopted WSIP goals. Therefore, in order to meet the WSIP goal of limiting rationing to a systemwide maximum of 20 percent during an 8.5-year drought, the SFPUC or its wholesale customers could decide to pursue additional projects such as water transfers so that, combined with this alternative, it could increase its dry-year and emergency pumping capacity by 7.2 mgd.

This alternative would have the same construction-related impacts as the proposed Project, except impacts associated with construction at Sites 1 and 4 would not occur.

The alternative would decrease pumping near Lake Merced by approximately 54 percent; however the operational impacts would be similar to those expected for the proposed Project. A 54 percent decrease in pumping near Lake Merced would result in groundwater levels that would have similar or slightly less well interference impacts on existing irrigation wells as compared to the Project. However, this alternative would have *significant and potentially unavoidable* well interference impacts, which would be the same level of significance for this impact as with the proposed Project. Alternative 2B would reduce the potential for subsidence and seawater intrusion as compared to the proposed Project; however both the proposed Project and Alternative 2B would result in less than significant impacts relative to subsidence and seawater intrusion. Water levels in Lake Merced would decrease slightly less under the alternative; however such impacts resulting from this alternative and the proposed Project would be less than significant following implementation of mitigation. Eliminating other wells would not further reduce impacts on Lake Merced water levels because other wells are too far from the lake to have a substantial influence on the lake. Potential impacts on groundwater quality and groundwater depletion would be the same for the proposed Project and the alternative (less than significant and less than significant with mitigation, respectively).

7.3.4.4 Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield

Alternative 3A was selected for analysis because it would reduce the significant well interference impacts of the Project during dry years at existing irrigation wells that are located at the Colma-area cemeteries. Under Alternative 3A, the SFPUC would construct only 14 wells and well facilities (instead of 16 wells under the proposed Project). The 14 wells would be located at the same preferred sites as the Project; however, Alternative 3A would not include a well or well facility at Sites 7 or 8 in Colma. Without wells at Sites 7 and 8, Project pumping would be reduced by approximately 1.2 mgd. To maintain the overall yield at 7.2 mgd, pumping would be redistributed to nine wells at Sites 1 through 4 and Sites 11 through 15. Project pumping at each of these sites would increase by approximately 31 percent compared to the proposed Project. Pumping at Sites 5, 6, 9, and 10 would be the same as the Project, because they are near Colma; pumping at Site 16 would also not increase under this alternative, as compared to the Project, because groundwater availability is restricted at this location (compared to the other preferred sites). The alternative would decrease pumping in the Colma area by approximately 32 percent.

Ability of Alternative to Meet Project Objectives Compared to the Proposed Project

Alternative 3A would fully meet the Project objectives. The overall yield would be at 7.2 mgd, which would meet the Project goal to increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by 7.2 mgd.

Environmental Impacts of Alternative 3A

The significant environmental impacts of Alternative 3A are presented in Table 7-2 (Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project). However, because Alternative 3A was evaluated for its ability to reduce groundwater impacts, a more detailed analysis of operational groundwater impacts is provided than for other impacts, as compared to the proposed Project. The operational groundwater impacts of the alternatives as compared to the proposed Project are presented below. The information provided comes from the groundwater modeling analysis and other technical studies, as identified below (Kennedy/Jenks 2012a, 2012b).

Production rate of preexisting nearby wells. A 32 percent reduction in pumping near Colma-area existing irrigation wells would reduce well interference impacts on these wells.

The Project is predicted to lower static water levels in the Eternal Home Cemetery well by 105 feet, reducing static water levels to below the top of the well screen at the end of the design drought (see Table 5.16-11 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought] in Section 5.16, Hydrology and Water Quality). Assuming a linear relationship between pumping and water level, a 32 percent reduction in nearby pumping would lower static water levels by 68 percent of 105 feet (i.e., by 71 feet). This same table shows that, at the end of the design drought, the Project is predicted to lower static water levels in the Woodlawn Cemetery Well by 116 feet; and lower static water levels in the Italian Cemetery Well by 110 feet. Assuming a linear relationship between pumping and water level, a 32 percent reduction in nearby pumping would lower static water levels by 68 percent of 116 feet (i.e., by 79 feet in the Woodlawn Cemetery Well); and by 68 percent of 110 feet (i.e., by 75 feet in the Italian Cemetery Well). With these estimated lowered static groundwater levels at the end of the design drought, the static water levels at the Eternal Home Cemetery well, Woodlawn Cemetery well, and Italian Cemetery well would fall below the top of the well screens under Alternative 3A. As a result, the well interference impact on these wells would also be *significant* under Alternative 3A, as it would be for the proposed Project.

Table 5.16-12 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) also shows that, at the end of the design drought, the Project is predicted to lower pumping water levels in the Holy Cross Cemetery Well #4 by 81 feet. The same table shows that, at the end of the design drought, the Project is predicted to lower pumping water levels in the Hills of Eternity Cemetery Well by 89 feet. Assuming a linear relationship between pumping and water level, a 32 percent reduction in nearby pumping would lower pumping water levels by 68 percent of 81 feet (i.e., by 55 feet in the Holy

Cross Cemetery Well #4); and by 68 percent of 89 feet (i.e., by 61 feet in the Hills of Eternity Cemetery Well). With these estimated lowered groundwater levels at the end of the design drought, the static water levels at the Holy Cross Cemetery well #4 and at the Hills of Eternity Cemetery well would fall below the top of the well screen under Alternative 3A; As a result, the well interference impact on these wells would be *significant* under Alternative 3A, as it would be for the proposed Project.

The Olivet Memorial Park well is expected to have just enough capacity to meet its expected demands, as predicted under modeled existing conditions (see Impact HY-6 in Section 5.16, Hydrology and Water Quality). Consequently, any lowering of groundwater levels at this well would likely result in this well having insufficient capacity to meet its expected demands. Therefore, even with the reduced pumping at Sites 7 and 8, the well interference impact on the Olivet Memorial Park well under Alternative 3A would be *significant*, as it would be for the proposed Project.

The Project is predicted to lower pumping water levels in the Holy Cross Cemetery Well #1 by 86 feet, at the end of the design drought (see Table 5.16-11 [Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought] in Section 5.16, Hydrology and Water Quality). Assuming a linear relationship between pumping and water level, a 32 percent reduction in pumping by eliminating pumping at GSR Sites 7 and 8 would lower pumping water levels by 68 percent of 86 feet (i.e., by 58 feet). If pumping were not increased at any other wells in the vicinity, the pumping water level in the Holy Cross Cemetery Well #1 at the end of the design drought is predicted to be slightly above the top of the well screen. However, because the pumping groundwater level would be very close to the top of the well screen, the additional drawdown from the increased pumping at Sites 11 and 12, as per Alternative 3A, is projected to drop the pumping water level below the top of the well screen. Therefore, the well interference impact on this well would be *significant* under Alternative 3A, as it would be for the proposed Project.

Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) also shows that, at the end of the design drought, the Project is predicted to lower pumping water levels in the Home of Peace Well by 81 feet. Therefore, under the Project, the pumping water level is predicted to be below the top of the screen at the end of the design drought. Assuming a linear relationship between pumping and water level, a 32 percent reduction in nearby pumping would lower pumping water levels by 68 percent of 81 feet (i.e., by 55 feet). The pumping water level in the Home of Peace Well at the end of the design drought is predicted to be sufficiently above the top of the well screen. Accordingly, the reduced pumping at Sites 7 and 8 is estimated to result in both pumping and static groundwater levels above the top of the well screen at the Home of Peace Cemetery well. The pumping capacities of this well under Alternative 3A are therefore estimated to meet peak demand even when Project pumping is at a maximum (see Impact HY-6 in Section 5.16, Hydrology and Water Quality). As a result, the well interference impact on the Home of Peace Cemetery well would be *less than significant* under Alternative 3A, while the impact of the proposed Project at this well would be *significant*.

Increasing pumping at Sites 1 through 4 by 31 percent would increase well interference impacts at the San Francisco Golf Club, Olympic Club, and Lake Merced Golf Club, as compared to the Project. The Project is predicted to lower pumping water levels in the San Francisco Golf Club Well #2 by 11 feet at the end of the design drought. Assuming a linear relationship between pumping and water level, a 31 percent increase in nearby pumping would lower pumping water levels by an additional 31 percent over the 11 feet of anticipated drawdown (i.e., by an additional 3 feet). The pumping water level in the San Francisco Golf Club Well #2 at the end of the design drought is predicted to be sufficiently above the top of the screen. Therefore, at the end of the design drought both static and pumping groundwater levels would remain above the top of the well screens in the San Francisco Golf Club Well #2 under Alternative 3A. Furthermore, as shown above, the drop in groundwater levels estimated to be caused by the 31 percent increased pumping (as compared to the Project) would be less than 3.5 feet, and therefore would cause a negligible change in the capacity of the existing irrigation wells in this region. As a result, the well interference impact on the San Francisco Golf Club Well #2 would be *less than significant* under Alternative 3A, as it would be for the Proposed Project.

Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) also shows that at the end of the design drought the Project is predicted to lower pumping water levels in the Olympic Club Well #8 by 10 feet; and lower pumping water levels in the Olympic Club Well #9 by 4 feet. Assuming a linear relationship between pumping and water level, a 31 percent increase in pumping at Sites 1 through 4 would lower pumping water levels by an additional 31 percent over the 10 feet of anticipated drawdown (i.e., by an additional 3 feet) at Olympic Club Well #8; and lower pumping water levels by an additional 31 percent of the 4 feet of anticipated drawdown (i.e., by an additional 1 foot) at Olympic Club Well #9. The pumping water level in the Olympic Club Well #8 at the end of the design drought is predicted to be just above the top of the screen; and the pumping water level in the Olympic Club Well #9 at the end of the design drought is predicted to be above the top of the screen. Neither well would be influenced by pumping from any other GSR wells. Therefore, both static and pumping groundwater levels at the end of the design drought are estimated to remain above the top of the well screens in the Olympic Club Wells #8 and #9 under Alternative 3A. Furthermore, as shown above, the drop in groundwater levels that estimated to be caused by the 31 percent increased pumping (as compared to the Project) is less than 3.5 feet, which would therefore cause a negligible change in the capacity of the existing irrigation wells in this area. As a result, the well interference impact on the Olympic Club Wells #8 and #9 would be *less than significant* under Alternative 3A, as it would be for the Proposed Project.

Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) also shows that at the end of the design drought the Project is predicted to lower static water levels in the Lake Merced Golf Club Well #3 by 85 feet. Assuming a linear relationship between pumping and water level, a 31 percent increase in nearby pumping would lower static water levels by an additional 31 percent of the 85 feet of anticipated drawdown (i.e., by an additional 26 feet). The static water level in the Lake Merced Golf Club Well #3 at the end of the design drought is predicted to be below the top of the screen. As a result, the well interference impact on the Lake Merced Golf Club well would be *significant*, as it would be for the proposed Project.

Table 5.16-11 (Estimated Static and Pumping Depth to Water at the End of the Design Drought) also shows that at the end of the design drought the Project is predicted to lower static water levels in the California Golf Club Well #7 by 168 feet, and to lower static water levels in the California Golf Club Well #8 by 169 feet. Assuming a linear relationship between pumping and water level, a 31 percent increase in pumping at Sites 11 through 15 would lower static water levels by an additional 31 percent of the 168 feet of anticipated drawdown at the California Golf Club Well #7 (i.e., by an additional 52 feet); and would lower static water levels by an additional 31 percent of the 169 feet of anticipated drawdown at the California Golf Club Well #8 (i.e., by an additional 52 feet). The static water level in the California Golf Club Well #7 at the end of the design drought is predicted to be below the top of screen; and the static water level in the California Golf Club Well #8 at the end of the design drought is predicted to be below the top of screen. As a result, the well interference impact on these wells would be *significant* under Alternative 3A, as it would be for the proposed Project.

However, implementation of Mitigation Measure M-HY-6 would reduce these impacts of well interference to *less-than-significant* levels, by either increasing irrigation efficiency, modifying irrigation operations, or undertaking other actions detailed in Mitigation Measure M-HY-6 (Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation). Nevertheless, the implementation of this mitigation measure cannot be assured at this time, until the existing irrigation well owners have agreed to allow the mitigation to take place on their property and, therefore, the impact is determined to be *significant and potentially unavoidable with mitigation*.

Land Subsidence. A 32 percent reduction in pumping near Colma would reduce the risk of subsidence in that area, as compared to the Project. A 31 percent increase in pumping at Sites 1 through 4 and 11 through 15 would increase the risk of subsidence slightly, but would not result in significant impacts, because estimated subsidence would remain below the established thresholds of 6 inches for structures and drainage patterns; and one foot for floodplain. The maximum expected subsidence under the proposed Project would be 3.4 inches; approximately half of the 6-inch threshold. The 31 percent increase in pumping at Sites 1 through 4 and 11 through 15 would result in a 31 percent increase in groundwater elevation decline compared to the proposed Project. The method for calculating subsidence indicates that subsidence changes would be proportionately smaller than groundwater elevation changes and, therefore, a 31 percent increase in groundwater level decline would not be expected to increase subsidence to significant levels, because to do so would require almost doubling the amount of subsidence anticipated for the proposed Project (Fugro 2012a). Therefore, subsidence impacts would be *less than significant* under Alternative 3A, as they would be for the proposed Project.

Seawater Intrusion. Decreasing pumping in the Colma area by 32 percent and increasing pumping at Sites 11 through 15 in South San Francisco and San Bruno by 31 percent would accordingly increase the risk of seawater intrusion from the San Francisco Bay, as compared to the Project. Seawater intrusion has been observed in sediments adjacent to the Bay and is expected to continue into the future. The proposed Project would reduce the risk of seawater intrusion a small amount. Over the 47 years simulated by the West Basin Model, estimated groundwater elevations at the Bay under Project conditions rise slightly (Table 10.3-2 in Kennedy/Jenks 2012c), and approximately 3 af per year more groundwater is predicted to flow out to the Bay than under modeled existing conditions (Table 10.3-5 in Kennedy/Jenks 2012c).

While there would be an incremental increase in the potential for seawater intrusion due to the 31 percent increase in pumping in the South San Francisco and San Bruno areas, the magnitude of the increase would be relatively small based on two lines of evidence. First, in general, the San Francisco Bay coast has physical controls that limit the rate of seawater intrusion, including the presence of the Bay Mud and a subsurface bedrock ridge, both of which provide some protection to the southern portion of the South Westside Basin (Kennedy/Jenks 2012c). Second, the proposed Project is estimated to increase groundwater flows to the Bay (due to the increase of in-lieu recharge) by about 2 to 3 af per month at the end of the design drought. For Alternative 3A, the increase in pumping from GSR wells at Sites 11 through 15 would slightly increase the potential for seawater intrusion from San Francisco Bay as compared to the proposed Project. This is not expected to result in a seawater intrusion impact because it would be similar to the amount of seawater intrusion predicted under modeled existing conditions (SFPUC 2012a). Therefore, seawater intrusion impacts would be *less than significant* under Alternative 3A, as they would be for the proposed Project.

Adverse Effects on Beneficial Uses at Lake Merced. A 31 percent increase in pumping in the Lake Merced area would result in a 31 percent increase in the decline of Lake Merced lake levels at the end of the design drought, because GSR Sites 1, 2, 3, and 4 would be within 1.3 miles of Lake Merced whereas the next closest GSR sites would be over 2 miles from the lake, and this alternative proposes to increase pumping at GSR Sites 1, 2, 3, and 4 by 31 percent. The proposed Project is expected to result in lake levels that are 1 foot lower than is predicted to occur under modeled existing conditions at the end of the design drought (SFPUC 2012b); under Alternative 3A, this impact would be increased to approximately 1.3 feet (instead of 1 foot under the proposed Project), due to the 31 percent increase in pumping in the Lake Merced area. Because recovery in lake levels is slower with the Project than under modeled existing conditions, the proposed Project is expected to result in lake levels about 4 feet lower than what is expected under modeled existing conditions after recovery from the design drought. With the proposed Project, the lake is expected to recover to a lake level of 0 feet City Datum within 37 months after the drought. Under Alternative 3A, this impact would be increased to approximately 5.2 feet (instead of 4 feet under the proposed Project), due to the increased pumping in this area during the drought, and the recovery period is expected to be longer. Monthly lake level averages are predicted to decline below 0 feet City Datum under both the proposed Project (a minimum of -2.5 feet) and this alternative (a minimum of -3.7 feet). Therefore, during the period following the design drought, when Lake Merced lake levels are recovering, the impact of Alternative 3A on water quality would be *significant*, which would be a greater impact under this alternative than for the proposed Project. However, implementation of Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) would reduce the water quality impacts of this alternative to *less-than-significant* levels, because it requires the SFPUC to implement lake level management procedures to maintain Lake Merced water levels above 0.0 feet. Nevertheless, the impact would be greater under Alternative 3A, requiring more supplemental water, redistribution of pumping, or discontinued pumping than under the proposed Project.

Water Quality Standards. A reduction in pumping in the Colma area and an increase in pumping away from Colma would not affect the ability of the SFPUC to provide drinking water that meets drinking water quality standards, because the SFPUC would treat or blend groundwater as necessary to meet primary and secondary water quality standards and because the groundwater to be pumped is not considered vulnerable to soil or groundwater contamination due to the depth of pumping proposed. Therefore, the potential impact of Alternative 3A on drinking water quality would be *less than significant*, as it would be for the proposed Project.

Because in-lieu recharge does not occur in the Colma area (because none of the Partner Agencies have wells in Colma) where pumping would decrease, Alternative 3A is not expected to result in higher groundwater levels than those expected under modeled existing conditions. Therefore, the impact of Alternative 3A on the potential to mobilize existing areas of contamination due to increasing groundwater levels from in-lieu recharge would be *less than significant*, as it would be for the proposed Project.

Water Quality Degradation. Decreasing pumping in the Colma area and increasing pumping to the north and south would not affect water quality degradation from constituents not currently regulated because the existing concentration of such non-regulated constituents in the groundwater is lower than what would be likely to cause environmental harm, and decreased pumping would not increase or decrease these concentrations. Therefore, potential impacts of Alternative 3A relative to water quality degradation would be the same as the proposed Project, which would be *less than significant*.

Groundwater Depletion. Because the overall yield from the Westside Groundwater Basin would be maintained at 7.2 mgd under Alternative 3A, potential impacts on groundwater depletion would be *less than significant with mitigation*, as they would be for the proposed Project. Both the proposed Project and Alternative 2A would have the potential to result in depletion of the basin if losses from the SFPUC Storage Account were not considered in the management of pumping. With implementation of Mitigation Measure M-HY-14 (Prevent Groundwater Depletion), pumping would be managed to ensure that GSR wells would only be pumped when there is a positive balance in the SFPUC Storage Account, which would be adjusted for losses from the basin due to leakage.

Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield Conclusions

Alternative 3A would fully meet the Project objectives and meet the Project goal to increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by 7.2 mgd. This alternative would have the same construction-related impacts as the proposed Project except impacts associated with construction at Sites 7 and 8, including the significant and unavoidable aesthetic impact at Site 7, would not occur. Operational impacts would be nearly the same as those expected for the proposed Project. A 32 percent reduction in pumping near the Colma-area existing irrigation wells from this alternative as compared to the proposed Project would reduce well interference on the existing wells; however, well interference would still be significant for Alternative 3A as it would for the proposed Project. The potential for subsidence impacts and for seawater intrusion would be slightly greater for Alternative 3A when compared to the proposed Project; however impacts would be *less than significant* for both the alternative and the proposed Project. Potential impacts on Lake Merced water levels would be slightly greater for Alternative 3A than for the proposed Project, prior to mitigation, but as mitigated, both would result in less-than-significant impacts on the water quality of Lake Merced (even though, under Alternative 3A, more supplemental water, redistribution of pumping, or discontinued pumping would be required to mitigate such impacts, as compared to the proposed Project). Potential impacts on groundwater quality and groundwater depletion would be the same for the proposed Project and this alternative.

7.3.4.5 *Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield*

Alternative 3B was selected for analysis because it would reduce the significant well interference impacts of the Project at existing irrigation wells for cemeteries in the Colma area due to Project pumping during dry years, but it would not include any redistribution of pumping as Alternative 3A does (in order to provide the SFPUC with a dry-year and emergency pumping capacity of 7.2 mgd). Under Alternative 3B, the SFPUC would construct only 14 wells and well facilities (instead of 16 wells under the proposed Project). The 14 wells would be located at the same preferred sites as the Project; however, Alternative 3B would not include a well or well facility at Sites 7 or 8 in Colma. Without wells at Sites 7 and 8, pumping would be reduced by approximately 1.2 mgd, and the overall yield would be 6.0 mgd. The alternative would also decrease pumping near Colma by approximately 32 percent (as would Alternative 3A).

Ability of Alternative to Meet Project Objectives Compared to Proposed Project

Alternative 3B would reduce pumping by 1.2 mgd; therefore, the alternative would meet most, but not all, of the Project objectives. This alternative would allow for the conjunctive use of the South Westside Groundwater Basin, and it would provide supplemental SFPUC surface water to Partner Agencies during normal and wet years to allow for in-lieu recharge of the Basin, albeit reduced by 1.2 mgd, as compared to the proposed Project. The alternative would not meet the objective of increasing the SFPUC's dry-year and emergency pumping capacity by 7.2 mgd; it would also provide a new dry-year groundwater supply though not at the same volume as under the proposed Project. Therefore, in order to meet the WSIP goal of limiting rationing to a systemwide maximum of 20 percent during an 8.5 year drought, if this alternative were implemented, the SFPUC or its wholesale customers could decide to pursue additional projects (e.g., water transfers) to increase dry-year and emergency pumping capacity up to 7.2 mgd.

The alternative would also not meet the project objective of providing an emergency supply, to be used in the event of a catastrophic emergency that would affect the other sources of supply for the regional water system. Therefore, the reduction in yield with Alternative 3B would limit the regional water system's ability to meet the WSIP goal of seismic and delivery reliability, adopted as part of approval of the WSIP under SFPUC Resolution 08-0200. Per the adopted resolution, the SFPUC will reevaluate 2030 demand projections, regional water system purchase requests, and water supply options by 2018. If this alternative were adopted, the up to 1.2-mgd reduction in drought-year water supply would be included as part of the reevaluation and taken into consideration as a part of the separate SFPUC decision regarding water deliveries after 2018. With the reduction in yield from this alternative, the SFPUC may need to revise the WSIP goals and objectives or develop additional water supply projects depending on demand projections.

Environmental Impacts of Alternative 3B

The significant environmental impacts of Alternative 3B are presented in Table 7-2 (Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project). However, because Alternative 3B was selected for analysis to reduce groundwater impacts, a more detailed analysis of operational groundwater impacts is provided than for other impacts as compared to the proposed Project. The operational groundwater impacts of the alternatives as compared to the proposed Project are presented below. The information provided comes from the groundwater modeling analysis and other technical studies, as identified below (Kennedy/Jenks 2012a, 2012b).

Production rate of preexisting nearby wells. A 32 percent reduction in pumping near Colma-area existing irrigation wells, as associated with this alternative, would reduce well interference impacts on those wells.

At the end of the design drought, the Project is predicted to lower static water levels by 105 feet in the Eternal Home Cemetery well; by 116 feet in the Woodlawn Cemetery Well; and by 110 feet in the Italian Cemetery Well (see Table 5.16-11 [Estimated Static and Pumping Depth Levels to Water at the End of the Design Drought] in Section 5.16, Hydrology and Water Quality). Assuming a linear relationship between pumping and water level, a 32 percent reduction in nearby pumping would lower static water levels by 68 percent of 105 feet (i.e., by 71 feet), in the Eternal Home Cemetery well; by 68 percent of 116 feet (i.e., by 79 feet) in the Woodlawn Cemetery Well; and by 68 percent of 110 feet (i.e., by 75 feet) in the Italian Cemetery Well. The static water levels in the Eternal Home Cemetery Well, Woodlawn Cemetery Well and Italian Cemetery Well at the end of the design drought are predicted to be below the top of the well screens. Therefore, the reduced pumping is expected to result in static groundwater levels at these three cemetery wells falling to below the top of the well screens under Alternative 3B. As a result, the well interference impact on these wells would be *significant* under Alternative 3B, as it would be for the proposed Project.

Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) also shows that, at the end of the design drought, the Project is predicted to lower pumping water levels in the Holy Cross Cemetery Well #4 by 81 feet. The same table shows that, at the end of the design drought, the Project is predicted to lower pumping water levels in the Hills of Eternity Cemetery Well by 89 feet. Assuming a linear relationship between pumping and water level, a 32 percent reduction in nearby pumping would lower pumping water levels by 68 percent of 81 feet (i.e., by 55 feet) in the Holy Cross Cemetery Well #4; and by 68 percent of 89 feet (i.e., by 61 feet) in the Hills of Eternity Cemetery Well. The pumping water levels in the Holy Cross Cemetery Well #4 and in the Hills of Eternity Cemetery Well at the end of the design drought are predicted to be below the top of the well screens. As a result, pumping groundwater levels at these wells is expected to fall below the top of the well screen under Alternative 3B; and the well interference impact on these wells would be *significant* under Alternative 3B, as it would be for the proposed Project.

Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) also shows that, at the end of the design drought, the Project is predicted to lower pumping water levels in the Holy Cross Cemetery Well #1 by 86 feet. Assuming a linear relationship between pumping and water level, a 32 percent reduction in nearby pumping would lower pumping water levels by 68 percent of 86 feet (i.e., by 58 feet). The pumping water level in the Holy Cross Cemetery Well #1 at the end of the design drought is predicted to be slightly above the top of the well screen. Because pumping would not be redistributed to any other well sites under Alternative 3B, unlike Alternative 3A, no further reductions in water level would be expected. Furthermore, the pumping capacity of the Holy Cross Cemetery Well #1 is estimated to meet its peak demand when Project pumping is at a maximum, and a 32 percent reduction in nearby pumping, as per this alternative, would therefore not reduce the well's pumping capacity. As a result, the potential well interference impacts on the Holy Cross Cemetery well #1 would be *less than significant* under Alternative 3B, while the proposed Project impacts would be *significant*.

The Olivet Memorial Park well is expected to have just enough capacity to meet its expected demands, as predicted modeled existing conditions (see Impact H-6 in Section 5.16, Hydrology and Water Quality). Consequently, any lowering of groundwater levels at this well would likely result in this well having insufficient capacity to meet its expected demands. Therefore, even with the reduced pumping at Sites 7 and 8, the well interference impact on the Olivet Memorial Park well under Alternative 3B would be *significant*, as it would be for the proposed Project.

Table 5.16-11 (Estimated Static and Pumping Depth to Water Levels at the End of the Design Drought) also shows that, at the end of the design drought, the Project is predicted to lower pumping water levels in the Home of Peace Well by 81 feet. Under these Project conditions, this pumping water level would be below the top of the screen. Assuming a linear relationship between pumping and water level, a 32 percent reduction in nearby pumping would lower pumping water levels by 68 percent of 81 feet (i.e., by 55 feet). The pumping water level in the Home of Peace Well at the end of the design drought under Alternative 3B is predicted to be sufficiently above the top of the screen. Therefore, the reduced pumping at Sites 7 and 8 is expected to result in both pumping and static groundwater levels above the top of the well screen at the Home of Peace Cemetery Well at the end of the design drought. The pumping capacity of this well is estimated to meet its peak demand even when Project pumping would be at a maximum (Tables 5.16-13 [Estimated Peak Demand and 12-Hour Production Capacities]), and pumping capacity under Alternative 3B would be slightly greater as a result of eliminating pumping at Sites 7 and 8. As a result, the well interference impact on the Home of Peace Cemetery well would be *less than significant* under Alternative 3B, while the impact of the proposed Project on this well would be *significant* because the water levels due to Project pumping would be below the well screen, even though the pump discharge rate would be adequate to meet peak demand.

Under Alternative 3B, there would be no increase in pumping at other well sites, so potential well interference impacts under Alternative 3B at the San Francisco Golf Club, Olympic Club, and Lake Merced Golf Club would be essentially the same as for the proposed Project. The elimination of Sites 7 and 8 would not change the groundwater levels in the vicinity of these irrigation wells because they are too far from those GSR well sites to be affected by Sites 7 and 8. Therefore, the potential well interference impacts on the San Francisco Golf Club, Olympic Club, and Lake Merced Golf Club wells under Alternative 3B would be *less than significant*, as they would be for the proposed Project.

Land Subsidence. A 32 percent reduction in pumping near Colma would reduce the risk of subsidence in that area as compared to the Project. Therefore, potential subsidence impacts would be *less than significant* under Alternative 3B, as they would be for the proposed Project.

Seawater intrusion. Decreasing pumping in the Colma area by 32 percent would decrease the risk of seawater intrusion from the San Francisco Bay. Therefore, potential seawater intrusion impacts would be *less than significant* under Alternative 3B, as they would be for the proposed Project.

Adverse Effects on Beneficial Uses at Lake Merced. Pumping under Alternative 3B would not change near Lake Merced, as compared to the Project. Therefore, impacts on Lake Merced under Alternative 3B would be *less than significant with mitigation* relative to biological resources and to water quality, as they would be for the proposed Project. Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) would require the SFPUC to implement a lake level management program that includes monitoring to detect changes in lake levels, water quality, and groundwater, and the development and implementation of a strategy to augment lake levels or alter pumping to avoid adverse effects on Lake Merced. This mitigation measure would reduce the impacts of Alternative 3B to *less-than-significant* levels, as it would for the Project.

Water Quality Standards. A reduction in pumping in the Colma area would not affect the ability of the SFPUC to provide drinking water that meets drinking water quality standards, because the SFPUC would treat or blend groundwater as necessary to meet primary and secondary water quality standards and because the groundwater to be pumped is not considered vulnerable to soil or groundwater contamination due to the depth of pumping proposed. Therefore, the potential impact of Alternative 3B on drinking water quality would be *less than significant*, as it would be for the proposed Project.

Water Quality Degradation. Decreasing pumping in the Colma area would not affect water quality degradation from constituents not currently regulated because the existing concentration of such non-regulated constituents in the groundwater is lower than what would be likely to cause environmental harm, and decreased pumping would not increase or decrease these concentrations. Therefore, potential impacts of Alternative 3B relative to water quality degradation would be *less than significant*, as they would be for the proposed Project.

Groundwater Depletion. Because the overall yield from the Westside Groundwater Basin would be reduced to 6.0 mgd under this alternative, potential impacts on groundwater depletion would be less than those of the proposed Project and would remain *less than significant with mitigation*. Both the proposed Project and Alternative 3B would have the potential to result in depletion of the basin if losses from the SFPUC Storage Account were not considered in the management of pumping. With implementation of Mitigation Measure M-HY-14 (Prevent Groundwater Depletion), pumping would be managed to ensure that GSR wells would only be pumped when there is a positive balance in the SFPUC Storage Account, which would be adjusted for losses from the basin due to leakage.

Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield Conclusions

Alternative 3B would meet most, but not all, of the Project goals and objectives. It would provide for the conjunctive management of the South Westside Groundwater Basin, and it would provide supplemental SFPUC surface water to Partner Agencies in normal and wet years to allow for in-lieu recharge of the Basin. However, Alternative 3B would not fully meet the Project goal to provide 7.2 mgd of water for a new dry-year water supply for the SFPUC and Partner Agencies because Alternative 3B would reduce the number of wells and reduce the dry-year and emergency pumping capacity to 6.0 mgd.

The alternative would decrease pumping near Colma-area cemeteries by approximately 32 percent. This alternative would have the same construction-related impacts as the proposed Project except impacts associated with construction at Sites 7 and 8 would not occur. Operational impacts would be nearly the same as those expected for the proposed Project. This alternative would partially support the WSIP goals and objectives to provide dry-year and emergency water pumping capacity. However, additional measures may be necessary to fully provide the dry-year and emergency water pumping volume required in order to meet the WSIP goal of limiting rationing to a systemwide maximum of 20 percent during an 8.5 year drought.

Although this alternative would decrease pumping near the Colma-area by approximately 32 percent, the operational impacts would be similar to those expected for the proposed Project. The expected groundwater levels would still result in the potential for well interference impacts as would the proposed Project and these impacts, in most cases, are similar to those that would occur with the proposed Project. Alternative 3B would reduce the potential for subsidence and seawater intrusion; however, both the proposed Project and Alternative 3B would result in less than significant impacts. Potential impacts on groundwater quality would be the same for the proposed Project and the alternative. Potential impacts related to groundwater depletion would be similar for both the Project and this alternative.

7.4 COMPARISON OF ALTERNATIVES

Table 7.2 (Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project) provides a comparison of the environmental impacts of the alternatives as compared to the impacts of the proposed Project. The table does not include those impact categories for which the proposed Project would result in No Impact or a Less than Significant Impact at all sites. A comparison of the alternatives follows the table along with a discussion of the environmentally superior alternative.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Land Use						
Impact LU-1. Project construction would have a substantial impact on the existing character of the vicinity and could substantially disrupt or displace existing land uses or land use activities.	**Significant and Unavoidable with Mitigation (SUM)** Construction-related noise, traffic, air quality and recreation impacts could temporarily substantially disrupt or displace existing land uses. Mitigation Measures M-NO-1, M-NO-3, M-LU-1a, AQ-2a, AQ-3, and M-TR-1 would reduce impacts to less-than-significant levels at some sites; however the impact would remain SUM at 10 sites.	**Same as existing condition (NI)** There would be no construction activities, and therefore no land use impacts.	**Similar to but less than the proposed Project (SUM)** Under the Project, Sites 1 and 4 contribute to the significant impact. With removal of these well facilities, construction impacts to land use would be slightly less than the proposed Project, however, eight sites would continue to have significant and unavoidable impacts.	**Similar to but less than the proposed Project (SUM)** Under the Project, Sites 1 and 4 contribute to the significant impact. With removal of these well facilities, construction impacts to land use would be slightly less than the proposed Project, however, eight sites would continue to have significant and unavoidable impacts.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Site 7 contributes to the significant impact though the impact would be mitigable. Omission of Site 7 would slightly reduce overall land use impacts, although 10 sites would continue to have significant and unavoidable impacts.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Site 7 contributes to the significant impact though the impact would be mitigable. Omission of Site 7 would slightly reduce overall land use impacts, although 10 sites would continue to have significant and unavoidable impacts.
Impact LU-2. Project operations would result in substantial long-term or permanent impacts on the existing character or disrupt or displace land uses.	**Less than Significant with Mitigation (LSM)** Nighttime noise from operations could potentially disrupt land uses at five sites. Mitigation Measure M-NO-5 would reduce the impact to a less-than-significant level.	**Same as existing condition (NI)** There would be no changes to existing operations at the Westlake Pump Station, and no new GSR well facilities would be constructed.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 1 would have a mitigable impact on its surrounding land use. This alternative would reduce the land use impact slightly by eliminating Site 4 where impacts are LSM. Impacts at four sites would remain LSM.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 1 would have a mitigable impact on its surrounding land use. This alternative would reduce the land use impact slightly by eliminating Site 1 where impacts are LSM. Impacts at four sites would remain LSM.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.
Impact C-LU-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to land use.	**Significant and Unavoidable with Mitigation (SUM)** Construction could result in a cumulatively considerable contribution to cumulative land use impacts at Sites 9, 12, and 19. Even with implementation of Mitigation Measures M-NO-1 and M-NO-3, the impact could remain SUM.	**Same as existing condition (NI)** There would be no construction activities. No new GSR well facilities would be constructed so no noise caused land use impacts would be generated.	**Same as the proposed Project (SUM)** Under the Project, Sites 1 and 4 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (SUM)** Under the Project, Sites 1 and 4 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (SUM)** Under the Project, Sites 7 (On-site) and Site 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (SUM)** Under the Project, Sites 7 (On-site) and Site 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Aesthetics						
Impact AE-1. Project construction would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.	**Significant and Unavoidable with Mitigation (SUM)** Project construction at seven sites would be visible from areas with moderate to high visual sensitivity and significant viewer concern, and construction of Site 15 would be visible from a locally designated scenic route, which would be a significant impact. Mitigation Measures M-AE-1a, M-AE-1b, M-AE-1c, M-AE-1d, M-AE-1e, and M-CR-1a would reduce the impact at most sites; however, construction would result in a significant and unavoidable impact at Site 7, even with the implementation of the mitigations.	**Same as existing condition (NI)** There would be no construction activities; and therefore no visual impacts.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Site 4 contributes to the significant impact. Omission of this site would reduce construction-related aesthetic impacts at residences, Ben Franklin Intermediate School athletic field and Garden Village Elementary School. However, visual impacts would still occur at seven other sites, and a significant and unavoidable impact would remain at Site 7.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Site 4 contributes to the significant impact. Omission of the site would reduce construction-related aesthetic impacts at residences, Ben Franklin Intermediate School athletic field and Garden Village Elementary School. However, visual impacts would still occur at seven sites, and a significant and unavoidable impact would remain at Site 7.	**Similar to but less than the proposed Project (LSM)** Under the Project, Site 7 (under both Consolidated Treatment at Site 6 and On-Site Treatment) contributes to the significant impact. Omission of this site would reduce aesthetic impacts at several cemeteries, the Colma Bay Area Rapid Transit (BART) Station and Metro Shopping Center. Visual impacts would still occur at six sites, but impacts can be reduced to less-than-significant levels.	**Similar to but less than the proposed Project (LSM)** Under the Project, Site 7 (Consolidated and On-Site) contributes to the significant impact. Omission of this site would reduce aesthetic impacts at several cemeteries, the Colma BART Station and Metro Shopping Center. Visual impacts would still occur at six sites, but impacts can be reduced to less-than-significant levels.
Impact AE-3. Project operation would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.	**Less than Significant with Mitigation (LSM)** Project facilities would be visible and may have an adverse impact on the visual character at five sites. Mitigation Measures M-AE-3a, M-CR-5a, and M-CR-5b would reduce impacts.	**Same as existing conditions (NI)** No new GSR well facilities would be constructed, and therefore no visual impacts would occur.	**Same as the proposed Project Less than Significant with Mitigation (LSM)** Under the Project, Site 4 contributes to the significant impact. Omission of the site under this alternative would reduce the impact; however, impacts on the visual character of the surrounding areas would remain at four other sites.	**Same as the proposed Project Less than Significant with Mitigation (LSM)** Under the Project, Site 4 contributes to the significant impact. Omission of the site under this alternative would reduce the impact; however, impacts on the visual character of the surrounding areas would remain at four other sites.	**Similar to but less than the proposed Project (LSM)** Under the Project, Site 7 contributes to the significant impact. Omission of Site 7 would eliminate the visual impact at the site. Significant, but mitigable impacts would remain at four sites.	**Similar to but less than the proposed Project (LSM)** Under the Project, Site 7 contributes to the significant impact. Omission of Site 7 would eliminate the visual impact at the site. Significant, but mitigable impacts would remain at foursites.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-AE-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to scenic resources and visual character.	**Less than Significant with Mitigation (LSM)** Project construction and operations in addition to other projects may result in a cumulative impact to visual character of the area at Sites 12 and 13 Mitigation Measure M-AE-1a, M-AE-1b, and M-AE-3a would reduce impacts to less-than-significant levels.	**Same as the existing conditions (NI)** No new GSR well facilities would be constructed, and therefore there would be no cumulative visual impacts.	**Same as the proposed Project (LSM)** Sites, 12 and13 would have a cumulatively considerable contribution to cumulative impacts on the visual character of the surrounding area. This alternative includes facilities at these sites.	**Same as the proposed Project (LSM)** Sites, 12 and 13 would have a cumulatively considerable contribution to cumulative impacts on the visual character of the surrounding area. This alternative includes facilities at these sites.	**Similar to but slightly less than the proposed Project (LSM)** Sites 12 and 13 would have a cumulatively considerable contribution to cumulative impacts on the visual character of the surrounding area. The alternative would not reduce the impact.	**Similar to but slightly less than the proposed Project (LSM)** Sites 12 and 13 would have a cumulatively considerable contribution to cumulative impacts on the visual character of the surrounding area. The alternative would not reduce the impact.
Cultural and Paleontological Resources						
Impact CR-1. Project construction could cause an adverse change in the significance of a historical resource.	**Less than Significant with Mitigation (LSM)** Construction of the Project could affect the significance of historical resources at Sites 14 and 15. Mitigation measures M-CR-1a, M-CR-1b, and M-NO-2 would reduce the potential impacts to less-than-significant levels.	**Same as the existing conditions (NI)** No new GSR well facilities would be constructed, and therefore, there would be impacts on historical resources.	**Same as the proposed Project (LSM)** Construction of well facilities at Sites 14 and 15 would be included as part of this alternative; therefore the impacts would be the same as the proposed Project.	**Same as the proposed Project (LSM)** Construction of well facilities at Sites 14 and 15 would be included as part of this alternative; therefore the impacts would be the same as the proposed Project.	**Same as the proposed Project (LSM)** Construction of well facilities at Sites 14 and 15 would be included as part of this alternative; therefore the impacts would be the same as the proposed Project.	**Same as the proposed Project (LSM)** Construction of well facilities at Sites 14 and 15 would be included as part of this alternative; therefore the impacts would be the same as the proposed Project.
Impact CR-2. Project construction could cause an adverse change in the significance of an archaeological resource.	**Less than Significant with Mitigation (LSM)** Construction of the Project could affect a previously undiscovered archaeological resource at all sites, except for the Westlake Pump Station. Mitigation Measure M-CR-2 would reduce impacts to less-than-significant levels.	**Same as the existing conditions (NI)** There would be no construction activities, and therefore no impacts on cultural resources.	**Similar to but slightly less than the proposed Project (LSM)** Because this alternative would involve less ground disturbance, the potential to adversely affect archaeological resources would be slightly decreased by eliminating Sites 1 and 4.	**Similar to but slightly less than the proposed Project (LSM)** Because this alternative would involve less ground disturbance, the potential to adversely affect archaeological resources would be slightly decreased by eliminating Sites 1 and 4.	**Similar to but slightly less than the proposed Project (LSM)** Because this alternative would involve less ground disturbance, the potential to adversely affect archaeological resources would be slightly decreased by eliminating Sites 7 and 8.	**Similar to but slightly less than the proposed Project (LSM)** Because this alternative would involve less ground disturbance, the potential to adversely affect archaeological resources would be slightly decreased by eliminating Sites 7 and 8.

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Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact CR-3. Project construction could result in a substantial adverse effect by destroying a unique paleontological resource or site.	**Less than Significant with Mitigation (LSM)** Construction could destroy a paleontological resource except at the Westlake Pump Station and Site 9. Mitigation Measure M-CR-3 would reduce the impacts to less-than-significant levels.	**Same as the existing conditions (NI)** There would be no construction activities, and therefore there would be no impacts on unique paleontological resources.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact because they are located on surface deposits considered to have a high paleontological sensitivity for significant paleontological resources. Therefore, without these two sites, the potential for adverse effects related to unique paleontological resources is slightly decreased.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact because they are located on surface deposits considered to have a high paleontological sensitivity for significant paleontological resources. Therefore, without these two sites, the potential for adverse effects related to unique paleontological resources is slightly decreased.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact because they are located on surface deposits considered to have a high paleontological sensitivity for significant paleontological resources. Therefore, without these two sites, the potential for adverse effects related to unique paleontological resources is slightly decreased.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact because they are located on surface deposits considered to have a high paleontological sensitivity for significant paleontological resources. Therefore, without these two sites, the potential for adverse effects related to unique paleontological resources is slightly decreased.
Impact CR-4. Project construction could result in a substantial adverse effect related to the disturbance of human remains.	**Less than Significant with Mitigation (LSM)** Construction could result in an impact on human remains at all sites except for the Westlake Pump Station. Mitigation Measure M-CR-4 would reduce the impacts to less-than-significant levels for all sites.	**Same as the existing conditions (NI)** There would be no construction activities. No impacts on human remains would occur.	**Similar to but slightly less than the proposed Project (LSM)** Because this alternative would involve less ground disturbance, the potential to encounter human remains would be slightly decreased by eliminating Sites 1 and 4.	**Similar to but slightly less than the proposed Project (LSM)** Because this alternative would involve less ground disturbance, the potential to encounter human remains would be slightly decreased by eliminating Sites 1 and 4.	**Similar to but slightly less than the proposed Project (LSM)** Because this alternative would involve less ground disturbance, the potential to encounter human remains would be slightly decreased by eliminating Sites 7 and 8.	**Similar to but slightly less than the proposed Project (LSM)** Because this alternative would involve less ground disturbance, the potential to encounter human remains would be slightly decreased by eliminating Sites 7 and 8.
Impact CR-5. Project facilities could cause an adverse change in the significance of a historical resource.	**Less than Significant with Mitigation (LSM)** Construction of the Project facilities could result in an impact on the historical resources at or near Sites 14 and 15 in the Golden Gate National Cemetery. Mitigation Measures M-CR-5a and M-CR-5b would reduce the impacts to less-than-significant levels for both well facility sites.	**Same as the existing conditions (NI)** There would be no construction activities, and therefore no impacts on historical resources would occur.	**Same as the proposed Project (LSM)** Construction of the Project facilities at Sites 14 and 15 would occur under this alternative, and therefore the potential impacts on historical resources are the same as the proposed Project.	**Same as the proposed Project (LSM)** Construction of the Project facilities at Sites 14 and 15 would occur under this alternative, and therefore the potential impacts on historical resources are the same as the proposed Project.	**Same as the proposed Project (LSM)** Construction of the Project facilities at Sites 14 and 15 would occur under this alternative, and therefore the potential impacts on historical resources are the same as the proposed Project.	**Same as the proposed Project (LSM)** Construction of the Project facilities at Sites 14 and 15 would occur under this alternative, and therefore the potential impacts on historical resources are the same as the proposed Project.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-CR-1. Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains.	**Less than Significant with Mitigation (LSM)** Construction could result in a cumulatively considerable contribution to cumulative impacts except at the Westlake Pump Station. Mitigation Measures M-CR-2, M-CR-3 and M-CR-4 would reduce impacts to less than significant levels.	**Same as existing conditions (NI)** There would be no construction activities, and no cumulative impacts on cultural, historical, or paleontological resources would occur.	**Similar to but slightly less than the proposed Project (LSM)** Under this alternative, cumulative impacts on paleontological resources, archaeological resources or human remains would be slightly reduced because there would be no ground disturbance in the locations of Sites 1 and 4.	**Similar to but slightly less than the proposed Project (LSM)** Under this alternative, cumulative impacts on paleontological resources, archaeological resources or human remains would be slightly reduced because there would be no ground disturbance in the locations of Sites 1 and 4.	**Similar to but slightly less than the proposed Project (LSM)** Under this alternative, cumulative impacts on paleontological resources, archaeological resources or human remains would be slightly reduced because there would be no ground disturbance in the locations of Sites 7 and 8.	**Similar to but slightly less than the proposed Project (LSM)** Under this alternative, cumulative impacts on paleontological resources, archaeological resources or human remains would be slightly reduced because there would be no ground disturbance in the locations of Sites 7 and 8.
Transportation and Circulation						
Impact TR-1. The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system.	**Less than Significant with Mitigation (LSM)** Construction traffic could affect the performance of the circulation system at 12 sites. Mitigation Measure M-TR-1 would reduce the impacts to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities and no impacts on the performance of the circulation system would occur.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 1 would not contribute to the significant impact related to travel lane closures. In this alternative, impacts to Park Plaza Drive would be slightly reduced by elimination of Site 4. A less-than-significant impact would remain at 11 sites.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 1 would not contribute to the significant impact related to travel lane closures. In this alternative, impacts to Park Plaza Drive would be slightly reduced by elimination of Site 4. A less-than-significant impact would remain at 11 sites.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 7 contributes to the significant impact related to travel lane closures. In this alternative, impacts to Colma Blvd. would be eliminated; therefore the impact would be slightly reduced. A less-than-significant impact would remain at 11 sites.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 7 contributes to the significant impact related to travel lane closures. In this alternative, impacts to Colma Blvd. would be eliminated; therefore the impact would be slightly reduced. A less-than-significant impact would remain at 11 sites.
Impact TR-2. The Project would temporarily impair emergency access to adjacent roadways and land uses during construction.	**Less than Significant with Mitigation (LSM)** Temporary impacts on emergency access could occur during construction at three sites. Mitigation Measure M-TR-1 would reduce impacts to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities and no temporary access impacts would occur.	**Same as the proposed Project (LSM)** Under the Project, Sites 1 and 4 would not contribute to the significant impact; therefore the impacts would the same as the proposed Project.	**Same as the proposed Project (LSM)** Under the Project, Sites 1 and 4 would not contribute to the significant impact; therefore the impacts would be the same as the proposed Project.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.
Impact TR-3. The Project would temporarily decrease the performance and safety of public transit, bicycle, and pedestrian facilities during construction.	**Less than Significant with Mitigation (LSM)** Project construction could temporarily impact the performance and safety of bicycle, pedestrian, and public transit systems during construction at five sites. Mitigation Measure M-TR-1 would reduce impacts to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities, and therefore no transit systems would be affected.	**Same as the proposed Project (LSM)** Under the Project, Sites 1 and 4 would not contribute to the significant impact on transit systems; therefore the impacts would be the same as the proposed Project.	**Same as the proposed Project (LSM)** Under the Project, Sites 1 and 4 would not contribute to the significant impact on transit systems; therefore the impacts would be the same as the proposed Project.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-TR-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to transportation and circulation.	**Less than Significant with Mitigation (LSM)** The Project could result in a cumulatively considerable contribution to impaired emergency access and create traffic hazards for alternative modes of transportation at 13 sites. Mitigation Measures M-TR-1 and M-C-TR-1 would reduce impacts to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities. No new GSR well facilities would be constructed and, therefore, no related traffic impacts would result.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 4 contributes to the cumulative significant impact related to impairing emergency access and the safety of pedestrians and bicyclists. In this alternative, impacts related to pedestrian, bicycle and emergency access to Park Plaza Drive would be eliminated, and therefore the impact would be slightly less than the proposed Project.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 4 contributes to the cumulative significant impact related to impairing emergency access and the safety of pedestrians. Under this alternative, impacts related to pedestrian, bicycle and emergency access to Park Plaza Drive would be eliminated, and therefore the impact would be slightly less than the proposed Project.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 7 contributes to the cumulative significant impact related to impairing emergency access and the safety of pedestrians and bicyclists; however, Site 8 does not contribute to the significant impact. Therefore, the elimination of Site 7 would reduce the impact slightly.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 7 contributes to the cumulative significant impact related to impairing emergency access and the safety of pedestrians and bicyclists; however, Site 8 does not contribute to the significant impact. Therefore, the elimination of Site 7 would reduce the impact slightly.
Noise and Vibration						
Impact NO-1. Project construction would result in noise levels in excess of local standards.	**Significant and Unavoidable with Mitigation (SUM)** Project construction would result in noise levels that exceed local noise standards at 14 sites. Mitigation Measure M-NO-1 would reduce this impact at seven of the sites, but the impact would remain significant at the other sites. At Sites 1, 4, 9, 12, 16, 18 (Alternate), and 19 (Alternate), there is no mitigation to avoid nighttime drilling, which is not allowed in the relevant jurisdictions, so the impact is significant and unavoidable at those sites.	**Same as existing conditions (NI)** There would be no construction activities, and no related noise impacts would occur.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Sites 1 and 4 contribute to the significant and unavoidable impact. Under this alternative, significant and unavoidable noise impacts would be reduced because of the omission of facilities at these sites; however the significant and unavoidable impact would still occur at five sites.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Sites 1 and 4 contribute to the significant and unavoidable impact. Under this alternative, significant and unavoidable noise impacts would be reduced because of the omission of facilities at these sites; however the significant and unavoidable impact would still occur at five sites.	**Same as the proposed Project (SUM)** Under the Project, Sites 7 and 8 do not contribute to the significant and unavoidable impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (SUM)** Under the Project, Sites 7 and 8 do not contribute to the significant and unavoidable impact, so the omission of these well facilities would not change the significance of this impact.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact NO-2. Project construction would result in excessive groundborne vibration.	**Less than Significant with Mitigation (LSM)** Project construction could result in excessive groundborne vibration at five sites. Mitigation Measures M-NO-2 would reduce this impact to less-than significant levels.	**Same as existing conditions (NI)** There would be no construction activities so groundborne vibration would not occur.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 4 contributes to the significant impact. Under this alternative, groundborne vibration impacts would be slightly reduced due to the omission of Site 4. However, excessive groundborne vibration would still occur at four sites.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 4 contributes to the significant impact. Under this alternative, groundborne vibration impacts would be slightly reduced due to the omission of Site 4. However, excessive groundborne vibration would still occur at four sites.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.
Impact NO-3. Project construction would result in a substantial temporary increase in ambient noise levels.	**Significant and Unavoidable with Mitigation (SUM)** Project construction would result in a substantial temporary increase in ambient noise levels at 15 sites, ten of which would have significant and unavoidable impacts. Mitigation Measures M-NO-1 and M-NO-3 would reduce this impact, but the impact would remain significant.	**Same as existing conditions (NI)** There would be no construction activities and no related temporary increases in ambient noise levels would occur.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Sites 1 and 4 contribute to the significant and unavoidable impact. Under this alternative, the number of sites with significant and unavoidable impacts would be reduced to eight because of the omission of Sites 1 and 4.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Sites 1 and 4 contribute to the significant and unavoidable impact. Under this alternative, the number of sites with significant and unavoidable impacts would be reduced to eight because of the omission of Sites 1 and 4.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Sites 7 and 8 do not contribute to the significant and unavoidable impact. Under this alternative, significant and unavoidable impacts would remain at 10 sites.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Sites 7 and 8 do not contribute to the significant and unavoidable impact. Under this alternative, significant and unavoidable impacts would remain at 10 sites.
Impact NO-5. Operation of the Project would result in exposure of people to noise levels in excess of local noise standards or result in a substantial permanent increase in ambient noise levels in the Project vicinity.	**Less than Significant with Mitigation (LSM)** Project operations would result in exposure of persons to, or generation of, noise levels in excess of standards established in the local general plan or noise ordinance at seven sites. Mitigation Measure M-NO-5 would reduce this impact to less-than significant levels.	**Same as existing conditions (NI)** No new GSR well facilities would be constructed, so no related noise would be generated.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 1 contributes to the significant impact. Under this alternative, operational noise impacts would be slightly reduced because of the omission of this site. Noise impacts would occur at six sites.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 1 contributes to the significant impact. Under this alternative, operational noise impacts would be slightly reduced because of the omission of this site. Noise impacts would occur at six sites.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 7 (On-site Treatment) contributes to the significant impact. Under this alternative, operational noise impacts would be slightly reduced because of the omission of this site. Noise impacts would occur at six sites.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Site 7 (On-site Treatment) contributes to the significant impact. Under this alternative, operational noise impacts would be slightly reduced because of the omission of this site. Noise impacts would occur at six sites.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-NO-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to noise.	**Significant and Unavoidable with Mitigation (SUM)** The Project could result in a cumulatively considerable contribution to cumulative impacts related to construction noise at Sites 12 and 19 (Alternate) even with the implementation of Mitigation Measures M-NO-1, M-NO-3, and M-NO-5.	**Same as existing conditions (NI)** There would be no construction activities. No new GSR well facilities would be constructed, so no related noise would be generated.	**Same as the proposed Project (SUM)** Under the Project, Sites 1 and 4 do not contribute to the significant and unavoidable impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (SUM)** Under the Project, Sites 1 and 4 do not contribute to the significant and unavoidable impact, so the omission of these well facilities would not change the significance of this impact.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Sites 7 (On-site Treatment) and 8 contribute to the significant cumulative impact. Under this alternative, cumulative construction noise impacts would be slightly reduced because of the omission of these two sites.	**Similar to but slightly less than the proposed Project (SUM)** Under the Project, Sites 7 (On-site Treatment) and 8 contribute to the significant cumulative impact. Under this alternative, cumulative construction noise impacts would be slightly reduced because of the omission of these two sites.
Air Quality						
Impact AQ-2: Emissions generated during construction activities would violate air quality standards and would contribute substantially to an existing air quality violation.	**Less than Significant with Mitigations (LSM)** Construction of the Project may result in violations of air quality standards and contribute substantially to existing air quality violations at all sites. Mitigation Measures M-AQ-2a and M-AQ-2b would reduce impacts at all sites to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities. Related construction emissions would therefore not occur.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, air quality impacts would be slightly reduced because of the overall decrease in construction. Emissions would occur at 14 sites and at the Westlake Pump Station.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, air quality impacts would be slightly reduced because of the overall decrease in construction. Emissions would occur at 14 sites and at the Westlake Pump Station.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, air quality impacts would be slightly reduced because of the overall decrease in construction. Emissions would occur at 14 sites and at the Westlake Pump Station.	**Similar to but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, air quality impacts would be slightly reduced because of the overall decrease in construction. Emissions would occur at 14 sites and at the Westlake Pump Station.
Impact AQ-3: Project construction would expose sensitive receptors to substantial pollutant concentrations.	**Less than Significant with Mitigations (LSM)** Project construction would expose sensitive receptors to pollutant concentrations at Site 5. Mitigation Measure M-AQ-3 would reduce impacts to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities. Sensitive receptors would not be exposed to related pollutant concentrations.	**Same as the proposed Project (LSM)** This alternative includes construction at Site 5; therefore the impact would be the same as the proposed Project.	**Same as the proposed Project (LSM)** This alternative includes construction at Site 5; therefore the impact would be the same as the proposed Project.	**Same as the proposed Project (LSM)** This alternative includes construction at Site 5; therefore the impact would be the same as the proposed Project.	**Same as the proposed Project (LSM)** This alternative includes construction at Site 5; therefore the impact would be the same as the proposed Project.
Impact C-AQ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality.	**Less than Significant with Mitigation (LSM)** Project construction could result in a cumulatively considerable contribution to cumulative impacts related to air quality at all sites. Mitigation Measure M-AQ-2b would reduce impacts to less-than significant levels.	**Same as existing conditions (NI)** There would be no construction activities. Cumulative air quality impacts would not occur.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, air quality impacts would be slightly reduced because of the overall decrease in construction.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, air quality impacts would be slightly reduced because of the overall decrease in construction.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, air quality impacts would be slightly reduced because of the overall decrease in construction.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, air quality impacts would be slightly reduced because of the overall decrease in construction.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Recreation						
Impact RE-2. The Project would deteriorate the quality of the recreational experience during construction.	**Less than Significant with Mitigation (LSM)** The Project would deteriorate the quality of the recreational experience during construction at Sites 1, 2, and 4. Mitigation Measure M-AQ-2a would reduce the impact at this site.	**Same as existing conditions (NI)** There would be no construction activities, and impacts to recreational resources would not occur.	**Similar but less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, because Sites 1 and 4 are omitted, the less-than-significant-with-mitigation impact is only associated with construction at Site 2.	**Similar but less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. In this alternative, because Sites 1 and 4 are omitted, the less-than-significant-with-mitigation impact is only associated with construction at Site 2.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.
Utilities and Service Systems						
Impact UT-1. Project construction could result in potential damage to or temporary disruption of existing utilities during construction.	**Less than Significant with Mitigation (LSM)** Construction of the Project could result in damage to or disruption of existing utilities at all sites. Mitigation Measures M-UT-1a through M-UT-1i would reduce impacts to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities and utility service would not be temporarily disrupted.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, impacts on existing utilities impacts would be slightly reduced because of the overall decrease in construction. Utility impacts could occur at 17 sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, impacts on existing utilities impacts would be slightly reduced because of the overall decrease in construction. Utility impacts could occur at 17 sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, impacts on existing utilities impacts would be slightly reduced because of the overall decrease in construction. Utility impacts could occur at 17 sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, impacts on existing utilities impacts would be slightly reduced because of the overall decrease in construction. Utility impacts could occur at 17 sites.
Impact UT-4. Project construction could result in a substantial adverse effect related to compliance with federal, State, and local statutes and regulations pertaining to solid waste.	**Less than Significant with Mitigation (LSM)** Project construction may not comply with federal, State, and local (Daly City, Colma, South San Francisco, San Bruno, Millbrae and San Mateo County) regulations pertaining to solid waste disposal at all sites. Mitigation Measure M-UT-4 would reduce impacts at all sites.	**Same as existing conditions (NI)** There would be no construction activities.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, impacts related to solid waste would be slightly reduced because of the overall decrease in construction. However, other sites would still need to comply with the applicable waste management ordinance.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, impacts related to solid waste would be slightly reduced because of the overall decrease in construction. However, other sites would still need to comply with the applicable waste management ordinance.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, impacts related to solid waste would be slightly reduced because of the overall decrease in construction. However, other sites would still need to comply with the applicable waste management ordinance.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, impacts related to solid waste would be slightly reduced because of the overall decrease in construction. However, other sites would still need to comply with the applicable waste management ordinance.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-UT-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to utilities and service systems.	**Less than Significant with Mitigation (LSM)** The Project could result in a cumulatively considerable contribution to cumulative impacts related to utilities and service systems at all sites. Mitigation Measures M-UT-1a through M-UT-1i and M-UT-4 would reduce impacts to less-than significant levels.	**Same as existing conditions (NI)** There would be no construction activities and, therefore, no related impacts on utilities.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant cumulative impact. Under this alternative, impacts related to existing utilities and solid waste would be slightly reduced because of the overall decrease in construction. However, other sites would still have the potential to contribute to cumulative impacts on existing utilities and solid waste disposal.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant cumulative impact. Under this alternative, impacts related to existing utilities and solid waste would be slightly reduced because of the overall decrease in construction. However, other sites would still have the potential to contribute to cumulative impacts on existing utilities and solid waste disposal.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant cumulative impact. Under this alternative, impacts related to existing utilities and solid waste would be slightly reduced because of the overall decrease in construction. However, other sites would still have the potential to contribute to cumulative impacts on existing utilities and solid waste disposal.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant cumulative impact. Under this alternative, impacts related to existing utilities and solid waste would be slightly reduced because of the overall decrease in construction. However, other sites would still have the potential to contribute to cumulative impacts on existing utilities and solid waste disposal.
Biological Resources						
Impact BR-1. Project construction would adversely affect candidate, sensitive, or special-status species.	**Less than Significant with Mitigation (LSM)** Project construction could adversely impact special-status species at all sites. Mitigation Measures M-BR-1a through M-BR-1d would reduce impacts to less-than–significant levels.	**Same as existing conditions (NI)** There would be no construction or operational activities and, therefore, no related construction or operational impacts on specials-status species.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact related to birds and bats. Site 1 contributes to significant impacts related to overwintering monarch butterfly habitat. Under this alternative, these impacts would be slightly reduced because of the omission of these sites. However, significant impacts on these special-status species could still occur at other sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact related to birds and bats. Site 1 contributes to significant impacts related to overwintering monarch butterfly habitat. Under this alternative, these impacts would be slightly reduced because of the omission of these sites. However, significant impacts on these special-status species could still occur at other sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact related to birds. Site 7 contributes to significant impacts related to bats and overwintering monarch butterfly habitat. Under this alternative, these impacts would be slightly reduced because of the omission of these sites. However, significant impacts on these special-status species could still occur at other sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact related to birds. Site 7 contributes to significant impacts related to bats and overwintering monarch butterfly habitat. Under this alternative, these impacts would be slightly reduced because of the omission of these sites. However, significant impacts on these special-status species could still occur at other sites.
Impact BR-2. Project construction could adversely affect riparian habitat or other sensitive natural communities.	**Less than Significant with Mitigation (LSM)** Project construction at Site 1 could adversely affect Central Coast riparian scrub habitat. Mitigation Measures M-BR-2 and M-HY-1 would reduce impacts at Site 1 to less-than–significant levels.	**Same as existing conditions (NI)** There would be no construction activities, and no sensitive natural communities would be affected as a result.	**Less than the proposed Project (NI)** Construction would not occur at Site 1; therefore there would be no impacts on riparian habitat or other sensitive natural communities at that site under this alternative.	**Less than the proposed Project (NI)** Construction would not occur at Site 1; therefore there would be no impacts on riparian habitat or other sensitive natural communities at that site under this alternative.	**Same as the proposed Project (LSM)** Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact under this alternative.	**Same as the proposed Project (LSM)** Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact under this alternative.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact BR-3. The Project would impact jurisdictional wetlands or waters of the United States.	**Less than Significant with Mitigation (LSM)** Project construction could impact jurisdictional wetlands and waters at Sites 8, 9, and 11. Mitigation Measure M-HY-1 would reduce the impacts at these sites to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities and no wetlands or waters would be impacted as a result.	**Same as the proposed Project (LSM)** Under the Project, Sites 1 and 4 do not contribute to the significant impact, so the omission of these well facilities per this alternative would not change the significance of this impact.	**Same as the proposed Project (LSM)** Under the Project, Sites 1 and 4 do not contribute to the significant impact, so the omission of these well facilities per this alternative would not change the significance of this impact.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 8 contributes to the significant impact. While the omission of this site would reduce overall impacts on jurisdictional waters, the impact level would be reduced but the impact would remain at LSM.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 8 contributes to the significant impact. While the omission of this site would reduce overall impacts on jurisdictional waters, the impact level would be reduced but the impact would remain at LSM.
Impact BR-4. Project construction would conflict with local tree preservation ordinances.	**Less than Significant with Mitigation (LSM)** Project construction would result in tree removal at 12 sites. Mitigation Measures M-BR-4a, M-AE-1b, and M-BR-4b would reduce impact to less-than-significant levels.	**Same as existing condition (NI)** There would be no construction activities and no trees would be removed.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 4 contributes to the significant impact. While the omission of this site would reduce the extent of tree removal in San Mateo County jurisdiction, trees would be removed at 11 other sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 4 contributes to the significant impact. While the omission of this site would reduce the extent of tree removal in San Mateo County jurisdiction, trees would be removed at 11 other sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 7 contributes to the significant impact. While the omission of this site would reduce the extent of tree removal in the Town of Colma's jurisdiction, trees would be removed at 11 other sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 7 contributes to the significant impact. While the omission of this site would reduce the extent of tree removal in the Town of Colma's jurisdiction, trees would be removed at 11 other sites.
Impact BR-5. Project operations could adversely affect candidate or sensitive special-status species.	**Less than Significant with Mitigation (LSM)** Project construction could result in adverse impacts to special-status species at five sites. Mitigation Measure M-NO-5 would reduce impact to less-than-significant levels.	**Same as existing condition (NI)** There would be no project operations and no special-status species would be affected.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 1 contributes to the significant impact. While the omission of the site would reduce the extent of operational impacts, special-status species could still be affected at four sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 1 contributes to the significant impact. While the omission of the site would reduce the extent of operational impacts, special-status species could still be affected at four sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 7 (On-site Treatment) contributes to the significant impact. While the omission of the site would reduce the extent of operational impacts, special-status species could still be affected at four sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 7 (On-site Treatment) contributes to the significant impact. While the omission of the site would reduce the extent of operational impacts, special-status species could still be affected at four sites.
Impact BR-7. Operation of the Project could adversely affect sensitive habitat types associated with Lake Merced.	**Less than Significant with Mitigation (LSM)** Project operation could increase water levels at Lake Merced, which could inundate sensitive habitats along the shores of Lake Merced. Mitigation Measures M-BR-7, M-HY-9a, and M-HY-9b would reduce impacts to less-than-significant levels.	**Same as existing condition (NI)** Water levels in Lake Merced would continue to fluctuate with varying hydrologic conditions, as they do now.	**Similar but slightly greater than the proposed Project (LSM)** Under Alternative 2A pumping near Lake Merced would be reduced, so lake levels would be expected to increase to higher levels than under the Project, potentially increasing the likelihood of inundating sensitive habitat.	**Similar but slightly greater than the proposed Project (LSM)** Under Alternative 2B pumping near Lake Merced would be reduced, so lake levels would be expected to increase to higher levels than under the Project, potentially increasing the likelihood of inundating sensitive habitat.	**Similar but slightly less than the proposed Project (LSM)** The Alternative would have slightly less impact on Lake Merced sensitive habitats because pumping would be redistributed to wells near Lake Merced, and water levels would not increase as much as they would with the Project.	**Same as the proposed Project (LSM)** Pumping would not be redistributed to wells near Lake Merced, so the impact would be the same as the Project.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact BR-8: Operation of the Project could adversely affect wetland habitats and other waters of the United States associated with Lake Merced.	**Less than Significant with Mitigation (LSM)** Project operation could decrease water levels at Lake Merced at the end of the design drought and could also increase water levels during wet and normal years such that a net loss of wetland habitat would occur. Mitigation Measures M-BR-8, M-HY-9a, and M-HY-9b would reduce impacts to less-than-significant levels.	**Same as existing condition (NI)** Water levels in Lake Merced would continue to fluctuate with varying hydrologic conditions, as they do now.	**Similar but slightly greater than the proposed Project (LSM)** Under Alternative 2A pumping near Lake Merced would be reduced, so the decline in lake levels at the end of the design drought would be 54 percent less than with the Project. This would reduce the impact on decreasing lake levels at the end of the design drought, but would increase the impact on rising lake levels during wet and normal years, thus increasing impacts on wetland habitat.	**Similar but slightly greater than the proposed Project (LSM)** Under Alternative 2B pumping near Lake Merced would be reduced, so the decline in lake levels at the end of the design drought would be 54 percent less than with the Project. This would reduce the impact on decreasing lake levels at the end of the design drought, but would increase the impact on rising lake levels during wet and normal years, thus increasing impacts on wetland habitat.	**Similar but slightly greater than the proposed Project (LSM)** The Alternative would increase pumping in wells near the lake. This would reduce the impact on rising lake levels during wet and normal years, but would increase the impact on decreasing lake levels at the end of the design drought, thus increasing impacts on wetland habitat.	**Same as the proposed Project (LSM)** Because pumping would not be redistributed to wells near Lake Merced, this alternative would have the same impact as the Project.
Impact BR-9: Operation of the Project could adversely affect native wildlife nursery sites associated with Lake Merced.	**Less than Significant with Mitigation (LSM)** Project operation could affect water levels at Lake Merced which would inundate eucalyptus trees that support cormorant and heron rookeries. Mitigation Measures M-BR-7 and M-HY-9a would reduce impacts to less-than significant levels.	**Same as existing condition (NI)** Water levels in Lake Merced would continue to fluctuate with varying hydrologic conditions, as they do now.	**Similar but slightly greater than the proposed Project (LSM)** Under Alternative 2A pumping near Lake Merced would be reduced, so lake levels would be expected to increase to higher levels than under the Project, potentially increasing the likelihood of inundating eucalyptus trees.	**Similar but slightly greater than the proposed Project (LSM)** Under Alternative 2B pumping near Lake Merced would be reduced, so lake levels would be expected to increase to higher levels than under the Project, potentially increasing the likelihood of inundating eucalyptus trees.	**Similar but slightly less than the proposed Project (LSM)** The Alternative would have slightly less impact on Lake Merced eucalyptus trees because pumping would be redistributed to wells near Lake Merced, and water levels would not increase as much as they would with the Project.	**Same as the proposed Project (LSM)** Pumping would not be redistributed to wells near Lake Merced, so the impact would be the same as the Project.
Impact C-BR-1. Construction and operation of the proposed Project could result in significant cumulative impacts related to biological resources.	**Less than Significant with Mitigation (LSM)** The Project could result in significant cumulative impacts related to biological resources at all sites associated with effects on nesting birds, disturbance of riparian habitat and wetlands, and tree removal. Mitigation Measures M-BR-1a, M-BR-1b, M-BR-1c, M-BR-1d, M-BR-2, M-HY-1, M-BR-4a, M-AE-1b, and M-BR-4b would reduce impacts to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities. No new GSR well facilities would be constructed.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant cumulative impact related to special-status species. Site 1 contributes to impacts related to Coastal Riparian Scrub habitat, and Site 4 contributes to impacts related to local tree ordinances. The omission of these two sites would reduce cumulative impacts on these biological resources.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant cumulative impact related to special-status species. Site 1 contributes to impacts related to Coastal Riparian Scrub habitat, and Site 4 contributes to impacts related to local tree ordinances. The omission of these two sites would reduce cumulative impacts on these biological resources.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant cumulative impact related to special-status species. Site 8 contributes indirectly to impacts related to jurisdictional waters, and Site 7 contributes to impacts related to local tree ordinances. The omission of these two sites would reduce cumulative impacts on these biological resources.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant cumulative impact related to special-status species. Site 8 contributes indirectly to impacts related to jurisdictional waters, and Site 7 contributes to impacts related to local tree ordinances. The omission of these two sites would reduce cumulative impacts on these biological resources.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-BR-2. The Project would not result in cumulative construction or operational impacts related to special-status species, riparian habitats, sensitive communities, wetlands, or water of the United States, or compliance with local policies and ordinances protecting biological resources at Lake Merced.	**Less than Significant with Mitigation (LSM)** Under cumulative conditions, the Project is expected to result in less dramatic water level fluctuations in most years than those for the Project alone, resulting in fewer impacts related to changes in water levels. Mitigation Measures M-BR-7, M-HY-9a, and M-HY-9b would reduce impacts to less-than-significant levels.	**Same as existing condition (NI)** Water levels in Lake Merced would continue to fluctuate with varying hydrologic conditions, as they do now.	**Similar but slightly greater than the proposed Project (LSM)** Under Alternative 2A pumping near Lake Merced would be reduced, so the decline in lake levels at the end of the design drought would be less than with the Project, but lake levels would increase more than with the Project in wet and normal years. This would increase the impact on sensitive habitat, wetlands, and eucalyptus trees around the lake.	**Similar but slightly greater than the proposed Project (LSM)** Under Alternative 2B pumping near Lake Merced would be reduced, so the decline in lake levels at the end of the design drought would be less than with the Project, but lake levels would increase more than with the Project in wet and normal years. This would increase the impact on sensitive habitat, wetlands, and eucalyptus trees around the lake.	**Similar but slightly greater than the proposed Project (LSM)** The Alternative would have slightly greater impacts on Lake Merced because there would be more pumping in wells near the lake at the end of the design drought, so water levels would be reduced further, resulting in loss of wetland habitat.	**Same as the proposed Project (LSM)** Because pumping would not be redistributed to wells near Lake Merced, this alternative would have the same impacts as the Project.
Geology and Soils						
Impact GE-3. The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic ground shaking, or landslides.	**Less than Significant with Mitigation (LSM)** Project operations would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic ground shaking, or landslides at all sites. Mitigation Measure M-GE-3 would reduce impacts to less-than significant levels.	**Same as existing conditions (NI)** No new GSR well facilities would be constructed.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact related to ground shaking. The omission of these sites would reduce the number of new GSR facilities susceptible to ground shaking.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact related to ground shaking. The omission of these sites would reduce the number of new GSR facilities susceptible to ground shaking.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact related to ground shaking. The omission of these sites would reduce the number of new GSR facilities susceptible to ground shaking.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact related to ground shaking. The omission of these sites would reduce the number of new GSR facilities susceptible to ground shaking.
Impact GE-4. The Project would be located on a geologic unit or soil that is unstable, or that would become unstable.	**Less than Significant with Mitigation (LSM)** Project facilities would be located on unstable soils or soils that may become unstable at 10 sites. Mitigation Measure M-GE-3 would reduce impacts to less-than-significant levels.	**Same as existing conditions (NI)** No new GSR well facilities would be constructed.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 1 would contribute to the significant impact related to settlement. The omission of this site would reduce the number of new GSR facilities susceptible to settlement to nine sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 1 would contribute to the significant impact related to settlement. The omission of this site would reduce the number of new GSR facilities susceptible to settlement to nine sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 8 would contribute to the significant impact related to settlement. The omission of this site would reduce the number of new GSR facilities susceptible to settlement to nine sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 8 would contribute to the significant impact related to settlement. The omission of this site would reduce the number of new GSR facilities susceptible to settlement to nine sites.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Hydrology and Water Quality						
Impact HY-1. Project construction activities would degrade water quality as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals during construction.	**Less than Significant with Mitigation (LSM)** Construction would result in earthmoving that if not properly managed could increase sediment loads in receiving water bodies, thereby adversely affecting water quality and designated beneficial uses for all sites. Mitigation Measure M-HY-1 would reduce impacts to less-than-significant levels for all sites.	**Same as existing conditions (NI)** There would be no construction activities that would degrade water quality.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, impacts on surface water quality would be slightly reduced because of the overall decrease in construction. However, the potential for surface water quality impacts would still occur at the remaining sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, impacts on surface water quality would be slightly reduced because of the overall decrease in construction. However, the potential for surface water quality impacts would still occur at the remaining sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, impacts on surface water quality would be slightly reduced because of the overall decrease in construction. However, the potential for surface water quality impacts would still occur at the remaining sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, impacts on surface water quality would be slightly reduced because of the overall decrease in construction. However, the potential for surface water quality impacts would still occur at the remaining sites.
Impact HY-2. Discharge of groundwater could result in minor localized flooding, violate water quality standards and/or otherwise degrade water quality.	**Less than Significant with Mitigation (LSM)** Well development, well pumping tests, initial well disinfection and excavation dewatering could result in increased sources of polluted runoff and may lead to degraded water quality at all sites except for the Westlake Pump Station. Mitigation Measure M-HY-2 would reduce impacts to less-than-significant levels.	**Same as existing conditions (NI)** There would be no wells constructed, and therefore no impacts from well testing or disinfection would occur.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, impacts on surface water quality would be slightly reduced because of the overall decrease in the total number of wells. However, the potential for water quality impacts resulting from groundwater discharge would still occur at the remaining sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 contribute to the significant impact. Under this alternative, impacts on surface water quality would be slightly reduced because of the overall decrease in the total number of wells. However, the potential for water quality impacts resulting from groundwater discharge would still occur at the remaining sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, impacts on surface water quality would be slightly reduced because of the overall decrease in the total number of wells. However, the potential for water quality impacts resulting from groundwater discharge would still occur at the remaining sites.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 contribute to the significant impact. Under this alternative, impacts on surface water quality would be slightly reduced because of the overall decrease in the total number of wells. However, the potential for water quality impacts resulting from groundwater discharge would still occur at the remaining sites.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact HY-6. Project operation would decrease the production rate of existing nearby irrigation wells due to localized groundwater drawdown within the Westside Groundwater Basin such that existing or planned land use(s) may not be fully supported.	**Significant and Potentially Unavoidable with Mitigation (SUM)** Operation of the Project would cause significant well interference at 13 existing irrigation wells. Mitigation Measure M-HY-6 would reduce impacts to less-than–significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.	**Similar but slightly less than the proposed Project (SU)** During a drought equivalent to the design drought, groundwater levels would decline to a point such that the production rate of existing wells may not fully support existing or planned land uses.	**Similar but slightly greater than the proposed Project (SUM)** Alternative 2A would decrease well interference at five existing irrigation wells and increase well interference at 12 existing irrigation wells. The level of significance for well interference at existing irrigation wells would not change compared to the Project. Mitigation Measure M-HY-6 would reduce impacts to less-than-significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.	**Similar but slightly less than the proposed Project (SUM)** Alternative 2B would decrease well interference at five existing irrigation wells, but the level of significance for well interference at existing irrigation wells would not change compared to the Project. Mitigation Measure M-HY-6 would reduce impacts to less-than-significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.	**Similar but slightly less than the proposed Project (SUM)** Alternative 3A would decrease well interference at 10 existing irrigation wells and increase well interference at seven existing irrigation wells. The level of significance for well interference at existing irrigation wells would not change compared to the Project, except that significant impacts would not occur at the Home of Peace Cemetery well. Mitigation Measure M-HY-6 would reduce impacts to less-than-significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.	**Similar but slightly less than the proposed Project (SUM)** Alternative 3B would decrease well interference at five existing irrigation wells. The level of significance for well interference at existing irrigation wells would not change compared to the Project, except that significant impacts would not occur at the Home of Peace Cemetery well and the Holy Cross Cemetery well #1. Mitigation Measure M-HY-6 would reduce impacts to less-than–significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact HY-9. Project operation could have a substantial, adverse effect on water quality that could affect the beneficial uses of Lake Merced.	**Less than Significant with Mitigation (LSM)** Operation of the Project is predicted to cause lake levels at Lake Merced to decline by approximately 4 feet more than modeled existing conditions to a minimum monthly average of -2.5 feet City Datum, after the end of the design drought during recovery of the lake levels. These lake level impacts could cause significant water quality impacts that would have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measure M-HY-9a and M-HY-9b would reduce impacts to less-than-significant levels.	**Similar but slightly less than the proposed Project (SU)** During a drought equivalent to the design drought, lake levels at Lake Merced are predicted to decline to -0.8 feet City Datum, a level at which substantial adverse effects on water quality and the beneficial uses of Lake Merced could occur.	**Similar but slightly less than the proposed Project (LSM)** Operation of the Project under this alternative is predicted to cause lake levels at Lake Merced to decline by approximately 2 feet more than under modeled existing conditions, to a minimum monthly average of -0.5 feet City Datum, after the end of the design drought during recovery of the lake levels. These lake level impacts could cause significant water quality impacts that would have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less-than-significant levels.	**Similar but slightly less than the proposed Project (LSM)** Operation of the Project under this alternative is predicted to cause lake levels at Lake Merced to decline by approximately 2 feet more than modeled existing conditions, to a minimum monthly average of -0.5 feet City Datum, after the end of the design drought during recovery of the lake levels. These lake level impacts could cause significant water quality impacts that would have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less–than–significant levels.	**Similar but slightly greater than the proposed Project (LSM)** Operation of the Project under this alternative is predicted to cause lake levels at Lake Merced to decline by approximately 5.2 feet more than modeled existing conditions, to a minimum monthly average of -3.7 feet City Datum, after the end of the design drought during recovery of the lake levels. These lake level impacts could cause significant water quality impacts that could have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less-than–significant levels.	**Similar to the proposed Project (LSM)** Operation of the Project under this alternative would not change effects on Lake Merced because pumping near the lake would be the same as under the Project. As with the Project, lake level impacts could cause significant water quality impacts that would have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less-than-significant levels.
Impact HY-14. Project operation may have a substantial adverse effect on groundwater depletion in the Westside Groundwater Basin over the very long term.	**Less than Significant with Mitigation (LSM)** Operation of the Project is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 20,000 af more than under modeled existing conditions over the 47-year hydrologic modeling period. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.	**Similar but slightly more than the proposed Project (SU)** Groundwater storage volumes in the Westside Groundwater Basin are predicted to decline by approximately 28,000 af over the 47-year hydrologic modeling period.	**Same as the proposed Project (LSM)** Because this alternative maintains the Project yield, operation of the Project under this alternative is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 20,000 af more than under modeled existing conditions over the 47-year hydrologic modeling period, the same as the Project. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.	**Similar but slightly less than the proposed Project (LSM)** Because this alternative reduces Project yield by 14 percent, operation of the Project under this alternative is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 13,000 af more than under modeled existing conditions over the 47-year hydrologic modeling period, or 7,000 af less than the Project over the same time span. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.	**Same as the proposed Project (LSM)** Because this alternative maintains the Project yield, operation of the Project under this alternative is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 20,000 af more than under existing conditions over the 47-year hydrologic modeling period, the same as the Project. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.	**Similar but slightly less than the proposed Project (LSM)** Because this alternative reduces Project yield by 16 percent, operation of the Project under this alternative is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 12,000 af more than under modeled existing conditions over the 47-year hydrologic modeling period, or 8,000 af less than the Project over the same time span. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.

TABLE 7-2
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Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-HY-2. Operation of the proposed Project would result in a cumulatively considerable contribution to cumulative impacts related to well interference.	**Significant and Unavoidable with Mitigation (SUM)** Operation of the Project under the cumulative scenario would cause significant well interference at 13 existing irrigation wells. Mitigation Measure M-HY-6 would reduce impacts to less-than-significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.	**Similar but slightly less than the proposed Project (SU)** During a drought equivalent to the design drought, groundwater levels would decline to a point such that the production rate of existing wells may not fully support existing or planned land uses.	**Similar but slightly greater than the proposed Project (SUM)** Under the cumulative scenario, alternative 2A would decrease well interference at five existing irrigation wells and increase well interference at 12 existing irrigation wells. The level of significance for well interference at existing irrigation wells would not change compared to the Project. Mitigation Measure M-HY-6 would reduce impacts to less-than-significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.	**Similar but slightly less than the proposed Project (SUM)** Under the cumulative scenario, alternative 2B would decrease well interference at five existing irrigation wells, but the level of significance for well interference at existing irrigation wells would not change compared to the Project. Mitigation Measure M-HY-6 would reduce impacts to less-than-significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.	**Similar but slightly less than the proposed Project (SUM)** Under the cumulative scenario, alternative 3A would decrease well interference at 10 existing irrigation wells and increase well interference at seven existing irrigation wells. The level of significance for well interference at existing irrigation wells would not change compared to the Project, except that significant impacts would not occur at the Home of Peace Cemetery well. Mitigation Measure M-HY-6 would reduce impacts to less-than-significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.	**Similar but slightly less than the proposed Project (SUM)** Under the cumulative scenario, alternative 3B would decrease well interference at five existing irrigation wells. The level of significance for well interference at existing irrigation wells would not change compared to the Project, except that significant impacts would not occur at the Home of Peace Cemetery well and the Holy Cross Cemetery well #1. Mitigation Measure M-HY-6 would reduce impacts to less-than–significant levels, except that the certainty of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; thus, this impact is conservatively deemed significant and potentially unavoidable with mitigation.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-HY-5. Operation of the proposed Project could have a cumulatively considerably contribution to cumulative impacts on beneficial uses of surface waters.	**Less than Significant with Mitigation (LSM)** Under the cumulative scenario, during a drought equivalent to the design drought, lake levels at Lake Merced are predicted to decline to -4.9 feet City Datum, a level at which substantial adverse effects on water quality and the beneficial uses of Lake Merced could occur. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less-than-significant levels.	**Similar but slightly less than the proposed Project (SU)** During a drought equivalent to the design drought, lake levels at Lake Merced are predicted to decline to -0.8 feet City Datum, a level at which substantial adverse effects on water quality and the beneficial uses of Lake Merced could occur.	**Similar but slightly less than the proposed Project (LSM)** Under the cumulative scenario, operation of the Project under this alternative is predicted to cause lake levels at Lake Merced to decline to a minimum monthly average of -2.3 feet City Datum, after the end of the design drought during recovery of the lake levels. These lake level impacts could cause significant water quality impacts that would have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less-than-significant levels.	**Similar but slightly less than the proposed Project (LSM)** Under the cumulative scenario, operation of the Project under this alternative is predicted to cause lake levels at Lake Merced to a minimum monthly average of -2.3 feet City Datum, after the end of the design drought during recovery of the lake levels. These lake level impacts could cause significant water quality impacts that would have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less-than–significant levels.	**Similar but slightly greater than the proposed Project (LSM)** Under the cumulative scenario, operation of the Project under this alternative is predicted to cause lake levels at Lake Merced to decline to a minimum monthly average of -6.5 feet City Datum, after the end of the design drought during recovery of the lake levels. These lake level impacts could cause significant water quality impacts that could have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less-than–significant levels.	**Similar to the proposed Project (LSM)** Under the cumulative scenario, operation of the Project under this alternative would not change effects on Lake Merced because pumping near the lake would be the same as under the Project. As with the Project, lake level impacts could cause significant water quality impacts that would have substantial adverse effects on the beneficial uses of Lake Merced. Mitigation Measures M-HY-9a and M-HY-9b would reduce impacts to less-than-significant levels.
Impact C-HY-8. Operation of the proposed Project would have a cumulatively considerably contribution to a cumulative impact related to groundwater depletion effect.	**Less than Significant with Mitigation (LSM)** Under the cumulative scenario, groundwater storage volumes in the Westside Groundwater Basin are predicted to decline by an approximately 45,000 af more than under modeled existing conditions over the 47-year hydrologic modeling period. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.	**Similar but slightly more than the proposed Project (SU)** Groundwater storage volumes in the Westside Groundwater Basin are predicted to decline by approximately 28,000 af over the 47-year hydrologic modeling period.	**Same as the proposed Project (LSM)** Because this alternative maintains the Project yield, operation of this Project alternative under the cumulative scenario is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 45,000 af more than under modeled existing conditions over the 47-year hydrologic modeling period, the same as the Project. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.	**Similar but slightly less than the proposed Project (LSM)** Because this alternative reduces Project yield by 14 percent, operation of this Project alternative under the cumulative scenario is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 35,000 af more than under modeled existing conditions over the 47-year hydrologic modeling period, or 10,000 af less than the Project over the same time span. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.	**Same as the proposed Project (LSM)** Because this alternative maintains the Project yield, operation of this Project alternative under the cumulative scenario is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 45,000 af more than under existing conditions over the 47-year hydrologic modeling period, the same as the Project. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.	**Similar but slightly less than the proposed Project (LSM)** Because this alternative reduces Project yield by 16 percent, operation of this Project alternative under the cumulative scenario is predicted to cause groundwater storage in the Westside Groundwater Basin to decline by approximately 33,000 af more than under modeled existing conditions over the 47-year hydrologic modeling period, or 12,000 af less than the Project over the same time span. Mitigation Measure M-HY-14 would reduce impacts to less-than-significant levels.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Hazards and Hazardous Materials						
Impact HZ-2. The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction.	**Less than Significant with Mitigation (LSM)** Construction of the Project could result in the accidental release of chemicals used during construction at all sites. Mitigation Measures M-HZ-2a, M-HZ-2b, M-HZ-2c, and, M-HY-1 would reduce impacts at all sites to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities and so no related hazardous material would be released.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 would contribute to the significant impact related to accidental release of hazardous construction chemicals. Site 1 would contribute to significant impacts related to hazardous building materials. Under this alternative, there would be no demolition of the existing restroom building at Site 1. The overall potential for these impacts would be reduced due to the omission of Sites 1 and 4.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 would contribute to the significant impact related to accidental release of hazardous construction chemicals. Site 1 would contribute to significant impacts related to hazardous building materials. Under this alternative, there would be no demolition of the existing restroom building at Site 1. The overall potential for these impacts would be reduced due to the omission of Sites 1 and 4.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 would contribute to the significant impact. Under this alternative, the overall potential for accidental release of hazardous construction chemicals would be reduced due to the omission of Sites 7 and 8.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 would contribute to the significant impact. Under this alternative, the overall potential for accidental release of hazardous construction chemicals would be reduced due to the omission of Sites 7 and 8.
Impact HZ-3. The Project would result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during construction.	**Less than Significant with Mitigation (LSM)** Project construction would occur within 0.25 mile of a school at seven sites and adjacent to four well facility sites and the Westlake Pump Station. Mitigation Measure M-HY-1 and M-HZ-2c would reduce impacts at Sites 2, 3, 4, WLPS, and 19 (Alternate) to less-than-significant levels.	**Same as existing conditions (NI)** There would be no construction activities.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 4 would contribute to the significant impact related to use of hazardous materials near schools. Under this alternative, the overall potential for this impact would be reduced due to the omission of Site 4.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Site 4 would contribute to the significant impact related to use of hazardous materials near schools. Under this alternative, the overall potential for this impact would be reduced due to the omission of Site 4.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.	**Same as the proposed Project (LSM)** Under the Project, Sites 7 and 8 do not contribute to the significant impact, so the omission of these well facilities would not change the significance of this impact.

TABLE 7-2
Environmental Impacts of the CEQA Alternatives as Compared to the Proposed Project

Impact	Proposed Project	Alternative 1: No Project	Alternative 2A: Reduce Lake Merced Impacts and Maintain Project Yield	Alternative 2B: Reduce Lake Merced Impacts and Reduce Project Yield	Alternative 3A: Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield	Alternative 3B: Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield
Impact C-HZ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials.	**Less than Significant with Mitigation (LSM)** The Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials at all sites. Mitigation Measures M-HZ-2a, M-HZ-2b, M-HZ-2c, and M-HY-1 would reduce impacts to less-than-significant levels.	**Same as existing condition (NI)** There would be no construction activities. No new GSR well facilities would be constructed.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 would contribute to the significant cumulative impact related to accidental release of hazardous construction chemicals. Site 1 would contribute to significant cumulative impacts related to hazardous building materials. Site 4 would contribute to significant cumulative impacts related to use of hazardous materials near schools. Under this alternative, the overall potential for these impacts would be reduced due to the omission of Sites 1 and 4.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 1 and 4 would contribute to the significant cumulative impact related to accidental release of hazardous construction chemicals. Site 1 would contribute to significant cumulative impacts related to hazardous building materials. Site 4 would contribute to significant cumulative impacts related to use of hazardous materials near schools. Under this alternative, the overall potential for these impacts would be reduced due to the omission of Sites 1 and 4.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 would contribute to the significant cumulative impact related to accidental release of hazardous construction chemicals. Under this alternative, the overall potential for these impacts would be reduced due to the omission of Sites 7 and 8.	**Similar but slightly less than the proposed Project (LSM)** Under the Project, Sites 7 and 8 would contribute to the significant cumulative impact related to accidental release of hazardous construction chemicals. Under this alternative, the overall potential for these impacts would be reduced due to the omission of Sites 7 and 8.

7.5 ENVIRONMENTALLY SUPERIOR ALTERNATIVE

The CEQA Guidelines require the identification of an environmentally superior alternative to the proposed project (Section 15126.6[e]). If it is determined that the No Project Alternative would be the environmentally superior alternative, then the EIR shall also identify an environmentally superior alternative among the other Project alternatives (Section 15126.6[e][2]).

Construction of the proposed Project would cause significant and unavoidable noise and land use impacts (Impacts LU-1, NO-1, and NO-3) (see Section 5.2, Land Use, and Section 5.7, Noise and Vibration) from well drilling at nighttime and well facility construction during the daytime. Impacts LU-1 and NO-3 would be significant, even with mitigation, and there is no mitigation available to reduce the impact of nighttime construction conflicting with local noise standards (NO-1). In addition, aesthetic impacts of construction (Impact AE-1) (see Section 5.3, Aesthetics) would be significant and unavoidable at Site 7. All other construction impacts would have no impact, would be less than significant, or would be less than significant with implementation of mitigation measures. Operation of the proposed Project would cause significant and potentially unavoidable well interference impacts from pumping during take years at up to 13 existing irrigation wells. Mitigation would reduce these impacts to less than significant, except that the implementation of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; for this reason, the impact is deemed to be significant and potentially unavoidable with mitigation (see Impact HY-6 in Section 5.16, Hydrology and Water Quality). All other operational impacts would either have no impact, would be less than significant, or would be less than significant with implementation of mitigation measures. The proposed Project would achieve all of the Project objectives.

The No Project Alternative would avoid the construction-related environmental impacts of the proposed Project, except for potential actions taken by the SFPUC or wholesale water customers to develop other dry-year water supplies. The No Project Alternative would avoid the significant and unavoidable land use and noise impacts (Impacts LU-1, NO-1, and NO-3) (see Section 5.2, Land Use, and Section 5.7, Noise and Vibration) and the significant and unavoidable visual impact (Impact AE-1) associated with the proposed Project (see Section 5.3, Aesthetics). This alternative would not achieve any of the Project objectives, and it would not fulfill the SFPUC's basic mission of providing a reliable water supply for its customers, because a new source of dry-year and/or emergency water supply would be unavailable for SFPUC customers. The No Project Alternative would not support conjunctive use of the South Westside Groundwater Basin, nor would it allow for in-lieu recharge of the Basin.

Both Alternative 2A and Alternative 2B were selected for consideration to allow evaluation of the effects of a project that would reduce impacts to Lake Merced by eliminating two wells near the lake. Alternative 2A maintains project yield by redistributing pumping, and Alternative 2A reduces project yield.

Alternative 2A (Reduce Lake Merced Impacts and Maintain Project Yield) would eliminate construction impacts at Sites 1 and 4, including significant and unavoidable land use and noise impacts (Impacts LU-1, NO-1, and NO-3) at both sites that would occur under the proposed Project (see Section 5.2, Land Use, and Section 5.7, Noise and Vibration). Construction impacts at the other sites would be the same as those of the proposed Project. During operations, this alternative would reduce the severity of water quality impacts (Impact HY-9) at Lake Merced through a 54 percent reduction in pumping in the Daly City area, but impacts of pumping would be significant while the lake is recovering from the design drought, similar to the proposed Project (see Section 5.16, Hydrology and Water Quality). This alternative would decrease the severity of well interference impacts at five existing irrigation wells, but increase the severity of well interference impacts (Impact HY-6) at 12 existing irrigation wells compared to the Project, due to a redistribution of pumping at GSR wells away from the Lake Merced area and an approximately 20 percent increase in pumping at Sites 5 through 15. Mitigation would reduce the well interference impacts to less-than-significant levels in all cases, except that the implementation of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; for this reason, the impact is deemed to be significant and potentially unavoidable with mitigation. All other operational impacts would be less than significant with implementation of mitigation measures, which would be the same as the Project. Alternative 2A would have significant impacts at fewer sites than the Project during construction; however, impacts during operations would be approximately the same as the impacts of the Project, because mitigation measures would be equally effective at reducing impacts in either case. Because construction-period significant and unavoidable impacts of the proposed Project would be eliminated at two sites, impacts of Alternative 2A would be less severe than those of the proposed Project. In addition, Alternative 2A would achieve the Project objectives and would support the SFPUC's goal of providing a reliable dry-year groundwater supply during the 8.5-year design drought cycle.

Alternative 2B (Reduce Lake Merced Impacts and Reduce Project Yield), would eliminate construction impacts at Sites 1 and 4, including significant and unavoidable land use and noise impacts (Impacts LU-1, NO-1, and NO-3) at both sites that would occur under the proposed Project (see Section 5.2, Land Use, and Section 5.7, Noise and Vibration). Construction impacts at the other sites would be the same as those of the proposed Project. During operations, the alternative would reduce the severity of water quality impacts on beneficial uses (Impact HY-9) at Lake Merced through a 54 percent reduction in pumping in the Daly City area compared to the Project, but impacts of pumping would be significant while the lake is recovering from the design drought, similar to the proposed Project (see Section 5.16, Hydrology and Water Quality). This alternative would decrease the severity of well interference impacts (Impact HY-6) at five existing irrigation wells. All other operational impacts would be less than significant with implementation of mitigation measures, the same as the Project. Alternative 2B would have significant impacts at fewer sites than the Project during construction; impacts during operations would initially be less than the Project, but would become approximately the same as the impacts of the Project with implementation of mitigation, because mitigation measures would be equally effective at reducing impacts in either case. Therefore, because construction-period significant and unavoidable impacts of the proposed Project would be eliminated at two sites, the impacts of Alternative 2B would be less severe than those of the proposed Project; and because pumping would not be redistributed as it would be in Alternative 2A, operational impacts of Alternative 2B would be less severe than those of Alternative 2A and the proposed Project. Alternative 2B would not fully achieve the Project objectives, although it would meet most of them. Specifically, it would not fully support the SFPUC's goal to supply water reliably to customers in the event of emergencies and drought, because with the reduced yield associated with Alternative 2B, the SFPUC may not be able to limit systemwide rationing to 20 percent. The alternative would allow for the conjunctive use of the South Westside Groundwater Basin through coordinated use of SFPUC surface water and groundwater pumped by Partner Agencies and it would allow for in-lieu recharge of the Basin. However, the alternative would not provide the full 7.2-mgd dry-year and emergency pumping capacity needed to limit systemwide rationing to 20 percent during the 8.5-year design drought. The alternative would result in an approximately 1.0-mgd shortfall during each year of a severe drought. As a result, water rationing could increase to greater than 20 percent systemwide, which would be greater than currently included in the WSIP and thus under the proposed Project (SFPUC Resolution 08-200). In addition, the SFPUC and wholesale water customers may undertake other actions (e.g., groundwater development, water transfers) to meet their dry-year water supply needs, and each of these potential actions would likely have environmental impacts.

Alternative 3A (Reduce Impacts on Colma-area Existing Irrigation Wells and Maintain Project Yield) would eliminate construction impacts at Sites 7 and 8, including significant and unavoidable aesthetic impacts from tree removal at Site 7 that would occur under the proposed Project. Construction impacts at the other sites would be the same as those of the proposed Project. During operations, this alternative would reduce the severity of well interference impacts (Impact HY-6) on 10 existing irrigation wells at cemeteries in Colma, but would increase well interference impacts at seven existing irrigation wells compared to the Project, due to redistribution of pumping to GSR wells away from the Colma area (see Section 5.16, Hydrology and Water Quality). As a result, one existing irrigation well in Colma (Home of Peace Cemetery well) would not experience significant impacts, as it otherwise would under the proposed Project. Mitigation would reduce the significant well interference impacts to less-than-significant levels, except that the implementation of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; for this reason, the impact has been deemed significant and potentially unavoidable with mitigation. All other operational impacts would be less than significant with implementation of mitigation measures, which would be the same as for the Project; however, impacts on Lake Merced water levels (prior to mitigation) would be slightly greater under this alternative. In addition, Alternative 3A would have significant impacts at fewer sites than the Project during construction, because this alternative eliminates significant construction aesthetic impacts at Site 7. No impacts would be more severe under this alternative than those of the Project with implementation of mitigation. However, the greater impact to Lake Merced water levels under Alternative 3A requires greater mitigation of impacts to Lake Merced water levels and would require additional supplemental water, redistribution of pumping, or discontinued pumping than under the proposed Project. Therefore, the operational impacts of Alternative 3A would be less severe than those of the Project or of Alternatives 2A or 2B, with the exception of slightly greater impacts associated with Lake Merced. Alternative 3A would fully achieve the Project objectives and support the SFPUC's basic goal of providing a reliable dry-year and emergency groundwater supply during the 8.5-year design drought cycle.

Alternative 3B (Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Project Yield) would eliminate construction impacts at Sites 7 and 8, including significant and unavoidable aesthetic tree removal impacts at Site 7 that would occur under the proposed Project (see Impact AE-1 in Section 5.3, Aesthetics). Construction impacts at the other sites would be the same as those of the proposed Project. During operations, the alternative would reduce the severity of well interference impacts (Impact HY-6) on 10 existing irrigation wells at cemeteries in Colma as compared to the Project (see Section 5.16, Hydrology and Water Quality). As a result, two existing irrigation wells in Colma (Home of Peace

Cemetery well and Holy Cross Cemetery well #1) would not experience significant impacts, as they otherwise would under the proposed Project. Mitigation would reduce the significant well interference impacts to less-than-significant levels, except that the implementation of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow the mitigation to take place on their property; for this reason, the impact has been deemed significant and potentially unavoidable with mitigation. All other operational impacts would be less than significant with implementation of mitigation measures, which would be the same as for the Project. Alternative 3B would have significant impacts at fewer sites than the Project during construction, because this alternative eliminates significant construction aesthetic impacts at Site 7. In addition, Alternative 3B reduces well interference at two existing irrigation wells to less than significant. No impacts would be more severe under this alternative than the Project with implementation of mitigation. Therefore, the operational impacts of Alternative 3B would be less severe than those of the Project or of Alternatives 2A, 2B, or 3A. Alternative 3B would not fully achieve the Project objectives, although it would achieve most of them. Specifically, it would not fully support the SFPUC's goal to supply water reliably to customers in the event of emergencies and an 8.5-year drought. This alternative would allow for the conjunctive use of the South Westside Groundwater Basin through coordinated use of SFPUC surface water and groundwater pumped by Partner Agencies and it would allow for in-lieu recharge of the Basin. However, the alternative would not provide the full 7.2-mgd dry-year and emergency pumping capacity needed during the 8.5-year design drought. The alternative would result in an approximately 1.2-mgd shortfall during each year of a severe drought. As a result, water rationing could increase to greater than 20 percent systemwide, which would be greater than currently included in the WSIP and under the proposed Project. In addition, the SFPUC and wholesale water customers may need to undertake other actions (e.g., groundwater development, water transfers) to meet their dry-year water supply needs, and each of these potential actions would likely have environmental impacts.

Conclusion

As described above, none of the alternatives would reduce all the significant and unavoidable impacts of the proposed Project. Alternatives 2A, 2B, 3A, and 3B would cause significant and unavoidable impacts related to construction at one or two fewer sites than the Project; however, significant and unavoidable construction-related impacts would still occur at nine or 10 other facility sites, as they would under the proposed Project. Such impacts, although significant and unavoidable, would be temporary and would only occur for portions of the 16-month construction period. Alternatives 2A and 2B avoid the significant construction-period noise and land use impacts at Sites 1 and 4. Alternatives 3A and 3B avoid the significant and unavoidable aesthetic impact during construction associated with tree removal at Site 7.

Alternatives 3A and 3B would cause significant and potentially unavoidable well interference impacts during operation at one or two fewer existing irrigation wells than the Project; however, significant and potentially unavoidable well interference impacts would still occur at 11 or 12 existing irrigation wells, as they would under the proposed Project. The No Project Alternative would not cause significant and unavoidable construction impacts (since no construction would occur), but water levels at Lake Merced would continue to fluctuate as they do now under varying hydrologic conditions, and during a drought as severe as the design drought, lake levels would decline to a level that could have adverse water quality effects at Lake Merced. Because permanent operational impacts are considered more severe than temporary construction-period impacts, Alternative 3B (Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Yield) is the environmentally superior alternative, in that it would have significant and potentially unavoidable well interference impacts at fewer sites than the proposed Project or Alternatives 2A, 2B, or 3A. Alternative 3B (Reduce Impacts on Colma-area Existing Irrigation Wells and Reduce Yield) is therefore identified as the environmentally superior alternative, although, while it would meet most, it would not fully meet all of the Project objectives or WSIP goals.

7.6 ALTERNATIVES CONSIDERED BUT REJECTED FROM FURTHER ANALYSIS

As described under Section 7.3, GSR Alternatives Analysis, there is no alternative that would reduce all significant and unavoidable environmental impacts to a less than significant level and also meet most of the project objectives. The alternatives that were considered and then eliminated from further consideration are discussed below.

7.6.1 Eliminate Facility Sites with Significant and Unavoidable Construction-related Noise Impacts

Under this alternative, all sites with significant and unavoidable impacts for construction-related noise would be eliminated (see Section 7.3.2 [Impacts of the Proposed Project]). The following sites would be eliminated under this alternative: Sites 1, 3, 4, 5 (On-site Treatment), 9, 12, 14, 16, 18 (Alternate), and 19 (Alternate). It would allow the SFPUC to conjunctively manage the South Westside Groundwater Basin; however, it would not allow the SFPUC to increase the dry-year and emergency capacity of the Basin by 7.2 mgd during the 8.5-year design drought cycle.

This alternative is rejected from further consideration in this Draft EIR because the elimination of nine GSR sites would severely reduce the SFPUC's ability to provide sufficient water during the 8.5-year design drought. Operation of only 10 GSR wells would require nearly double the pumping rates proposed under the Project, which would be infeasible due to the lack of sufficient groundwater availability, in addition to the increased well interference effects at existing irrigation wells and Partner Agency municipal wells (MWH et al. 2008).

7.6.2 Construct and Operate 19 or More Well Facilities

Under this alternative, 19 or more new well facilities would be constructed and operated instead of the 16 sites proposed for the Project. The alternative would meet all the Project objectives. Specifically, it would provide for the conjunctive use of the South Westside Groundwater Basin, would increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by an annual average 7.2 mgd, and would provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8.5-year design drought cycle.

However, the alternative is rejected from further consideration in the Draft EIR because of increased construction-related and operations-related environmental impacts and possible infeasibility. The alternative would construct more well facilities than the Project and, therefore, increase the environmental impacts from construction. The SFPUC, in cooperation with the Partner Agencies, completed an Alternatives Analysis Report (AAR) that identified and evaluated potential well facility sites to support the Project (MWH 2007). The analysis used evaluation criteria for selection of preferred facility sites. The AAR identified nine preferred sites with 14 wells. Following completion of the AAR, the SFPUC developed the Conceptual Engineering Report (CER) (MWH et al. 2008). Based on Project reviews during development of the CER, the SFPUC conducted analyses to determine potential effects of pumping the original 14 well locations on groundwater levels near the wells and potential impacts to existing irrigation wells in the Basin. Results of the analysis indicated that a more distributed network of wells than the original nine sites should be developed to reduce potential well interference impacts. The analysis determined that 16 wells distributed across the Basin would be the optimal number to reduce well interference effects at existing irrigation wells, Partner Agency municipal wells, and proposed GSR well sites. Further, expansion of the number of well facility sites would require that wells be located further out toward the edges of the Groundwater Basin where groundwater availability would be more limited, or closer to existing wells or proposed GSR well sites where well interference effects would be greater (MWH et al. 2008).

7.6.3 Construct Well Facilities at Different Locations within the South Westside Groundwater Basin

Under this alternative, a total of 16 well facilities, some of which would be constructed at locations different than those identified and evaluated for the proposed Project, would be constructed. The alternative would meet all the project objectives. Specifically, it would provide for the conjunctive use of the South Westside Groundwater Basin, would increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by an average annual 7.2 mgd, and would provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8.5-year design drought cycle.

However, the alternative is rejected from further consideration in the Draft EIR because the selection of different sites, rather than the 19 sites (16 preferred sites and three alternate sites) evaluated for the proposed Project, would not reduce environmental impacts and may increase impacts beyond those identified for the proposed Project. The SFPUC and Partner Agencies completed an Alternatives Analysis Report (AAR) to evaluate potential well sites (MWH 2007). The AAR compared 48 potential well sites within the South Westside Groundwater Basin. The analysis evaluated potential well sites based on four evaluation criteria including the following:

- **Well Site Suitability** – including access to the site, the footprint of the site, underground obstructions and horizontal setback distances.
- **Groundwater System Considerations** – including potential well yield, groundwater quality, well interference potential, and geologic stability.

- **Distribution System Considerations** – including proximity to existing Partner Agency and SFPUC conveyance and treatment facilities.
- **Land Use Considerations** – including land ownership, property acquisition, ease of permitting, and local acceptance.

The evaluation criteria were applied to the preliminary well locations and a prioritized list of well locations was developed to meet the goal 7.2 mgd. The AAR identified nine preferred sites with 14 wells, and the nine sites were evaluated more fully to refine assumptions of the Basin properties at each preferred well site. Following completion of the AAR, two additional well sites were added to reduce well interference. The analysis performed by the SFPUC to identify the preferred well locations indicates that the remaining 32 well locations evaluated in the AAR would not reduce environmental impacts compared to the well sites in the proposed Project (MWH 2007; MWH et al. 2008).

7.6.4 Decreased Yield for all Proposed Wells

Under this alternative, a total of 16 well facilities would be constructed at the locations identified in the proposed Project (this could include a combination of any 16 of the 19 sites evaluated in this EIR, including Alternate location). However, the yield from each of these wells would be reduced to reduce significant groundwater impacts, such as well interference and water quality impacts at Lake Merced. The alternative would meet two of the four Project objectives. Specifically, it would provide for the conjunctive use of the South Westside Groundwater Basin and it would provide supplemental SFPUC surface water to Partner Agencies in normal and wet years and allow for in-lieu recharge through reduced groundwater pumping by Partner Agencies. The alternative would not create a dry-year and emergency pumping capacity of 7.2 mgd in the South Westside Groundwater Basin, and it would not provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8.5-year design drought cycle.

The alternative is rejected from further consideration in the Draft EIR because it would not meet most of the Project's basic objectives and therefore would not be a reasonable project alternative. Alternatives 2B and 3B would reduce the Project yield in a targeted manner so that significant groundwater impacts affecting water quality at Lake Merced (Impact HY-9) or well interference at existing irrigation wells in Colma (Impact HY-6) are reduced as much as feasible (see Section 5.16, Hydrology and Water Quality). An alternative that reduces yield equally at all of the well facilities would be less effective at reducing significant impacts, and therefore is not needed to provide decision-makers and the public with a reasonable range of alternatives for study.

7.6.5 Provide Water to Serve Less than an 8.5-year Design Drought Cycle

Under this alternative, a total of 16 well facilities would be constructed at the locations identified in the proposed Project. These wells would operate to meet the dry-year and emergency pumping capacity of the South Westside Groundwater Basin by 7.2 mgd in the event of an 8.5-year drought; however, pumping would cease before significant groundwater impacts would occur, resulting in water supplied for less than the full 8.5-year design drought cycle (should such an event ever occur). The alternative would meet three of the four Project objectives. Specifically, it would provide for the conjunctive use of the South Westside Groundwater Basin, it would provide supplemental SFPUC surface water to Partner Agencies in normal and wet years and allow for in-lieu recharge through reduced groundwater pumping by the Partner Agencies, and it would increase the dry-year and emergency pumping capacity of the South Westside Groundwater Basin to 7.2 mgd. However, the alternative would not provide a new dry-year groundwater supply for SFPUC customers nor increase water supply reliability during the entire 8.5-year design drought cycle.

The alternative is rejected from further consideration in the Draft EIR because the alternative would not meet the Project's most important objective, which is providing additional water for the entire 8.5-year design drought cycle and because it would not decrease significant impacts compared to the proposed Project. It is likely that significant well interference impacts would occur during the early years of a drought, because some of the existing irrigation wells have production capacity only slightly in excess of that needed to meet peak demand (see Table 5.6-13 [Estimated Peak Demand and 12-Hour Production Capacities] in Section 5.16, Hydrology and Water Quality). Therefore, pumping would need to be reduced early in the design drought cycle, and no additional environmental benefit would occur.

7.6.6 Construct a Year-round Desalination Plant for Drought

Under this alternative, the SFPUC would construct a desalination plant to provide water during drought years. The PEIR evaluated construction and operation of a 25-mgd year-round desalination plant as a means to provide supplemental water during all hydrological year types to blend with the regional system water, including supplemental water during drought years (San Francisco Planning Department 2008). The alternative would involve the construction of the Oceanside Seawater Desalination Plant on the west side of San Francisco near the existing Oceanside Water Pollution Plant. Under this alternative, 25 mgd of potable water supplies produced by reverse-osmosis technologies would be provided year-round to retail customers. The desalinated water would be introduced into the regional water system at Sunset Reservoir; this reservoir serves only customers in San Francisco and these customers would primarily receive desalinated water.

The San Francisco Public Utilities Commission rejected the alternative as infeasible at the time of approval of the WSIP in 2008 because construction and operation of a desalination facility raised unresolved environmental issues, including questions about protection of aquatic resources, water quality and brine disposal issues (SFPUC 2008). The desalination plant would require a significant amount of long-term energy use, which would increase emissions of greenhouse gases (unless powered by 100 percent non-GHG-generating energy sources). The Commission also rejected the alternative because the feasibility of a desalination plant was uncertain at that time, because it would require numerous additional permits and approvals and, therefore, would be unlikely that the facility could be approved within the ten years following approval of the WSIP. Moreover, the SFPUC determined that the alternative would be quite costly for the SFPUC, as set forth in Resolution 08-200.

This alternative is rejected from further consideration in the Draft EIR because, although the alternative would meet the Project's objective to provide a new dry-year water supply, it may not be cost effective to construct a year-round desalination plant for a dry-year water supply that would likely be needed less than 25 percent of the time on average. The unresolved environmental and regulatory compliance issues currently remain as they were when the Commission rejected this alternative during approval of the PEIR. Moreover, while the Commission rejected this alternative at the time of the 2008 WSIP approval (SFPUC Resolution 08-200), it continues to examine the feasibility of a year-round desalination plant in addition to a regional desalination plant, along with other opportunities and options to increase water supply to meet future demand and dry year needs. This ongoing evaluation was contemplated at the time of adoption of the WSIP and is part of the comprehensive assessment of water supply beyond 2018 and is appropriate for review in that context.

7.7 REFERENCES

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SFPUC. 2012c. *Effectiveness of Mitigation Measures for Well Interference*. August 21.

8 EIR AUTHORS AND CONSULTANTS

8.1 EIR AUTHORS

Planning Department, City and County of San Francisco
Environmental Planning

1650 Mission Street, Suite 400
San Francisco, CA 94103

- Sarah Jones, AICP, Acting Environmental Review Officer
- Paul Maltzer, Senior Environmental Planner
- Timothy Johnston, Senior Environmental Planner

Office of the City Attorney, City and County of San Francisco

City Hall Room 234
1 Dr. Carlton B. Goodlett Place
San Francisco, CA 94102

- Lori Wider, Deputy City Attorney
- Elaine Warren, Deputy City Attorney
- Josh Milstein, Deputy City Attorney

8.2 EIR CONSULTANTS

Prime Consultant

GHD Inc.

2235 Mercury Way, Suite 150
Santa Rosa, CA 95407

- Iver Skavdal, P.E., Project Principal
- Pat Collins, Project Manager
- Carrie Lukacic, Deputy Project Manager
- David D. Davis, AICP, Senior Planner
- Kristine Gaspar, Senior Planner
- Brian Bacciarini, Senior Scientist
- Chelsea Phlegar, Planner
- Katherine Ross, Junior Planner
- Renee Remillard, Senior Designer
- Carol Kielusiak, Supervising Planner

- Barrie Thom, Senior Designer
- Adam Fisher, P.E., Civil Engineer

Aesthetics

William Kanemoto & Associates

- William Kanemoto, Principal

Air Quality

Illingworth & Rodkin, Inc.

- James Reyff, Project Scientist
- Joshua Carman, Project Scientist

Archaeology

Archeo-Tech, Consulting Archaeologists

- Allen G. Pastron, Ph.D., RPA, Archaeologist – President
- Michelle Touton, MA, RPA

Biology

Ward & Associates

- Mike Wood, Senior Biologist

Historic Architecture

Carey & Co. Inc.

- Hisashi "Bill" Sugaya, AICP, Principal
- Nancy Goldenberg, Project Manager
- Elizabeth Graux, Architectural Historian & Designer

Hydrology (Groundwater)

HydroMetrics

- Derrik Williams, P.G., C.Hg., Geologist/Hydrogeologist
- Cameron Tana, P.E., Hydrologist

Noise

Illingworth & Rodkin, Inc.

- Rich Rodkin, Principal/Senior Project Engineer
- Joshua Carman, Project Scientist

Paleontology

Kenneth L. Finger, Ph.D.

- Kenneth L. Finger, Ph.D., Consulting Micropaleontologist

Quality Control/Quality Review

Valerie J. Young, Environmental Planning Consultant

- Valerie J. Young, AICP

RMC

- Robin Cort, Environmental Project Manager

8.3 Contributors

Lake Merced Analysis

Environmental Science Associates Inc. (ESA)

- Martha Lowe, Biological Resources
- Alisa Moore, Biological Resources, Recreation
- Chris Rogers, Biological Resources
- Wes McCollough, Geographic Information Systems (GIS)

8.4 Project Sponsor

San Francisco Public Utilities Commission

Bureau of Environmental Management
525 Golden Gate Avenue
San Francisco, CA 94102

- Irina Torrey, Bureau Manager
- Kelley Capone, Senior Environmental Project Manager
- YinLan Zhang, Environmental Project Manager
- Greg Bartow, Project Manager

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April 2013

DRAFT
Environmental Impact Report

Volume 3 of 3

For the
San Francisco Public Utilities Commission's

Regional Groundwater Storage and Recovery Project

Important Dates:

Draft EIR Publication Date:	April 10, 2013
Draft EIR Hearing Dates:	May 14, 2013 in San Mateo County
	May 16, 2013 in San Francisco
Draft EIR Public Comment Period:	April 10, 2013 through May 28, 2013

San Francisco Planning Department
Case No. 2008.1396E
State Clearinghouse No. 2005092026

Regional Groundwater Storage and Recovery Project

Draft Environmental Impact Report
Volume 3 of 3

San Francisco Planning Department Case No. 2008.1396E
State Clearinghouse No. 2005092026

Important Dates:

Draft EIR Publication Date:	April 10, 2013
Draft EIR Hearing Dates:	May 14, 2013, San Mateo County
	May 16, 2013, San Francisco
Draft EIR Public Comment Period:	April 10, 2013 through May 28, 2013

Written comments should be sent to:

Sarah Jones, Acting Environmental Review Officer
Regional Groundwater Storage and Recovery Project
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

TABLE OF CONTENTS

Regional Groundwater Storage and Recovery Project Draft Environmental Impact Report

Volume 3 – Appendices

Appendix A

Notice of Preparation

SAN FRANCISCO
PLANNING DEPARTMENT

Notice of Preparation of an Environmental Impact Report

1650 Mission St.
Suite 400
San Francisco,
CA 94103-2479

Reception:
415.558.6378

Fax:
415.558.6409

Planning
Information:
415.558.6377

Date:	June 24, 2009
Case No.:	~~[illegible]~~ 2008.1396E
Project Title:	**Regional Groundwater Storage and Recovery Project**
Location:	The proposed Project is located in the South Westside Groundwater Basin in San Mateo County, and the proposed facilities will be constructed in northern San Mateo County. The South Westside Groundwater Basin is located in San Mateo County within the larger Westside Groundwater Basin which underlies both San Francisco and San Mateo counties. Proposed facilities are located in the cities of South San Francisco, Colma, San Bruno, Millbrae, and Daly City and in unincorporated portions of San Mateo County.
BPA Nos.:	N/A
Zoning:	N/A
Block/Lot:	N/A
Lot Size:	Various
Project Sponsor	Greg Bartow, San Francisco Public Utilities Commission (415) 934-5724
Lead Agency:	San Francisco Planning Department
Staff Contact:	Diana Sokolove – (415) 575-9046 diana.sokolove@sfgov.org

PROJECT DESCRIPTION

The purpose of the Regional Groundwater Storage and Recovery (GSR) Project (Project or proposed Project) is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. This new dry-year water supply would be made available to the cities of Daly City and San Bruno, the California Water Company (Cal Water) in its South San Francisco service area (collectively referred to as Partner Agencies) and San Francisco Public Utilities Commission (SFPUC) wholesale water customers.

The SFPUC proposes to provide surface water, when available, to Partner Agencies, to be used by these agencies in lieu of pumping groundwater during normal and wet rainfall years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. This supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of pumping by Partner Agencies would ultimately increase groundwater storage within the South Westside Groundwater Basin by up to 61,000 acre-feet (AF) (approximately 20 billion gallons). Stored groundwater would be utilized by pumping new Project wells during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would construct new groundwater production well facilities, which would be operated by either the Partner Agencies or SFPUC for pumping groundwater at a rate of 7.2 million gallons per day during dry years. The proposed Project would help meet the water supply reliability needs of all SFPUC customers during dry years and may provide some increased level of regional operational flexibility to respond and restore service during unplanned outages.

The proposed Project is one of several facility improvement projects identified in the San Francisco Region as part of the SFPUC's Water System Improvement Program (WSIP). The WSIP was adopted by the SFPUC in October 2008 to improve the SFPUC's regional water system with respect to water quality, seismic response, water delivery, and water supply to meet water delivery needs in the service area and establishes level of service goals and system performance objectives. The proposed Project's primary contribution to the WSIP goals is its ability to meet the water supply needs of SFPUC customers during drought years.

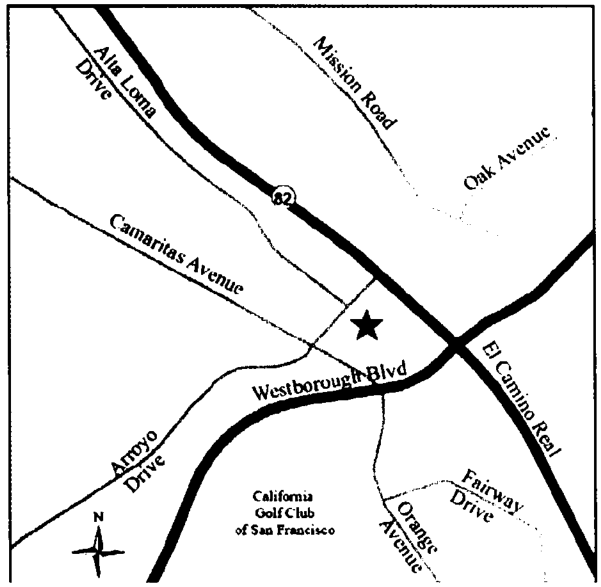
The proposed Project consists of 1) cooperative management of surface water and groundwater to optimize the water demand and supply balance; and 2) construction and operation of groundwater production well facilities on 16 of 19 potential sites in northern San Mateo County. Each groundwater well facility site would contain a groundwater production well, pump station, underground distribution piping, and utility connections. Some well facility sites would contain groundwater disinfection units and groundwater treatment facilities. Well facilities would connect to distribution systems for Daly City, San Bruno, Cal Water, and SFPUC. In addition, the Westlake Pump Station in Daly City may need to be upgraded and treatment facilities may need to be added to several well facility sites.

FINDING

This project may have a significant effect on the environment and an Environmental Impact Report is required. This determination is based upon the criteria of the State CEQA Guidelines, Sections 15063 (Initial Study), 15064 (Determining Significant Effect), and 15065 (Mandatory Findings of Significance), and for the reasons documented in the attached project description and description of potential environmental effects. (Documents are also available online at: http://www.sfgov.org/planning/mea.)

PUBLIC SCOPING PROCESS

Pursuant to the State of California Public Resources Code Section 21083.9 and CEQA Guidelines Section 15206, a public scoping meeting will be held to receive oral comments concerning the scope of the EIR at the following location, date, and time.



DATE: Thursday, July 9, 2009
6:15-7:00 p.m. Informational Session
7:00 p.m. Scoping meeting

LOCATION:
South San Francisco Municipal Services Building
Community Room
33 Arroyo Drive
South San Francisco, CA

Written comments will also be accepted at this meeting and until the close of business on **July 28, 2009**. Written comments should be sent to Bill Wycko, Environmental Review Officer, Regional Groundwater Storage and Recovery Project Scoping Comments, San Francisco Planning Department, 1650 Mission Street, Suite 400, San Francisco, CA 94103. They also may be submitted by fax to (415) 558-6409 or sent by email to diana.sokolove@sfgov.org.

If you work for a Responsible or Trustee Agency, we need to know the views of your agency regarding the scope and content of the environmental information that is germane to your agency's statutory responsibilities in connection with the proposed Project. Your agency may need to use the EIR when considering a permit or other approval for this proposed Project. Please include the name of a contact person in your agency.

June 24, 2009
Date

[signature] for
Bill Wycko
Environmental Review Officer

Regional Groundwater Storage and Recovery Project

2008.1396E

~~Case No 2005.0164E~~

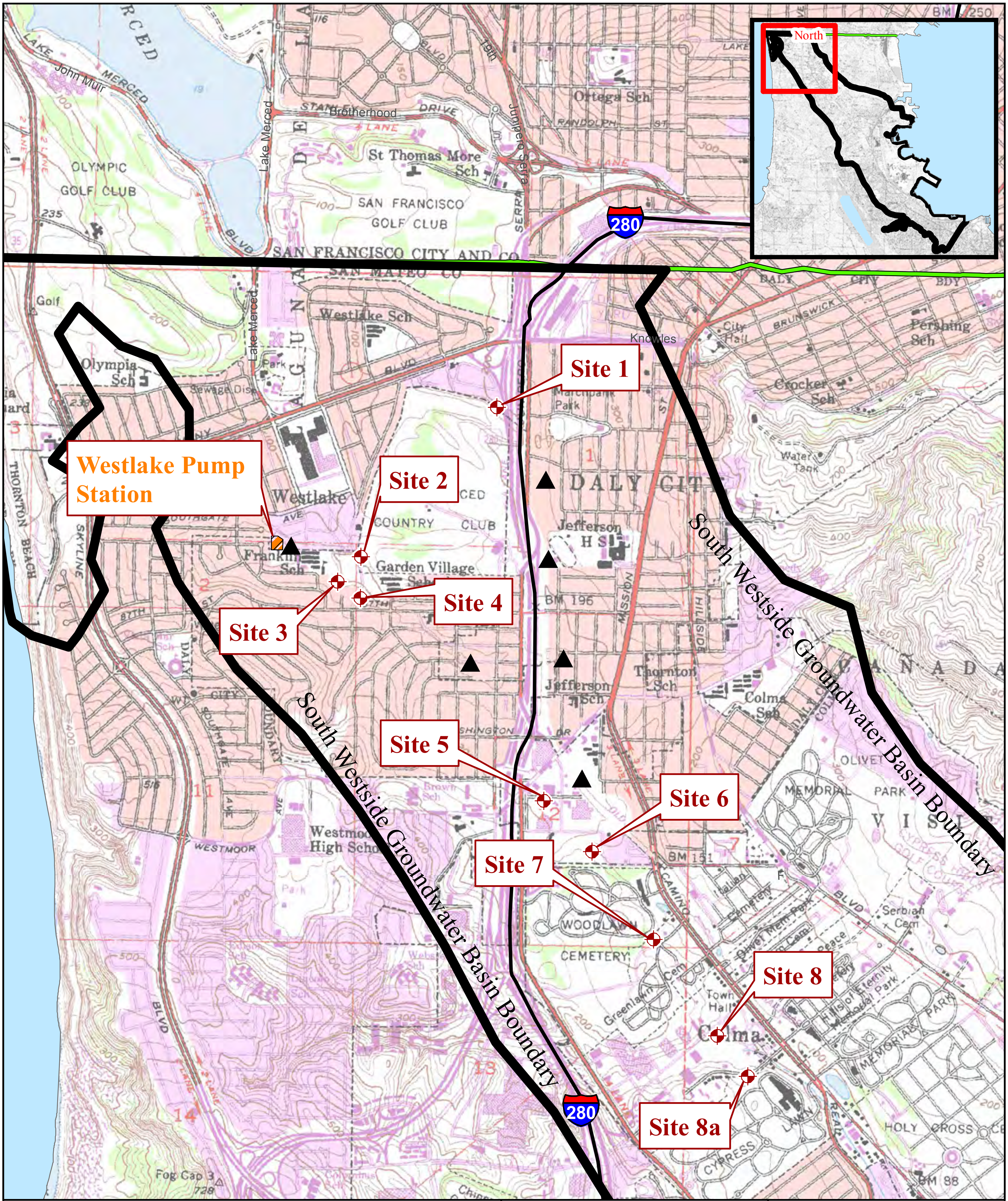
1.0 OVERVIEW AND BACKGROUND

The San Francisco Public Utilities Commission (SFPUC) is proposing the Regional Groundwater Storage and Recovery (GSR) Project (Project or proposed Project), which would be located in northern San Mateo County, California (see Figures 1, 2, and 3). To meet California Environmental Quality Act (CEQA) requirements, the San Francisco Planning Department's Major Environmental Analysis Division (MEA) will prepare and distribute an Environmental Impact Report (EIR) describing and analyzing the environmental effects of the proposed Project. This Notice of Preparation (NOP) provides a description of the Project background, a brief description of the proposed Project elements, and describes some of the proposed Project's potential environmental effects.

The purpose of the proposed Project is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. This new dry-year water supply would be made available to the cities of Daly City and San Bruno, the California Water Company (Cal Water) in its South San Francisco service area (collectively designated as Partner Agencies) and SFPUC wholesale water customers.

SFPUC proposes to provide excess surface water when available to the Partner Agencies to be used by these agencies in lieu of pumping groundwater during normal and wet years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. This supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of groundwater pumping by Partner Agencies would ultimately increase groundwater storage within the South Westside Groundwater Basin by up to 61,000 acre-feet[1] (AF) (approximately 20 billion gallons). Stored

[1] The SFPUC plans for an 8.5-year drought. Over this 8.5-year period, the SFPUC anticipates it will exercise its dry-year supplies after the first year of the drought. Therefore, the 61,000 AF of storage is assumed to be used over 7.5 years of the design drought, with wells operating at a maximum capacity of 7.2 MGD.



Legend

- Proposed Well Facility Sites
- Partner Agency Well
- County Boundary
- Westlake Pump Station
- South Westside Groundwater Basin

0 1,000 2,000
Scale Feet
1" = 2000'

Project Location Map-North

Regional Groundwater Storage and Recovery Project

Figure 1

Source: SFPUC and Kennedy/Jenks

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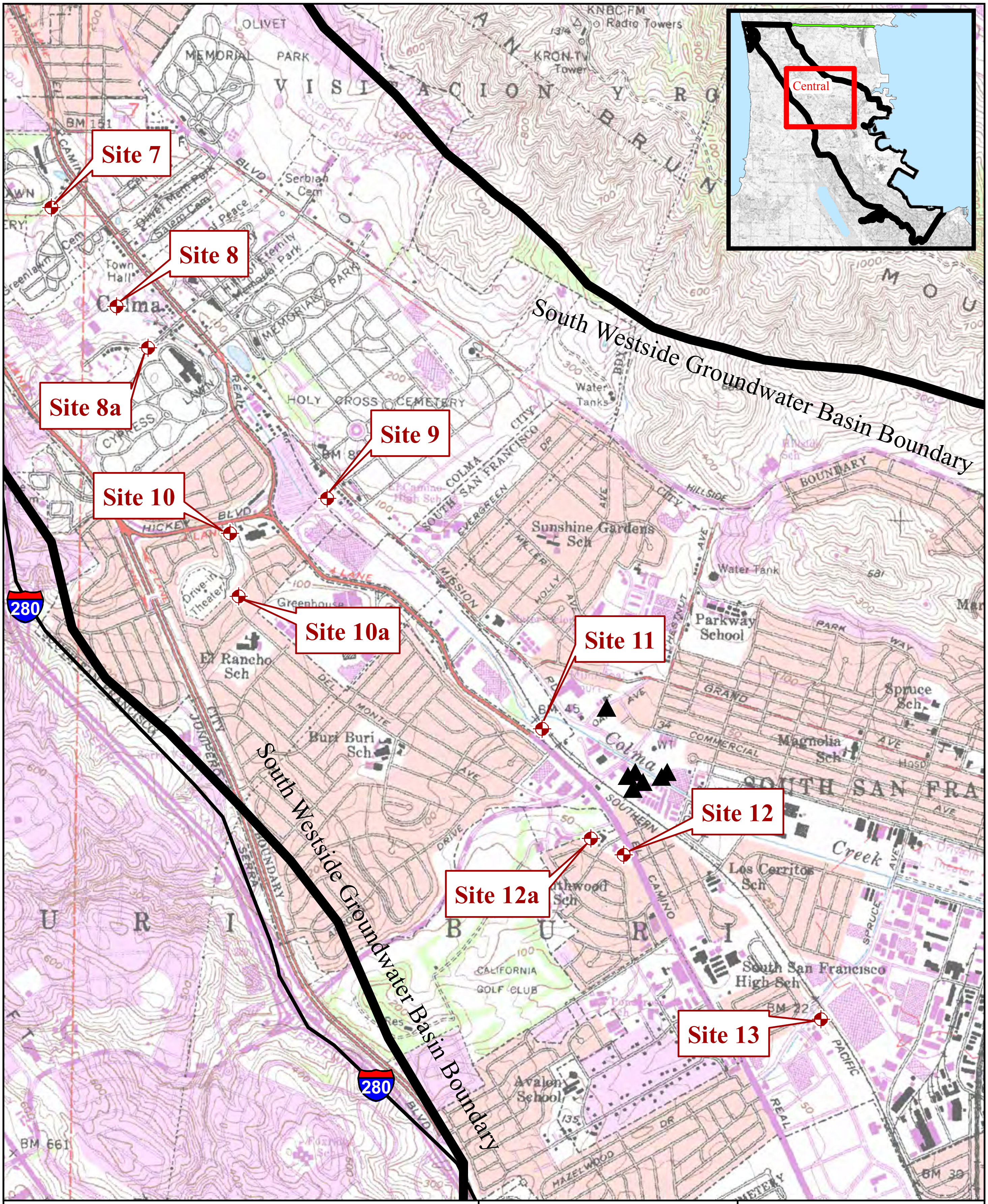

Legend

Proposed Well Facility Sites

Partner Agency Well

South Westside Groundwater Basin

0 1,000 2,000

Scale Feet

1" = 2000'

N

Project Location Map-Central

Regional Groundwater Storage and Recovery Project

Figure 2

Source: SFPUC and Kennedy/Jenks

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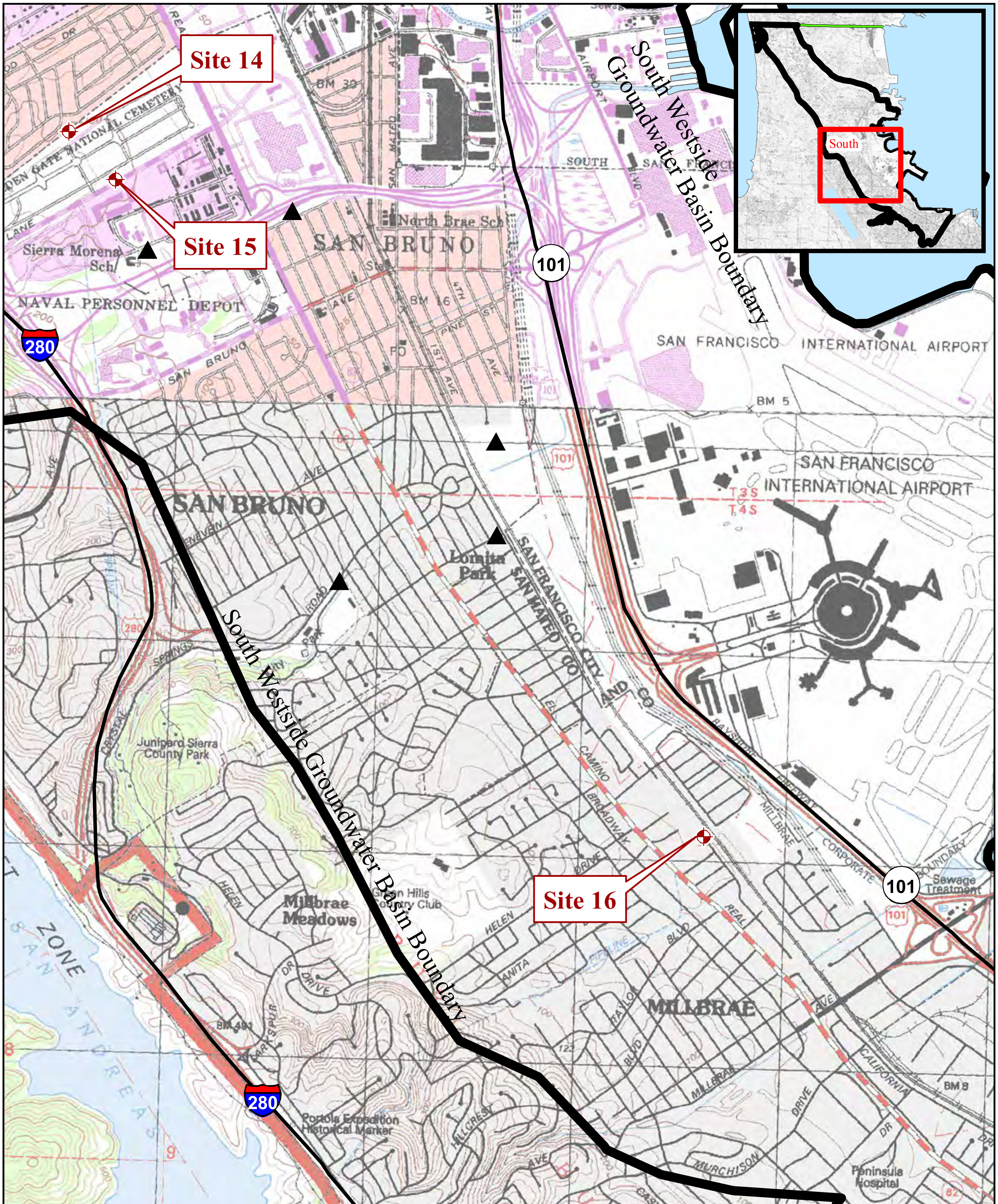

Legend

- Proposed Well Facility Sites
- Partner Agency Well
- South Westside Groundwater Basin

0 1,000 2,000
Scale Feet
1" = 2000'

Project Location Map-South

Regional Groundwater Storage and Recovery Project

Figure 3

Source: SFPUC and Kennedy/Jenks

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groundwater would be utilized by pumping new Project wells during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would create new groundwater production well facilities, which would be operated by either the Partner Agencies or SFPUC for pumping groundwater at a rate of up to 7.2 million gallons per day (MGD) during dry years. The proposed Project would help meet the water supply reliability needs of all SFPUC customers during dry years and may provide some increased level of regional operational flexibility to respond and restore service during unplanned outages.

The proposed Project is a component of the SFPUC's proposed Water System Improvement Program (WSIP) (see www.sfwater.org). The basic goals of the WSIP are to increase the reliability of the regional water system with respect to water quality, seismic response, delivery, and water supply to meet water delivery needs in the service area. A Program EIR (PEIR) for the WSIP was certified by the San Francisco Planning Commission, and the WSIP was adopted by the SFPUC on October 30, 2008. The PEIR addresses the potential environmental impacts of the WSIP facilities on a programmatic level and evaluates regional water supply alternatives. The proposed Project, which is the subject of this NOP, is one component of the WSIP[2]; implementation of this proposed Project would contribute to meeting the WSIP's overall goals and objectives.

For purposes of the WSIP PEIR, the SFPUC's regional water system facilities were subdivided into six regions: Hetch Hetchy, San Joaquin, Sunol Valley, Bay Division, Peninsula, and San Francisco. The proposed Project would occur in the San Francisco Region.

2.0 PROPOSED PROJECT FACILITIES

The proposed Project facilities would consist of new groundwater production well facilities within the South Westside Groundwater Basin (Basin); the facilities are designed to withdraw up to 7.2 MGD from the volume of stored groundwater directly resulting from Project-related reduced groundwater

[2] The Regional Groundwater Storage and Recovery Project was listed as the Conjunctive Use Project in the PEIR.

pumping in the Basin by Partner Agencies during normal and wet years. Up to 16 new groundwater well facilities would be constructed on 16 of the 19 potential sites in northern San Mateo County to supply the needed withdrawal capacity. Well facilities would be connected to Daly City, San Bruno, Cal Water, or SFPUC distribution systems. In addition, the existing Westlake Pump Station in Daly City may need to be modified and treatment facilities may need to be added.

Each groundwater well facility site would contain a groundwater production well, pump station, underground distribution piping, and utility connections. Each well facility would have a disinfection unit as required, unless it is near an existing disinfection unit that can accommodate the additional volume, in which case the well would be connected to the existing unit. Well facility sites where the groundwater may need treatment have been designed with appropriate treatment facilities.

3.0 ENVIRONMENTAL REVIEW PROCESS

As described above, the San Francisco Planning Commission certified the WSIP PEIR in October 2008. The PEIR addressed the potential environmental impacts of the WSIP facilities on a programmatic level and evaluated regional water supply alternatives. The PEIR is available on the San Francisco Planning Department website at www.sfgov.org/planning/mea.

The San Francisco Planning Department will prepare a project-specific EIR to evaluate the environmental effects of the proposed Project. The EIR will be prepared in compliance with the CEQA Guidelines Section 15161 and will address project-specific construction and operational impacts.

The first step in the environmental review process is the formal public scoping process, for which this NOP has been prepared. Following the public scoping period, a Draft EIR will be prepared and circulated for a 45-day public review period. Public comments on the Draft EIR will be accepted in writing during the review period or verbally at a formal public hearing to be held by the San Francisco Planning Commission. The San Francisco Planning Department then will prepare written responses to comments on environmental issues raised during the public review period, and a Response to Comments document will be prepared. That document will be considered by the San Francisco Planning

Commission, along with the Draft EIR and any revisions to the draft based on the response to comments, for certification as a Final EIR.

4.0 PUBLIC SCOPING MEETING

The San Francisco Planning Department will hold a public scoping meeting at the following location, date, and time.

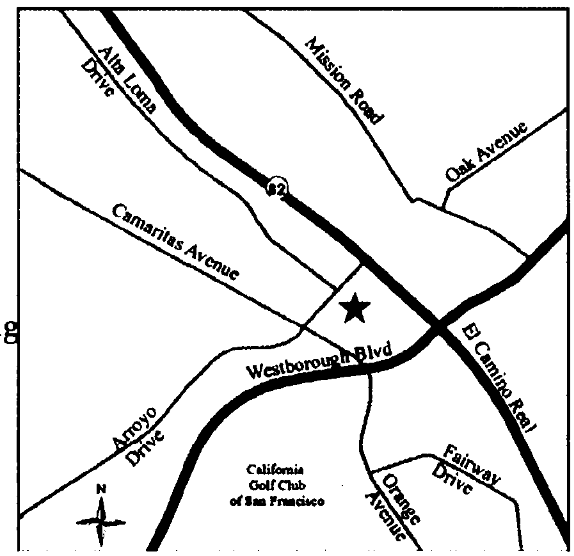
DATE: Thursday, July 9, 2009

6:15-7:00 p.m. Informational Session

7:00 p.m. Scoping meeting

LOCATION:

South San Francisco Municipal Services Building
Community Room
33 Arroyo Drive
South San Francisco, CA



The purpose of this meeting is to assist the Planning Department with its review of the proposed scope and content of the EIR as summarized in this NOP. The public will be given the opportunity to provide comment for consideration. The San Francisco Planning Department also will accept written comments on the scope of the EIR at the meeting or by mail, email, or fax until close of business (5:00 p.m.) on **July 28, 2009**. Written comments may be submitted by mail to the San Francisco Planning Department, Attn: Bill Wycko, Environmental Review Officer, Regional Groundwater Storage and Recovery Project Scoping Comments, 1650 Mission Street, Suite 400, San Francisco, CA 94103. They also may be submitted by fax to (415) 558-6409, or sent by email to diana.sokolove@sfgov.org.

5.0 PROJECT DESCRIPTION

5.1 Project Location

The proposed Project is located in the South Westside Groundwater Basin in San Mateo County, and the proposed facilities will be constructed in northern San Mateo County as shown in Figures 1, 2, and 3. The South Westside Groundwater Basin is located in San Mateo County within the larger Westside Groundwater Basin[3], which underlies both San Francisco and San Mateo counties. The Project is also located within the water service areas for the cities of Daly City, San Bruno, and Millbrae and within the Cal Water service area, which includes portions of South San Francisco, Colma, and unincorporated San Mateo County.

Groundwater well facilities would be constructed and operated at up to 16 locations in the cities of Colma, Daly City, South San Francisco, San Bruno, Millbrae, and unincorporated San Mateo County (see Figures 1, 2, and 3). Well facilities would be connected to existing water distribution pipelines owned by Daly City, San Bruno, Cal Water, and SFPUC. The Project also includes an upgrade of the existing Westlake Pump Station in Daly City to serve the proposed new well facility sites.

5.2 Project Objectives

The proposed Project is a regional groundwater storage and recovery project that is part of the SFPUC's WSIP. The overall goals of the WSIP for the regional water system are to maintain high-quality water; reduce vulnerability to earthquakes; increase water delivery reliability; meet customer water supply needs; enhance sustainability; and achieve a cost-effective, fully operational system. The proposed Project's primary contribution to the WSIP goals is its ability to meet the water supply needs of SFPUC customers during drought years. In addition,

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[3] The Westside Groundwater Basin extends from western San Francisco south into San Mateo County. The Basin has an area of approximately 40 square miles and underlies Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame. The Westside Groundwater Basin has been administratively divided at the San Francisco County-San Mateo County line. This is a political boundary, not a physical boundary. The portion of the basin that lies within San Francisco County is referred to as the North Westside Groundwater Basin. The portion of the basin that lies within San Mateo County is referred to as the South Westside Groundwater Basin. The Project would occur solely within the South Westside Groundwater Basin.

the Project may provide some increased level of regional operational flexibility to respond and restore service under unplanned outages.

The specific objectives of the proposed Project are to:

- Cooperatively manage the South Westside Groundwater Basin through the coordinated use of SFPUC surface water and the groundwater pumped by the Partner Agencies;
- Provide increased SFPUC surface water to the Partner Agencies in normal and wet years, resulting in a reduction of groundwater pumping by these agencies and an increase in groundwater storage in the South Westside Groundwater Basin;
- Increase the pumping capacity from the South Westside Groundwater Basin by up to 7.2 MGD to supply water during dry years and emergencies; and
- Provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8½-year design drought cycle.

5.3 Proposed Project

The proposed Project is a groundwater storage and recovery project, which includes the operation of new groundwater production wells and associated distribution and treatment facilities. This section includes a description of these proposed Project components.

5.3.1 Groundwater Storage and Recovery

The Partner Agencies currently supply potable water to their customers through a combination of groundwater from the South Westside Groundwater Basin and purchase of SFPUC surface water. The proposed Project would provide additional SFPUC surface water to the Partner Agencies during normal and wet years when sufficient surface water supplies are available. The Partner Agencies would reduce their groundwater pumping by a comparable amount and allow the groundwater basin to recharge naturally during these periods.

Figure 4 illustrates the increase in groundwater storage expected from a reduction in pumping during normal and wet years, as well the decrease in groundwater storage projected from an increase in pumping during dry years.

During normal and wet years, the volume of groundwater in the South Westside Groundwater Basin would naturally increase due to the reduced groundwater pumping, eventually reaching an increased storage volume of up to 61,000 AF. During dry or drought years, the Partner Agencies and SFPUC would pump previously stored groundwater. This new dry-year water supply would be made available to both the Partner Agencies and SFPUC wholesale customers under the terms of the Shortage Allocation Plan between the SFPUC and its wholesale customers[4]. A groundwater storage and recovery agreement would be negotiated by and between the SFPUC and Partner Agencies for groundwater and surface water management. Specifically, the agreement would cover water accounting; ownership principles; and operation, maintenance and replacement of facilities.

5.3.2 *Production Wells and Associated Facilities*

The proposed Project includes new groundwater production well facilities within the South Westside Groundwater Basin to withdraw the increased volume of stored groundwater at a rate of 7.2 MGD. Up to 16 new groundwater well facilities would be constructed on 16 of the 19 potential sites in northern San Mateo County. Of the 19 sites, 5 well facilities would connect to Daly City's distribution system, 3 well facilities would connect to San Bruno's distribution system, 4 well facilities would connect to Cal Water's distribution system, and 7 well facilities would connect to the SFPUC distribution system. In addition, the Westlake Pump Station in Daly City may be expanded and additional treatment facilities added.

Each groundwater well facility site would contain a groundwater production well, a pump station, underground distribution piping, and

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[4] The Shortage Allocation Plan identified a water allocation method to be used to determine the share of water for wholesale customers during shortages caused by drought.

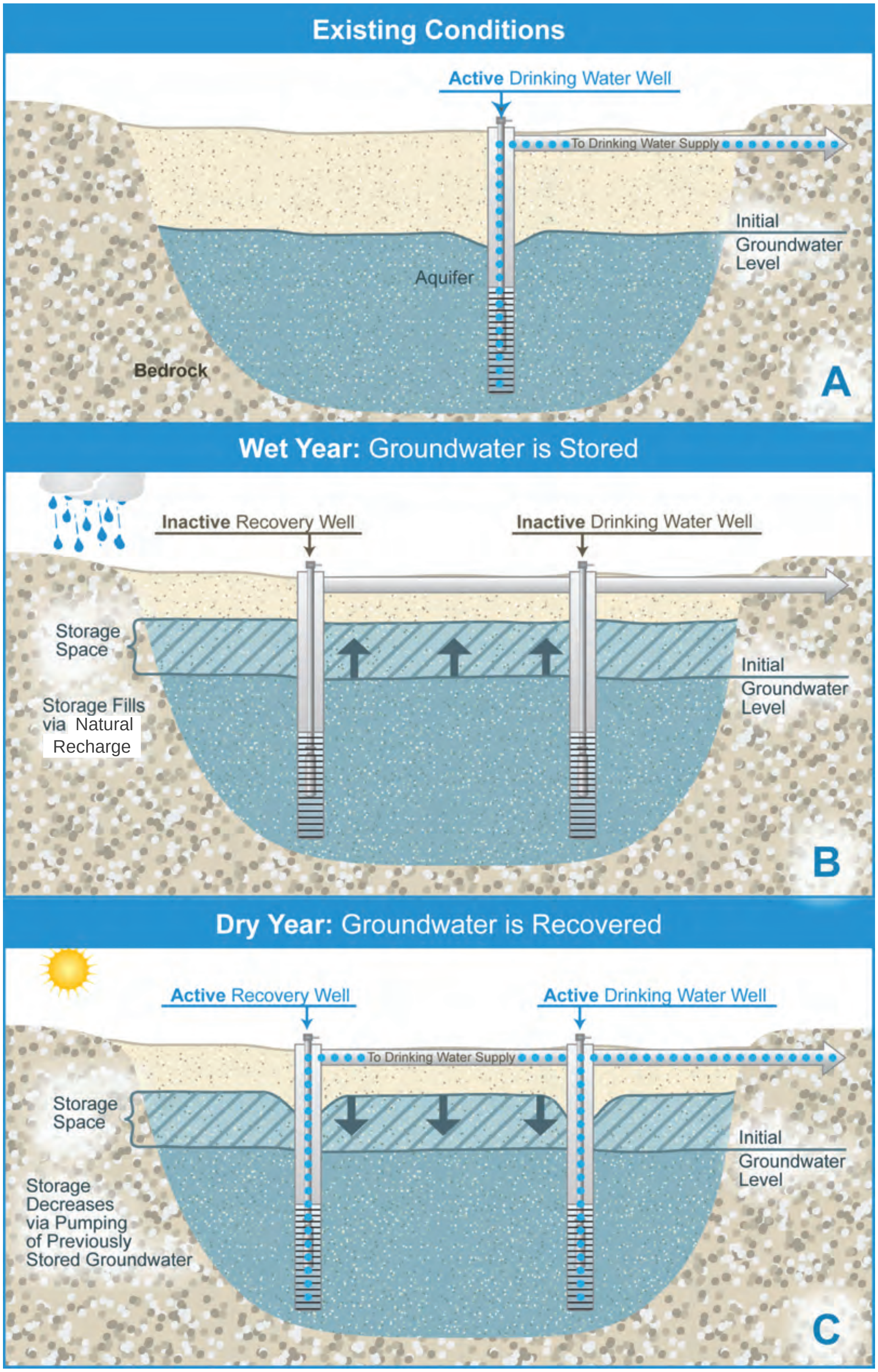

Figure (A) reflects the existing groundwater conditions, showing available storage space above the aquifer. In (B) the upward arrows represent the filling of the storage space with groundwater during wet years; in (C) the downward arrows represent the decline in stored water during dry years. The "Drinking Water Wells" represent the existing wells operated by the Cities of San Bruno and Daly City and California Water Service Company. The "Recovery Wells" represent the new wells that are proposed as part of the Project.

Groundwater Storage and Recovery

Regional Groundwater Storage and Recovery Project

Figure 4

utility connections. Each well facility also would have a disinfection unit, unless it is located near an existing disinfection unit that can accommodate the additional volume, in which case the well would be connected to the existing unit. Well facility sites where the groundwater may need treatment have been designed with appropriate treatment facilities (e.g., disinfection and manganese treatment). The facilities and the nature, extent and anticipated duration of construction activities are described further below.

Prior to confirming the final selected sites and full development of the groundwater well facilities, monitoring wells and test wells may be installed at the well facility sites to gather information about local groundwater characteristics and to determine the technical feasibility of each of the sites to produce sufficient volumes and quality of water for operation of a groundwater production well. If selected, sites would be converted from test wells to permanent production wells; pumps would be added, well enclosures would be built (fencing or building), disinfection units and treatment facilities would be constructed as needed, and utility and distribution pipelines would be installed.

A list of the 19 potential well facility sites and pump station upgrade is provided in Table 1.

TABLE 1
Well Facility Locations

Site ID[a]	Site Name	Location
1	Lake Merced Golf Course	Daly City
2	Park Plaza Meter	Daly City
3	Ben Franklin Intermediate School	Unincorporated San Mateo County (Broadmoor)
4	Garden Village Elementary School	Unincorporated San Mateo County (Broadmoor)
5	Right-of-Way at Serra Bowl	Daly City
6	Right-of-Way at Colma BART	Daly City
7	Right-of-Way at Colma Boulevard	Colma
8	Right-of-Way at Serramonte Boulevard	Colma

TABLE 1
Well Facility Locations

Site ID[a]	Site Name	Location
8a	Standard Plumbing Supply	Colma
9	Treasure Island Trailer Court	South San Francisco
10	Right-of-Way at Hickey Boulevard	South San Francisco
10a	Alta Loma Drive	South San Francisco
11	South San Francisco Main Area	South San Francisco
12	Funeral Home	South San Francisco
12a	Funeral Home	South San Francisco
13	South San Francisco Linear Park	South San Francisco
14	Golden Gate National Cemetery	San Bruno
15	Golden Gate National Cemetery	San Bruno
16	Millbrae Corporation Yard	Millbrae
PS	Westlake Pump Station Upgrade	Daly City

a. The EIR will evaluate the environmental effects of the development of all 19 well facility sites, even though a maximum of 16 well facilities would be constructed.

Well Station Design

The SFPUC has considered institutional, regulatory, operational, maintenance, and technical information in the design of the well stations. Three well station types are included in the proposed Project:

- Type 1 - well only, building or fenced enclosure;
- Type 2 - well plus chemical treatment building; and
- Type 3 - well plus chemical treatment and filtration building.

Site-specific well station design characteristics are listed in Table 2 and described in detail below. These characteristics include proposed building type, pump type, water distribution system connection point, groundwater disinfection location, and the method that would be used to achieve agency-specific water quality goals (i.e., blending with surface water or treatment).

TABLE 2
Site-Specific Well Station Characteristics

Site ID	Site Description	Well Station Type[a]	Pump Type	Connection Point	Alternate Connection Point	Disinfection Location	Method for Achieving Water Quality Goals
1	Lake Merced Golf Club	Type 2	Above-ground	SFPUC San Andreas Pipeline #2	Daly City	At site	Blending[b]
2	Park Plaza Meter	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending
3	Ben Franklin Intermediate School	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending
4	Garden Village Elementary School	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending or iron/manganese treatment
5	Right-of-Way at Serra Bowl	Type 2	Above-ground	Daly City	Cal Water	At site	Blending or iron/manganese treatment
6	Right-of-Way at Colma BART	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
7	Right-of-Way at Colma Boulevard	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
8	Right-of-Way at Serramonte Boulevard	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
8a	Standard Plumbing Supply	Type 2	Above-ground	Cal Water	SFPUC	At site	Blending
9	Treasure Island Trailer Court	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	None	At site	Blending

TABLE 2
Site-Specific Well Station Characteristics

Site ID	Site Description	Well Station Type[a]	Pump Type	Connection Point	Alternate Connection Point	Disinfection Location	Method for Achieving Water Quality Goals
10	Right-of-Way at Hickey Boulevard	Type 2	Above-ground	Daly City	SFPUC San Andreas #2	At site	Blending
10a	Alta Loma Drive	Type 2	Above-ground	SFPUC San Andreas Pipeline #2	Cal Water	At site	Blending
11	SSF Main Area	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water	At site	Blending
12	Funeral Home	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water or other SFPUC pipeline	At site	Blending
12a	Funeral Home	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water or other SFPUC pipeline	At site	Blending
13	SSF Linear Park	Type 3	Above-ground	San Bruno	Cal Water, SFPUC, or other San Bruno	At site	Blending or iron/manganese treatment
14	Golden Gate National Cemetery	Type 1 with building enclosure	Above-ground	San Bruno	SFPUC pipeline	At site	Blending or iron/manganese treatment
15	Golden Gate National Cemetery	Type 3	Above-ground	San Bruno	SFPUC pipeline	At site	Blending or iron/manganese treatment
16	Millbrae Corp Yard	Type 2	Above-ground	SFPUC Crystal Springs Pipeline #2	None	At site	Blending

a. Type 1 is Well Only; Type 2 is Well plus Chemical Treatment Building; Type 3 is Well plus Chemical Treatment and Filtration Building; see text below for further description of conceptual layouts.

b. Blending is the mixing of groundwater with other potable supply water

Buildings would be about 15 feet tall and constructed of concrete block. Acoustical louvers for noise reduction would be used. The buildings would be painted in neutral colors with anti-graffiti coating.

It is anticipated that all outdoor site lighting would be activated by motion-controlled sensors, with manual switching available for as-needed night operations. Facilities would be designed to meet California's energy efficiency standards outlined in Title 24 of the California Code of Regulations and use recycled materials to the extent possible.

Type 1 Conceptual Layout: Well-Only. The conceptual layout for the "well-only" type includes an approximately 40-foot by 20-foot building or fenced enclosure to house the wellhead, pump, piping, and associated electrical and control equipment.

Type 2 Conceptual Layout: Well plus Chemical Treatment. The conceptual layout for the "well with chemical treatment" type would consist of a 40-foot by 20-foot building to house the wellhead, pump, pipeline, and associated electrical and control equipment, plus an approximately 15-foot by 15-foot building extension for chemical storage and handling. Space would be provided onsite for disinfection, pH adjustment, and fluoride addition if needed.

Type 3 Conceptual Layout: Well plus Chemical Treatment and Filtration. The conceptual layout for the "well with chemical treatment and filtration" type would be similar to Type 2 but with the addition of a filtration system. The building dimensions would be approximately 25 feet by 80 feet. Filtration would be located only at well facilities that require manganese and/or iron removal. This well station type would be larger than the other types to provide space for the wellhead, treatment facilities, and filtration vessels. The filtration system consists of a series of vertical pressure vessels. The number and size of the pressure vessels would depend on the well yield and the number of wells connected to the filtration system. The backwash water from the system would connect to a nearby sanitary sewer. It is anticipated that filters would be backwashed, on average, once a day for 4 minutes.

Well Pumps

Each well facility site would contain either a submersible or above-ground pump. The selection of the pump type is based on the preference of the Partner Agency responsible for well operation. In most cases, the wells would be equipped with above-ground pumps. In comparison to submersible motors, above-ground motors are more efficient, have a longer service life, are more durable in cases where variable frequency drives are required, and are more accessible and thus easier to maintain. In cases where noise, visibility, or lack of space is an issue, submersible pumps would be used. Submersible motors are quieter to operate, but more difficult to maintain, because maintenance requires the removal of the entire pump assembly. Any wells that are in fenced enclosures (i.e., without buildings) have been designated for submersible pumps.

Utility and Distribution Piping

Underground piping would connect the wells to the local distribution systems or SFPUC water distribution system. In addition, underground piping would connect well facilities to the storm drain system and/or the sanitary sewer system to allow discharge of the initial flush of water. Chloraminated water would be de-chlorinated or sent to the local sanitary sewer system. Backwash from the manganese treatment facilities would also be sent to the local sanitary sewer system. The piping for all selected sites would consist of a total of approximately 4,600 feet of 6-inch pipe and 12,500 feet of 8-inch pipe. In general, the pipeline route would be excavated to a depth of 6 feet. The maximum width of the pipeline work area (including the trenches) would be 20 feet. The pipelines would be constructed using conventional open-cut trenching techniques. Above or underground electrical lines would also be installed from the groundwater well facilities to the nearest power source (PG&E facilities). The dimension of the trenches for the underground electrical lines would be smaller than those of the water pipelines.

Westlake Pump Station Upgrade

Upgrades to the Westlake Pump Station may be necessary to serve the well stations at Sites 2, 3 and 4. The upgrades would include new chemical storage tanks, replaced or upgraded chemical metering pumps, a resized transformer, and up to three new booster pumps to deliver the additional water into the distribution system.

5.3.3 *Construction Methods*

Monitoring Wells, Geotechnical Borings, and Test Wells

Prior to the selection and full development of the groundwater production well sites, monitoring wells and test wells may be installed and geotechnical borings may be drilled at the well facility sites to gather information about local groundwater characteristics and to determine the technical feasibility of each of the sites to produce sufficient volumes and quality of water for operation of a groundwater production well. Depending upon the results of the testing, well facility sites would be selected, and test wells converted to permanent production wells, which would consist of full development of the well facility site to include the addition of pumps to the wells, the addition of enclosures around the well, installation of disinfection units and treatment facilities as needed, and installation of utilities and distribution pipelines.

In the event that additional monitoring or test wells are needed, the selected site would need to be cleared of vegetation and graded for installation and drilling of the borehole. For monitoring wells, a borehole would be drilled to a depth of approximately 750 feet below ground. For test wells, one steel casing would be installed to a depth of approximately 50 feet, with a borehole drilled to a depth of approximately 550 to 700 feet. Equipment used for well drilling and construction would include a mounted drill rig on a support truck, pump and pick up trucks or trailers and similar equipment. Construction of a monitoring well would be completed in approximately three weeks, with construction activities occurring between 8:00 AM and 7:00 PM Monday through Friday only. Construction and testing of test wells would require approximately 4 weeks. Drilling would extend for about a week both during the day and night. If the results of the test wells were favorable and the wells were selected as permanent production well sites, then development of production well facilities would occur, as described below.

Additional geotechnical borings may be required and would be drilled to a depth of approximately 50 feet below ground surface (deeper if fill or soft soil is encountered). A boring would be completed in approximately two days. Drilling activities would occur between 8:00 AM and 7:00 PM Monday through Friday only.

Construction of Well Station Facilities

Each well facility site would include a construction staging area; some sites may have two optional locations for staging areas. The minimum size of the staging area would be 1,500 square feet. Staging areas would be fenced. Any temporary spoils (excavated material) storage would occur inside the staging areas.

Construction of facilities at the well sites would require site clearing and grubbing. Site excavation and grading would be minor, with grading to a maximum depth of 5 feet for the building foundation (if the well facility includes a building) and utilities underneath the building. After the foundation and utilities connections are constructed, the remainder of the building would be constructed and the well pump and other equipment installed, as needed. No significant near-surface groundwater is expected at any site; therefore dewatering for construction of project facilities is not anticipated. Diesel generators with self-contained fuel tanks may be used during construction. Construction equipment is expected to include: a front end loader, backhoe/excavator, fork lift, telescopic crane, cement mixer, concrete pump truck, compactor, hauling trucks, pump-setting rig, and arc welder.

It is estimated that during the peak construction period, the maximum number of construction workers at any one site would be 15.

Construction of Distribution and Utility Connections

In general, the pipeline routes would be excavated up to a depth of 6 feet. The width of pipeline construction zones would be generally 20 feet, and the width of the electrical connection construction zones would be less than 20 feet. The pipelines would be constructed using conventional open-cut trenching techniques. Construction equipment is expected to include: an excavator, front-end loader, hauling trucks, compactor, asphalt trucks, and arc welder. Diesel generators with self-contained fuel tanks may be used during construction. At some sites, pipeline excavation would generate excess soil (called spoils) that would be reused onsite (for engineering fill) or disposed of at a Class III non-hazardous waste disposal site. After pipeline placement, the trenched area would be restored to its original condition.

5.3.4 *Operation and Maintenance*

Project operations would be designed to allow natural recharge of the South Westside Groundwater Basin through reduced Partner Agency groundwater pumping, to provide up to 61,000 AF of increased groundwater in storage to be used by the SFPUC and Partner Agencies during drought conditions.

Figure 5 illustrates how the Project would change the source of water supply for the Partner Agencies. During normal and wet years, the portion of water supply coming from SFPUC surface water would increase compared to the existing condition. During dry years, the portion of water supply coming from groundwater would increase compared to the existing condition. For SFPUC wholesale water customers, the source of water supply would not change during normal and wet years; but the portion of groundwater delivered to some SFPUC customers would increase during dry years, compared to existing conditions.

An accounting of additional storage volumes (called the SFPUC Storage Account) would track the amount of water that has been stored during the normal and wet years and the amount of water pumped during dry years. The specific volumes shown in Figure 5 are based on historic rainfall and hydrology (MWH, 2007), but actual volumes in any given year would vary depending on several factors, including: 1) the final location and capacity of the project well facilities, 2) the availability of additional stored water in the SFPUC Storage Account, and 3) direction from the Operating Committee[5] regarding which wells should be used.

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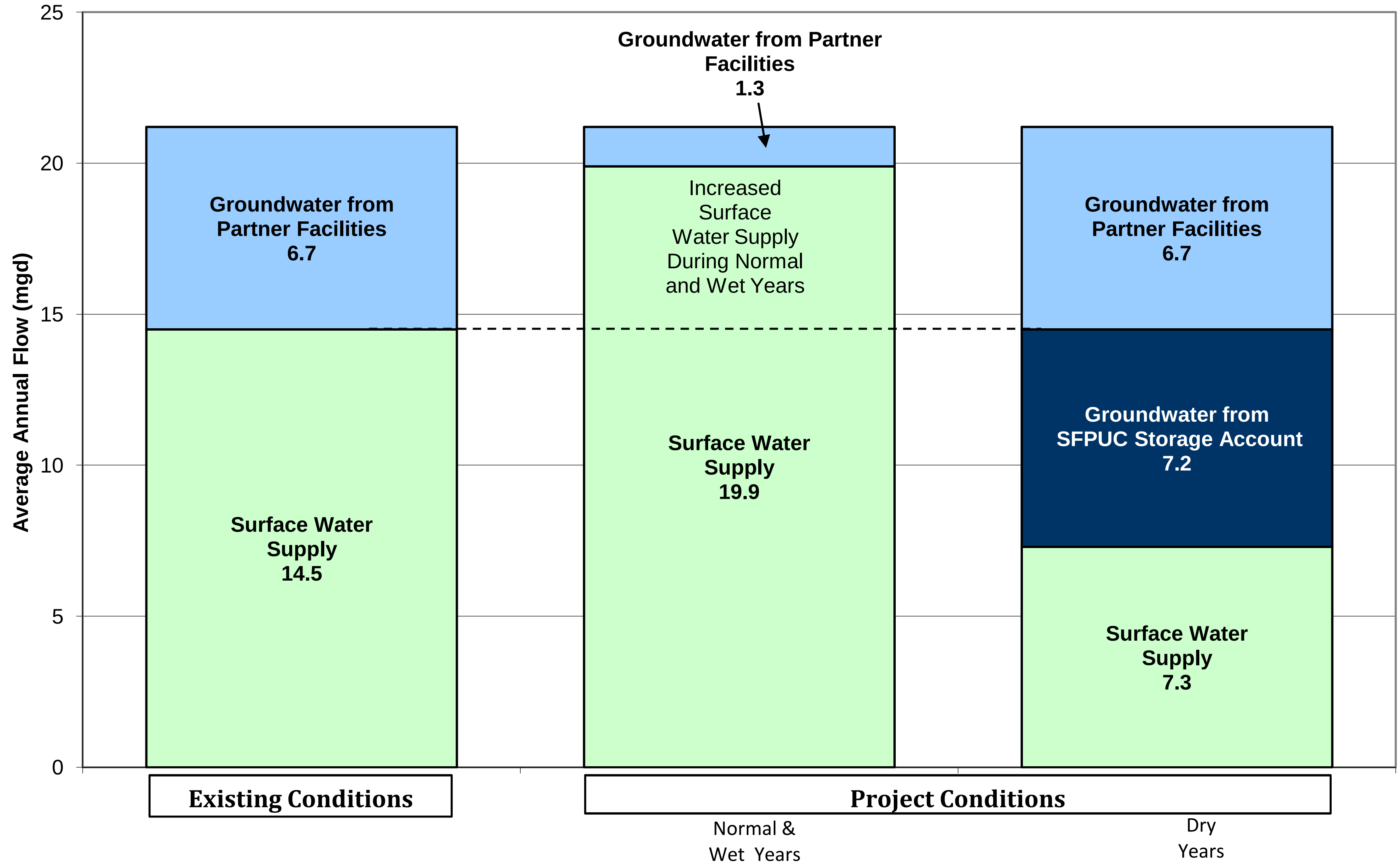
[5] It is expected that a Project agreement by and between SFPUC and the Partner Agencies would establish an Operating Committee. The role of the Operating Committee would be to monitor and track the SFPUC Storage Account, including any losses from the system, and establish pumping schedules for the project wells.



[1] Partner facilities are operated by City of Daly City, City of San Bruno, and Cal Water.

Source of Water Supply for Partner Agencies

Regional Groundwater Storage and Recovery Project

Figure 5

During normal and wet years, the proposed groundwater well facilities would be operated by SFPUC or by Partner Agencies only periodically for maintenance purposes. During dry years, the proposed groundwater well facilities would be operated by SFPUC or by Partner Agencies for additional water supply.

All well stations would be unmanned, but subject to remote monitoring and operation by the Partner Agency or SFPUC who would operate the well facility. Each well station would be visited daily when wells are operating for routine equipment checks, lasting approximately 30 minutes each. During normal and wet years, wells would be visited on a weekly basis, would be normally off, but regular exercising would be conducted. Longer term maintenance would include removal and repair or replacement of pumps, valves, and other equipment. Production wells may require redevelopment and/or rehabilitation on an infrequent basis.

6.0 PERMITS AND APPROVALS REQUIRED

The SFPUC may be required to obtain the following permits and approvals for Project construction and operation:

- Section 404 Permit from the U.S. Army Corps of Engineers (USACE) if the Project affects jurisdictional wetlands or waters of the U.S.
- U.S. Department of Veterans Affairs approval and National Environmental Policy Act (NEPA) review for Sites 14 and 15 at the Golden Gate National Cemetery.
- U.S. Fish & Wildlife Service Section 7 consultation under the federal Endangered Species Act, if the Project affects threatened or endangered species or their habitat.
- Review by the Advisory Council on Historic Preservation may be required if the Project affects properties listed on or eligible for the National Register of Historic Places.
- Permit amendments and approval of well construction and operation from the California Department of Public Health, Water Supply Division.
- Section 1602 Lake and Streambed Alteration Agreement from the California Department of Fish and Game if the Project could affect streambeds under California jurisdiction.
- Section 2081/2080.1 Incidental Take Permit from the California Department of Fish and Game if a "take" (to hunt, pursue, catch, capture,

or kill, or attempt the same) could occur to state-listed species as a result of the Project.

- California Department of Fish and Game Memorandum of Agreement if needed to ensure no effect to fully protected species.
- Preparation of a California Department of Toxic Substances Control Contaminated Soil Treatment Work Plan (required only if contaminated soil is encountered during construction).
- San Francisco Bay Regional Water Quality Control Board Discharge permits, if required, for emergency and/or maintenance water discharges, and for "overboard" pumping of well waters.
- San Francisco Bay Regional Water Quality Control Board Section 401 Certification, the state certification of the federal Section 404 Wetlands Permit.
- California Department of Transportation Encroachment permits to cross State roadways and Interstate Highways.
- State Water Resources Control Board Stormwater General Permit and Stormwater Pollution Prevention Plan, if more than one acre of land is disturbed.
- Bay Area Air Quality Management District permit for stationary equipment that may generate air pollutants (e.g., generators).
- EIR certification by the San Francisco Planning Commission.
- Board of Supervisors approval may be needed for funding appropriation or property rights acquisition.
- SFPUC approval, adoption of CEQA findings and mitigation monitoring and reporting program (MMRP).
- Adoption of CEQA findings and MMRP by local City Councils or Boards of Supervisors.
- San Francisco Historic Preservation Commission review of local, state and national landmarks and historical landscapes.
- Determination of Project consistency with park use by local Recreation and Park Commissions and approval of use of property under their jurisdiction.
- Approval of local Unified School District(s) for use of property under their jurisdiction.
- Approval of exterior design of proposed facilities on SFPUC property or right-of-way by the San Francisco Arts Commission.
- Agreements with Partner Agencies.
- Local Department(s) of Public Health approval of well construction and operation permits in accordance with California Department of Water Resources Standards.

- Local Department(s) of Public Health approval of Certified Unified Program Agencies (CUPA)/Hazardous Materials Business Plan for Project operations.
- Local Department(s) of Public Works approval of excavation permits, encroachment permits, and temporary occupancy permits for street space.
- Bay Area Rapid Transit (BART) encroachment permits to cross existing BART system.

7.0 PROPERTY RIGHTS ACQUISITION

Several types of property rights would be needed for Project construction and operation, as shown in Table 3. The process for acquiring right-of-way involves the preparation of deed and appraisal map, an appraisal of fair market value, negotiations with property owners, and condemnation (if necessary).

TABLE 3
Property Rights Proposed for Acquisition

Property Acquisition Type	Rights
Access Easement	Temporary or permanent rights to enter or cross another property
Pipeline Easement	Rights to install and maintain a pipeline over or across another property
Fee Acquisition	Purchase of all the property rights, land, improvements (if any), etc.
Encroachment Permit	Rights to encroach across a publicly-owned street or highway for pipeline or other purposes

Of the 19 potential well sites, 12 sites are on SFPUC fee-owned land or within SFPUC right-of-way. The other seven well sites are on other public and private parcels which would require an acquisition of property use rights for the well(s), connecting pipelines, and/or access. Lastly, several sites have lengthy connecting pipeline requirements that would most likely be constructed on a combination of public and private parcels.

8.0 CONSTRUCTION SCHEDULE

The proposed Project schedule expected at the time of this NOP includes construction of permanent well facilities and pipeline connections from April 2012 through approximately May 2014.

9.0 ENVIRONMENTAL ANALYSIS

9.1 Environmental Issues to be Addressed in the EIR

The EIR will address all environmental issue areas required under CEQA. The EIR will address environmental impacts of the proposed Project due to construction and operation activities and will propose mitigation measures for impacts considered to be significant. The following sections describe the anticipated environmental issues that will be addressed by the EIR.

9.1.1 Land Use and Visual Quality

Construction and operation of the proposed Project could affect land uses and visual quality of the Project sites and surrounding areas. Potential impacts to be evaluated in the EIR include:

- Temporary and permanent disruption or displacement of existing land uses during construction including construction impacts on such sensitive land uses as schools, residences and funeral homes, and the potential temporary closure of a portion of South San Francisco Linear Park to the public.
- Impacts on scenic vistas or visual character, including potential impacts on the visual character of Golden Gate National Cemetery, Woodlawn Cemetery, Greenlawn Memorial Park, and Lake Merced Golf Club.

9.1.2 *Geology, Soils and Seismicity*

Construction and operation of new well facilities and below-ground distribution pipelines and electrical power lines could result in site-specific impacts on or from local geology and soils conditions. Potential impacts to be evaluated in the EIR include:

- Seismic hazards and/or increased exposure of people and structures to seismic hazards, including impacts from ground-shaking in the event of an earthquake on the San Andreas fault or other Bay Area fault.
- Increased exposure of people or structures to geologic hazards (such as liquefaction, poor soil conditions, or unstable slopes) from construction in geologic hazard zones.
- Soil erosion potential from construction activities.
- Potential land subsidence from drawdown of the groundwater aquifer.

9.1.3 *Hydrology and Water Quality*

Construction and operation of the Project could affect surface water quality and could affect groundwater levels and quality in the Project area and in the South Westside Groundwater Basin as a whole. Potential impacts to be evaluated include:

- Changes in local groundwater quality and levels within the South Westside Groundwater Basin as a whole.
- Changes in drinking water quality due to use of treated groundwater.
- Alteration of drainage patterns and increase in stormwater flows due to increase in the amount of impervious surfaces.
- Degradation of surface water quality as a result of erosion and sedimentation, hazardous materials release during construction, and construction dewatering discharges.

9.1.4 *Biological Resources*

The proposed Project could result in a permanent loss of wetlands and sensitive habitats and could directly impact special-status wildlife and plant species. Temporary impacts to biological resources could result from proximity to construction activities, including noise, vibration, and dust. Potential impacts to be evaluated include:

- Impacts on wetlands and aquatic resources.
- Impacts on sensitive wildlife habitats and protected/heritage trees.
- Impacts on special-status wildlife and plant species – direct mortality and/or habitat effects.
- Conflicts with adopted conservation plans or other approved biological resources plans.

9.1.5 *Cultural Resources*

The proposed Project could affect archaeological, historical, or paleontological resources through ground-disturbing activities during construction, or by introducing new facilities that compromise the historic integrity of historic buildings or landscapes. Potential impacts to be evaluated include:

- Impacts on archaeological and paleontological resources.
- Impacts on the historical significance of a historic district, contributor to a historic district, or historic landscape. Of particular focus will be the proposed well facilities on 1920s Lake Merced Golf Club; the turn of the century Woodlawn Cemetery, the Cypress Lawn Cemetery, and the Golden Gate National Cemetery.
- Impacts on Native American cultural resources.

9.1.6 *Traffic, Transportation and Circulation*

Construction could have temporary impacts on traffic volumes, traffic safety, and parking in the vicinity of the well facility sites and at the Westlake Pump Station. Potential impacts to be evaluated EIR include:

- Temporary reduction in roadway capacity and increased traffic delays, including impacts from short-term closure of one parking and/or traffic lane. Impaired access to adjacent roadways and land uses.
- Temporary displacement of on- or off-street parking.
- Increased traffic safety hazards during construction.
- Long-term traffic increases during facility operation.

9.1.7 Noise and Vibration

Construction noise and vibration impacts from the proposed Project would be associated with facility construction activities, and therefore, would be temporary and short-term. Operation of the proposed pumps and treatment facilities could create permanent noise impacts. Potential impacts to be evaluated include:

- Impacts of construction noise and vibration on sensitive receptors in the vicinity of Project construction sites, especially such sensitive land uses as schools, health care facilities, cemeteries, funeral homes, and churches.
- Noise impacts from groundwater well station operation, including pumps and groundwater treatment facilities.

9.1.8 Recreational Resources

Construction could temporarily disrupt recreational uses in the vicinity of the well facility sites as a result of noise, dust, and temporary access restrictions. The EIR will evaluate the impact of the Project on recreational resources. Potential impacts to be evaluated include:

- Temporary and permanent impacts on recreational facilities, including but not limited to Lake Merced Golf Club and Linear Park in South San Francisco.

9.1.9 Other Environmental Issues

Other environmental issues that will be evaluated in the EIR include the Project's potential impacts on air quality and greenhouse gas emissions; public services and utilities, including the Project's beneficial effect on water supply; agricultural resources; hazards, including the potential hazards from chemical storage at the well sites; and energy resources.

The EIR also will evaluate any potential growth-inducing impacts that could result from implementation of the Project. The EIR also will address whether the Project could result in impacts that would be significant when combined with the impacts of other SFPUC or non-SFPUC projects occurring in the same geographic area as the Project and at the same time.

9.2 Alternatives

CEQA requires that an EIR evaluate a reasonable range of feasible alternatives to the project, or to the location of the project, that would attain most of the basic project objectives but that could avoid or substantially lessen any of the significant effects of the project. The EIR will identify the potentially significant impacts of the proposed Project. The findings of the EIR impact analysis will guide the refinement of an appropriate range of alternatives to be evaluated in the EIR that would avoid or substantially lessen significant impacts, while still meeting the project objectives. Alternatives suggested during the public scoping period would also be considered. The EIR will include a discussion of impacts associated with the No Project Alterative.

10.0 REFERENCES

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Appendix B

GSR Scoping Report

SCOPING SUMMARY MEMORANDUM

REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT

October 2009

TABLE OF CONTENTS

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1. INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

The San Francisco Planning Department is the lead agency for implementation of the California Environmental Quality Act (CEQA) for all projects sponsored by the City and County of San Francisco or conducted within San Francisco. The San Francisco Planning Department is preparing an Environmental Impact Report (EIR) on the San Francisco Public Utilities Commission's (SFPUC's) proposed Regional Groundwater Storage and Recovery Project (Project or proposed Project). The EIR, which will assess the potential impacts of the Project on the physical environment of the project area, is being prepared in accordance with CEQA. CEQA requires the preparation of an EIR when a proposed project could significantly affect the physical environment.

As part of the EIR process, the San Francisco Planning Department conducted a public scoping meeting in July 2009, soliciting comments from the public to help determine the scope of the EIR. This report describes the scoping process and summarizes the public's and regulatory agencies' comments received during scoping.

1.2 NOTICE OF PREPARATION

As the first step in the CEQA process, the San Francisco Planning Department published a Notice of Preparation (NOP) on June 24, 2009, announcing the anticipated preparation of the Draft EIR for the proposed Project. The NOP summarized the goals, objectives, and elements of the proposed Project, and presented the San Francisco Planning Department's determination that the proposed Project may have a significant effect on the environment. The NOP also described the requirement for preparation of an EIR on the proposed Project under CEQA. The San Francisco Planning Department determined that an EIR is the appropriate environmental document for the proposed Project. The NOP also described the scoping process and included information on a public scoping meeting. The scoping process, notification procedures, and outcome of the scoping meetings are described below, following a brief description of the proposed Project.

1.3 REGIONAL GROUNDWATER AND STORAGE RECOVERY PROJECT

The purpose of the Project is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. This new dry-year water supply would be made available to the cities of Daly City and San Bruno, the California Water Company (Cal Water) in its South San Francisco service area (collectively referred to as Partner Agencies) and San Francisco Public Utilities Commission (SFPUC) retail water customers.

The SFPUC proposes to provide surface water, when available, to Partner Agencies, to be used by these agencies in lieu of pumping groundwater during normal and wet rainfall years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. This supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of pumping by Partner Agencies would ultimately increase groundwater storage within the South Westside Groundwater Basin by up to 61,000 acre-feet (AF) (approximately 20 billion gallons). Stored groundwater would be utilized by pumping new Project wells during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would construct new groundwater production well facilities, which would be operated by either the Partner Agencies or SFPUC for pumping groundwater at a rate of 7.2 million gallons per day during dry years. The proposed Project would help meet the water supply reliability needs of all SFPUC customers during dry years and may provide some increased level of regional operational flexibility to respond and restore service during unplanned outages.

The proposed Project is one of several facility improvement projects identified in the SFPUC's Water System Improvement Program (WSIP). The WSIP was adopted by the SFPUC in October 2008 to improve the SFPUC's regional water system with respect to water quality, seismic response, water delivery, and water supply to meet water delivery needs in the service area and establishes level of service goals and system performance objectives. The proposed Project's primary contribution to the WSIP goals is its ability to meet the water supply needs of SFPUC customers during drought years. To address the potential environmental impacts of the WSIP, the San Francisco Planning Department prepared a Program EIR (PEIR) on the proposed WSIP, which was certified by the San Francisco Planning Commission on October 30, 2008 (San Francisco Planning Commission Motion No. 17734). At a project-level of detail, the PEIR evaluated the environmental impacts of the WSIP's water supply strategy and, at a program level of detail, it evaluated the environmental impacts of the WSIP's facility improvement projects, including the proposed Project.

The proposed Project consists of: 1) cooperative management of surface water and groundwater to optimize the water demand and supply balance; and 2) construction and operation of groundwater production well facilities on 16 of 19 potential sites in northern San Mateo County. Each groundwater well facility site would contain a groundwater production well, pump station, underground distribution piping, and utility connections. Some well facility sites would contain groundwater disinfection units and groundwater treatment facilities. Well facilities would connect to distribution systems for Daly City, San Bruno, Cal Water, and to the SFPUC regional water transmission system for delivery of blended surface and grounwater supplies to retail customers in San Francisco. In addition, the Westlake Pump Station in Daly City may need to be upgraded, and treatment facilities may need to be added to several well facility sites.

2. SCOPING MEETING PROCESS

2.1 PURPOSE OF SCOPING MEETING

The purpose of scoping is to solicit input from the public and agencies on the appropriate scope, focus, and content of the EIR. The San Francisco Planning Department will consider all of the input received during the scoping process in the preparation of the Draft EIR. The Draft EIR will describe the existing environmental conditions of the area that could be affected by the proposed Project and evaluate the potential effects of the proposed Project in accordance with CEQA. The comments provided by the public and agencies during scoping will help the San Francisco Planning Department identify pertinent issues, methods of analyses, and level of detail that should be addressed in the Draft EIR. The scoping comments will also provide the basis for developing a reasonable range of feasible alternatives that will be evaluated in the Draft EIR. The Draft EIR is scheduled to be available for public comment in summer 2010. In addition to facilitating public and regulatory agency input on the scope and focus of the Draft EIR, scoping allows the San Francisco Planning Department to explain the EIR process to the public and to identify additional opportunities for public comment and public involvement during the EIR process. CEQA requires that the public be informed about the significant environmental effects of a proposed project, and the ways in which those environmental effects can be avoided or reduced, before the project is approved.

2.2 NOTIFICATION OF SCOPING MEETING

The scoping period began on June 24, 2009, with the issuance of the NOP. A public scoping meeting was held on July 9, 2009, and written comments were accepted through July 28, 2009. Agencies and the public were notified about the availability of the NOP and the public scoping meeting date and location, and were provided with details on the comment process. The following methods of notification were used:

Mailing List. A mailing list was compiled, including approximately 1,500 contacts for affected federal, state, regional, and local agencies; federal, state, regional, and local elected officials; regional and local interest groups; member agencies of the Bay Area Water Supply and Conservation Agency (BAWSCA) within San Mateo County; other potentially affected groundwater and irrigation users; and land owners and residents within approximately 300 feet of the Project well facility sites.

NOP Form and Report. On June 24, 2009, the NOP Form and Report (Appendix A) were distributed via certified mail to 32 potentially affected agencies and the State Clearinghouse. The NOP Form was also sent via first-class mail to the entire mailing list.

Meeting Notification. Notice of the public scoping meeting was provided to individuals and the general public through the following means (see Appendix B):

- **Legal notices.** Notices of the public scoping meeting, including information on how to obtain a copy of the NOP and provide public comment, were placed in the legal classified section of the San Francisco Examiner (6/24/09) and San Mateo County Times (6/24/09).

- **Display ads.** Display ads with information about the public scoping meeting, including information on how to obtain a copy of the NOP and provide public comment, were placed in the San Francisco Examiner (date) and San Mateo County Times (date) by the PUC.

- **Locations where NOP was made available.** The NOP Form and Report were posted to the San Francisco Planning Department's website (www.sfgov.org/planning/mea) as well as the SFPUC project website (www.sfwater.org). A printed copy of the NOP was also provided to anyone who requested it from the San Francisco Planning Department or the SFPUC.

2.3 SCOPING MEETING

The public scoping meeting was held on July 9, 2009 at the South San Francisco Municipal Services Building at 33 Arroyo Drive in South San Francisco, California, and was attended by 33 individuals.

The meeting included a presentation on the environmental review process and the proposed Project, followed by a formal public comment period. Attendees interested in presenting verbal comments submitted speaker cards and were called upon to speak. The meetings concluded with closing remarks. A transcript of this meeting is provided in Appendix C. Appendix D contains copies of the scoping meeting presentation, handout agenda, fact sheet, comment cards, speaker cards and sign-in sheets.

Immediately prior to the scoping meeting, an Informational Session was held by the SFPUC at the scoping meeting location where attendees were invited to view Project display boards and ask questions of the SFPUC project team.

3. SCOPING COMMENTS RECEIVED

3.1 OVERVIEW

Table 1 lists comments received by commenter type and source. Six people spoke at the scoping meeting, and ten comment letters were received during the comment period. One additional comment letter was received after the close of the comment period. This additional written comment is included in this summary.

TABLE 1
Comments Received by Commenter Type and Source

Commenter Type	Comment Source
Federal Agency	• None
State Agencies	• Governor's Office of Planning and Research, State Clearinghouse and Planning Unit, Scott Morgan (Written Comment #1) • California Department of Transportation, Lisa Carboni (Written Comment #2) • California Department of Water Resources, Karl P. Winkler (Written Comment #3)
Regional and Local Agencies	• County of San Mateo Planning and Building Department, Melissa Ross (Written Comment #4) • Town of Colma, Laura Allen (Written Comment #5) • Bay Area Water Supply & Conservation Agency, Nicole M. Sandkulla (Written Comment #6) • Town of Colma, Andrea Ouse (Oral Comment #101) • Montara Water and Sanitary District, Paul Perkovic (Oral Comment #106)
Business	• Bold, Polisner, Maddow, Nelson, & Judson, Robert B. Maddow (BPMNJ) (Written Comment #7) • Kathryn Slater Carter (Oral Comment #103) • BPMNJ, Robert B. Maddow (Oral Comment #105)
Groups	• California Trout, Mondy Lariz (Written Comment #8) • Committee to Save Lake Merced, Jerry Cadagan (Written Comment #9) • Tuolumne River Trust, Peter Drekmeier (Written Comment #10) • Restore Hetch Hetchy, Bob Hackamack (Written Comment #11) • Tuolumne River Trust, Peter Drekmeier (Oral Comment #102) • Lakeshore Area Improvement Club, Jim Stark (Oral Comment #104)

3.2 SUBJECT AREA OF COMMENTS

This section presents a summary of the comments received during the scoping process period. Table 2 identifies the issue areas raised by individual commenters. The corresponding comment number is provided in parentheses at the end of each comment. A transcript of the oral comments from the public scoping meeting is provided in Appendix C. The written comments (by number) can be found in Appendix E.

TABLE 2
Comments Received by Commenter and Type of Communication

No.	Commenter	Date	Notice of Preparation	Scope of EIR	Project Description	Project Alternatives	Permits and Approvals	Water Rights	Hydrology & Water Quality	Land Use & Planning	Aesthetics	Cultural Resources	Transportation/Circulation	Climate Change	Cumulative Impacts
Written Comments															
#1	Scott Morgan, State Clearinghouse	6/25/09	X												
#2	Lisa Carboni, California Department of Transportation	7/13/09	X									X	X		
#3	Karl P. Winkler, California Department of Water Resources	7/28/09							X						
#4	Melissa Ross, County of San Mateo	7/24/09								X					
#5	Laura Allen, Town of Colma	7/28/09		X	X			X	X	X					

TABLE 2

Comments Received by Commenter and Type of Communication

No.	Commenter	Date	Notice of Preparation	Scope of EIR	Project Description	Project Alternatives	Permits and Approvals	Water Rights	Hydrology & Water Quality	Land Use & Planning	Aesthetics	Cultural Resources	Transportation/Circulation	Climate Change	Cumulative Impacts
#6	Nicole M. Sandkulla, BAWSCA	7/31/09		X	X	X	X		x						
#7	Robert B. Maddow, Bold, Polisner, Maddow, Nelson & Judson	7/28/09		X				X	X						X
#8	Mondy Lariz, California Trout	7/28/09	X						X						
#9	Jerry Cadagan, Committee to Save Lake Merced	7/28/09	X		X	X			X					X	
#10	Peter Drekmeier, Tuolumne River Trust	7/28/09				X			X						
#11	Bob Hackamack, Restore Hetch Hetchy	7/28/09		X	X			X							
Oral Comments															
101	Andrea Ouse, Town of Colma	7/9/09		X				X	X		X				

TABLE 2
Comments Received by Commenter and Type of Communication

No.	Commenter	Date	Notice of Preparation	Scope of EIR	Project Description	Project Alternatives	Permits and Approvals	Water Rights	Hydrology & Water Quality	Land Use & Planning	Aesthetics	Cultural Resources	Transportation/Circulation	Climate Change	Cumulative Impacts
102	Peter Drekmeier, Tuolumne River Trust	7/9/09				X			X						
103	Kathryn Slater Carter	7/9/09				X			X						
104	Jim Stark, Lakeshore Area Improvement Club	7/9/09							X						
105	Robert B. Maddow, BPMNJ	7/9/09		X		X		X	X						
106	Paul Perkovic, resident of Montara and a member of the Board of Directors of the Montara Water and Sanitary District	7/9/09							X						

Please note that some of the comments summarized below may not characterize the project or its potential effects correctly. It is not uncommon for scoping comments to misrepresent the proposed project. The meaning of the comment summaries has not been changed, even if the comments appear to be incorrect. This summary does not include commentary on the comments. The comments will be considered in preparation of the EIR.

Notice of Preparation

Comment: The commenter states that he was dismayed to find no mention of Lake Merced in the NOP. (#8, California Trout)

Comment: The commenter states that there are too few details in the project description found in the NOP. Nowhere in the NOP or related material presented at the scoping meeting is Lake Merced or the Tuolumne River mentioned. It is within these two water bodies that the potentially significant negative environmental effects of the Project might materialize. Amplifying the project description after the deadline for scoping comments has passed would seem inconsistent with the spirit of the scoping process. Based on the inadequacy of the detail in the project description, the NOP should be withdrawn at this time and reissued only when an adequately detailed project description is submitted by the SFPUC. (#9, Committee to Save Lake Merced)

Scope of EIR

Comment: Several commenters expressed uncertainty over whether the test wells warrant a categorical exemption under CEQA. The Town of Colma requested that the project description and any other available information about the test wells be provided to the Town of Colma for review and comment. The test wells and the rest of the Project are all part of the same reasonably foreseeable "project" under CEQA, and that the EIR should describe the construction and operational impacts of the test wells; provide information regarding rates of pumping to be used to test the stability of the underlying aquifer, planned draw-down of groundwater levels to evaluate subsurface hydrogeological conditions, and the potential for well testing to result in a cone of depression affecting nearby groundwater users). It is appropriate to include the test wells in the EIR, so that they cannot be placed in full operation until the EIR is certified and the Project is approved. (#101, Andrea Ouse, Town of Colma; #5, Town of Colma; #7, Bold, Polisner, Maddow, Nelson & Judson)

Comment: Commenters suggest that the EIR should look at the additional use of recycled water as a source of water for irrigation purposes. The EIR should address how the water recycling program could work in parallel with the proposed project a the EIR should include an assessment of potential impacts if recycled water is used. (#105, Robert B. Maddow, Bold, Polisner, Maddow, Nelson & Judson; #6, BASWCA)

Comment: The environmental impacts of planned upgrades to the Westlake Pump Station and the addition of treatment facilities at well facility sites should be addressed in the EIR. (#5, Town of Colma)

Comment: The EIR should present the detailed operation strategy for the proposed Project, including the individual facilities, along with a detailed hydrological and environmental impact analysis of the proposed Project and associated facilities based upon the known operational strategy. (#6, BAWSCA)

Comment: The EIR should clarify how the administrative board for the management of the Westside Basin was arranged, and asks if the SFPUC intends to include representatives from the neighboring jurisdictions, public representatives, and representatives from existing irrigators (cemeteries and golf courses). The purview of the administrative board also should be described, as well as regulations and administrative rules that will govern the Board and the South Westside Groundwater Basin, and the notification process and timing for review and comment by users on any proposed administrative regulations. Describe if the board (assuming there will be an oversight committee) has a right to dictate how much water can be pumped and if there will be pumping limits. The EIR should clarify the rules that the SFPUC and participating pumpers have agreed to that will govern the operation of the Project during wet, normal, and dry periods, as well as the development of additional groundwater capability to meet future local water supply reliability needs. (#6, BAWSCA; #5, Town of Colma)

Comment: The EIR should describe how the baseline data for existing groundwater users, such as irrigators, will be determined, and if there has been an assessment of their future needs and the associated impacts. (#5, Town of Colma)

Comment: The EIR should describe the jurisdiction the water providers would have over procedures for replacement of existing wells, which is currently permitted by the County. The EIR should describe if there will be another approval process that will have oversight in these requests. (#5, Town of Colma)

Comment: The EIR should describe the bases for the establishment of the various baseline quantity numbers provided in the NOP, including 1) the estimate of the quantity currently in storage in the groundwater basin, 2) how it was determined that 61,000 acre-feet of groundwater storage is available in the Westside Basin, 3) the method of determining that 7.2 million gallons a day would be pumped in dry years, and 4) the length of time it will take for the aquifer to be replenished or brought to the desired levels. (#5, Town of Colma)

Comment: The EIR should describe if there is a plan to assemble an agreement (Memorandum of Understanding) between the irrigators, water providers, and legislative bodies in each jurisdiction to define the various limits and protections for current and future activities. (#5, Town of Colma)

Comment: The EIR should describe if irrigation uses have been factored into the calculations for replenishing the water table. (#5, Town of Colma)

Comment: The project description must include information on the location of the distribution system extensions necessary to connect Project facilities to existing distribution lines. Issues addressed should include aesthetics impacts, street and on-street parking closures affecting traffic, parking, and emergency response, and any economic impacts on local businesses that would result in indirect impacts on the physical environment. (#5, Town of Colma)

Comment: The existing project description (provided with the NOP) is inadequate to allow for meaningful CEQA review for the following reasons:

1) It lacks definitions of critical terms such as "excess surface water", "dry, normal and wet" years, and "sufficient surface water supplies."
2) It lacks adequate information regarding the aquifer in question to give meaning and context to the stated Project purposes. For example, the total capacity, current storage volume, and unused capacity for future conjunctive use in the South Westside Groundwater Basin are not given.
3) It should spell out how the proposed Project integrates with SFPUC's plans for groundwater development in the North Westside Groundwater Basin.

The commenter states that many answers to these issues may be found in the "groundwater storage and recovery agreement" mentioned in the project description. If so, then that agreement should be publicly disclosed before preparation of the EIR, and the scoping process should occur after, not before, those critical details are revealed. (#302-3, Jerry Cadagan, Committee to Save Lake Merced)

Comment: If this is a regional project, why is the North Westside Groundwater Basin not included? (#11, Restore Hetch Hetchy)

Comment: The EIR should repeat the clarification made on Page 1, Footnote 1 of the NOP whenever the 8.5-year design drought cycle is discussed. (#6, BAWSCA)

Comment: The EIR should address the potential for other users of the basin, who are not participating in this Project, to affect the overall storage level in the basin and the amount of water potentially available for withdrawal under the Project. The EIR should discuss what mechanisms can be implemented to protect the Program Storage against withdrawal by other non-participating pumpers. (#6, BAWSCA)

Comment: The EIR should clarify exactly how the new dry-year water supply would be made available to Partner Agencies and SFPUC wholesale customers under the terms of the Shortage Allocation Plan between the SFPUC and its wholesale customers. If the intent is that the available Program Storage, as quantified by the SFPUC Storage Account, will be taken into consideration by the SFPUC when determining how much water is available for delivery and whether a shortage condition exists, the EIR should provide this clarity. (#6, BAWSCA)

Comment: The EIR should address how the Program Storage and associated Project facilities might be used during an emergency, what rules would be applied to such operations, and who the beneficiaries would potentially be. (#6, BAWSCA)

Comment: The EIR should provide the water supply availability criteria to be used to determine the conditions of a “normal”, “wet”, and “dry” year associated with Project operation. (#6, BASWCA)

Comment: The EIR should provide a definition of “excess surface water” that determines the amount of reduced groundwater pumping in normal and wet years. (#6, BASWCA)

Comment: The EIR should define the methods to determine the amount of groundwater in the storage account at any point in time. Also, the basis for estimating underground losses of stored water that is not subsequently available for recapture needs to be explained. (#6, BASWCA)

Project Alternatives

Comment: Several commenters suggested that the EIR look at the possibility of using stormwater as a component of the recharge of the basin. The EIR should look at recharge of the groundwater with stormwater even in wet years, thus decreasing reliance on the Tuolumne River. The EIR should study using treated stormwater runoff, since most of the cities have existing stormwater drainage systems. Preliminary inquiry into the injection of stormwater and/or recycled water to the aquifer in this regard was that local geological conditions do not lend themselves to effective use of injection wells. This issue needs to be examined and discussed in the EIR in greater detail, including consideration of using the soon-to-be-made-available public groundwater model to determine optimum locations for injecting stormwater and recycled water. (#105, Robert B. Maddow, Bold, Polisner, Maddow, Nelson & Judson; #102, Peter Drekmeier, Tuolumne River Trust; #103, Kathryn Slater-Carter; #10, Tuolomne River Trust; #9, Committee to Save Lake Merced)

Comment: The EIR should discuss what would be necessary to recharge more of the 75,000 acre feet vacant storage available in this aquifer and the time to accomplish refilling. (#11, Restore Hetch Hetchy)

Comment: If there are alternatives that consider different well locations than those listed in the NOP, the EIR should discuss the siting criteria used to select an alternative well site. (#6, BASWCA)

Comment: Discuss using recycled water and urban stormwater runoff after the first flushing rain as source to raise the level in Lake Merced for this recharge purpose. (#11, Restore Hetch Hetchy)

Permits and Approvals

Comment: The California Department of Public Health (CDPH) should be added to the list of permitting agencies. (#6, BASWCA)

Hydrology and Water Quality

Groundwater Levels

Comment: The EIR should study the potential settlement issues associated with the more active management of the aquifer, including recharging the aquifer and deleting a part of the aquifer. It appears there is a gradual decrease in the amount of water in the aquifer right now. (#101, Andrea Ouse, Town of Colma)

Comment: Several of the golf courses throughout the basin have switched from use of groundwater to use of recycled water, and they have worked hard and paid money to preserve the aquifer. The proposed doubling of production of groundwater from the aquifer is of concern to some owners of private wells who have the legal rights to groundwater use within the basin. Beyond the in-lieu pilot program, no one knows what will happen when the aquifer is refilled. The EIR should describe how the effects of refilling the aquifer will be measured, both from the standpoint of its long-term productivity and from the standpoint of the impact on private well owners who have legal right to use water from the aquifer. There is potential for negative impacts to the production wells of pumpers, including the golf clubs, particularly during dry years. Should water levels be depressed below the screened intervals of the well casings, there is possibility of long-term well damage. The impacts on private wells may require mitigation by the SFPUC, and this needs to be analyzed and disclosed in the EIR. The locations of the new extraction wells proposed by the SFPUC, and any new wells planned by their municipal partners, need to be fully disclosed and analyzed in the EIR, with detailed maps. The results of the analysis, to be determined by mutual interference modeling, needs to be fully disclosed and analyzed in the EIR and the mitigation plan. (#105, Robert B. Maddow, Bold, Polisner, Maddow, Nelson & Judson; #7, Bold, Polisner, Maddow, Nelson & Judson)

Comment: The EIR should address the effect of aquifer replenishment to the assessed amounts (61,000 acre feet) on whatever lies above the basin, and also the effect of lowering the water table on whatever lies above the basin. (#5, Town of Colma)

Comment: There is the possibility that the ratio of "stored" to future extracted water is not actually or even close to 1:1. There is the potential for new users, or the potential for the "stored" water to be lost (not remain within the aquifer or the portion that is utilized), or the actual "usable" available storage may not be accurate. Careful environmental and technical analysis of the actual storage capacity and the effects of its use are needed before the Project is approved. (#7, Bold, Polisner, Maddow, Nelson & Judson)

Groundwater Quality

Comment: Will contaminants be remobilized when the basin is refilled? Numerous gas stations are located throughout the urbanized area in the basin. Some may have had leakage problems with MTBE-supplemented fuel. Some contaminants may have adhered to the soil particles when water levels were lower, and as the water levels are raised, the contaminants may be remobilized. Beyond leaking underground storage tanks, contaminants might have been deposited in the basin through industrial activity long ago and during the time when the aquifer was being hit hard. (#106, Paul Perkovic, member of the Board of Directors of the Montara Water and Sanitary District; #105, Robert B. Maddow, Bold, Polisner, Maddow, Nelson & Judson; #5, Town of Colma)

Comment: The potential for water levels to decline, even temporarily, as a result of dry year pumping may negatively impact water quality by concentrating contaminants and minerals. There may also be a potential for mixing of waters (and minerals) that may not otherwise have occurred, which would be a cause of concern and should be analyzed in the EIR. (#7, Bold, Polisner, Maddow, Nelson & Judson)

Comment: The EIR should explain how the high nitrate and manganese concentrations in water from the aquifer will be handled during drought when about 7.2 mgd will be added to the diminished surface supply. Describe if wellhead treatment will be used to accomplish reduction of these two chemicals or of blending with system water take care of these problems. (#11, Restore Hetch Hetchy)

Comment: The EIR should discuss the reason(s) for providing disinfection facilities at each well as disinfection is not necessarily required under Title 22 of the California Code of Regulations. It should specify the type of disinfection method to be used (chlorine or chloramines) and discuss any blending impacts or water quality compatibility issues. (#6, BASWCA)

Comment: The EIR should include the site-specific water quality testing data which is required in the pre-design. (#6, BASWCA)

Comment: The EIR should include an assessment to determine the ability to meet water quality goals when blending under the planned operational scheme. Project documentation indicates this will be verified from water samples collected from the test wells in the pre-design phase. The commenter asks if sufficient information will be available at the time of the EIR analysis to confirm that blending is a viable method to achieve water quality goals. (#6, BASWCA)

Comment: The EIR should provide the details of the long term monitoring program which will be used to assess changes in local groundwater quality and levels within the South Westside Groundwater Basin as a whole. The program should include the development of a best practices plan to protect the groundwater basin if not already developed. (#6, BASWCA)

Comment: It is indicated in the documentation for this Project that Drinking Water Source Assessments will be performed during pre-design. The commenter asks if these assessments will be available for use in the EIR analysis. (#6, BASWCA)

Water Supply

Comment: The commenter asks if the rate of recharge for the basin has been calculated and how long the water supply will last given that during dry years there would be more water extracted. (#103, Kathryn Slater-Carter)

Comment: The commenter asks how the Project will stabilize the water supplies that would be available from Hetch Hetchy to meet the coastal needs, including within the Montara Water and Sanitary District and the Coastside County Water District. (#106, Paul Perkovic, member of the Board of Directors of the Montara Water and Sanitary District)

Comment: It would be prudent to include in Project plans emergency generators or backup generators in the well pump-housing and treatment facilities. (#106, Paul Perkovic, member of the Board of Directors of the Montara Water and Sanitary District)

Comment: The Bay Area Water Supply and Conservation agency has a very complex water allocation scheme for drought periods, which is based on historic use and recent use. If participating agencies take delivery of a much higher quantity of water from the SFPUC system during the recharge period, then would their groundwater allocation be much higher during a drought? (#106, Paul Perkovic, member of the Board of Directors of the Montara Water and Sanitary District)

Comment: The Department of Water Resources states that it strongly supports the concept of the Project, and recognizes the importance of this Project and similar groundwater storage projects that meet the State of California's future water supply needs. (#3, Department of Water Resources)

Comment: The EIR should address any effect of the Project on reducing the availability of water supplies provided by California Water Company to the Town of Colma and its residents, thus requiring the Town and its residents to acquire water from other sources, and to identify other sources that are available. (#5, Town of Colma)

Comment: The current Notice and Description did not mention the specific source of the surface water supply that would be used to replace the present well water being pumped. The concern is that more water will be drawn from other watersheds. Those sources must be acknowledged and their impacts shown and mitigation provided in the Project EIR. The EIR should present a water balance stating the source of replacement water and provide a detailed water balance for the SFPUC delivery system as a whole. The comment provides a list of surface water diversions and inputs that should be presented in the water balance. (#11, Restore Hetch Hetchy).

Comment: The EIR should include a groundwater recovery assessment. (#6, BASWCA)

Surface Water – Lake Merced

Comment: The Lakeshore Acres Improvement Club has been concerned with lake levels at Lake Merced. The EIR should examine Lake Merced water levels and respond to all the concerns that are already known regarding the lake's water levels. (#104, Lakeshore Area Improvement Club)

Comment: The commentor states that a significant contributing factor to the decline in Lake Merced lake levels during the 80's was excessive pumping from the Westside Basin, resulting in an overdraft condition of the aquifer. The EIR should analyze whether the Project would cause excessive aquifer pumping and resultant overdraft, resulting in significant harm to the environment. (#9, Committee to Save Lake Merced)

Comment: The EIR should discuss the "potential for the flow from the shallow aquifer/lake system toward the underlying aquifer from which nearby production wells withdraw water" in the South Westside Groundwater Basin south of Lake Merced (quote from the Draft WSIP PEIR). (#11, Restore Hetch Hetchy)

Comment: The EIR should discuss the lake level management plan for Lake Merced. (#6, BASWCA)

Surface Water – Tuolumne River

Comment: The EIR should address the impacts of what sounds like the diversion of an extra 6.7 million gallons of water per day from the Tuolumne River in wet years, in addition to what was studied in the WSIP EIR. Additional information will be available at the end of this year or early next year that was not available at the time of the WSIP EIR. The PUC is doing a biological study of the stretch of the river below Hetch Hetchy as part of the Kirkwood Powerhouse Agreement in 1988. (#102, Peter Drekmeier, Tuolumne River Trust)

Comment: The commenter states that in general the Tuolumne River Trust supports the concept of cooperative management of surface water and groundwater to optimize the water demand and supply balance. However, the trust has concerns that the Project could harm the Tuolumne River by increasing diversions in normal and wet years. The EIR needs to identify the source(s) of the additional surface water that would provide an additional 5.4 millions gallons per day to SFPUC customers in normal and wet years. It also should define wet, normal and dry years. (#10, Tuolumne River Trust)

Comment: Currently, 60 percent of the Tuolumne River is used for agricultural and urban uses, and even more water is diverted, causing significant impacts to the river ecosystem, including a decline in anadromous fish. Diverting more water from the river would exacerbate this problem. The commenter states that the WSIP PEIR analysis of the impacts on salmon and steelhead from diverting more water from the Tuolumne River was wholly inadequate. New information about potential impacts to the Tuolumne River from increasing diversion should be included in the EIR for the Project, such as the SFPUC study of biological resources in the stretch of the river downstream of the Hetch Hetchy Reservoir, expected to be completed by the end of 2009. (#10, Tuolumne River Trust)

Comment: The EIR should address comments submitted by the Department of Fish and Game on January 15, 2009 for the San Joaquin Pipeline System Project regarding the effect of increased diversions from the Tuolumne River on fish species in the river. (#10, Tuolumne River Trust)

Comment: Wet years do not result in "wasted" water. Wet years can provide better flows for juvenile salmon and steelhead, enabling them to get flushed out into the Bay and Ocean in higher numbers. The EIR should study the impacts of diverting additional water from the Tuolumne River on fish populations even in wet and normal years. (#10, Tuolumne River Trust)

Comment: Requirements for instream flows in the lower Tuolumne River are likely to increase as a result of the Federal Energy Regulatory Commission (FERC) relicensing process that will begin in 2011 and be completed in 2016. FERC actions must be considered in the CEQA analysis for the Project. (#10, Tuolumne River Trust)

Water Rights

Comment: The EIR should describe if the water in the South Westside Groundwater Basin is to be used for the purposes of supplying residential, commercial, agricultural and recreational needs of those who reside over the basin, or if there are plans to export the water to communities beyond the underlying limits of the basin. If the plans are to export the water, describe of this will affect the ability of existing users to access more of the water in the basin. Describe if those jurisdictions that are not Partner Agencies will be allowed to review any agreement made with customers not located directly over the basin. (#5, Town of Colma)

Comment: The EIR should describe if the current and future water rights of an established pumper will be preserved by their current standard (#5, Town of Colma).

Comment: The project description should identify the proposed management structure in terms of the assertion of authority over the aquifer. It should address whether the Project will change the rights and ownership of the water to include entities other than those that already have rights to the water (#101, Andrea Ouse, Town of Colma).

Comment: The commenter asks about the legal implications of the undertaking and the impact of the Project on private property owners' rights to extract water from the basin for productive, beneficial uses, including the potential for some wells to be rendered obsolete, or require deepening, or require users to make new pumping or water supply arrangements. (#105, Robert B. Maddow, Bold, Polisner, Maddow, Nelson & Judson)

Comment: The EIR should discuss the rights that municipalities, residents, and property owners that are located in the overlying lands of the South Westside Groundwater Basin have to the use of groundwater within the Basin. The comment also provides a summary of water use rights under California law. (#5, Town of Colma)

Comment: The EIR should address any reasonably likely effects of the Project on groundwater rights, including the effects of water storage during wet periods and water recapture during dry periods on the town of Colma and its residents' use of the groundwater. (#5, Town of Colma)

Comment: The EIR should describe the provisions the City of San Francisco plans to make to avoid or minimize any adverse effects on groundwater rights of overlying municipalities, including through project design or compensation. (#5, Town of Colma)

Comment: The EIR needs to address protection of existing overlying rights, including any existing overlying rights that are not currently utilized due to the use of recycled water for irrigation in areas served by the aquifer. If the SFPUC seeks to recover the 15,000 AF they have already stored, the EIR should indicate how the interests of the overlying owners will be protected – i.e. how will the SFPUC assure other pumpers that their water rights will not be impaired by this excess pumping? (#7, Bold, Polisner, Maddow, Nelson & Judson)

Water Supply Cost

Comment: What would be the cost of the increased use of Hetch Hetchy water, which is very expensive water, and would business owners see an increase in their water rates. Daly City is able to keep the cost down by also using groundwater? (#103, Kathryn Slater-Carter)

Comment: If Daly City, South San Francisco, and Cal Water are provided additional water from Hetch Hetchy instead of pumping groundwater, would these entities pay the current Hetch Hetchy wholesale price for this water or would it be treated as an advance of so many acre feet of water that could be drawn on in the future? Because the cost for Hetch Hetchy water increases each year, paying current prices to purchase water to allow recharge, and then drawing on that water in the future when the agencies otherwise would be paying much higher rates to purchase Hetch Hetchy water, would mean that the other Hetch Hetchy water users, the Bay Area Water Supply and Conservation Agency, are underwriting the cost of water to South City, Daly City, and Cal Water. It would seem fairer to treat it as an advance of water that is then repaid later by drawing on groundwater, and the payments for Hetch Hetchy water remain at an average use and escalating price to pay for the seismic improvement program. (#106, Paul Perkovic, member of the Board of Directors of the Montara Water and Sanitary District)

Comment: Energy costs for irrigation users of the aquifer should be analyzed in the EIR. (#7, Bold, Polisner, Maddow, Nelson & Judson)

Climate Change

Comment: The EIR must consider climate change in detail given that the Project is partially based on the premise that there will be undefined “excess” surface water available in the undefined “normal and wet years.” (#9, Committee to Save Lake Merced)

Land Use and Planning

Comment: The two potential Project sites located in Broadmoor are within unincorporated San Mateo County jurisdiction. Therefore, the SFPUC is required to submit a project description for review and determination of General Plan conformity pursuant to Government Code Section 65402. (#4, County of San Mateo)

Comment: The EIR should list the municipalities that are located in the overlying lands of the South Westside Groundwater Basin. The commenter asks if the Town of Colma, in particular, is located in these lands. (#5, Town of Colma)

Aesthetics

Comment: The commenter is concerned about the buildings associated with each well site, specifically their location and physical appearance. The Town of Colma tries to keep its policies in line with the Town's existing tranquil and serene environment. (#101, Andrea Ouse, Town of Colma)

Cultural Resources

Comment: If construction activities are proposed within the State's Right-of-Way (ROW), Caltrans requires documented results of a current (no more than 5 years old) archaeological record search at the Northwest Information Center of the California Historical Resources Information System before an encroachment permit can be issued. If warranted, a cultural resource study by a qualified, professional archaeologist in compliance with NEPA (if there is a federal action on the Project), CEQA, and PRC section Section 5024.5 (for state-owned historic resources), and Volume 2 of Caltrans "Standard Environmental Reference." (#2, California Department of Transportation)

Transportation and Circulation

Comment: Caltrans comments that, as lead agency, the San Francisco Planning Department is responsible for all Project mitigation, including any needed improvements to State Highways. The EIR should fully discuss the Project's fair share contribution, financing, scheduling, and implementation responsibilities as well as lead agency monitoring for all proposed mitigation measures. The Project's traffic mitigation fees should also be specifically identified. (#2, California Department of Transportation)

Comment: Any required roadway improvements must be completed prior to issuance of Project occupancy permits. Also, an encroachment permit is required when a project involves work in the State's ROW so the lead agency should ensure resolution of Caltrans concerns prior to submittal of the encroachment permit application. Traffic-related mitigation measures will be incorporated into the construction plans during the encroachment permit process. (#2, California Department of Transportation)

Comment: Because the proposed Project is located adjacent to State highway facilities, the EIR must evaluate traffic impacts on State facilities to determine if a Traffic Impact Study is warranted. In addition, Project vehicle trips and hours of operation should be discussed and street routes for vehicles should be identified. Use of the Caltrans guidance for preparation of traffic impact studies is recommended. (#2, California Department of Transportation)

Comment: Project work that requires movement of oversized or excessive load vehicles on State facilities requires a transportation permit. (#2, California Department of Transportation)

Comment: Caltrans encourages the San Francisco Planning Department to coordinate with Caltrans for all SFPUC WSIP projects, and provides a contact name and address. (#2, California Department of Transportation)

Cumulative Impacts

Comment: The Draft WSIP PEIR lists several golf courses located atop the aquifer that are successfully using recycled water for irrigation. The EIR should discuss the impact on aquifer recovery from conversion to using recycled water for additional golf courses and other irrigated landscapes that still pump from this aquifer or use system water for irrigation. (#11, Restore Hetch Hetchy)

Comment: The commenter expresses concern about the test wells and indicates that the test wells appear to be handled as a separate project and not encompassed as part of a cumulative review of the Groundwater Storage and Recovery Project. (#101, Andrea Ouse, Town of Colma)

Comment: The EIR needs to fully analyze the impacts of the Project and other groundwater-related projects in the area, including, but not limited to the SFPUC's proposed lake level restoration project for Lake Merced; the project to pump groundwater at production rates from the North Westside Basin; the variety of recycled water projects proposed in various portions of the land overlying the aquifer; and stormwater management projects being considered in the area, particularly to the extent they may involve detention basins. (#7, Bold, Polisner, Maddow, Nelson & Judson)

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Appendix A
Notice of Preparation

SAN FRANCISCO
PLANNING DEPARTMENT

Notice of Preparation of an Environmental Impact Report

1650 Mission St.
Suite 400
San Francisco,
CA 94103-2479

Reception:
415.558.6378

Fax:
415.558.6409

Planning
Information:
415.558.6377

Date:	June 24, 2009
Case No.:	~~[illegible]~~ 2008.1396E
Project Title:	**Regional Groundwater Storage and Recovery Project**
Location:	The proposed Project is located in the South Westside Groundwater Basin in San Mateo County, and the proposed facilities will be constructed in northern San Mateo County. The South Westside Groundwater Basin is located in San Mateo County within the larger Westside Groundwater Basin which underlies both San Francisco and San Mateo counties. Proposed facilities are located in the cities of South San Francisco, Colma, San Bruno, Millbrae, and Daly City and in unincorporated portions of San Mateo County.
BPA Nos.:	N/A
Zoning:	N/A
Block/Lot:	N/A
Lot Size:	Various
Project Sponsor	Greg Bartow, San Francisco Public Utilities Commission (415) 934-5724
Lead Agency:	San Francisco Planning Department
Staff Contact:	Diana Sokolove – (415) 575-9046 diana.sokolove@sfgov.org

PROJECT DESCRIPTION

The purpose of the Regional Groundwater Storage and Recovery (GSR) Project (Project or proposed Project) is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. This new dry-year water supply would be made available to the cities of Daly City and San Bruno, the California Water Company (Cal Water) in its South San Francisco service area (collectively referred to as Partner Agencies) and San Francisco Public Utilities Commission (SFPUC) wholesale water customers.

The SFPUC proposes to provide surface water, when available, to Partner Agencies, to be used by these agencies in lieu of pumping groundwater during normal and wet rainfall years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. This supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of pumping by Partner Agencies would ultimately increase groundwater storage within the South Westside Groundwater Basin by up to 61,000 acre-feet (AF) (approximately 20 billion gallons). Stored groundwater would be utilized by pumping new Project wells during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would construct new groundwater production well facilities, which would be operated by either the Partner Agencies or SFPUC for pumping groundwater at a rate of 7.2 million gallons per day during dry years. The proposed Project would help meet the water supply reliability needs of all SFPUC customers during dry years and may provide some increased level of regional operational flexibility to respond and restore service during unplanned outages.

The proposed Project is one of several facility improvement projects identified in the San Francisco Region as part of the SFPUC's Water System Improvement Program (WSIP). The WSIP was adopted by the SFPUC in October 2008 to improve the SFPUC's regional water system with respect to water quality, seismic response, water delivery, and water supply to meet water delivery needs in the service area and establishes level of service goals and system performance objectives. The proposed Project's primary contribution to the WSIP goals is its ability to meet the water supply needs of SFPUC customers during drought years.

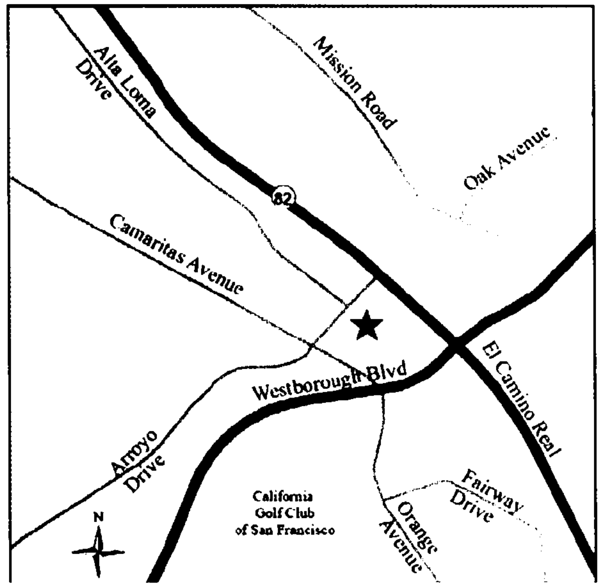
The proposed Project consists of 1) cooperative management of surface water and groundwater to optimize the water demand and supply balance; and 2) construction and operation of groundwater production well facilities on 16 of 19 potential sites in northern San Mateo County. Each groundwater well facility site would contain a groundwater production well, pump station, underground distribution piping, and utility connections. Some well facility sites would contain groundwater disinfection units and groundwater treatment facilities. Well facilities would connect to distribution systems for Daly City, San Bruno, Cal Water, and SFPUC. In addition, the Westlake Pump Station in Daly City may need to be upgraded and treatment facilities may need to be added to several well facility sites.

FINDING

This project may have a significant effect on the environment and an Environmental Impact Report is required. This determination is based upon the criteria of the State CEQA Guidelines, Sections 15063 (Initial Study), 15064 (Determining Significant Effect), and 15065 (Mandatory Findings of Significance), and for the reasons documented in the attached project description and description of potential environmental effects. (Documents are also available online at: http://www.sfgov.org/planning/mea.)

PUBLIC SCOPING PROCESS

Pursuant to the State of California Public Resources Code Section 21083.9 and CEQA Guidelines Section 15206, a public scoping meeting will be held to receive oral comments concerning the scope of the EIR at the following location, date, and time.



DATE: Thursday, July 9, 2009

6:15-7:00 p.m. Informational Session

7:00 p.m. Scoping meeting

LOCATION:

South San Francisco Municipal Services Building

Community Room

33 Arroyo Drive

South San Francisco, CA

Written comments will also be accepted at this meeting and until the close of business on **July 28, 2009**. Written comments should be sent to Bill Wycko, Environmental Review Officer, Regional Groundwater Storage and Recovery Project Scoping Comments, San Francisco Planning Department, 1650 Mission Street, Suite 400, San Francisco, CA 94103. They also may be submitted by fax to (415) 558-6409 or sent by email to diana.sokolove@sfgov.org.

If you work for a Responsible or Trustee Agency, we need to know the views of your agency regarding the scope and content of the environmental information that is germane to your agency's statutory responsibilities in connection with the proposed Project. Your agency may need to use the EIR when considering a permit or other approval for this proposed Project. Please include the name of a contact person in your agency.

June 24, 2009

Date

[signature] for

Bill Wycko

Environmental Review Officer

Regional Groundwater Storage and Recovery Project

2008.1396E

~~Case No 2005.0164E~~

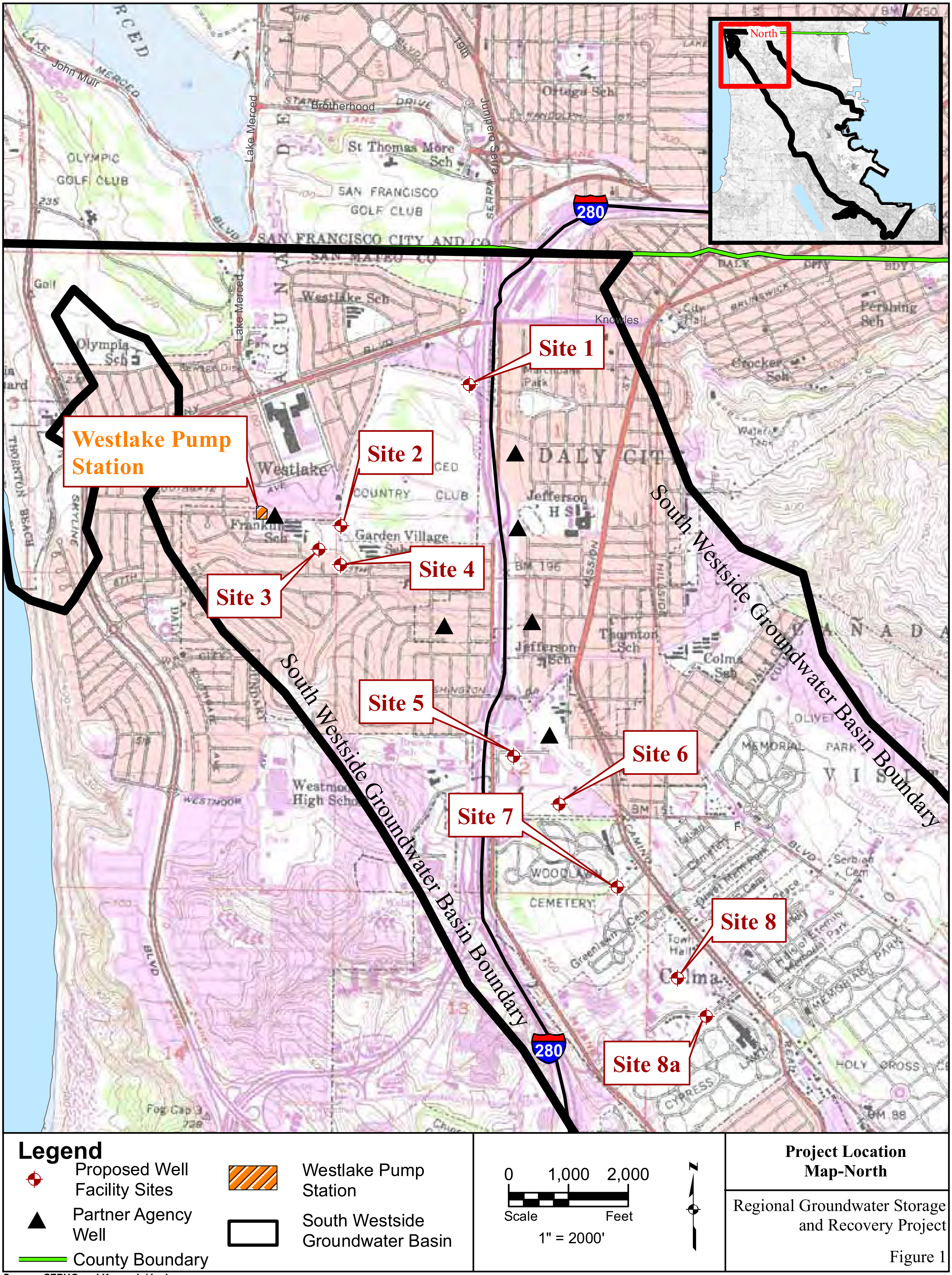
1.0 OVERVIEW AND BACKGROUND

The San Francisco Public Utilities Commission (SFPUC) is proposing the Regional Groundwater Storage and Recovery (GSR) Project (Project or proposed Project), which would be located in northern San Mateo County, California (see Figures 1, 2, and 3). To meet California Environmental Quality Act (CEQA) requirements, the San Francisco Planning Department's Major Environmental Analysis Division (MEA) will prepare and distribute an Environmental Impact Report (EIR) describing and analyzing the environmental effects of the proposed Project. This Notice of Preparation (NOP) provides a description of the Project background, a brief description of the proposed Project elements, and describes some of the proposed Project's potential environmental effects.

The purpose of the proposed Project is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. This new dry-year water supply would be made available to the cities of Daly City and San Bruno, the California Water Company (Cal Water) in its South San Francisco service area (collectively designated as Partner Agencies) and SFPUC wholesale water customers.

SFPUC proposes to provide excess surface water when available to the Partner Agencies to be used by these agencies in lieu of pumping groundwater during normal and wet years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. This supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of groundwater pumping by Partner Agencies would ultimately increase groundwater storage within the South Westside Groundwater Basin by up to 61,000 acre-feet[1] (AF) (approximately 20 billion gallons). Stored

[1] The SFPUC plans for an 8.5-year drought. Over this 8.5-year period, the SFPUC anticipates it will exercise its dry-year supplies after the first year of the drought. Therefore, the 61,000 AF of storage is assumed to be used over 7.5 years of the design drought, with wells operating at a maximum capacity of 7.2 MGD.



Project Location Map-North

Regional Groundwater Storage and Recovery Project

Figure 1

Source: SFPUC and Kennedy/Jenks

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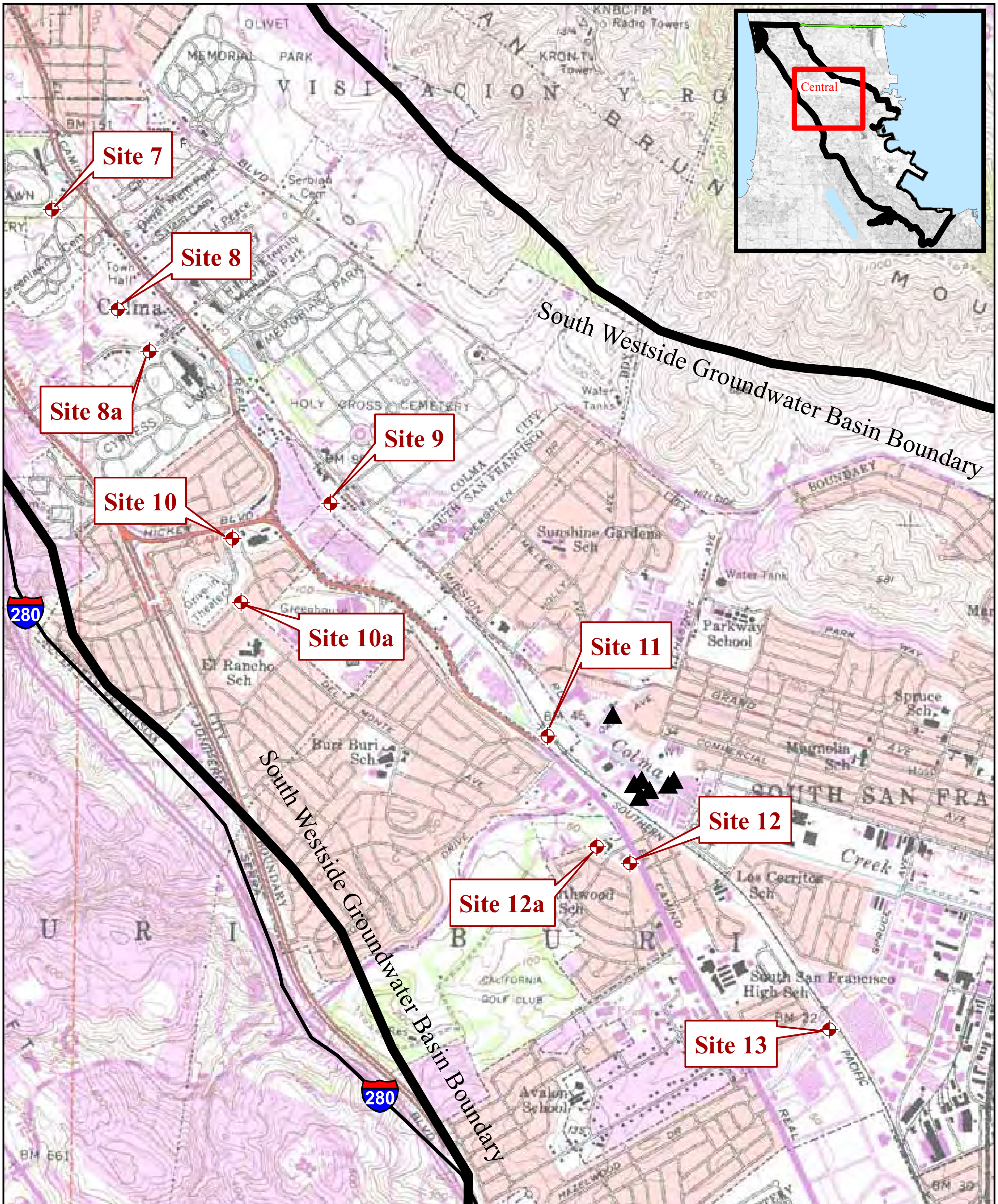

Legend

- Proposed Well Facility Sites
- Partner Agency Well
- South Westside Groundwater Basin

0 1,000 2,000
Scale Feet
1" = 2000'

Project Location Map-Central

Regional Groundwater Storage and Recovery Project

Figure 2

Source: SFPUC and Kennedy/Jenks

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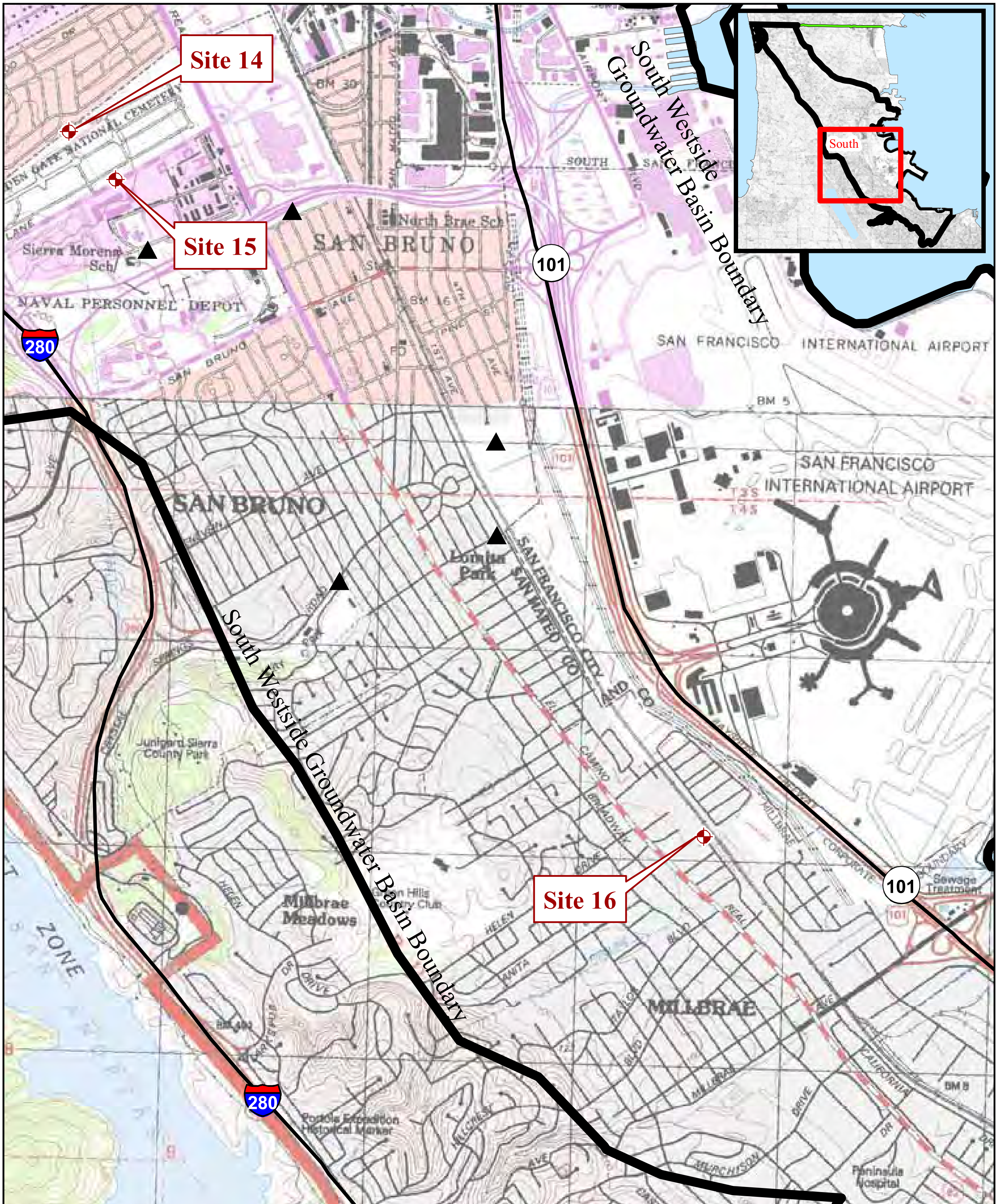

Legend

Proposed Well Facility Sites

Partner Agency Well

South Westside Groundwater Basin

0 1,000 2,000

Scale Feet

1" = 2000'

N

Project Location Map-South

Regional Groundwater Storage and Recovery Project

Figure 3

Source: SFPUC and Kennedy/Jenks

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groundwater would be utilized by pumping new Project wells during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would create new groundwater production well facilities, which would be operated by either the Partner Agencies or SFPUC for pumping groundwater at a rate of up to 7.2 million gallons per day (MGD) during dry years. The proposed Project would help meet the water supply reliability needs of all SFPUC customers during dry years and may provide some increased level of regional operational flexibility to respond and restore service during unplanned outages.

The proposed Project is a component of the SFPUC's proposed Water System Improvement Program (WSIP) (see www.sfwater.org). The basic goals of the WSIP are to increase the reliability of the regional water system with respect to water quality, seismic response, delivery, and water supply to meet water delivery needs in the service area. A Program EIR (PEIR) for the WSIP was certified by the San Francisco Planning Commission, and the WSIP was adopted by the SFPUC on October 30, 2008. The PEIR addresses the potential environmental impacts of the WSIP facilities on a programmatic level and evaluates regional water supply alternatives. The proposed Project, which is the subject of this NOP, is one component of the WSIP[2]; implementation of this proposed Project would contribute to meeting the WSIP's overall goals and objectives.

For purposes of the WSIP PEIR, the SFPUC's regional water system facilities were subdivided into six regions: Hetch Hetchy, San Joaquin, Sunol Valley, Bay Division, Peninsula, and San Francisco. The proposed Project would occur in the San Francisco Region.

2.0 PROPOSED PROJECT FACILITIES

The proposed Project facilities would consist of new groundwater production well facilities within the South Westside Groundwater Basin (Basin); the facilities are designed to withdraw up to 7.2 MGD from the volume of stored groundwater directly resulting from Project-related reduced groundwater

[2] The Regional Groundwater Storage and Recovery Project was listed as the Conjunctive Use Project in the PEIR.

pumping in the Basin by Partner Agencies during normal and wet years. Up to 16 new groundwater well facilities would be constructed on 16 of the 19 potential sites in northern San Mateo County to supply the needed withdrawal capacity. Well facilities would be connected to Daly City, San Bruno, Cal Water, or SFPUC distribution systems. In addition, the existing Westlake Pump Station in Daly City may need to be modified and treatment facilities may need to be added.

Each groundwater well facility site would contain a groundwater production well, pump station, underground distribution piping, and utility connections. Each well facility would have a disinfection unit as required, unless it is near an existing disinfection unit that can accommodate the additional volume, in which case the well would be connected to the existing unit. Well facility sites where the groundwater may need treatment have been designed with appropriate treatment facilities.

3.0 ENVIRONMENTAL REVIEW PROCESS

As described above, the San Francisco Planning Commission certified the WSIP PEIR in October 2008. The PEIR addressed the potential environmental impacts of the WSIP facilities on a programmatic level and evaluated regional water supply alternatives. The PEIR is available on the San Francisco Planning Department website at www.sfgov.org/planning/mea.

The San Francisco Planning Department will prepare a project-specific EIR to evaluate the environmental effects of the proposed Project. The EIR will be prepared in compliance with the CEQA Guidelines Section 15161 and will address project-specific construction and operational impacts.

The first step in the environmental review process is the formal public scoping process, for which this NOP has been prepared. Following the public scoping period, a Draft EIR will be prepared and circulated for a 45-day public review period. Public comments on the Draft EIR will be accepted in writing during the review period or verbally at a formal public hearing to be held by the San Francisco Planning Commission. The San Francisco Planning Department then will prepare written responses to comments on environmental issues raised during the public review period, and a Response to Comments document will be prepared. That document will be considered by the San Francisco Planning

Commission, along with the Draft EIR and any revisions to the draft based on the response to comments, for certification as a Final EIR.

4.0 PUBLIC SCOPING MEETING

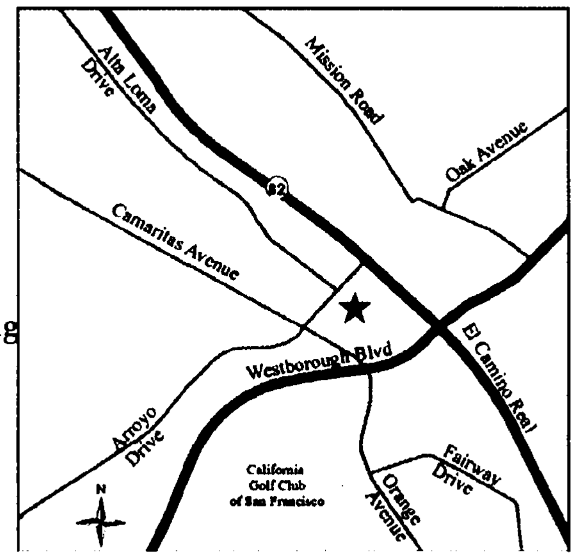
The San Francisco Planning Department will hold a public scoping meeting at the following location, date, and time.

DATE: Thursday, July 9, 2009

6:15-7:00 p.m. Informational Session

7:00 p.m. Scoping meeting

LOCATION:
South San Francisco Municipal Services Building
Community Room
33 Arroyo Drive
South San Francisco, CA



The purpose of this meeting is to assist the Planning Department with its review of the proposed scope and content of the EIR as summarized in this NOP. The public will be given the opportunity to provide comment for consideration. The San Francisco Planning Department also will accept written comments on the scope of the EIR at the meeting or by mail, email, or fax until close of business (5:00 p.m.) on **July 28, 2009**. Written comments may be submitted by mail to the San Francisco Planning Department, Attn: Bill Wycko, Environmental Review Officer, Regional Groundwater Storage and Recovery Project Scoping Comments, 1650 Mission Street, Suite 400, San Francisco, CA 94103. They also may be submitted by fax to (415) 558-6409, or sent by email to diana.sokolove@sfgov.org.

5.0 PROJECT DESCRIPTION

5.1 Project Location

The proposed Project is located in the South Westside Groundwater Basin in San Mateo County, and the proposed facilities will be constructed in northern San Mateo County as shown in Figures 1, 2, and 3. The South Westside Groundwater Basin is located in San Mateo County within the larger Westside Groundwater Basin[3], which underlies both San Francisco and San Mateo counties. The Project is also located within the water service areas for the cities of Daly City, San Bruno, and Millbrae and within the Cal Water service area, which includes portions of South San Francisco, Colma, and unincorporated San Mateo County.

Groundwater well facilities would be constructed and operated at up to 16 locations in the cities of Colma, Daly City, South San Francisco, San Bruno, Millbrae, and unincorporated San Mateo County (see Figures 1, 2, and 3). Well facilities would be connected to existing water distribution pipelines owned by Daly City, San Bruno, Cal Water, and SFPUC. The Project also includes an upgrade of the existing Westlake Pump Station in Daly City to serve the proposed new well facility sites.

5.2 Project Objectives

The proposed Project is a regional groundwater storage and recovery project that is part of the SFPUC's WSIP. The overall goals of the WSIP for the regional water system are to maintain high-quality water; reduce vulnerability to earthquakes; increase water delivery reliability; meet customer water supply needs; enhance sustainability; and achieve a cost-effective, fully operational system. The proposed Project's primary contribution to the WSIP goals is its ability to meet the water supply needs of SFPUC customers during drought years. In addition,

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[3] The Westside Groundwater Basin extends from western San Francisco south into San Mateo County. The Basin has an area of approximately 40 square miles and underlies Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame. The Westside Groundwater Basin has been administratively divided at the San Francisco County-San Mateo County line. This is a political boundary, not a physical boundary. The portion of the basin that lies within San Francisco County is referred to as the North Westside Groundwater Basin. The portion of the basin that lies within San Mateo County is referred to as the South Westside Groundwater Basin. The Project would occur solely within the South Westside Groundwater Basin.

the Project may provide some increased level of regional operational flexibility to respond and restore service under unplanned outages.

The specific objectives of the proposed Project are to:

- Cooperatively manage the South Westside Groundwater Basin through the coordinated use of SFPUC surface water and the groundwater pumped by the Partner Agencies;
- Provide increased SFPUC surface water to the Partner Agencies in normal and wet years, resulting in a reduction of groundwater pumping by these agencies and an increase in groundwater storage in the South Westside Groundwater Basin;
- Increase the pumping capacity from the South Westside Groundwater Basin by up to 7.2 MGD to supply water during dry years and emergencies; and
- Provide a new dry-year groundwater supply for SFPUC customers and increase water supply reliability during the 8½-year design drought cycle.

5.3 Proposed Project

The proposed Project is a groundwater storage and recovery project, which includes the operation of new groundwater production wells and associated distribution and treatment facilities. This section includes a description of these proposed Project components.

5.3.1 Groundwater Storage and Recovery

The Partner Agencies currently supply potable water to their customers through a combination of groundwater from the South Westside Groundwater Basin and purchase of SFPUC surface water. The proposed Project would provide additional SFPUC surface water to the Partner Agencies during normal and wet years when sufficient surface water supplies are available. The Partner Agencies would reduce their groundwater pumping by a comparable amount and allow the groundwater basin to recharge naturally during these periods.

Figure 4 illustrates the increase in groundwater storage expected from a reduction in pumping during normal and wet years, as well the decrease in groundwater storage projected from an increase in pumping during dry years.

During normal and wet years, the volume of groundwater in the South Westside Groundwater Basin would naturally increase due to the reduced groundwater pumping, eventually reaching an increased storage volume of up to 61,000 AF. During dry or drought years, the Partner Agencies and SFPUC would pump previously stored groundwater. This new dry-year water supply would be made available to both the Partner Agencies and SFPUC wholesale customers under the terms of the Shortage Allocation Plan between the SFPUC and its wholesale customers[4]. A groundwater storage and recovery agreement would be negotiated by and between the SFPUC and Partner Agencies for groundwater and surface water management. Specifically, the agreement would cover water accounting; ownership principles; and operation, maintenance and replacement of facilities.

5.3.2 *Production Wells and Associated Facilities*

The proposed Project includes new groundwater production well facilities within the South Westside Groundwater Basin to withdraw the increased volume of stored groundwater at a rate of 7.2 MGD. Up to 16 new groundwater well facilities would be constructed on 16 of the 19 potential sites in northern San Mateo County. Of the 19 sites, 5 well facilities would connect to Daly City's distribution system, 3 well facilities would connect to San Bruno's distribution system, 4 well facilities would connect to Cal Water's distribution system, and 7 well facilities would connect to the SFPUC distribution system. In addition, the Westlake Pump Station in Daly City may be expanded and additional treatment facilities added.

Each groundwater well facility site would contain a groundwater production well, a pump station, underground distribution piping, and

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[4] The Shortage Allocation Plan identified a water allocation method to be used to determine the share of water for wholesale customers during shortages caused by drought.

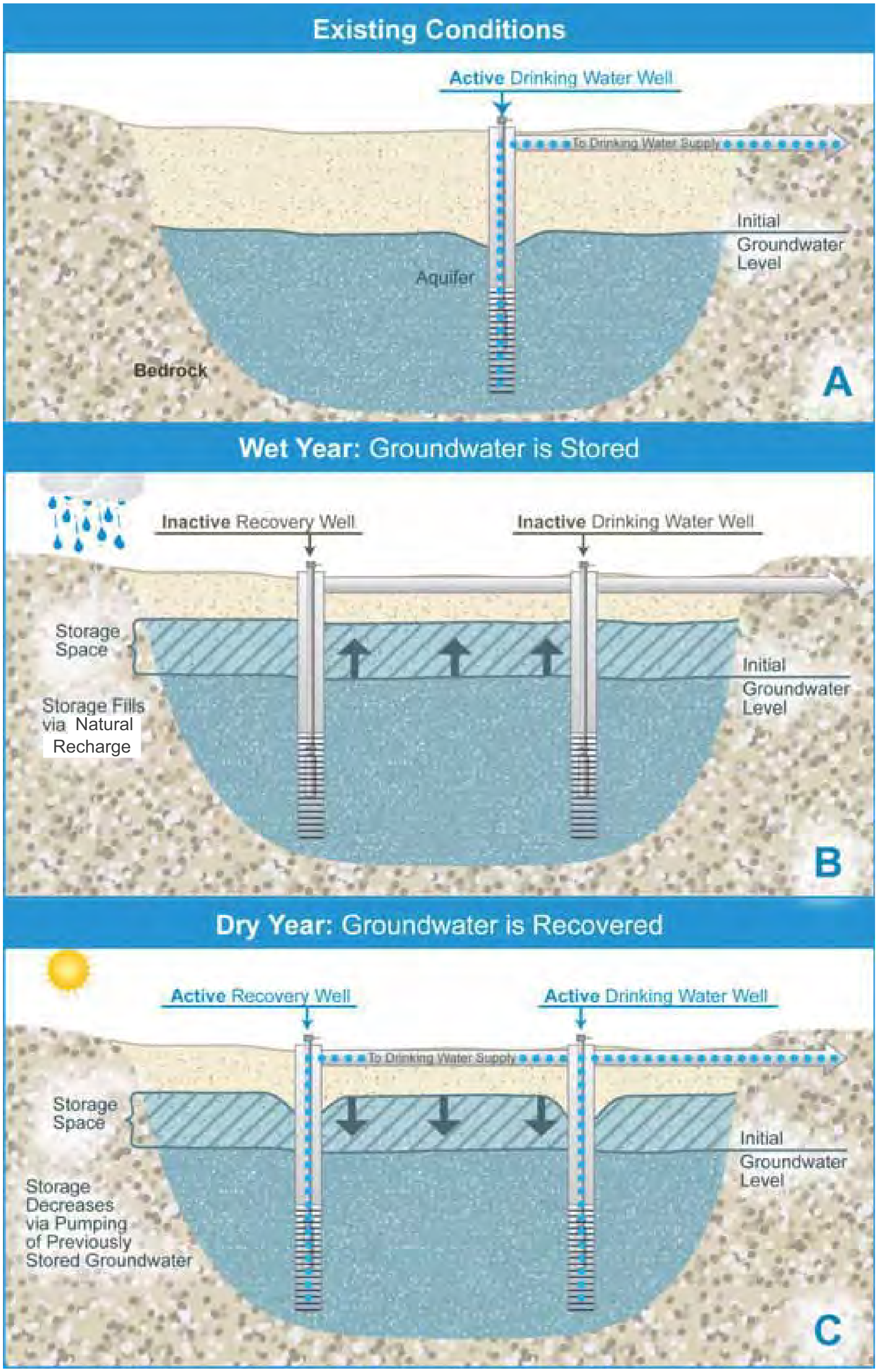

Figure (A) reflects the existing groundwater conditions, showing available storage space above the aquifer. In (B) the upward arrows represent the filling of the storage space with groundwater during wet years; in (C) the downward arrows represent the decline in stored water during dry years. The "Drinking Water Wells" represent the existing wells operated by the Cities of San Bruno and Daly City and California Water Service Company. The "Recovery Wells" represent the new wells that are proposed as part of the Project.

Groundwater Storage and Recovery

Regional Groundwater Storage and Recovery Project

Figure 4

utility connections. Each well facility also would have a disinfection unit, unless it is located near an existing disinfection unit that can accommodate the additional volume, in which case the well would be connected to the existing unit. Well facility sites where the groundwater may need treatment have been designed with appropriate treatment facilities (e.g., disinfection and manganese treatment). The facilities and the nature, extent and anticipated duration of construction activities are described further below.

Prior to confirming the final selected sites and full development of the groundwater well facilities, monitoring wells and test wells may be installed at the well facility sites to gather information about local groundwater characteristics and to determine the technical feasibility of each of the sites to produce sufficient volumes and quality of water for operation of a groundwater production well. If selected, sites would be converted from test wells to permanent production wells; pumps would be added, well enclosures would be built (fencing or building), disinfection units and treatment facilities would be constructed as needed, and utility and distribution pipelines would be installed.

A list of the 19 potential well facility sites and pump station upgrade is provided in Table 1.

TABLE 1
Well Facility Locations

Site ID[a]	Site Name	Location
1	Lake Merced Golf Course	Daly City
2	Park Plaza Meter	Daly City
3	Ben Franklin Intermediate School	Unincorporated San Mateo County (Broadmoor)
4	Garden Village Elementary School	Unincorporated San Mateo County (Broadmoor)
5	Right-of-Way at Serra Bowl	Daly City
6	Right-of-Way at Colma BART	Daly City
7	Right-of-Way at Colma Boulevard	Colma
8	Right-of-Way at Serramonte Boulevard	Colma

TABLE 1
Well Facility Locations

Site ID[a]	Site Name	Location
8a	Standard Plumbing Supply	Colma
9	Treasure Island Trailer Court	South San Francisco
10	Right-of-Way at Hickey Boulevard	South San Francisco
10a	Alta Loma Drive	South San Francisco
11	South San Francisco Main Area	South San Francisco
12	Funeral Home	South San Francisco
12a	Funeral Home	South San Francisco
13	South San Francisco Linear Park	South San Francisco
14	Golden Gate National Cemetery	San Bruno
15	Golden Gate National Cemetery	San Bruno
16	Millbrae Corporation Yard	Millbrae
PS	Westlake Pump Station Upgrade	Daly City

a. The EIR will evaluate the environmental effects of the development of all 19 well facility sites, even though a maximum of 16 well facilities would be constructed.

Well Station Design

The SFPUC has considered institutional, regulatory, operational, maintenance, and technical information in the design of the well stations. Three well station types are included in the proposed Project:

- Type 1 - well only, building or fenced enclosure;
- Type 2 - well plus chemical treatment building; and
- Type 3 - well plus chemical treatment and filtration building.

Site-specific well station design characteristics are listed in Table 2 and described in detail below. These characteristics include proposed building type, pump type, water distribution system connection point, groundwater disinfection location, and the method that would be used to achieve agency-specific water quality goals (i.e., blending with surface water or treatment).

TABLE 2

Site-Specific Well Station Characteristics

Site ID	Site Description	Well Station Type[a]	Pump Type	Connection Point	Alternate Connection Point	Disinfection Location	Method for Achieving Water Quality Goals
1	Lake Merced Golf Club	Type 2	Above-ground	SFPUC San Andreas Pipeline #2	Daly City	At site	Blending[b]
2	Park Plaza Meter	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending
3	Ben Franklin Intermediate School	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending
4	Garden Village Elementary School	Type 1 with fenced enclosure	Submersible	Daly City	SFPUC Sunset Supply	Westlake Pump Station	Blending or iron/manganese treatment
5	Right-of-Way at Serra Bowl	Type 2	Above-ground	Daly City	Cal Water	At site	Blending or iron/manganese treatment
6	Right-of-Way at Colma BART	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
7	Right-of-Way at Colma Boulevard	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
8	Right-of-Way at Serramonte Boulevard	Type 2	Above-ground	Cal Water	SFPUC Pipeline	At site	Blending or iron/manganese treatment
8a	Standard Plumbing Supply	Type 2	Above-ground	Cal Water	SFPUC	At site	Blending
9	Treasure Island Trailer Court	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	None	At site	Blending

TABLE 2
Site-Specific Well Station Characteristics

Site ID	Site Description	Well Station Type[a]	Pump Type	Connection Point	Alternate Connection Point	Disinfection Location	Method for Achieving Water Quality Goals
10	Right-of-Way at Hickey Boulevard	Type 2	Above-ground	Daly City	SFPUC San Andreas #2	At site	Blending
10a	Alta Loma Drive	Type 2	Above-ground	SFPUC San Andreas Pipeline #2	Cal Water	At site	Blending
11	SSF Main Area	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water	At site	Blending
12	Funeral Home	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water or other SFPUC pipeline	At site	Blending
12a	Funeral Home	Type 2	Above-ground	SFPUC Sunset Supply Pipeline	Cal Water or other SFPUC pipeline	At site	Blending
13	SSF Linear Park	Type 3	Above-ground	San Bruno	Cal Water, SFPUC, or other San Bruno	At site	Blending or iron/manganese treatment
14	Golden Gate National Cemetery	Type 1 with building enclosure	Above-ground	San Bruno	SFPUC pipeline	At site	Blending or iron/manganese treatment
15	Golden Gate National Cemetery	Type 3	Above-ground	San Bruno	SFPUC pipeline	At site	Blending or iron/manganese treatment
16	Millbrae Corp Yard	Type 2	Above-ground	SFPUC Crystal Springs Pipeline #2	None	At site	Blending

a. Type 1 is Well Only; Type 2 is Well plus Chemical Treatment Building; Type 3 is Well plus Chemical Treatment and Filtration Building; see text below for further description of conceptual layouts.

b. Blending is the mixing of groundwater with other potable supply water

Buildings would be about 15 feet tall and constructed of concrete block. Acoustical louvers for noise reduction would be used. The buildings would be painted in neutral colors with anti-graffiti coating.

It is anticipated that all outdoor site lighting would be activated by motion-controlled sensors, with manual switching available for as-needed night operations. Facilities would be designed to meet California's energy efficiency standards outlined in Title 24 of the California Code of Regulations and use recycled materials to the extent possible.

Type 1 Conceptual Layout: Well-Only. The conceptual layout for the "well-only" type includes an approximately 40-foot by 20-foot building or fenced enclosure to house the wellhead, pump, piping, and associated electrical and control equipment.

Type 2 Conceptual Layout: Well plus Chemical Treatment. The conceptual layout for the "well with chemical treatment" type would consist of a 40-foot by 20-foot building to house the wellhead, pump, pipeline, and associated electrical and control equipment, plus an approximately 15-foot by 15-foot building extension for chemical storage and handling. Space would be provided onsite for disinfection, pH adjustment, and fluoride addition if needed.

Type 3 Conceptual Layout: Well plus Chemical Treatment and Filtration. The conceptual layout for the "well with chemical treatment and filtration" type would be similar to Type 2 but with the addition of a filtration system. The building dimensions would be approximately 25 feet by 80 feet. Filtration would be located only at well facilities that require manganese and/or iron removal. This well station type would be larger than the other types to provide space for the wellhead, treatment facilities, and filtration vessels. The filtration system consists of a series of vertical pressure vessels. The number and size of the pressure vessels would depend on the well yield and the number of wells connected to the filtration system. The backwash water from the system would connect to a nearby sanitary sewer. It is anticipated that filters would be backwashed, on average, once a day for 4 minutes.

Well Pumps

Each well facility site would contain either a submersible or above-ground pump. The selection of the pump type is based on the preference of the Partner Agency responsible for well operation. In most cases, the wells would be equipped with above-ground pumps. In comparison to submersible motors, above-ground motors are more efficient, have a longer service life, are more durable in cases where variable frequency drives are required, and are more accessible and thus easier to maintain. In cases where noise, visibility, or lack of space is an issue, submersible pumps would be used. Submersible motors are quieter to operate, but more difficult to maintain, because maintenance requires the removal of the entire pump assembly. Any wells that are in fenced enclosures (i.e., without buildings) have been designated for submersible pumps.

Utility and Distribution Piping

Underground piping would connect the wells to the local distribution systems or SFPUC water distribution system. In addition, underground piping would connect well facilities to the storm drain system and/or the sanitary sewer system to allow discharge of the initial flush of water. Chloraminated water would be de-chlorinated or sent to the local sanitary sewer system. Backwash from the manganese treatment facilities would also be sent to the local sanitary sewer system. The piping for all selected sites would consist of a total of approximately 4,600 feet of 6-inch pipe and 12,500 feet of 8-inch pipe. In general, the pipeline route would be excavated to a depth of 6 feet. The maximum width of the pipeline work area (including the trenches) would be 20 feet. The pipelines would be constructed using conventional open-cut trenching techniques. Above or underground electrical lines would also be installed from the groundwater well facilities to the nearest power source (PG&E facilities). The dimension of the trenches for the underground electrical lines would be smaller than those of the water pipelines.

Westlake Pump Station Upgrade

Upgrades to the Westlake Pump Station may be necessary to serve the well stations at Sites 2, 3 and 4. The upgrades would include new chemical storage tanks, replaced or upgraded chemical metering pumps, a resized transformer, and up to three new booster pumps to deliver the additional water into the distribution system.

5.3.3 *Construction Methods*

Monitoring Wells, Geotechnical Borings, and Test Wells

Prior to the selection and full development of the groundwater production well sites, monitoring wells and test wells may be installed and geotechnical borings may be drilled at the well facility sites to gather information about local groundwater characteristics and to determine the technical feasibility of each of the sites to produce sufficient volumes and quality of water for operation of a groundwater production well. Depending upon the results of the testing, well facility sites would be selected, and test wells converted to permanent production wells, which would consist of full development of the well facility site to include the addition of pumps to the wells, the addition of enclosures around the well, installation of disinfection units and treatment facilities as needed, and installation of utilities and distribution pipelines.

In the event that additional monitoring or test wells are needed, the selected site would need to be cleared of vegetation and graded for installation and drilling of the borehole. For monitoring wells, a borehole would be drilled to a depth of approximately 750 feet below ground. For test wells, one steel casing would be installed to a depth of approximately 50 feet, with a borehole drilled to a depth of approximately 550 to 700 feet. Equipment used for well drilling and construction would include a mounted drill rig on a support truck, pump and pick up trucks or trailers and similar equipment. Construction of a monitoring well would be completed in approximately three weeks, with construction activities occurring between 8:00 AM and 7:00 PM Monday through Friday only. Construction and testing of test wells would require approximately 4 weeks. Drilling would extend for about a week both during the day and night. If the results of the test wells were favorable and the wells were selected as permanent production well sites, then development of production well facilities would occur, as described below.

Additional geotechnical borings may be required and would be drilled to a depth of approximately 50 feet below ground surface (deeper if fill or soft soil is encountered). A boring would be completed in approximately two days. Drilling activities would occur between 8:00 AM and 7:00 PM Monday through Friday only.

Construction of Well Station Facilities

Each well facility site would include a construction staging area; some sites may have two optional locations for staging areas. The minimum size of the staging area would be 1,500 square feet. Staging areas would be fenced. Any temporary spoils (excavated material) storage would occur inside the staging areas.

Construction of facilities at the well sites would require site clearing and grubbing. Site excavation and grading would be minor, with grading to a maximum depth of 5 feet for the building foundation (if the well facility includes a building) and utilities underneath the building. After the foundation and utilities connections are constructed, the remainder of the building would be constructed and the well pump and other equipment installed, as needed. No significant near-surface groundwater is expected at any site; therefore dewatering for construction of project facilities is not anticipated. Diesel generators with self-contained fuel tanks may be used during construction. Construction equipment is expected to include: a front end loader, backhoe/excavator, fork lift, telescopic crane, cement mixer, concrete pump truck, compactor, hauling trucks, pump-setting rig, and arc welder.

It is estimated that during the peak construction period, the maximum number of construction workers at any one site would be 15.

Construction of Distribution and Utility Connections

In general, the pipeline routes would be excavated up to a depth of 6 feet. The width of pipeline construction zones would be generally 20 feet, and the width of the electrical connection construction zones would be less than 20 feet. The pipelines would be constructed using conventional open-cut trenching techniques. Construction equipment is expected to include: an excavator, front-end loader, hauling trucks, compactor, asphalt trucks, and arc welder. Diesel generators with self-contained fuel tanks may be used during construction. At some sites, pipeline excavation would generate excess soil (called spoils) that would be reused onsite (for engineering fill) or disposed of at a Class III non-hazardous waste disposal site. After pipeline placement, the trenched area would be restored to its original condition.

5.3.4 *Operation and Maintenance*

Project operations would be designed to allow natural recharge of the South Westside Groundwater Basin through reduced Partner Agency groundwater pumping, to provide up to 61,000 AF of increased groundwater in storage to be used by the SFPUC and Partner Agencies during drought conditions.

Figure 5 illustrates how the Project would change the source of water supply for the Partner Agencies. During normal and wet years, the portion of water supply coming from SFPUC surface water would increase compared to the existing condition. During dry years, the portion of water supply coming from groundwater would increase compared to the existing condition. For SFPUC wholesale water customers, the source of water supply would not change during normal and wet years; but the portion of groundwater delivered to some SFPUC customers would increase during dry years, compared to existing conditions.

An accounting of additional storage volumes (called the SFPUC Storage Account) would track the amount of water that has been stored during the normal and wet years and the amount of water pumped during dry years. The specific volumes shown in Figure 5 are based on historic rainfall and hydrology (MWH, 2007), but actual volumes in any given year would vary depending on several factors, including: 1) the final location and capacity of the project well facilities, 2) the availability of additional stored water in the SFPUC Storage Account, and 3) direction from the Operating Committee[5] regarding which wells should be used.

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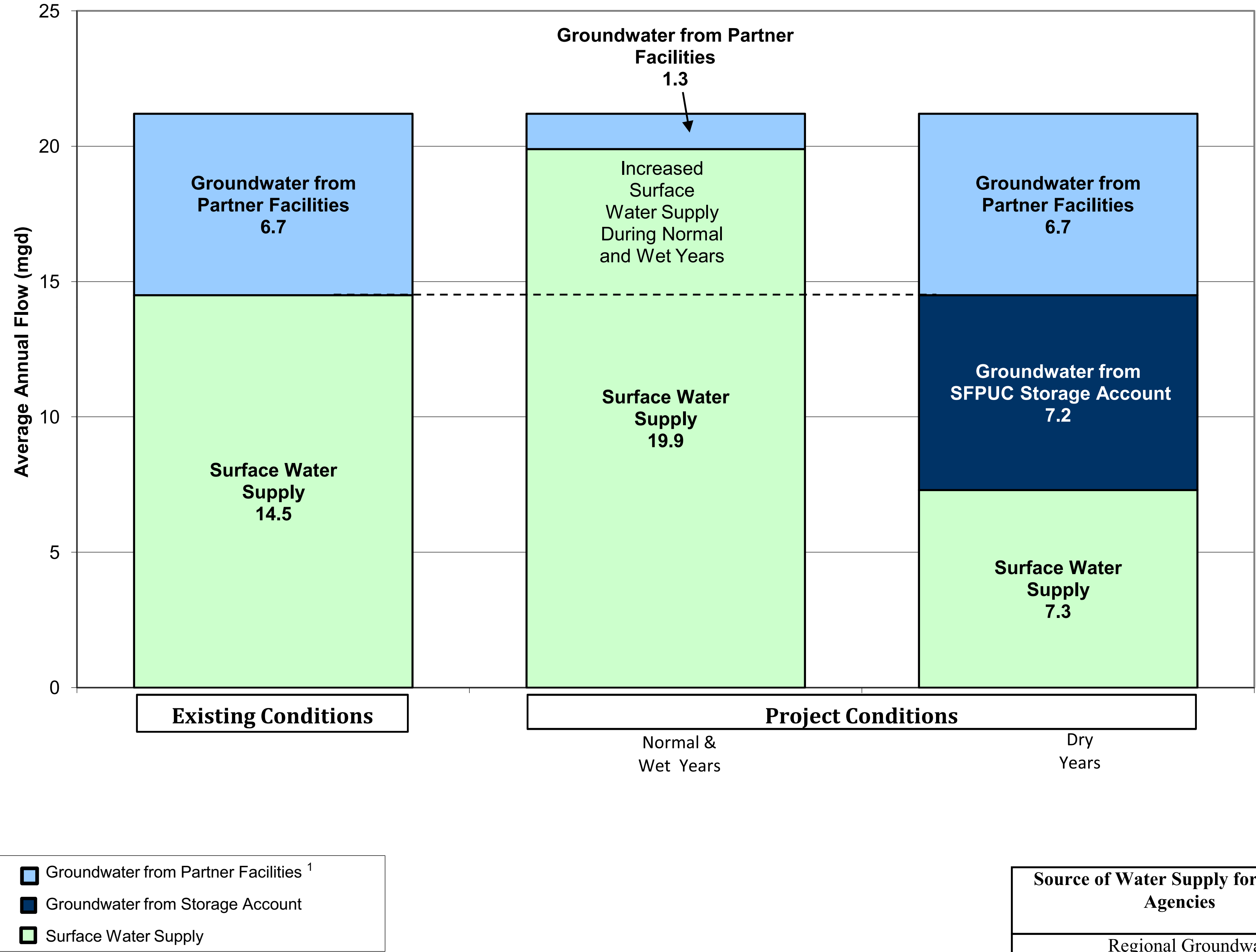
[5] It is expected that a Project agreement by and between SFPUC and the Partner Agencies would establish an Operating Committee. The role of the Operating Committee would be to monitor and track the SFPUC Storage Account, including any losses from the system, and establish pumping schedules for the project wells.



[1] Partner facilities are operated by City of Daly City, City of San Bruno, and Cal Water.

Source of Water Supply for Partner Agencies

Regional Groundwater Storage and Recovery Project

Figure 5

During normal and wet years, the proposed groundwater well facilities would be operated by SFPUC or by Partner Agencies only periodically for maintenance purposes. During dry years, the proposed groundwater well facilities would be operated by SFPUC or by Partner Agencies for additional water supply.

All well stations would be unmanned, but subject to remote monitoring and operation by the Partner Agency or SFPUC who would operate the well facility. Each well station would be visited daily when wells are operating for routine equipment checks, lasting approximately 30 minutes each. During normal and wet years, wells would be visited on a weekly basis, would be normally off, but regular exercising would be conducted. Longer term maintenance would include removal and repair or replacement of pumps, valves, and other equipment. Production wells may require redevelopment and/or rehabilitation on an infrequent basis.

6.0 PERMITS AND APPROVALS REQUIRED

The SFPUC may be required to obtain the following permits and approvals for Project construction and operation:

- Section 404 Permit from the U.S. Army Corps of Engineers (USACE) if the Project affects jurisdictional wetlands or waters of the U.S.
- U.S. Department of Veterans Affairs approval and National Environmental Policy Act (NEPA) review for Sites 14 and 15 at the Golden Gate National Cemetery.
- U.S. Fish & Wildlife Service Section 7 consultation under the federal Endangered Species Act, if the Project affects threatened or endangered species or their habitat.
- Review by the Advisory Council on Historic Preservation may be required if the Project affects properties listed on or eligible for the National Register of Historic Places.
- Permit amendments and approval of well construction and operation from the California Department of Public Health, Water Supply Division.
- Section 1602 Lake and Streambed Alteration Agreement from the California Department of Fish and Game if the Project could affect streambeds under California jurisdiction.
- Section 2081/2080.1 Incidental Take Permit from the California Department of Fish and Game if a "take" (to hunt, pursue, catch, capture,

or kill, or attempt the same) could occur to state-listed species as a result of the Project.

- California Department of Fish and Game Memorandum of Agreement if needed to ensure no effect to fully protected species.
- Preparation of a California Department of Toxic Substances Control Contaminated Soil Treatment Work Plan (required only if contaminated soil is encountered during construction).
- San Francisco Bay Regional Water Quality Control Board Discharge permits, if required, for emergency and/or maintenance water discharges, and for "overboard" pumping of well waters.
- San Francisco Bay Regional Water Quality Control Board Section 401 Certification, the state certification of the federal Section 404 Wetlands Permit.
- California Department of Transportation Encroachment permits to cross State roadways and Interstate Highways.
- State Water Resources Control Board Stormwater General Permit and Stormwater Pollution Prevention Plan, if more than one acre of land is disturbed.
- Bay Area Air Quality Management District permit for stationary equipment that may generate air pollutants (e.g., generators).
- EIR certification by the San Francisco Planning Commission.
- Board of Supervisors approval may be needed for funding appropriation or property rights acquisition.
- SFPUC approval, adoption of CEQA findings and mitigation monitoring and reporting program (MMRP).
- Adoption of CEQA findings and MMRP by local City Councils or Boards of Supervisors.
- San Francisco Historic Preservation Commission review of local, state and national landmarks and historical landscapes.
- Determination of Project consistency with park use by local Recreation and Park Commissions and approval of use of property under their jurisdiction.
- Approval of local Unified School District(s) for use of property under their jurisdiction.
- Approval of exterior design of proposed facilities on SFPUC property or right-of-way by the San Francisco Arts Commission.
- Agreements with Partner Agencies.
- Local Department(s) of Public Health approval of well construction and operation permits in accordance with California Department of Water Resources Standards.

- Local Department(s) of Public Health approval of Certified Unified Program Agencies (CUPA)/Hazardous Materials Business Plan for Project operations.
- Local Department(s) of Public Works approval of excavation permits, encroachment permits, and temporary occupancy permits for street space.
- Bay Area Rapid Transit (BART) encroachment permits to cross existing BART system.

7.0 PROPERTY RIGHTS ACQUISITION

Several types of property rights would be needed for Project construction and operation, as shown in Table 3. The process for acquiring right-of-way involves the preparation of deed and appraisal map, an appraisal of fair market value, negotiations with property owners, and condemnation (if necessary).

TABLE 3
Property Rights Proposed for Acquisition

Property Acquisition Type	Rights
Access Easement	Temporary or permanent rights to enter or cross another property
Pipeline Easement	Rights to install and maintain a pipeline over or across another property
Fee Acquisition	Purchase of all the property rights, land, improvements (if any), etc.
Encroachment Permit	Rights to encroach across a publicly-owned street or highway for pipeline or other purposes

Of the 19 potential well sites, 12 sites are on SFPUC fee-owned land or within SFPUC right-of-way. The other seven well sites are on other public and private parcels which would require an acquisition of property use rights for the well(s), connecting pipelines, and/or access. Lastly, several sites have lengthy connecting pipeline requirements that would most likely be constructed on a combination of public and private parcels.

8.0 CONSTRUCTION SCHEDULE

The proposed Project schedule expected at the time of this NOP includes construction of permanent well facilities and pipeline connections from April 2012 through approximately May 2014.

9.0 ENVIRONMENTAL ANALYSIS

9.1 Environmental Issues to be Addressed in the EIR

The EIR will address all environmental issue areas required under CEQA. The EIR will address environmental impacts of the proposed Project due to construction and operation activities and will propose mitigation measures for impacts considered to be significant. The following sections describe the anticipated environmental issues that will be addressed by the EIR.

9.1.1 Land Use and Visual Quality

Construction and operation of the proposed Project could affect land uses and visual quality of the Project sites and surrounding areas. Potential impacts to be evaluated in the EIR include:

- Temporary and permanent disruption or displacement of existing land uses during construction including construction impacts on such sensitive land uses as schools, residences and funeral homes, and the potential temporary closure of a portion of South San Francisco Linear Park to the public.
- Impacts on scenic vistas or visual character, including potential impacts on the visual character of Golden Gate National Cemetery, Woodlawn Cemetery, Greenlawn Memorial Park, and Lake Merced Golf Club.

9.1.2 *Geology, Soils and Seismicity*

Construction and operation of new well facilities and below-ground distribution pipelines and electrical power lines could result in site-specific impacts on or from local geology and soils conditions. Potential impacts to be evaluated in the EIR include:

- Seismic hazards and/or increased exposure of people and structures to seismic hazards, including impacts from ground-shaking in the event of an earthquake on the San Andreas fault or other Bay Area fault.
- Increased exposure of people or structures to geologic hazards (such as liquefaction, poor soil conditions, or unstable slopes) from construction in geologic hazard zones.
- Soil erosion potential from construction activities.
- Potential land subsidence from drawdown of the groundwater aquifer.

9.1.3 *Hydrology and Water Quality*

Construction and operation of the Project could affect surface water quality and could affect groundwater levels and quality in the Project area and in the South Westside Groundwater Basin as a whole. Potential impacts to be evaluated include:

- Changes in local groundwater quality and levels within the South Westside Groundwater Basin as a whole.
- Changes in drinking water quality due to use of treated groundwater.
- Alteration of drainage patterns and increase in stormwater flows due to increase in the amount of impervious surfaces.
- Degradation of surface water quality as a result of erosion and sedimentation, hazardous materials release during construction, and construction dewatering discharges.

9.1.4 *Biological Resources*

The proposed Project could result in a permanent loss of wetlands and sensitive habitats and could directly impact special-status wildlife and plant species. Temporary impacts to biological resources could result from proximity to construction activities, including noise, vibration, and dust. Potential impacts to be evaluated include:

- Impacts on wetlands and aquatic resources.
- Impacts on sensitive wildlife habitats and protected/heritage trees.
- Impacts on special-status wildlife and plant species – direct mortality and/or habitat effects.
- Conflicts with adopted conservation plans or other approved biological resources plans.

9.1.5 *Cultural Resources*

The proposed Project could affect archaeological, historical, or paleontological resources through ground-disturbing activities during construction, or by introducing new facilities that compromise the historic integrity of historic buildings or landscapes. Potential impacts to be evaluated include:

- Impacts on archaeological and paleontological resources.
- Impacts on the historical significance of a historic district, contributor to a historic district, or historic landscape. Of particular focus will be the proposed well facilities on 1920s Lake Merced Golf Club; the turn of the century Woodlawn Cemetery, the Cypress Lawn Cemetery, and the Golden Gate National Cemetery.
- Impacts on Native American cultural resources.

9.1.6 *Traffic, Transportation and Circulation*

Construction could have temporary impacts on traffic volumes, traffic safety, and parking in the vicinity of the well facility sites and at the Westlake Pump Station. Potential impacts to be evaluated EIR include:

- Temporary reduction in roadway capacity and increased traffic delays, including impacts from short-term closure of one parking and/or traffic lane. Impaired access to adjacent roadways and land uses.
- Temporary displacement of on- or off-street parking.
- Increased traffic safety hazards during construction.
- Long-term traffic increases during facility operation.

9.1.7 Noise and Vibration

Construction noise and vibration impacts from the proposed Project would be associated with facility construction activities, and therefore, would be temporary and short-term. Operation of the proposed pumps and treatment facilities could create permanent noise impacts. Potential impacts to be evaluated include:

- Impacts of construction noise and vibration on sensitive receptors in the vicinity of Project construction sites, especially such sensitive land uses as schools, health care facilities, cemeteries, funeral homes, and churches.
- Noise impacts from groundwater well station operation, including pumps and groundwater treatment facilities.

9.1.8 Recreational Resources

Construction could temporarily disrupt recreational uses in the vicinity of the well facility sites as a result of noise, dust, and temporary access restrictions. The EIR will evaluate the impact of the Project on recreational resources. Potential impacts to be evaluated include:

- Temporary and permanent impacts on recreational facilities, including but not limited to Lake Merced Golf Club and Linear Park in South San Francisco.

9.1.9 Other Environmental Issues

Other environmental issues that will be evaluated in the EIR include the Project's potential impacts on air quality and greenhouse gas emissions; public services and utilities, including the Project's beneficial effect on water supply; agricultural resources; hazards, including the potential hazards from chemical storage at the well sites; and energy resources.

The EIR also will evaluate any potential growth-inducing impacts that could result from implementation of the Project. The EIR also will address whether the Project could result in impacts that would be significant when combined with the impacts of other SFPUC or non-SFPUC projects occurring in the same geographic area as the Project and at the same time.

9.2 Alternatives

CEQA requires that an EIR evaluate a reasonable range of feasible alternatives to the project, or to the location of the project, that would attain most of the basic project objectives but that could avoid or substantially lessen any of the significant effects of the project. The EIR will identify the potentially significant impacts of the proposed Project. The findings of the EIR impact analysis will guide the refinement of an appropriate range of alternatives to be evaluated in the EIR that would avoid or substantially lessen significant impacts, while still meeting the project objectives. Alternatives suggested during the public scoping period would also be considered. The EIR will include a discussion of impacts associated with the No Project Alterative.

10.0 REFERENCES

MWH. 2007. Final Alternatives Analysis Report, Groundwater Conjunctive Use Project. October.

MWH. 2008. San Francisco Public Utilities Commission Water System Improvement Project Groundwater Conjunctive Use Project WSIP Project CUW30103 Conceptual Engineering Report. November.

SFPUC. 2005. 2005 Urban Water Management Plan for the City and County of San Francisco. December.

SFPUC. 2009. Conceptual Engineering Report Checklist for Environmental Review. February.

City of San Francisco Planning Department. Program Environmental Impact Report for the San Francisco Public Utilities Commission's Water System Improvement Program (State Clearinghouse No. 2005092026). 2008. September.

Appendix B
Notification Materials (Proof of Publication)

San Mateo County Times

c/o Bay Area News Group-East Bay, Legal Advertising
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PROOF OF PUBLICATION

FILE NO.

In the matter of

The undersigned deposes that he/she is the Public Notice Advertising Clerk of the SAN MATEO COUNTY TIMES, a newspaper of general circulation as defined by Government Code Section 6000, adjudicated as such by the Superior Court of the State of California, County of San Mateo (Order Nos. 55795 on September 21, 1951), which is published and circulated in said county and state daily (Sunday excepted).

The PUBLIC NOTICE

was published in every issue of the SAN MATEO COUNTY TIMES on the following date(s):

6/24/2009

I certify (or declare) under the penalty of perjury that the foregoing is true and correct.

Public Notice Advertising Clerk

Legal No. **0003188359**

SAN FRANCISCO PLANNING DEPARTMENT ENVIRONMENTAL REVIEW NOTICE

Notice is hereby given to the general public of the following actions under the Environmental Review Process. Review of the documents concerning these projects can be arranged by calling (415) 558-6378 and asking for the staff person indicated.

NOTICE OF PREPARATION OF EIR AND NOTICE OF SCOPING MEETING

The initial evaluation conducted by the Planning Department determined that the following project(s) may have significant effects on the environment and that an Environmental Impact Report (EIR) must be prepared.

Case No. 2005.0164E: Regional Groundwater Storage and Recovery Project

The San Francisco Public Utilities Commission (SFPUC) is proposing the Regional Groundwater Storage and Recovery Project to provide surface water to the cities of Daly City and San Bruno and the California Water Service Company (Cal Water) (collectively referred to as Partner Agencies), to be used by these agencies in lieu of pumping groundwater during normal and wet years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. The supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of pumping by Partner Agencies would increase groundwater storage in northern San Mateo County within the southern portion of the Westside Groundwater Basin, known as the :South Westside Groundwater Basin." The Westside Groundwater Basin spans northern San Mateo County and the City and County of San Francisco. Stored groundwater would be pumped during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would construct new groundwater production well facilities in the cities of Colma, Daly City, South San Francisco, San Bruno, Millbrae, and unincorporated San Mateo County that would be operated by SFPUC and the Partner Agencies. Well facilities would be connected to Daly City, San Bruno, Cal Water, or SFPUC distribution systems.
The project is part of the SFPUC's Water System Improvement Program (WSIP). The WSIP was adopted in October 2008 to improve the SFPUC's regional water system with respect to water quality, seismic response, water delivery, and water supply to meet water delivery needs in the service area.

Notice is hereby given to the general public as follows:

1)A Notice of Preparation of an EIR was published on June 24, 2009 by the Planning Department in connection with this project.

2)Public comments concerning the scope of the EIR will be accepted from June 24, 2009 to July 28, 2009, 5:00 p.m. Mail written comments to the San Francisco Planning Department, Attn. Bill Wycko, Environmental Review Officer, Regional Groundwater

Storage and Recovery Project NOP, 1650 Mission Street, Suite 400, San Francisco, CA 94103. Comments also may be submitted by fax to (415) 558-6409, or sent by email to diana.sokolove@sfgov.org.

3)The San Francisco Planning Department will hold a scoping meeting starting at 7:00 p.m. at the South San Francisco Municipal Services Building, Community Room, 33 Arroyo Drive, South San Francisco, CA. Preceding the Scoping Meeting, the San Francisco Public Utilities Commission will hold a Public Information Session from 6:15-7:00 p.m.

San Mateo County Times, #3188359
June 24, 2009

SAN FRANCISCO EXAMINER

This space for filing stamp only

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1650 MISSION ST #400
SAN FRANCISCO, CA - 94103

EXM#: 1628277

PROOF OF PUBLICATION

(2015.5 C.C.P.)

State of California)
County of SAN FRANCISCO) ss

Notice Type: GPN - GOVT PUBLIC NOTICE

Ad Description: 2005.0164E: Regional Groundwater Storage and Recovery Project

I am a citizen of the United States and a resident of the State of California; I am over the age of eighteen years, and not a party to or interested in the above entitled matter. I am the principal clerk of the printer and publisher of the SAN FRANCISCO EXAMINER, a newspaper published in the English language in the city of SAN FRANCISCO, county of SAN FRANCISCO, and adjudged a newspaper of general circulation as defined by the laws of the State of California by the Superior Court of the County of SAN FRANCISCO, State of California, under date 10/18/1951, Case No. 410667. That the notice, of which the annexed is a printed copy, has been published in each regular and entire issue of said newspaper and not in any supplement thereof on the following dates, to-wit:

06/24/2009

Executed on: 06/24/2009
At Los Angeles, California

I certify (or declare) under penalty of perjury that the foregoing is true and correct.

Signature

SAN FRANCISCO PLANNING DEPARTMENT NVIRONMENTAL REVIEW NOTICE

Notice is hereby given to the general public of the following actions under the Environmental Review Process. Review of the documents concerning these projects can be arranged by calling (415) 575-9025 and asking for the staff person indicated.

PRELIMINARY MITIGATED NEGATIVE DECLARATION

The initial evaluation conducted by the Planning Department determined that the following projects could not have a significant effect on the environment, and that no environmental impact report is required. Accordingly, a Preliminary Mitigated Negative Declaration has been prepared.

Public recommendations for amendment of the text of the finding, or any appeal of this determination to the Planning Commission (with $500 filing fee) must be filed with the Department within 20 days following the date of this notice. In the absence of an appeal, the Negative Declaration shall be made final, subject to any necessary modifications, 20 days from the date of this notice.

2008.1286E: 1100 Ellis Street/Sacred Heart Cathedral Preparatory Theatre. The 61,105 square?foot project site (Assessor's Block 0711, Lot 031) is located on the north side of Ellis Street, on a block bounded by Gough, Ellis and Laguna Streets, and Geary Boulevard, within the Western Addition neighborhood. The site is located in an RM-4 (Residential Mixed-Use, High Density) District and 80-B Height and Bulk District. The proposed project involves the construction of a new theater, renovation of two existing buildings, and construction of a new elevator within the Sacred Heart Cathedral Preparatory school campus. The proposed theater would be located within the existing interior courtyard of the campus, would total approximately 11,513 square feet, would be 36 feet 9 inches in height, and would seat approximately 299 people. The proposed project would not result in an increase in the number of students or staff. (FORDHAM)

NOTICE OF PREPARATION OF EIR AND NOTICE OF SCOPING MEETING

The initial evaluation conducted by the Planning Department determined that the following project(s) may have significant effects on the environment and that an Environmental Impact Report (EIR) must be prepared.

2005.0164E: Regional Groundwater Storage and Recovery Project - The San Francisco Public Utilities Commission (SFPUC) is proposing the Regional Groundwater Storage and Recovery Project to provide surface water to the cities of Daly City and San Bruno and the California Water Service Company (Cal Water) (collectively referred to as Partner Agencies), to be used by these agencies in lieu of pumping groundwater during normal and wet years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. The supply would be partially replaced by surface water supplies from the SFPUC regional water system. The reduction of pumping by Partner Agencies would increase groundwater storage in northern San Mateo County within the southern portion of the Westside Groundwater Basin, known as the "South Westside Groundwater Basin." The Westside Groundwater Basin spans northern San Mateo County and the City and County of San Francisco. Stored groundwater would be pumped during periods of insufficient surface water supplies (i.e., dry years). As part of the proposed Project, SFPUC would construct new groundwater production well facilities in the cities of Colma, Daly City, South San Francisco, San Bruno, Millbrae, and unincorporated San Mateo County that would be operated by SFPUC and the Partner Agencies. Well facilities would be connected to Daly City, San Bruno, Cal Water, or SFPUC distribution systems. The project is part of the SFPUC's Water System Improvement Program (WSIP). The WSIP was adopted in October 2008 to improve the SFPUC's regional water system with respect to water quality, seismic response, water delivery, and water supply to meet water delivery needs in the service area.

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Notice is hereby given to the general public as follows:
1) A Notice of Preparation of an EIR was published on June 24, 2009 by the Planning Department in connection with this project.
2) Public comments concerning the scope of the EIR will be accepted from June 24, 2009 to July 28, 2009, 5:00 p.m. Mail written comments to the San Francisco Planning Department, Attn. Bill Wycko, Environmental Review Officer, Regional Groundwater Storage and Recovery Project NOP, 1650 Mission Street, Suite 400, San Francisco, CA 94103. Comments also may be submitted by fax to (415) 558-6409, or sent by email to diana.sokolove@sfgov.org.
3) The San Francisco Planning Department will hold a scoping meeting starting at 7:00 p.m. at the South San Francisco Municipal Services Building, Community Room, 33 Arroyo Drive, South San Francisco, CA. Preceding the Scoping Meeting, the San Francisco Public Utilities Commission will hold a Public Information Session from 6:15-7:00 p.m.

Appendix C
Public Scoping Meeting Transcript

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SAN FRANCISCO PLANNING DEPARTMENT

PUBLIC SCOPING MEETING

PROPOSED REGIONAL GROUNDWATER STORAGE & RECOVERY PROJECT

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THURSDAY, JULY 9, 2009

SOUTH SAN FRANCISCO, CALIFORNIA

REPORTED BY: Katy Leonard
Certified Shorthand Reporter
License Number 11599

A P P E A R A N C E S

Moderator:

DIANA H. SOKOLOVE, Senior Environmental Planner
SAN FRANCISCO PLANNING DEPARTMENT
(415) 575-9046
(415) 558-6409 (Fax)
diana.sokolove@sfgov.org

Presenter:

GREG BARTOW, Project Manager
SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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A G E N D A

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A T T A C H M E N T S

SF Planning Department Public Scoping Meeting Agenda 1 page

SF Planning Department "Notice of Preparation of an Environmental Impact Report," 30 pages

Regional Groundwater Storage and Recovery Project handout, 2 pages

Regional Groundwater Storage and Recovery project "Frequently Asked Questions" handout, 2 pages

SF Public Utilities Commission "WSIP" brochure, 1 page

(Attached to the original transcript)

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P R O C E E D I N G S

JULY 9, 2009 7:02 P.M.

INTRODUCTION

MS. SOKOLOVE: Hi. Good evening. Thank you for coming tonight.

Welcome to tonight's Public Scoping Meeting for the Regional Groundwater Storage and Recovery Project.

Can everyone hear me?

My name is Diana Sokolove, and I'm a Senior Environmental Planner with the San Francisco Planning Department, and I'll be the moderator for tonight's meeting.

So, I just wanted to review with you briefly the purpose of the meeting tonight for those of you who may be unfamiliar with the environmental review process.

Essentially, I'm here to hear from you. And I want to hear your comments on the scope and focus of the proposed project that's sponsored by the San Francisco Public Utilities Commission.

Your comments tonight can help me understand the depth of analysis that I need to perform in the

Environmental Impact Report, the alternatives to the proposed project, et cetera. So, we really want to understand what you think about the environmental effects of the project. So, that's the main reason why

I'm here tonight.

Here's our agenda: I'm going to introduce some folks from the project team here from the City and County of San Francisco and some other folks who are here from the partner agencies.

I'll make a brief presentation about the environmental review process in general, and then a representative from the San Francisco Public Utilities Commission will give a brief presentation and overview of the proposed project. Then we'll take your comments, and I'll make some closing remarks, and you can all go home.

So, just some reminders: If you haven't already, please sign in at the front desk. That's our way of keeping in touch with you, unless, of course, you don't want us to keep in touch with you, but that is our way to keep track and make sure that you receive our notices and publications regarding this project, so please do sign in. Pick up copies of the meeting materials, such as the Notice of Preparation.

And if you would like to speak tonight, you'll

fill out one of these yellow cards, please, and you can hand those cards to Pat and she'll give them to me.

And if you don't want to speak tonight, but you want to submit comments, you can fill out one of these sheets of paper. (Indicating) They're at the front desk, and I think we have some up here as well so you can submit some written comments.

And if you so choose, when we're done with the presentation, you can speak directly to the Court Reporter here and she can transcribe your comments directly.

Please do hold all of your comments until the end of the meeting so that we can -- I'm sorry -- until the end of the presentation so that we can get through the presentation as quickly as possible.

And I know you all have cell phones and pagers and lots of beeping things, so just turn those off. And if you do need to take a call, feel free to step outside. And I know there are restrooms. If you go out this door, make a right. And there is also a water fountain over there.

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ENVIRONMENTAL REVIEW PROCESS OVERVIEW

MS. SOKOLOVE: So, again, my name is Diana Sokolove. I'm with the San Francisco Planning Department, and the Planning Department is the lead agency for performing the environmental review of this proposed project under the California Environmental

Quality Act, or CEQA, and the project sponsor is the San Francisco Public Utilities Commission.

And here tonight is the Project Manager, Greg Bartow. And we also have Sue Chau, who is the Environmental Project Manager. Michele Liapes in the back with communications, and also, Les Chau with Kennedy/Jenks, who's a designer working with the Public Utilities Commission.

And I think there's some folks from the partner agencies here.

MR. BARTOW: I just want to acknowledge our three partner agency representatives that are here tonight: Patrick Sweetland from Daly City, Tom Salzano from Cal Water, and Steve Davis from the City of San Bruno.

Also, two managers from the San Francisco Public Utilities Commission that are here tonight: Andrew Degraco, Manager of our Water Quality Department,

and Paula Kehoe, Director of Water Resources.

MS. SOKOLOVE: So, I did want to talk to you a little bit about the California Environmental Quality Act. Proposed projects do require environmental review under CEQA before they can be considered for approval. So, again, we're here tonight to hear your comments on what the environmental effects of the project will be so that we can be sure to disclose all of those facts in the environmental document.

And again, as I explained, for projects that are sponsored by or within the City and County of San Francisco, including San Francisco Public Utilities Commission Projects, CEQA is implemented by the San Francisco Planning Department, and that's who I represent.

Here are the objectives of CEQA -- I'll just read these off to you: To prevent environmental impact of proposed projects; identify ways to avoid or reduce environmental impacts; support the agency decision-making process, such as planning commissions or the San Francisco Public Utilities Commissions or any of the partner agencies commissions, and also, resource agencies; to encourage public participation -- so, this is another reason why we're here tonight -- and to enhance interagency coordination.

So, what will our Environmental Impact Report do. Well, the -- the meat of the Environmental Impact Report is an analysis of the environmental effects of the project and looking at alternatives to the proposed project that could reduce or avoid or lessen environmental effects.

So, it's going to have a really good description of the proposed project, and it's going to talk about the environmental effects of the project. And those environmental effects range from air quality impacts, transportation impacts, traffic, hazardous materials impacts, impacts on plants and wildlife. Those kinds of things.

And then there will be a section on ways that we can reduce the environmental impacts of the project, be that through mitigation measures or through alternatives to the project.

So, now, a representative from the San Francisco Public Utilities Commission, Greg Bartow, will talk to you a little bit about the project itself.

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PROJECT OVERVIEW

MR. BARTOW: Thanks, Diana.

Good evening, everybody. I'm Greg Bartow, the Project Manager for this project, and I want to thank everybody for coming out this evening to learn more about the project. I'm just going to give you a brief overview of the project. The Notice of Preparation goes into the project in a lot more detail. There's also information on our Web site, and materials on the back of the table.

First, I want to just talk about the

San Francisco Public Utilities Commission in general. We're a wholesale water provider and resale water supplier in the San Francisco Bay Area.

We supply 2.4 million residents in the Bay Area. About a third of those are San Francisco retail customers, and two-thirds of those are wholesale suburban customers, as -- the light area around the Bay shows the service area, which is a portion of the East Bay, a portion of the South Bay, almost all of San Mateo County, and all of San Francisco. (Indicating)

The Water System Improvement Program was a voter-approved bond measure in 2002 to do seismic restoration or rehabilitation of the project -- of a

number of our projects, including pipelines, reservoirs, and treatment plants.

It also included a component to diversify our water supply, and that's where this project fits in. It includes this project, as well as drilling new wells in San Francisco for a water supply, recycled water facilities, as two other examples.

So, on the need for the project, so that it -- this is basically a dry-year water supply project, and what it is designed to do is to meet our commission-approved 80 percent reliability goal, which said another way is, we have -- the Commission has adopted a policy to not -- in any dry year, not have our cutbacks to be more than 20 percent so we wouldn't have mandatory rationing greater than 20 percent.

But this is part of the project that would need to happen to keep that mandatory rationing at no greater than 20 percent in any one year or any series of years.

Okay. So, now I'll take you into the Westside Basin here. And so, the Westside Basin is about 40 square miles. It extends from Golden Gate Park to the north, all the way down to Burlingame.

And the focus of this project is the South Westside Basin. And we're working with three partner

agencies: Daly City to the north, Cal Water, which serves South San Francisco and Colma and some unincorporated areas in San Mateo County, and then the City of San Bruno.

This is a Conjunctive Use Project, and so to -- that term means the use of the -- the managed use of groundwater and surface water. And what really works out for this part of the basin is that these utilities already use groundwater to meet a portion of their water supply needs, and they have an ability to use San Francisco surface water supplies.

So, what is groundwater. Groundwater is water that has -- that is in the subsurface that has been recharged, either from rainfall or from streams and irrigation.

And so, what this map or this cross section shows is the unsaturated zone above the groundwater table and a typical well. (Indicating) So, just schematically just to give you a little overview of what we're talking about. Groundwater.

How would the project work? So, there's sort of the three components of the project here. The existing conditions, which is the cross section on the upper -- just first of all, I think a simple way to look at the west -- South Westside Basin, if you think about

it as a bathtub full of sand, and then the water levels, due to historic pumping, have been depressed, and so, there's some available storage.

So, that bathtub is roughly a half or two-thirds full of water, and the space between the sand grains above that water has available storage space to it. And so, currently, water levels are, in some cases, 200 feet below sea level. There's a significant amount of available storage in this underground reservoir. And that's what we want to utilize for this project.

So, the existing condition is that there's -- the pumping has decreased and stabilized over the years, and the existing conditions is that there are those municipal pumpers and some other irrigation pumpers in the basin that are used in the basin.

And the way the project works is, in normal and wet years, when we have water, extra water within the system, we have no -- we don't have places to put it. We top off our reservoirs, and there's no other location where we can store this. And the South Westside Basin provides such a storage location.

So, you can see what we do is, in normal and wet years, we would supply to those three partner agencies more surface water and they would reduce their pumping from the groundwater basin. By reducing the

groundwater pumping, that allows the natural recharge to build up.

So, we're not talking about injecting water. We're not talking about recharged ponds like some other utilities. It's just going to be the natural recharge that accumulates in the basin over time. So, that's the middle slide. That's how we've increased the storage there.

And then when we get to a drought, we will have installed 16 new wells in the basin that we can draw from this stored water, and then those partner agencies -- the City of Daly City, Cal Water, and San Bruno -- would turn their existing wells back on and pump the amount of water they had previously pumped, and will be able to pump from these new wells.

So, that's the benefit of the project, is being able to recover that stored water.

To say this a little differently, we'll just look at those same time slices that we were showing from top to bottom, only this time it's left to right.

So, under existing conditions right now, if you take those three agencies together -- Daly City, Cal Water, and San Bruno -- and look at how much water they're using collectively, they're using 14.5 million gallons per day of surface water and 5.7 million gallons

per day of groundwater. So, this is collectively. In Daly City and San Bruno, it's more 50/50. In Cal Water, it's a smaller percent, but it averages out to be about a third, two-thirds.

So, then we get into the storage component of the project, and in wet or normal years, they'll reduce their pumping. So, you can see the blue portion of the chart is decreasing.

And then we're adding -- we're providing more surface water to them. So, that's how the water then -- by reducing that pumping, then that's allowing groundwater to accumulate in the basin.

Then the payout where this project makes -- provides the benefit is during the dry year. And during the dry year, we would reduce our surface water deliveries to those utilities, and then we would pump through those 16 new wells -- the middle, the darker blue portion of the water (Indicating) -- and then they would return to pumping their previously pumped amount of water.

This is -- this provides a regional benefit to all the 2.4 million customers. It sort of helps float everybody's boat by having this additional pumping -- pumped groundwater in dry years in this project.

I'll talk now more about how we got these well

sites. How did we get to these 16 well sites. Initially, we started with 48 sites that we looked at throughout the basin. We were looking for sites on properties we owned, on other public properties, and private properties.

We ranked those relative to a number of criteria, but, for example, distance to transmission lines, location of where they are in the basin. The center of the basin is deeper, so we wanted to stay away from the sides of the basin, which are shallower. We wanted to stay away from potential contaminating activities like underground storage tanks.

And so, we winnowed that down from 48 to 19 sites that are in the Environmental Impact Report that are listed in this Notice of Preparation. And then of those, we want to build up to 16 sites. So, there's maps in the Notice of Preparation, and this exact map is in there.

But just to take you through -- so, starting in the north -- and these are a series of three overlapping maps showing you the location of these 19 sites. So, that's in the Daly City and Colma area, Colma, South San Francisco area, and then San Bruno and down to Millbrae.

So, let me go over the overall project

description. So, we're working on an agreement with these three utilities to store up to 61,000-acre-feet of water in the South Westside Basin. That's about as much water as in our Crystal Springs Reservoir. If you ever go down 280 or cross over 92 to go to Half Moon Bay, you're going through upper and lower Crystal Springs Reservoirs.

Starting this spring, there were 54,000-acre-feet, and at that time the reservoir was full, so, this is a lot of water that we're able to store in this -- this South Westside Basin. The scope is to develop 7.2 million gallons per day pumping capacity, and to be able to pump that for 7 1/2 years.

So, the map is, if you pumped that amount at that rate for that amount of time, that would equal 61,000-acre-feet. And we'd only pump the stored water, the water that we had stored through the exchange program with those agencies.

I mentioned this before, the project is to construct 16 wells. Each of the facilities would also have pipelines there. There would be electrical connections. There would be connections to the stormwater in the sanitary sewer.

We'd disinfect the water per the California Department of Public Health requirements. We'd provide

other treatment, if needed. If the water naturally doesn't meet the drinking water standards, then we would treat it to be below those standards. And then the wells would be connected to either Daly City, San Bruno, Cal Water, or the SFPUC pipelines. It will be a combination of those up and down the basin.

I want to emphasize that the water will -- you'll continue to have high-quality drinking water from this project. The groundwater will be in compliance with the California Department of Public Health requirements. There will be disinfection of the water where we'll have a monitoring program, and in most cases, the groundwater will continue to be blended with San Francisco's imported surface water.

Just a typical site layout. So, this is a site in South San Francisco off of Hickey Boulevard. We own the right of way along this proposed site, and the -- this is the well. This is the building. (Indicating) These other lines are existing pipelines or proposed pipelines. (Indicating)

As I mentioned, we're going to need connections to the sanitary sewer, storm drains, etc. And then there's a larger line drawn around this that would be the areas of construction, so when we're constructing the facility, we'd have a larger area that

would be impacted, and then we'll end up with a smaller building there when we're all done.

This is a sample facility from Southern California, a well station. This is a well only. If we have to have disinfection or treatment, the facility could be twice that size.

And then I'll turn it back over to Diana.

MS. SOKOLOVE: So, here's our environmental review schedule. We distributed the Notice of Preparation on June 24th of this year. Tonight is our Public Scoping Meeting. The scoping period ends on July 28th, so that's the last day that we'll be accepting scoping comments. And then we begin our draft Environmental Impact Report. We hope to publish the draft Environmental Impact Report next summer, and then we would release that Environmental Impact Report for a 45-day review. Once we get comments back, we will prepare responses to comments, and we would release the response-to-comments document, or the final Environmental Impact Report the following year. We hope to certify in mid 2001.

So, here is your chance to give me your comments, and I'm just wondering if anyone has a speaker card, if they wanted to speak tonight.

Given the fact that we have a court

transcriber here, if you could stay up in the front of the room and sort of speak to her and the audience, that would be great.

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PUBLIC COMMENT

PUBLIC SPEAKER: Hi. My name is Andrea Ouse. ← ORAL COMMENT 101
I'm the City Planner for the Town of Colma. Thank you very much for the Scoping Meeting tonight. I'm here on behalf of the Town of Colma, its residents, and property owners.

First of all, I think in concept, the Town agrees with and respects the type of work that's being done here. It's an overall public good. I do think that there are some considerations that maybe haven't been vetted out quite yet.

Um, one of the things that concerns us in the Town is the test wells. The test wells appear to be being handled as a separate project and not encompassed as part of a cumulative review of the recharge project.

So, I understand from talking to staff, and from a workshop that was held in Colma, that it's -- they're being considered under a categorical exemption.

Also, what I understand is there's a cluster of wells. There's approximately five or six different sites in our town of Colma, and there's many others throughout the stretch.

There are approximately five different wells in each site, so there's a number of very large, deep holes that will be dug throughout our community, and we're really not sure that that warrants a categorical exemption under CEQA, and we would appreciate being forwarded any paperwork that's been already developed on the test-well issue so that we have the opportunity to review and comment on it.

The scope of those test wells, we really didn't know to much about it, but we would also appreciate it, if there's any project description on those test wells, to be sent that information.

On the project description of the storage project here, we don't feel at this point that it is quite adequate to describe the -- sort of the depth, and again whether or not this will include clustering. I didn't know that there's going to be buildings associated with each well site.

Maybe there is or isn't, but this is kind of -- this was new information for me. We do have some pretty significant concerns if buildings are going to be associated with each well site and where those are going to be located and what they're going to look like.

For any of you not familiar, Colma has 76 percent of its land in cemetery use. And there's -- you know, we try to keep our policies in line with a very tranquil and serene environment. Our cemeteries have been there over a hundred years and they use a lot of the groundwater to irrigate their property, so we have a very distinct, vested interest in maintaining some sort of rights associated with that usage.

At this point I'm not quite sure what the management structure is going to be in terms of the assertion of authority over this -- this aquifer, so I think the project description should include a description of what that breakdown is going to be and what that authority -- who's going to have the authority over this water, and if it's going to change the rights and the ownership of that water to the partner agencies or different entities, other than those that are already existing and have those rights to the water.

One of the things I would like to see in the Environmental Impact Report is some sort of study of the potential settlement issues associated with recharging the aquifer and deleting the part of the aquifer.

Since it appears to be either a gradual decrease in the amount of water in the aquifer right now, is there going to be any consideration for potential settlement issues with sort of a more active management of the aquifer?

And that concludes my comments. Thank you.

MS. SOKOLOVE: Thank you.

Did anybody else want to make any comments tonight?

PUBLIC SPEAKER: Good evening. My name is Peter Drekmeier. I'm with the Tuolumne River Trust. ORAL COMMENT 102

And I'm curious if the EIR is going to look at the impacts of -- it sounds like it might divert an extra 6.7 million gallons of water per day from the Tuolumne in wet years, and I'm wondering if in addition to what was studied in the program EIR for the WSIP, that that would be looked at.

If that wasn't the plan, I would encourage you to do that, because there's going to be additional information coming out at the end of this year or early next year. The PC is doing a biological study of the stretch below Hetch Hetchy as part of the settlement on the Kirkwood Powerhouse Agreement in 1988. So, we're going to have additional information that wasn't available at the time of the WSIP, and that would be good to incorporate that.

I'd also encourage you to look at the recharge

of the groundwater with stormwater so that we might be able to tap it sustainably ongoing even in wet years and rely less on the Tuolumne River.

Thank you.

MS. SOKOLOVE: (Indicating)

PUBLIC SPEAKER: Good evening. I'm Kathryn Slater-Carter, and I am a business owner in Daly City and a property owner in Pacifica. ORAL COMMENT 103

I have a question, actually, about whether the rate of recharge for the basin has been calculated and is part of this, given that during the dry years there would be more water taken out of it, how long will that water supply be good for.

There's substantial impervious surface in the basin, and to Peter's earlier comments, I think it might be worthwhile to be looking at treated stormwater runoff, since most of the cities do have stormwater drainage systems in them.

The other question is, What will the cost of the -- from the increased use of Hetch Hetchy water be? It's a very expensive water. I'm sure that Daly City is able to blend its rates to keep the cost down by using groundwater.

Is this going to cause me, as a business owner that uses a significant amount of water, to see an

increase in my rates?

Thank you.

MS. SOKOLOVE: (Indicating)

PUBLIC SPEAKER: My name is Jim Stark. I reside in San Francisco, and I live in the area known as "Lakeshore" or "Lakeshore Acres," and for many years, our organization, the Lakeshore Acres Improvement Club, has been concerned with lake levels at Lake Merced, and we hope that the Environmental Impact Report will examine it and respond to all the concerns that are already known regarding lake levels at Lake Merced. ← ORAL COMMENT 104

Thank you.

MS. SOKOLOVE: (Indicating)

PUBLIC SPEAKER: I'm going to talk to you since you're the one who's writing everything the EIR, and I'm happy to have everybody who's here hear me say what I have to say.

My name is Bob Maddow. I'm an attorney. I represent a number of golf courses throughout the basin. Several of them have switched from use of groundwater from this very same aquifer to use of recycled water. That's been an important achievement that the City and County of San Francisco and the City of Daly City are very proud of, and rightly so, and so are those golf courses. And they're very satisfied with the recycled ← ORAL COMMENT 105

water as a substitute supply for the groundwater that was being pumped.

I have to say that a number of my clients, which are owners of private wells in this same basin who have the legal right to use groundwater within this basin -- that they find it somewhat ironic that we're now looking at more than doubling the production of groundwater from this aquifer, which they have worked hard and they are paying good money to preserve, and they're very concerned about making sure that in the long run, the doubling of the production of this aquifer is thought through very carefully before it's undertaken.

Greg talked about the aquifer and analogized with the bathtub full of sand, and that's pretty good, because he did not do something that I have seen suggested, or at least implied, in some of the things that I have read about the Conjunctive Use Program, and that's an intent to analogize this to a lake. It's not a lake.

You've got -- Greg talked about the fact that the groundwater levels within this basin are depressed dramatically from years of pumping, but it's still an aquifer that has enormous productivity and enormous potential for storage, but nobody knows what's going to

happen when you refill it.

There's been a pilot program in which something on the order of 15,000-acre-feet was, in fact, recharged into this aquifer as a result of the same kind of in-lieu program that you're talking about on a larger scale now, but beyond that 15,000-acre-foot pilot program, nobody really knows exactly what's going to happen.

So, I think it's very important that the Environmental Impact Report describe how it is that that -- the effects of refilling that aquifer will, in fact, be measured, both from the standpoint of its long-term productivity, from the standpoint of the impact of private well owners who still have the legal right to use water from that aquifer.

And with regard to water-quality issues, I realize that the water that is extracted from that basin now for municipal purposes is a high-quality water. In fact, the water quality in this area is excellent, if you compare it with what you can find in most of California and much of the nation.

But you're dealing with refilling a basin that has been empty, and a significant portion of that basin underlies something that is proudly called "The Industrial City." I don't know what kind of quality

considerations might crop up once that basin is refilled. In other words, are there contaminants that will be remobilized? Let me put it that way.

Greg mentioned leaking underground storage tanks. I think it could conceivably go beyond that. I don't have any particular contaminant in mind or source of contaminants in mind.

It just occurs to me that there's the potential for remobilization of contaminants that might have been deposited there through industrial activity long, long ago and during the time when this aquifer was, in fact, being hit pretty hard.

From the standpoint of private well owners throughout the basin, both those whom I represent and others whom I know to exist, there needs to be a clear understanding of the possibility for mutual interference. I'm aware of a little work that's been done with regard to mutual interference. I'm not aware of all that has been done or will be done.

I hope that that issue is, in fact, discussed in the environmental analysis and in the technical memoranda that accompanies the environmental analysis so that the owners of private wells will understand exactly what they can anticipate. This is not an adjudicated basin.

I really appreciate the comments made by the woman from Colma. What are the legal implications of the type of program that you are actually talking about undertaking? And what are the rights of the private-property owners who are going to find that as a result -- who might find -- we'll know from your EIR, I hope -- that the rights that they have to extract water for productive, beneficial uses from this basin are adversely impacted?

They might -- might some of their wells be rendered obsolete? Might some of their wells have to be deepened? Might they need new pumping arrangements? Might they have to move to entirely new water supply arrangements as a result of this?

We don't know any of that yet. Those are among the suite of issues that need to be addressed. And, of course, there is the overlay of the legal issue that has been referred to a couple of times tonight.

All in all, it's an exciting project. It's the kind of project that should be done. It needs to be done in a careful, integrated way, looking at all the opportunities.

There was a reference to -- by Mr. Drekmeier to the possibility of using stormwater as a component of the recharge of this basin. And that obviously is a

potential. I'm not quite sure how you intend to look at that, but it is an issue that needs to be addressed.

A parallel issue is one that comes right out of your Water System Improvement Program, and that's the additional use of recycled water as a source of water for irrigation purposes throughout the portions of the basin where it is not now available.

I know that San Francisco is working hard with Daly City to extend the use of the tertiary water that's produced at the Daly City plant, to move it to Harding

Park, and I know at various times, San Francisco has considered other aspects of the water recycling program that would be a part of and would work in conjunction with the WSIP program.

How does that work throughout the balance of the Westside Basin?

There are a number of opportunities there, it would seem to me, for there to be a recycled water program that might allow you to get even more bang for your conjunctive use if you were to get those two things in parallel.

In other words, integrated water resources management. Paula Kehoe's favorite term. Integrated water resources management needs to be considered and analyzed in this EIR just as it would need to be

considered and analyzed in an EIR for a stormwater treatment program of the type Mr. Drekmeier referred to for an extended recycled water program.

We look forward to participating. We appreciate the opportunity, and hope to be able to submit comments by the 28th and participate in the balance of the project.

MS. SOKOLOVE: Does anybody else want to speak tonight?

PUBLIC SPEAKER: Good evening. My name is Paul Perkovic. I live in Montara, and I'm on the Board ← ORAL COMMENT 106
of Directors along with Kathryn of the Montara Water and

Sanitary District which serves the Montara, Moss Beach area.

Our water -- our district does not receive water from the Hetch Hetchy system. However, the neighboring district to our south, Coastside County Water District, does receive water from Hetch Hetchy. And because the entire coastside is affected by water supplies that meet our domestic and agricultural needs, I'm interested in how this project may stabilize the water supplies that would be available from Hetch Hetchy to meet the coastside needs.

Coming from the coastside, I have a different perspective on a couple of the items. I just got

through the materials this evening and scanned through them fairly quickly, but we have a frequent problem where we lose power, and I didn't see any plans for emergency generators, backup generators in any of the well pump-housing or treatment facilities.

Certainly, I think that it would be prudent, unless your power supplies are much more reliable here than they are on the coast, that you have some provision for emergency power, unless you have 99.9 percent availability from your public power supplier. We often lose power for hours at a time, sometimes several days at a time, and backup power is necessary on all our facilities.

Secondly, before our district acquired the water system from the previous owners, (Inaudible) Corporation of California, there was an instance where an underground fuel tank that was used to store gasoline leaked into our -- one of the aquifers that served our community, and the resulting MTBE contamination meant that two of the major production wells were taken out of service for a period of time, and that had a very dramatic impact on our district.

You mentioned that the siting looked at potential contaminant sources. However, there are numerous gas stations located throughout the urbanized

area in the basin area, and I don't know if any of those have had any leakage problems with MTPE-supplemented fuel.

And I share the concern of the attorney who just spoke, in that some of the materials -- some of the contaminants may have adhered to the soil particles when water levels were at a lower level, and as the water levels are raised, they may be remobilized.

Um, those are the major concerns or questions I have that are directly relevant to the EIR scoping process. However, I have a number of other questions that are sort of business-related questions, and if I may, I'd like to just put those forward.

Kathryn raised the question about how the cost of the water would effect the relevant agencies. It looks to me like the plan is during years when there is an adequate supply, Daly City and South San Francisco and Cal Water would take additional water from Hetch Hetchy and not pump the groundwater wells.

Would they be paying the current Hetch Hetchy wholesale prices for the water that they take, or would that be treated as an advance of so many million acre feet or so many thousand acre feet that could be drawn on in the future?

This is particularly important, because the

price of an acre foot of water this year is about 17 percent less than the price of an acre foot of water next year, and about 21 percent less than the price of an acre -- or, cumulative, you know, 38 percent less than the cost of an acre foot two years from now.

So, if the agency is paying 2009 prices to purchase water to allow recharge, and then that agency can draw on that water two years from now when they otherwise would be paying much higher rates to purchase water from the Hetch Hetchy system, basically the other users of the Hetch Hetchy water, the Bay Area Water Supply and Conservation Agency, are underwriting the cost of water to the South City and Daly City and CalAm [sic] users.

If it's treated as an advance of water that is then repaid later by dry underground water basin, and the payments to Hetch Hetchy to SFPUC remain at the sort of average use and escalating price to pay for the seismic improvement program, that would seem to me to be more fair.

The second question that's related to that -- and maybe this is within the scope of the EIR, at least within our scope, the Bay Area Water Supply and conservation agency -- there's a very complex water allocation scheme, as I understand it, for drought

periods.

And agencies get some percentage of their water purchase in a base year, plus some percentage of their water purchased in the previous water year, and that affects the water supply assurance during a drought period so that it's based on sort of historic use and recent use to determine how much is delivered. Coastside County Water District is in a very unfortunate situation that their historic water use is very low, and during the planning for this year's drought, it was looking like if Hetch Hetchy -- if the SFPUC cut back 20 percent, their water delivery would be cut back 36 percent.

Now, how will those formulas apply for the agencies we're looking at here that are participants if they are taking delivery of a much higher quantity of water from the SFPUC system during the recharge period?

Then when the drought period comes, is their allocation much higher as a consequence?

Now, again, this may be something that's part of the contract negotiations. That's true.

And those are the only comments I have at the moment. Thank you very much.

(To Mr. Maddow) And I very much appreciated your comments, sir.

MS. SOKOLOVE: Anyone else?

(No response from the audience)

---oOo---

CLOSING REMARKS

MS. SOKOLOVE: I just wanted to let you know where you can send your comments, if you have any further comments.

If you didn't speak tonight, or even if you did speak tonight, and you want to submit some additional comments, you should feel free to send them to me at my E-mail address. You can fax them to my office or you can send them in by mail to the Planning Department through July 28th.

And I believe that all of this information is also on your agenda. It's in the Notice of Preparation, et cetera, but if you need my business card, I can give one to you.

And for more information, you can contact me. There's my phone number, my E-mail. Please do read the Notice of Preparation. We have extra copies here tonight, so if you'd like to take one with you, I can give you one.

And if you have questions or comments about

the project itself, you can contact the San Francisco Public Utilities Commission. And again, all of this information is on your agenda.

So, that concludes our presentation for this evening. And I really do want to thank you for coming tonight. Your comments were excellent, and we will certainly take them all into consideration when we're preparing the Environmental Impact Report.

Again, thank you very, very much for your time.

(Whereupon the Public Scoping Meeting was concluded at 7:49 p.m.)

---oOo---

STATE OF CALIFORNIA) SS.

I, Katy Leonard, CSR No. 11599, in and for the State of California, do hereby certify:

That the foregoing is a true, correct, and complete transcript of the Public Scoping Meeting made this date.

I further certify:

That I am not interested in the events of this action.

WITNESS MY HAND this 15th day of July, 2009.

____

Katy Leonard

CSR No. 11599

Appendix D
Public Scoping Meeting Materials (Handouts, etc.)

San Francisco Planning Department

Major Environmental Analysis Division

SCOPING MEETING

REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT

Environmental Impact Report

JULY 9, 2009

Scoping Meeting Purpose

- Hear your comments on the proposed scope and focus of environmental review of the proposed Regional Groundwater Storage and Recovery Project
- Help identify the following to be analyzed in depth:
  - ***Range of alternatives***
  - ***Environmental effects***
  - ***Methods of assessment***
  - ***Mitigation measures***

Scoping Meeting Agenda

- Introductions
- Presentation
  - ***Overview of Environmental Review Process***
  - ***Overview of Regional Groundwater Storage and Recovery Project***
- Public Comments
- Closing Remarks

Scoping Meeting Reminders

- Sign in at the table near the entrance.
- Pick up copies of meeting materials.
- If you would like to speak during tonight's hearing, fill out a speaker card.
- To make written comments, pick up comment cards.
  - ***Drop off at the end of the meeting***
  - ***Mail or fax later***
- Please hold all comments until the end of the presentation.

Project Team Introductions

San Francisco Planning Department
(Lead Agency under CEQA)

- ***Diana Sokolove, Senior Environmental Planner***

San Francisco Public Utilities Commission
(Project Sponsor)

- ***Greg Bartow, Project Manager***
- ***Suet Chau, Environmental Project Manager***
- ***Michele Liapes, Communications***
- ***Les Chau, Kennedy/Jenks Consultants***

ENVIRONMENTAL REVIEW PROCESS

California Environmental Quality Act

Proposed projects require environmental review under the California Environmental Quality Act (CEQA) before they can be considered for approval

For SFPUC projects, CEQA is implemented by the San Francisco Planning Department

CEQA Objectives

- Present environmental impacts of proposed projects
- Identify ways to avoid or reduce environmental impacts
- Support the agency decision-making process
- Encourage public participation
- Enhance interagency coordination

What will the EIR do?

- Provide a detailed description of the project and the existing environment
- Identify potential environmental impacts
- Identify ways to avoid or reduce significant environmental effects through mitigation or alternatives to the proposed project

PROPOSED REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT

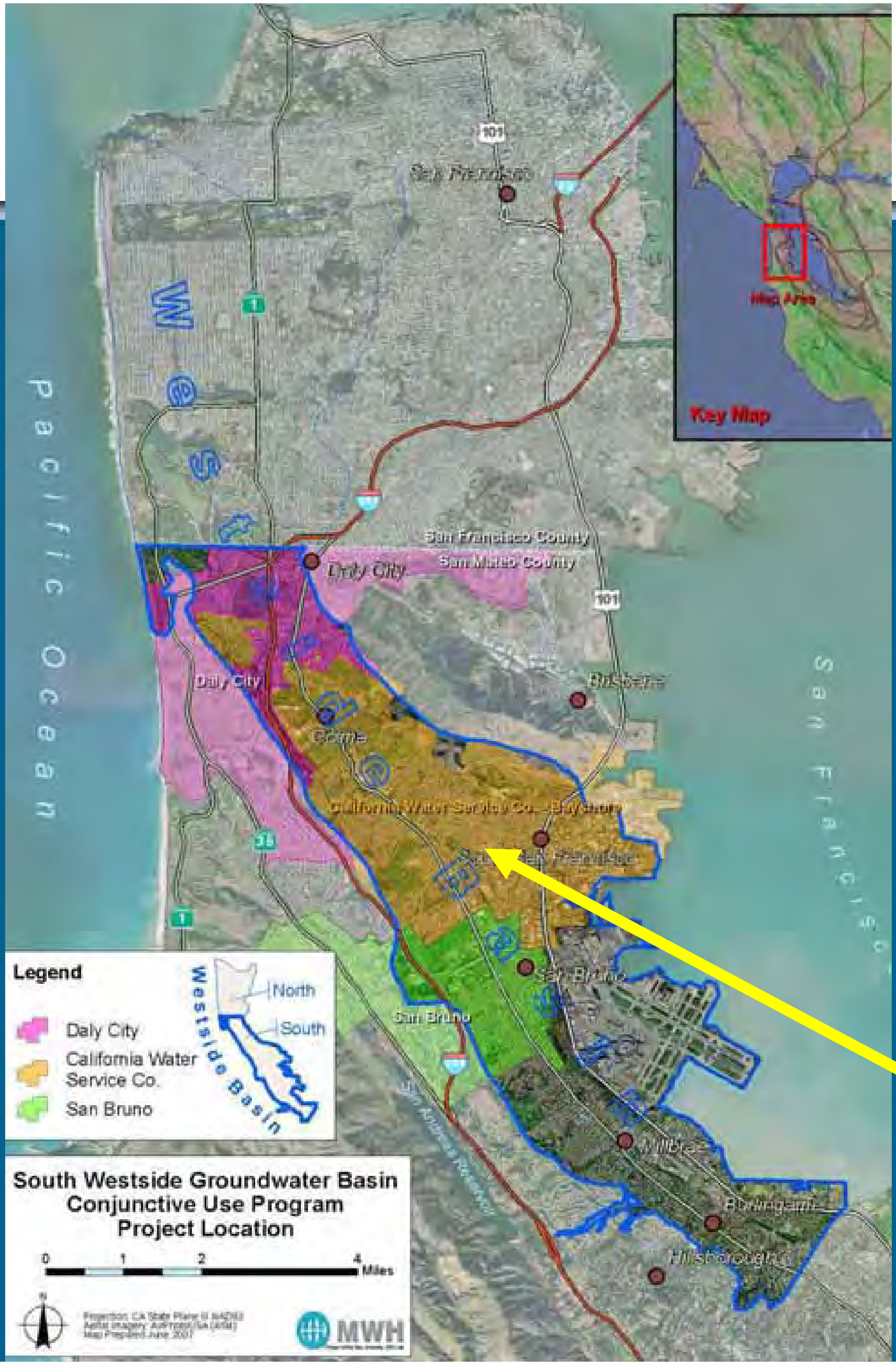
SFPUC Hetch Hetchy Water System

Water System Improvement Program (WSIP)

- Voter Approved November 2002
- More than 85 projects to:
  - ***repair, replace and seismically upgrade key water system facilities***
  - ***add new, redundant facilities to insure system reliability***
  - ***diversify water supply and increase dry year supplies***

Need for the Project

- Develop dry-year water supply
- Meet the 80% water supply reliability goal adopted by the SFPUC Commission



Partner Agencies:

City of Daly City

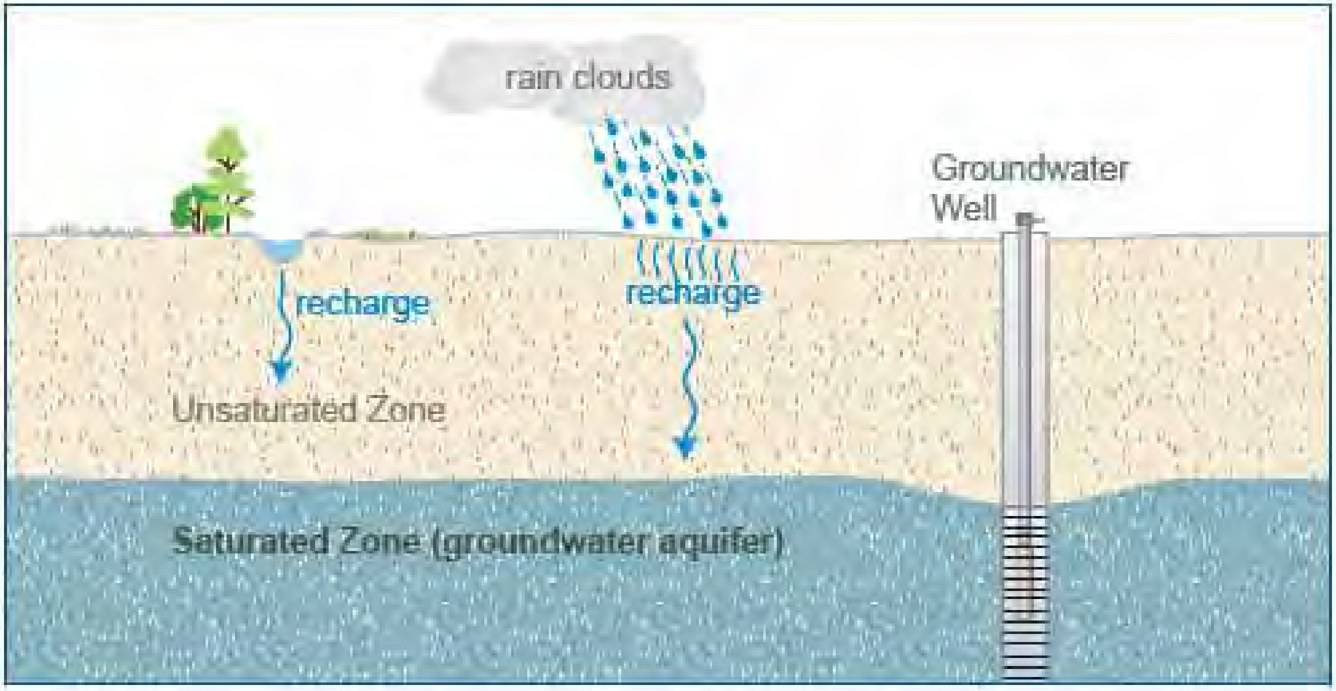
California Water Service Co

City of San Bruno

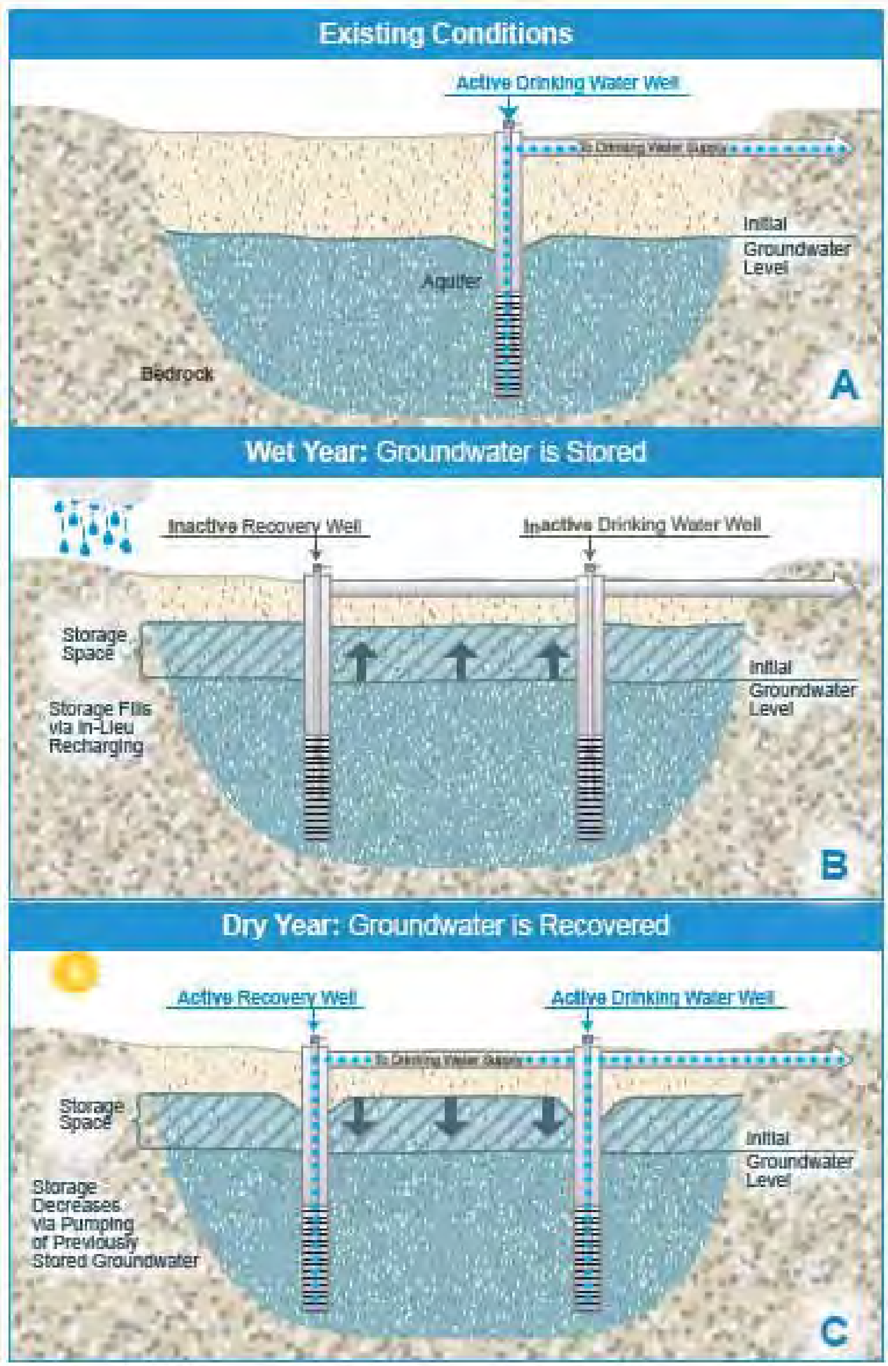
South Westside Groundwater Basin

What Is Groundwater?

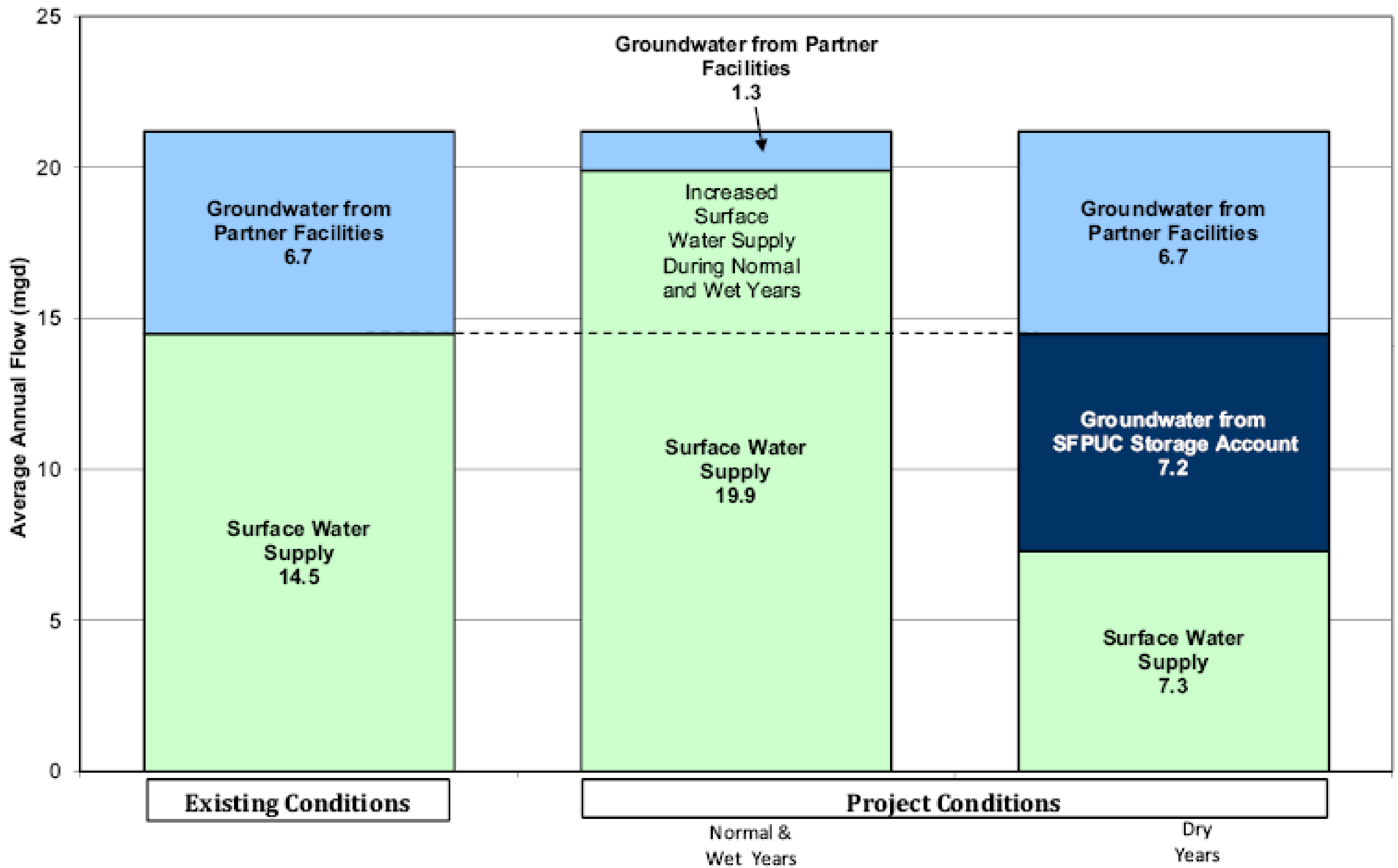
As rainwater or surface water seeps into the ground, it moves downward between soil particles and collects in an underground geologic reservoir. When such a reservoir can readily yield water to springs or wells, it is called an aquifer and is a potential source of drinking water.



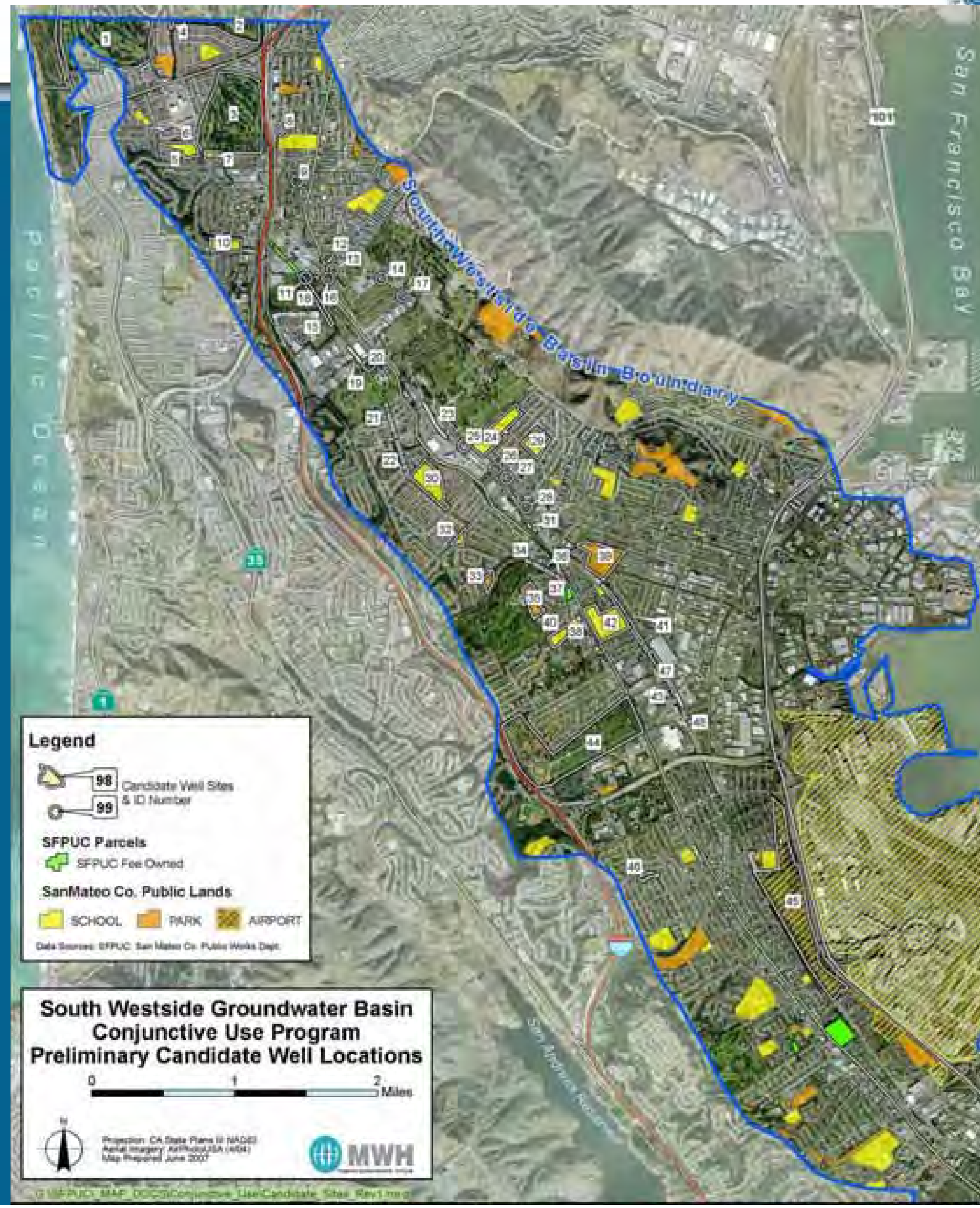
How Would The Project Work?



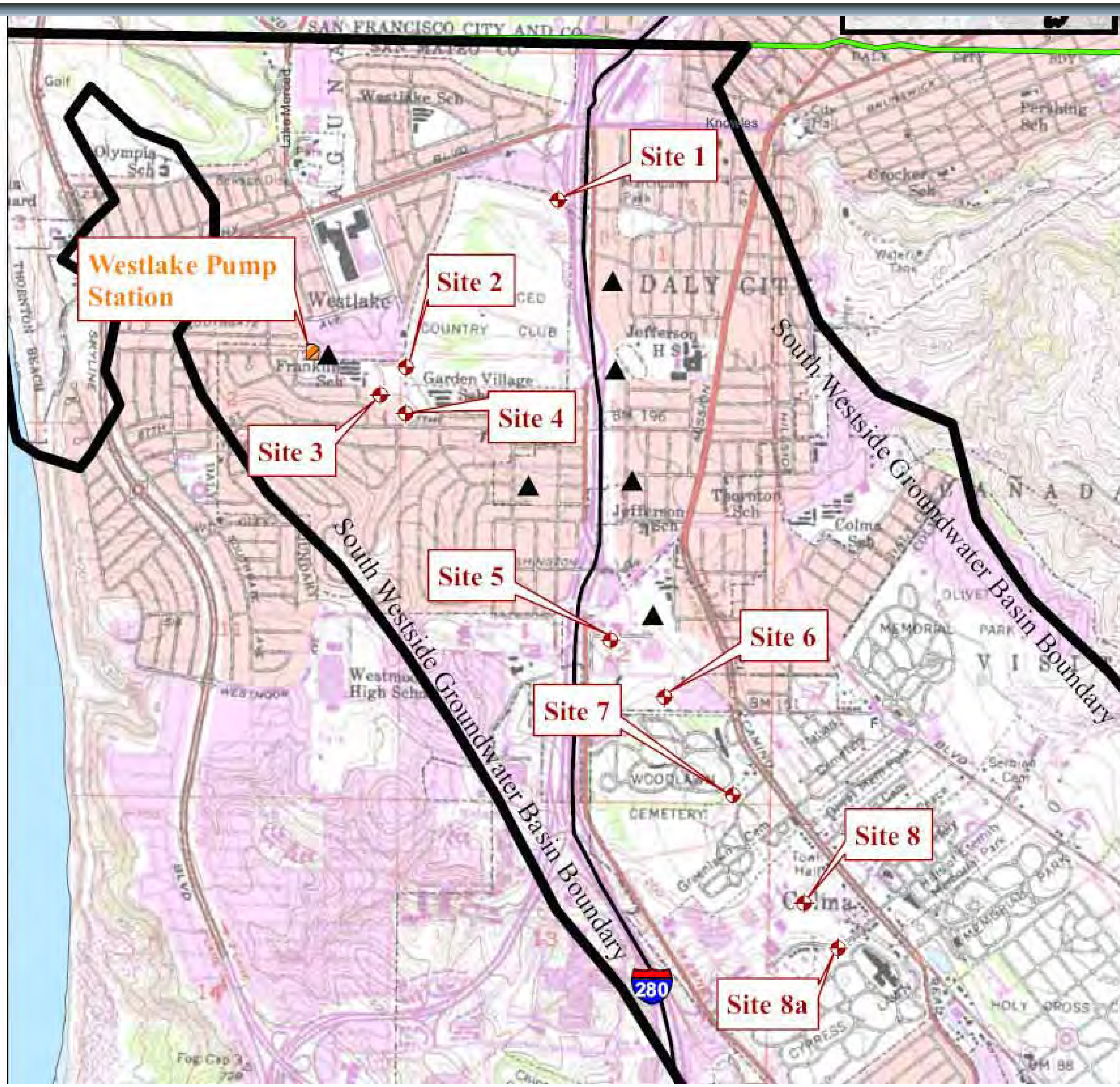
How Would The Project Work?



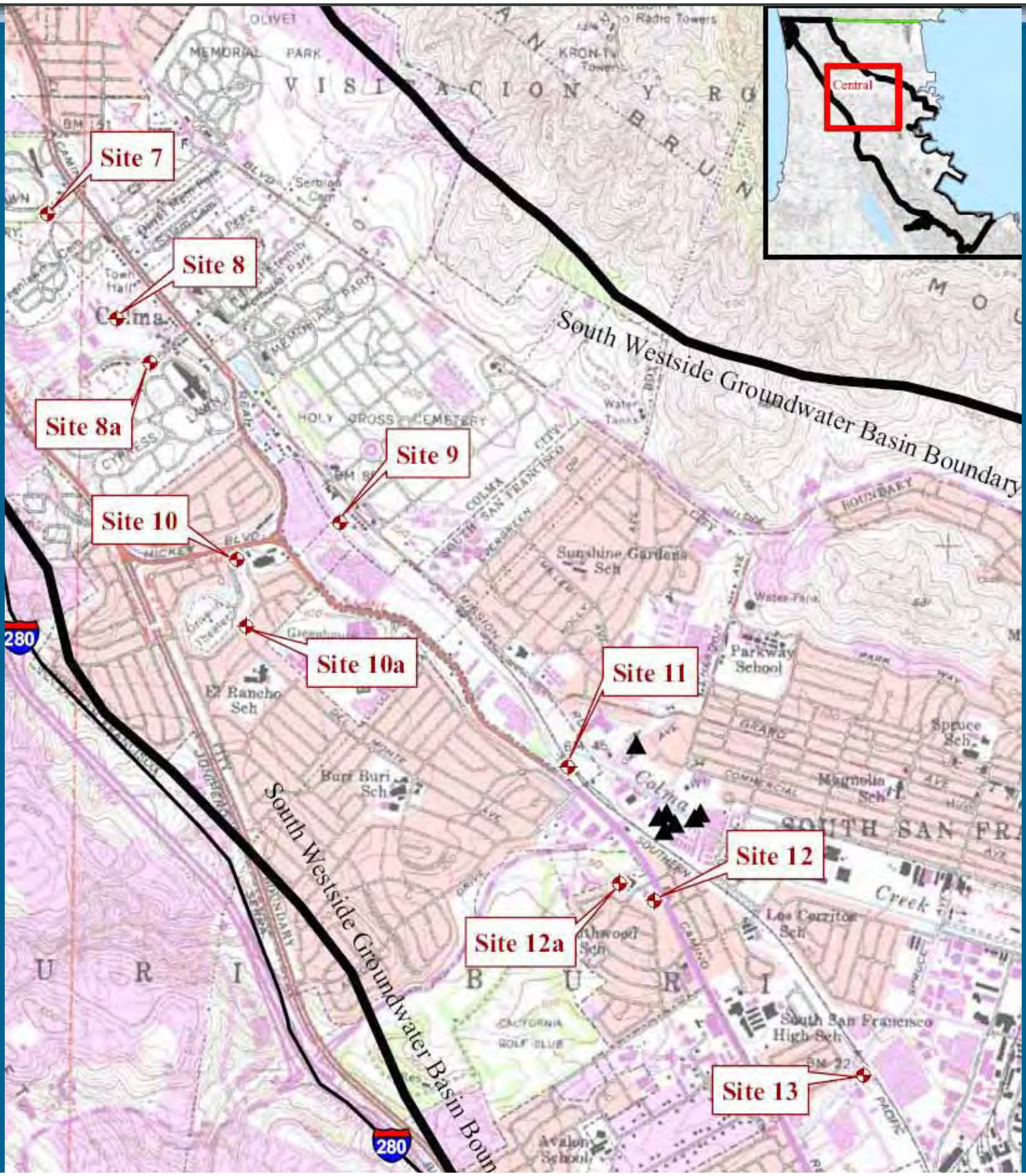
- 48 Potential Well Sites Evaluated
- 19 Sites advanced for EIR
- Up to 16 sites would be developed



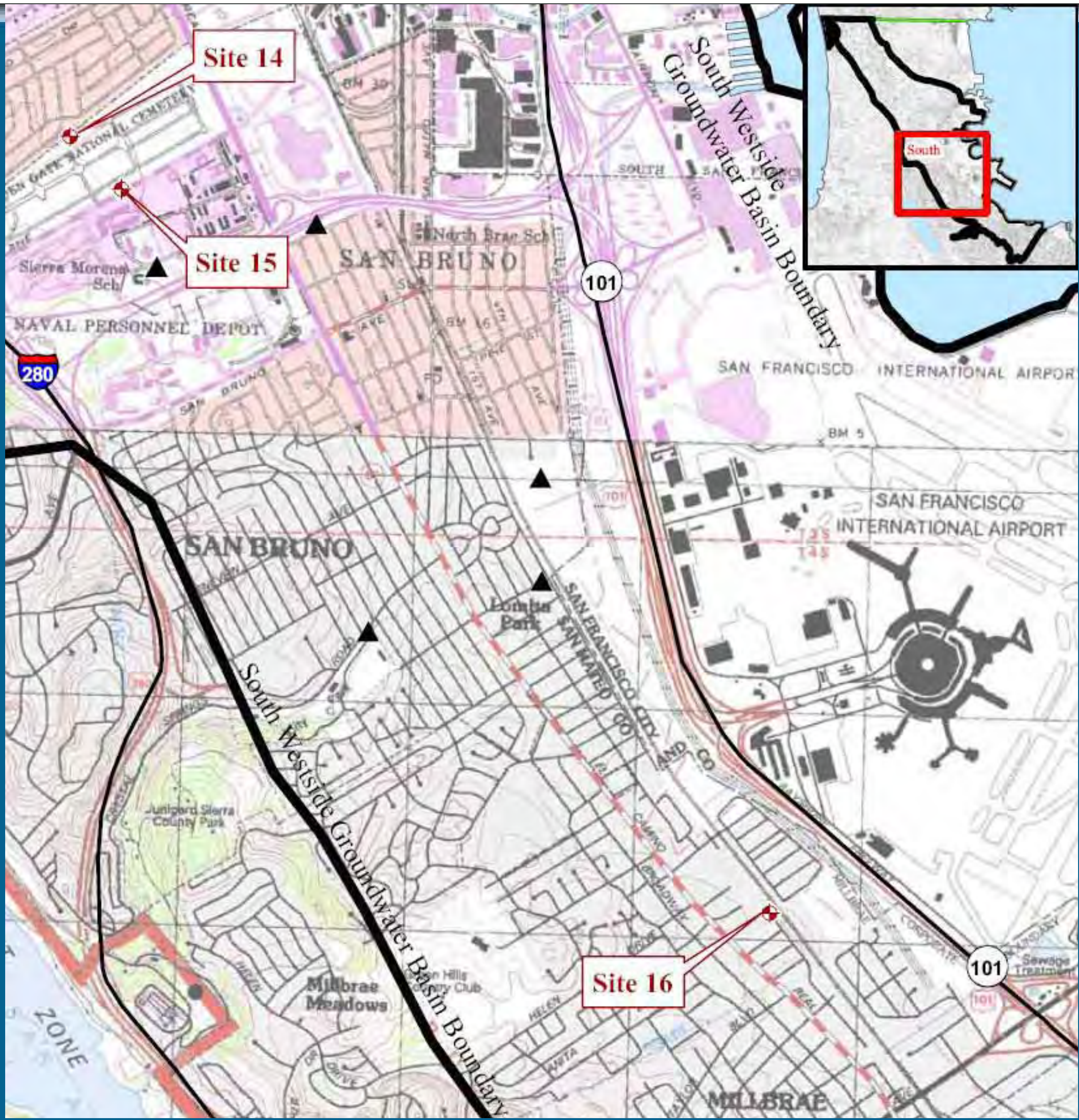
Well Facility Locations (1 of 3)



Well Facility Locations (2 of 3)



Well Facility Locations (3 of 3)



Project Description

- Develop agreements with Daly City, San Bruno, and Cal Water to store 61,000 acre feet of water (approximately 20 billion gallons)
- Develop capacity to pump 7.2 million gallons per day over 7.5 years
- Pump only stored water (an operating committee would be created to monitor the volume of stored and pumped project water)

Project Description

- Construct up to 16 well facilities (including pipelines, etc.)
- Disinfect water per state Department of Public Health requirements
- Provide other treatment if needed (e.g., manganese)
- Connect to Daly City, San Bruno, Cal Water or SFPUC drinking water systems (depending on location).

Ensuring a High Quality Drinking Water

Groundwater Safety

- Groundwater will be in compliance with all California Department of Public Health requirements
- In addition, groundwater will be disinfected before entering the municipal drinking water supply

For over 100 years, groundwater from the Westside Basin has been used for irrigation and drinking water purposes. The cities of Daly City, South San Francisco, and San Bruno currently use groundwater from the Basin as part of their drinking water supply.

Ensuring a high quality drinking water supply

- Monitoring programs will be established to ensure the continued safety and quality of groundwater supplies
- In most cases, groundwater will be blended with imported surface water from the Regional Water System

Typical Site Layout

Sample Well Facility (with Enclosure)

Environmental Review Schedule

- Notice of Preparation – June 24, 2009
- Public Scoping Meeting – July 9, 2009
- Scoping Period Ends – July 28, 2009
- Public Review of Draft EIR – Summer 2010
- Release of Final EIR – Mid 2011
- Certification of Final EIR – Mid 2011

PUBLIC COMMENT

Comment Session Ground Rules

- Submit speaker cards to speak
- Wait until your name is called
- Speak into the microphone and state your name
- Summarize comments verbally and provide more detail in writing
- Use comment forms for more extensive input

CLOSING REMARKS

Where to Send Comments

Scoping comments accepted through July 28, 2009

Send by email to: ***diana.sokolove@sfgov.org***

Send by fax to: **(415) 558-6409**

Send by U.S. mail to:

San Francisco Planning Dept
Attn: Bill Wycko, ERO
Groundwater Storage and Recovery
1650 Mission Street, Suite 400
San Francisco, CA 94103

For More Information

About the Environmental Review Process:

Diana Sokolove, San Francisco Planning Department, Major Environmental Analysis Division

(415) 575-9046, diana.sokolove@sfgov.org

The Notice of Preparation is available online at www.sfgov.org/planning/mea

About the Regional Groundwater Storage and Recovery Project

Michele Liapes, SFPUC

(415) 554-3211, mliapes@sfwater.org

SAN FRANCISCO PLANNING DEPARTMENT

Public Scoping Meeting
Proposed Regional Groundwater Storage and Recovery Project
South San Francisco, CA - July 9, 2009

AGENDA

7:00 PM

Introductions - Diana Sokolove, San Francisco Planning Department

Presentation:

- **Environmental Review Process Overview -** Diana Sokolove, San Francisco Planning Department
- **Project Overview -** Greg Bartow, San Francisco Public Utilities Commission

Public Comment

Closing Remarks

Glossary

SFPUC: San Francisco Public Utilities Commission

MEA: Major Environmental Analysis Division, San Francisco Planning Department

CEQA: California Environmental Quality Act

WSIP: Water System Improvement Program

GSR*: Regional Groundwater Storage and Recovery Project

EIR: Environmental Impact Report

* *The GSR was formerly called the Groundwater Conjunctive Use Project*

Documents Currently Available

The following document is available by calling (415) 575-9046 or at www.sfgov.org/site/uploadedfiles/planning/NOP(1).pdf

- GSR Notice of Preparation of an EIR

The following documents are available by calling (415) 554-3211 or at www.sfwater.org/msc_main.cfm/MC_ID/13/MSC_ID/427

- GSR Fact Sheet
- 2008 Annual Groundwater Monitoring Report, Westside Basin

For More Information

Planning Department Web Site: www.sfgov.org/site/planning

SFPUC Web Site: www.sfwater.org

For GSR Project: Michele Liapes at SFPUC, (415)554-3211 or mliapes@sfwater.org

For EIR: Diana Sokolove at SF Planning, (415) 575-9046 or diana.sokolove@sfgov.org

SAN FRANCISCO PLANNING DEPARTMENT

Public Scoping Meeting

Proposed Regional Groundwater Storage and Recovery Project

South San Francisco, CA - July 9, 2009

SIGN-IN SHEET

(Please print)

NAME	AFFILIATION	ADDRESS	PHONE	EMAIL

SAN FRANCISCO PLANNING DEPARTMENT

Public Scoping Meeting

Proposed Regional Groundwater Storage and Recovery Project

South San Francisco, CA - July 9, 2009

SPEAKER CARD

CONTACT INFORMATION

Name: ______________________________

Affiliation: ______________________________

Street Address: ______________________________

City, State, Zip: ______________________________

Phone: ______________________________

Email: ______________________________

SAN FRANCISCO PLANNING DEPARTMENT

Public Scoping Meeting

Proposed Regional Groundwater Storage and Recovery Project

South San Francisco, CA - July 9, 2009

SPEAKER CARD

CONTACT INFORMATION

Name: ______________________________

Affiliation: ______________________________

Street Address: ______________________________

City, State, Zip: ______________________________

Phone: ______________________________

Email: ______________________________

SAN FRANCISCO PLANNING DEPARTMENT

Public Scoping Meeting

Proposed Regional Groundwater Storage and Recovery Project

South San Francisco, CA - July 9, 2009

COMMENTS

Thank you for participating in tonight's Public Scoping Meeting on the SFPUC's Regional Groundwater Storage and Recovery Project. Your comments on the scope and focus of the environmental review are encouraged.

Name (Please print): ______________________________

Affiliation (if applicable): ______________________________

Phone: ____________________ Email: ____________________

Address: ______________________________

City, State, Zip: ______________________________

COMMENTS

____

____

____

____

____

____

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Mail Questions to: Diana Sokolove, San Francisco Planning Department, 1650 Mission Street, Suite 400, San Francisco, CA 94103

Fax: (415) 558-6409 Email: diana.sokolove@sfgov.org

For more information on SFPUC's project, contact: Michele Liapes, SFPUC Communications Division

Phone: (415) 554-3211 Email: mliapes@sfwater.org

Appendix E
Written Comments Received During Scoping Process

STATE OF CALIFORNIA

GOVERNOR'S OFFICE *of* PLANNING AND RESEARCH

STATE CLEARINGHOUSE AND PLANNING UNIT

ARNOLD SCHWARZENEGGER
GOVERNOR

CYNTHIA BRYANT
DIRECTOR

Notice of Preparation

June 25, 2009

To: Reviewing Agencies

Re: Regional Groundwater Storage and Recovery Project
SCH# 2009062096

Attached for your review and comment is the Notice of Preparation (NOP) for the Regional Groundwater Storage and Recovery Project draft Environmental Impact Report (EIR).

Responsible agencies must transmit their comments on the scope and content of the NOP, focusing on specific information related to their own statutory responsibility, within 30 days of receipt of the NOP from the Lead Agency. This is a courtesy notice provided by the State Clearinghouse with a reminder for you to comment in a timely manner. We encourage other agencies to also respond to this notice and express their concerns early in the environmental review process.

Please direct your comments to:

Diana Sokolove
City and County of San Francisco
Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103-2479

with a copy to the State Clearinghouse in the Office of Planning and Research. Please refer to the SCH number noted above in all correspondence concerning this project.

If you have any questions about the environmental document review process, please call the State Clearinghouse at (916) 445-0613.

Sincerely,

Scott Morgan
Assistant Deputy Director & Senior Planner, State Clearinghouse

Attachments
cc: Lead Agency

Document Details Report
State Clearinghouse Data Base

SCH# 2009062096
Project Title Regional Groundwater Storage and Recovery Project
Lead Agency San Francisco, City and County of

Type **NOP** Notice of Preparation

Description NOTE: Review per lead.

The Project would provide potable surface water to the cities of Daly City and San Bruno and the California Water Service Company (Cal Water) (Collectively referred to as Partner Agencies), to be used by these agencies in lieu of pumping groundwater during normal and wet years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. The supply would be partially replaced by surface water supplies from the San Francisco Public Utilities Commission (SFPUC) regional water system. The reduction of pumping by Partner Agencies would increase groundwater storage within the South Westside Groundwater Basin. Stored groundwater would be pumped during periods of insufficient surface water supplies: (i.e., dry years).

Lead Agency Contact

Name Diana Sokolove
Agency City and County of San Francisco
Phone 415-575-9046 **Fax**
email
Address Planning Department
1650 Mission Street, Suite 400
City San Francisco **State** CA **Zip** 94103-2479

Project Location

County San Mateo
City Daly City, South San Francisco, San Bruno, Burlingame
Region
Cross Streets Various (16 sites)
Lat / Long
Parcel No. Various
Township **Range** **Section** **Base**

Proximity to:

Highways 280, 101, 82, 380, 1, 35
Airports SFO, San Carlos
Railways BART, Caltrain
Waterways Various
Schools Various
Land Use Various

Project Issues Aesthetic/Visual; Archaeologic-Historic; Biological Resources; Geologic/Seismic; Noise; Public Services; Recreation/Parks; Schools/Universities; Soil Erosion/Compaction/Grading; Traffic/Circulation; Vegetation; Water Quality; Water Supply; Cumulative Effects

---

Reviewing Agencies Resources Agency; Department of Parks and Recreation; Department of Water Resources; Department of Fish and Game, Region 3; Public Utilities Commission; Native American Heritage Commission; Department of Health Services; Caltrans, Division of Aeronautics; California Highway Patrol; Caltrans, District 4; State Water Resources Control Board, Division of Loans and Grants; Department of Toxic Substances Control; Regional Water Quality Control Board, Region 2

Date Received 06/25/2009 **Start of Review** 06/25/2009 **End of Review** 07/28/2009

Note: Blanks in data fields result from insufficient information provided by lead agency.

NOP Distribution List — County: San Mateo — SCH#

Resources Agency

- [x] **Resources Agency** — Nadell Gayou
- [ ] **Dept. of Boating & Waterways** — Mike Sotelo
- [ ] **California Coastal Commission** — Elizabeth A. Fuchs
- [ ] **Colorado River Board** — Gerald R. Zimmerman
- [ ] **Dept. of Conservation** — Rebecca Salazar
- [ ] **California Energy Commission** — Dale Edwards
- [ ] **Cal Fire** — Allen Robertson
- [ ] **Office of Historic Preservation** — Wayne Donaldson
- [x] **Dept of Parks & Recreation** — Environmental Stewardship Section
- [ ] **Central Valley Flood Protection Board** — Jon Yego
- [ ] **S.F. Bay Conservation & Dev't. Comm.** — Steve McAdam
- [x] **Dept. of Water Resources** — Resources Agency, Nadell Gayou
- [ ] ____________ Conservancy

Fish and Game

- [ ] **Depart. of Fish & Game** — Scott Flint, Environmental Services Division
- [ ] **Fish & Game Region 1** — Donald Koch
- [ ] **Fish & Game Region 1E** — Laurie Harnsberger
- [ ] **Fish & Game Region 2** — Jeff Drongesen
- [x] **Fish & Game Region 3** — Robert Floerke
- [ ] **Fish & Game Region 4** — Julie Vance
- [ ] **Fish & Game Region 5** — Don Chadwick, Habitat Conservation Program
- [ ] **Fish & Game Region 6** — Gabrina Gatchel, Habitat Conservation Program
- [ ] **Fish & Game Region 6 I/M** — Gabrina Getchel, Inyo/Mono, Habitat Conservation Program
- [ ] **Dept. of Fish & Game M** — George Isaac, Marine Region

Other Departments

- [ ] **Food & Agriculture** — Steve Shaffer, Dept. of Food and Agriculture
- [ ] **Depart. of General Services** — Public School Construction
- [ ] **Dept. of General Services** — Anna Garbeff, Environmental Services Section
- [x] **Dept. of Public Health** — Bridgette Binning, Dept. of Health/Drinking Water

Independent Commissions,Boards

- [ ] **Delta Protection Commission** — Linda Flack
- [ ] **Office of Emergency Services** — Dennis Castrillo
- [ ] **Governor's Office of Planning & Research** — State Clearinghouse
- [x] **Native American Heritage Comm.** — Debbie Treadway
- [x] **Public Utilities Commission** — Leo Wong
- [ ] **Santa Monica Bay Restoration** — Guangyu Wang
- [ ] **State Lands Commission** — Marina Brand
- [ ] **Tahoe Regional Planning Agency (TRPA)** — Cherry Jacques

Business, Trans & Housing

- [x] **Caltrans - Division of Aeronautics** — Sandy Hesnard
- [ ] **Caltrans - Planning** — Terri Pencovic
- [x] **California Highway Patrol** — Scott Loetscher, Office of Special Projects
- [ ] **Housing & Community Development** — CEQA Coordinator, Housing Policy Division

Dept. of Transportation

- [ ] **Caltrans, District 1** — Rex Jackman
- [ ] **Caltrans, District 2** — Marcelino Gonzalez
- [ ] **Caltrans, District 3** — Bruce de Terra
- [x] **Caltrans, District 4** — Lisa Carboni
- [ ] **Caltrans, District 5** — David Murray
- [ ] **Caltrans, District 6** — Michael Navarro
- [ ] **Caltrans, District 7** — Elmer Alvarez
- [ ] **Caltrans, District 8** — Dan Kopulsky
- [ ] **Caltrans, District 9** — Gayle Rosander
- [ ] **Caltrans, District 10** — Tom Dumas
- [ ] **Caltrans, District 11** — Jacob Armstrong
- [ ] **Caltrans, District 12** — Chris Herre

Cal EPA

Air Resources Board

- [ ] Airport Projects — Jim Lerner
  - [ ] Transportation Projects — Douglas Ito
  - [ ] Industrial Projects — Mike Tollstrup
- [ ] **California Integrated Waste Management Board** — Sue O'Leary
- [x] **State Water Resources Control Board** — Regional Programs Unit, Division of Financial Assistance
- [ ] **State Water Resources Control Board** — Student Intern, 401 Water Quality Certification Unit, Division of Water Quality
- [ ] **State Water Resouces Control Board** — Steven Herrera, Division of Water Rights
- [x] **Dept. of Toxic Substances Control** — CEQA Tracking Center
- [ ] **Department of Pesticide Regulation** — CEQA Coordinator

Regional Water Quality Control Board (RWQCB)

- [ ] **RWQCB 1** — Cathleen Hudson, North Coast Region (1)
- [x] **RWQCB 2** — Environmental Document Coordinator, San Francisco Bay Region (2)
- [ ] **RWQCB 3** — Central Coast Region (3)
- [ ] **RWQCB 4** — Teresa Rodgers, Los Angeles Region (4)
- [ ] **RWQCB 5S** — Central Valley Region (5)
  - [ ] **RWQCB 5F** — Central Valley Region (5), Fresno Branch Office
  - [ ] **RWQCB 5R** — Central Valley Region (5), Redding Branch Office
- [ ] **RWQCB 6** — Lahontan Region (6)
  - [ ] **RWQCB 6V** — Lahontan Region (6), Victorville Branch Office
- [ ] **RWQCB 7** — Colorado River Basin Region (7)
- [ ] **RWQCB 8** — Santa Ana Region (8)
- [ ] **RWQCB 9** — San Diego Region (9)
- [ ] Other ____________

Last Updated on 03/24/2009

Notice of Completion & Environmental Document Transmittal

Mail to: State Clearinghouse, P. O. Box 3044, Sacramento, CA 95812-3044 (916) 445-0613
For Hand Delivery/Street Address: 1400 Tenth Street, Sacramento, CA 95814

SCH # 2008082096

Project Title: Regional Groundwater Storage and Recovery Project

Lead Agency: San Francisco Planning Department, City and County
Contact Person: Diana Sokolove
Mailing Address: 1650 Mission Street, Suite 400
Phone: (415) 575-9046
City: San Francisco Zip: 94103-2479 County: San Francisco

Project Location: County: San Mateo City/Nearest Community: Daly City, So. San Francisco, San Bruno, Burlingame
Cross Streets: Various Zip Code:
Lat. / Long.: ___° ___' ___" N/ ___° ___' ___" W Total Acres: 0.3-1.2 ea. at 16 sites
Assessor's Parcel No.: Various Section: Twp.: Range: Base:
Within 2 Miles: State Hwy #: 280, 101, 82, 380, 1, 35 Waterways: Various
Airports: SFO, San Carlos Railways: BART, Caltrain Schools: Various

RECEIVED
JUN 25 2009
STATE CLEARING HOUSE

Document Type:

CEQA: ☑ NOP ☐ Early Cons ☐ Neg Dec ☐ Mit Neg Dec ☐ Draft EIR ☐ Supplement/Subsequent EIR (Prior SCH No.) ___ Other ___
NEPA: ☐ NOI ☐ EA ☐ Draft EIS ☐ FONSI
Other: ☐ Joint Document ☐ Final Document ☐ Other ___

Local Action Type:

☐ General Plan Update ☐ General Plan Amendment ☐ General Plan Element ☐ Community Plan
☐ Specific Plan ☐ Master Plan ☐ Planned Unit Development ☐ Site Plan
☐ Rezone ☐ Prezone ☐ Use Permit ☐ Land Division (Subdivision, etc.)
☐ Annexation ☐ Redevelopment ☐ Coastal Permit ☑ Other Water Supp

Development Type:

☐ Residential: Units ___ Acres ___
☐ Office: Sq.ft. ___ Acres ___ Employees ___
☐ Commercial: Sq.ft. ___ Acres ___ Employees ___
☐ Industrial: Sq.ft. ___ Acres ___ Employees ___
☐ Educational ___
☐ Recreational ___
☑ Water Facilities: Type Production Wells MGD Up to 7.2
☐ Transportation: Type ___
☐ Mining: Mineral ___
☐ Power: Type ___ MW ___
☐ Waste Treatment: Type ___ MGD ___
☐ Hazardous Waste: Type ___
☐ Other: ___

Project Issues Discussed in Document:

☑ Aesthetic/Visual ☐ Agricultural Land ☐ Air Quality ☑ Archeological/Historical ☑ Biological Resources ☐ Coastal Zone ☐ Drainage/Absorption ☐ Economic/Jobs
☐ Fiscal ☐ Flood Plain/Flooding ☐ Forest Land/Fire Hazard ☑ Geologic/Seismic ☐ Minerals ☑ Noise ☐ Population/Housing Balance ☑ Public Services/Facilities
☑ Recreation/Parks ☑ Schools/Universities ☐ Septic Systems ☐ Sewer Capacity ☑ Soil Erosion/Compaction/Grading ☐ Solid Waste ☐ Toxic/Hazardous ☑ Traffic/Circulation
☑ Vegetation ☑ Water Quality ☑ Water Supply/Groundwater ☐ Wetland/Riparian ☐ Wildlife ☐ Growth Inducing ☐ Land Use ☑ Cumulative Effects
☐ Other ___

Present Land Use/Zoning/General Plan Designation:
Various

Project Description: *(please use a separate page if necessary)*
The Project would provide potable surface water to the cities of Daly City and San Bruno and the California Water Service Company (Cal Water) (collectively referred to as Partner Agencies), to be used by these agencies in lieu of pumping groundwater during normal and wet years. The Partner Agencies currently use groundwater as one of the sources of their drinking water supply. The supply would be partially replaced by surface water supplies from the San Francisco Public Utilities Commission (SFPUC) regional water system. The reduction of pumping by Partner Agencies would increase groundwater storage within the South Westside Groundwater Basin. Stored groundwater would be pumped during periods of insufficient surface water supplies (i.e., dry years). (see continuation sheet)

Note: The state Clearinghouse will assign identification numbers for all new projects. If a SCH number already exists for a project (e.g. Notice of Preparation or previous draft document) please fill in.

WRITTEN COMMENT #2

STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY ARNOLD SCHWARZENEGGER, Governor

DEPARTMENT OF TRANSPORTATION
111 GRAND AVENUE
P. O. BOX 23660
OAKLAND, CA 94623-0660
PHONE (510) 622-5491
FAX (510) 286-5559
TTY 711

Flex your power!
Be energy efficient!

July 13, 2009

BAG0044
SM – 280/82 - VAR
SCH#2009062096

Ms. Diane Sokolove
City and County of San Francisco
Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

Dear Ms. Sokolove:

Regional Groundwater Storage and Recovery – Notice of Preparation (NOP)

Thank you for including the California Department of Transportation (Department) in the environmental review process for the Regional Groundwater Storage and Recovery Project. The following comments are based on the Notice of Preparation.

As lead agency, the San Francisco Planning Department is responsible for all project mitigation, including any needed improvements to State highways. The project's fair share contribution, financing, scheduling, and implementation responsibilities as well as lead agency monitoring should be fully discussed for all proposed mitigation measures and the project's traffic mitigation fees should be specifically identified in the Draft Environmental Impact Report. Any required roadway improvements should be completed prior to issuance of project occupancy permits. An encroachment permit is required when the project involves work in the State's Right of Way (ROW). Therefore, we strongly recommend that the lead agency ensure resolution of the Department's concerns prior to submittal of the encroachment permit application; see the end of this letter for more information regarding the encroachment permit process.

Traffic Impact Study (TIS)

The Department is primarily concerned with impacts to the State Highway System. The proposed project is located adjacent to State facilities. Please ensure that the environmental analysis evaluates the traffic impacts on State facilities by applying the following criteria to determine if a TIS is warranted:

1. The project will generate over 100 peak hour trips assigned to a State highway facility.

2. The project will generate between 50 to 100 peak hour trips assigned to a State highway facility, and the affected highway facilities are experiencing noticeable delay; approaching unstable traffic flow (level of service (LOS) "C" or "D") conditions.

3. The project will generate between 1 to 49 peak hour trips assigned to a State highway facility, and the affected highway facilities are experiencing significant delay; unstable or forced traffic flow (LOS "E" or "F") conditions.

In addition to evaluating peak hour trips for the facility, project vehicle trips and hours of operations should be discussed to determine traffic impacts on roadways. Anticipated street routes for construction vehicles should be identified as well.

We recommend using the Department's "*Guide for the Preparation of Traffic Impact Studies*" for determining which scenarios and methodologies to use in the analysis. It is available at the following website address:
http://www.dot.ca.gov/hq/traffops/developserv/operationalsystems/reports/tisguide.pdf

Cultural Resources
If construction activities are proposed within the State's ROW, the Department requires documented results of a current archaeological record search from the Northwest Information Center (NIC) of the California Historical Resources Information System before an encroachment permit can be issued. Current record searches must be no more than five years old.

The Department requires the records search, and if warranted, a cultural resource study by a qualified, professional archaeologist, to ensure compliance with NEPA (if there is federal action on the project), CEQA, Section 5024.5 of the California Public Resources Code (for state-owned historic resources) and Volume 2 of the Department's "*Standard Environmental Reference*" available at http://www.dot.ca.gov/hq/env/index.htm). Work subject to these requirements includes, but is not limited to: lane widening, channelization, auxiliary lanes, and/or modification of existing features such as slopes, drainage features, curbs, sidewalks and driveways within or adjacent to State ROW.

Transportation Permit
Project work that requires movement of oversized or excessive load vehicles on State facilities requires a transportation permit issued by the Department. To apply, a completed transportation permit application with the determined specific route(s) for the shipper to follow from origin to destination must be submitted to the address below.

Office of Transportation Permits
California DOT Headquarters
P.O. Box 942874
Sacramento, CA 94274-0001

See the following website link for more information:
http://www.dot.ca.gov/hq/traffops/permits/.

Encroachment Permit
Any work or traffic control within the State ROW requires an encroachment permit issued by the Department. Traffic-related mitigation measures will be incorporated into the construction plans during the encroachment permit process. See the following website link for more information: http://www.dot.ca.gov/hq/traffops/developserv/permits/

To apply for an encroachment permit, submit a completed encroachment permit application, environmental documentation, and five (5) sets of plans which clearly indicate State ROW to the address at the top of this letterhead, marked ATTN: Michael Condie, Mail Stop #5E.

Water System Improvement Projects
We encourage the San Francisco Planning Department to coordinate with our Project Manager, Howard Reynolds, at 510-286-7252 for all San Francisco Public Utilities Commission Water System Improvement Program (WSIP) Projects.

Should you have any questions regarding this letter, please contact Lisa Courington of my staff at (510) 286-5505 or via email at lisa.ann.courington@dot.ca.gov.

Sincerely,

Lisa Carboni

LISA CARBONI
District Branch Chief
Local Development - Intergovernmental Review

c: State Clearinghouse

WRITTEN COMMENT #3

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY

ARNOLD SCHWARZENEGGER, Governor

DEPARTMENT OF WATER RESOURCES
1416 NINTH STREET, P.O. BOX 942836
SACRAMENTO, CA 94236-0001
(916) 653-5791

July 28, 2009

Mr. Bill Wycko
Environmental Review Officer
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

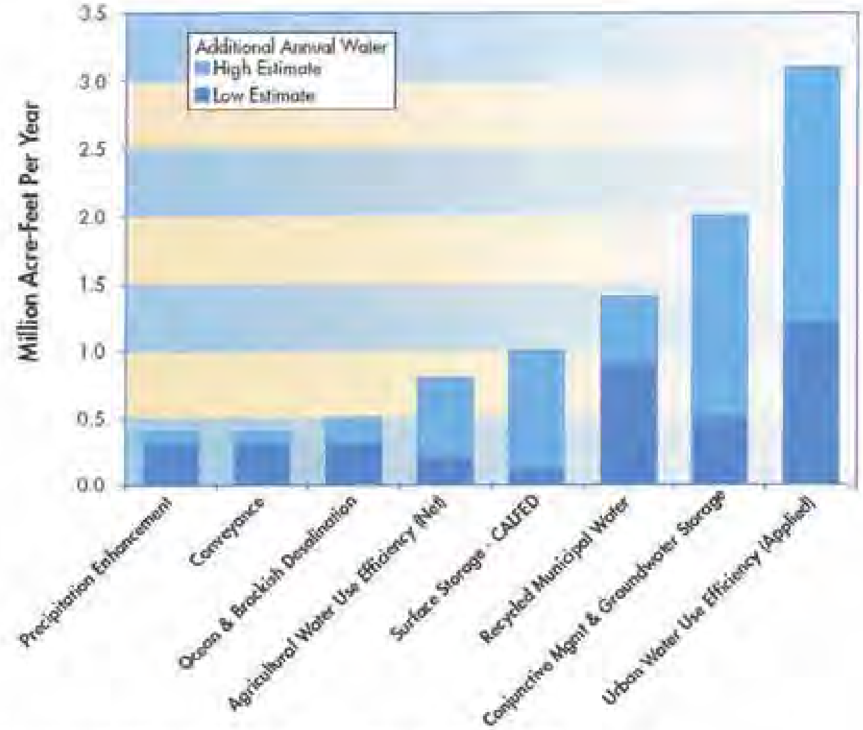
REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT

Dear Mr. Wycko:

The Department of Water Resources (DWR) appreciates the opportunity to express support for the concept of San Francisco Public Utilities Commission's (SFPUC) Regional Groundwater Storage and Recovery Project. DWR is aware SFPUC is currently asking for public comments on the above referenced project as SFPUC will soon begin preparation of a Draft Environmental Impact Report (EIR). It is understood specifically that the EIR will document potential impacts resulting from the use of the South Westside Groundwater Basin (basin) as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods.

The intent of this letter is not to comment specifically on any technical aspects of SFPUC's project but rather to recognize the importance of SFPUC's groundwater storage project and other similar groundwater storage projects that meet the State of California's future water supply needs.

The State of California faces a number of challenges to meet its water supply needs in the future, a growing population, changing land use, and environmental and legal restrictions on diversions from the Delta and Colorado River, not to mention the decreasing snow pack and changed hydrology that will result from climate change. A number of approaches will be needed to meet future demands, including water conservation, recycled water, and desalination. As illustrated below, DWR has identified conjunctive management and groundwater storage as one of the resource management strategies in the California Water Plan Update 2005 for making new water supplies available to meet future 2030 year water demands. In fact, conjunctive management and groundwater projects are projected to play a relatively large role in meeting future demands. Groundwater storage projects will provide flexibility as well as water supply reliability improvements on the local, regional, and statewide levels and may equate to an increase in supply up to 2 million acre-feet per year.



Source: *California State Water Plan Update 2005*

DWR strongly supports and has been working aggressively for the last decade to implement additional groundwater storage through locally driven projects such as SFPUC's project. For this reason, DWR will continue to support and look for potential opportunities to work with SFPUC, other state agencies, and project stakeholders to develop successful groundwater storage projects to meet California's water needs. Furthermore, DWR looks forward to the opportunity to review SFPUC's project as outlined in a future EIR.

If you have any questions or wish to discuss this matter further, please contact Trevor Joseph of my staff at (916) 376-9619.

Sincerely,

for Karl P. Winkler, Chief
North Central Region Office

WRITTEN COMMENT #4

County of San Mateo

Planning & Building Department

455 County Center, 2nd Floor
Redwood City, California 94063
650/363-4161 Fax: 650/363-4849

Mail Drop PLN122
plngbldg@co.sanmateo.ca.us
www.co.sanmateo.ca.us/planning

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CITY & COUNTY OF S.F.
PLANNING DEPARTMENT
MEA

July 23, 2009

Bill Wycko, Environmental Review Officer
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

Dear Mr. Wycko:

SUBJECT: Comments on the San Francisco Public Utilities Commission (SFPUC) Regional Groundwater Storage and Recovery Project

Thank you for the opportunity to comment on the Notice of Preparation of an Environmental Impact Report for the SFPUC Regional Groundwater Storage and Recovery Project. Of the various locations noted in the proposal, two sites located in Broadmoor are within the Unincorporated San Mateo County jurisdiction. As such, the SFPUC is required to submit a project description to the San Mateo County Planning Department for review and determination of General Plan conformity pursuant to Government Code Section 65402.

If you have questions, please do not hesitate to contact Melissa Ross at 650/599-1559 or via email at mross@co.sanmateo.ca.us. Thank you again for the opportunity to review and provide comments on the above referenced project and please continue to include the County Planning Department in the processing of the project.

Sincerely,

Melissa Ross, Planner II

MR:pac – MART0573_WPN.DOC

cc: Lisa Grote, Community Development Director
Jim Eggemeyer, Community Development Deputy Director
Steve Monowitz, Long Range Planning Manager

WRITTEN COMMENT #5

TOWN OF COLMA

1198 El Camino Real • Colma, California • 94014-3212
Tel 650-997-8300 • Fax 650-997-8308

July 28, 2009

Mr. Bill Wycko
Environmental Review Officer
1650 Mission Street
San Francisco, CA. 94103

RE: *Regional Groundwater Storage and Recovery Programs, Notice of Preparation of an Environmental Impact Report and Scoping Meeting – Written Comments*

Dear Mr. Wycko,

Thank you for the opportunity to comment on the Regional Groundwater Storage and Recovery Project. Attached are several concerns and questions that the Town of Colma has in regards to the project.

Please contact Brad Donohue, Deputy Director of Public Works at 650-757-8895 or bdonohue@colma.ca.gov or myself at 650-997-8318, if you have any questions.

Sincerely,

Laura Allen
City Manager

c: Honorable Mayor and Members of the City Council
Roger Peters, City Attorney
Andrea Ouse, City Planner
Rick Mao, City Engineer
Diana Sokolove, SF Planner-Senior Planner

The Town of Colma believes that the following questions are relevant to the environmental impacts of the proposed project, as well as reasonable alternatives and mitigation measures relating to the project, and therefore should be analyzed in the proposed Environmental Impact Report (EIR) for the project.

1. What municipalities are located in the overlying lands of the South Westside Groundwater Basin? In particular, is the Town of Colma located in the overlying lands?

2. What rights do the overlying municipalities, including the Town of Colma, and the residents of and property owners within such municipalities have to the use of groundwater in the South West Groundwater Basin (SWGB)? Under California law, an overlying landowner has the right to reasonable use of groundwater located in an underlying basin, subject to reasonable use by other overlying landowners. In addition, landowners may have other rights to the use of groundwater, consisting of appropriative rights (where the landowner has appropriated water from the basin) and prescriptive rights (where the landowner has used the groundwater with knowledge by other groundwater users).

3. Assuming that the overlying municipalities, including the Town of Colma, the residents of and property owners within such municipalities have the right to use groundwater from the SWGB, based on any of the rights described above, would the project have any effect on such groundwater rights, and if so, what effects would be reasonably likely to occur? In particular, would the storage of water in the SWBG during wet periods have any reasonably-foreseeable effects on the Town of Colma and its residents to the use of the groundwater during such periods, and if so, what would be the effects? Would the recapture of water from the SWBG during dry periods have any reasonably-foreseeable effects on the Town of Colma and its residents to the use of the groundwater during these periods, and if so, what would be the effects?

4. If the project has an adverse effect on the Town of Colma, its residents and property owners to the use of groundwater in the SWBG, what provision, if any, does the City of San Francisco, through its planning department or other agencies, plan to take to avoid or minimize such adverse effects? Does the City of San Francisco plan to design the project in a way that avoids or minimizes such effects, and if so, how? If not, does the City of San Francisco plan to provide compensation to those whose rights have been lost or reduced? Does the City of San Francisco plan to take any other action to prevent or minimize the loss or reduction of such rights?

5. The project description in the Notice of Preparation states that California Water Company would provide the water "in its South San Francisco service area . . . ." Does this service area include the Town of Colma, including residential areas located in the Town of Colma? If not, does the project have an adverse environmental effect by reducing the availability of water supplies provided by California Water Company to the Town of Colma and its residents, thus requiring the Town of Colma and its residents to acquire water from other sources? What other sources are available to the Town of Colma and its residents under such circumstances?

6. It is stated that SF Water (SFPUC), Daly City, San Bruno and Cal Water will be the administrative board overseeing the management of the Westside Basin. Please clarify how that was arranged; does the SFPUC intend to include representatives from the neighboring jurisdictions, public representatives and representatives from already existing irrigators (Cemeteries and golf courses)? Why or why not?

7. What will be the purview of the administrative board? Will there be regulations and administrative rules that will govern both the Board and the SWGB? What type and form of notice and how much time will be given to jurisdictions and direct users of the Basin to review and comment on any administrative regulations that may be proposed?

8. How will the baseline data for existing users, such as irrigators, be determined? For existing irrigators who use groundwater for their agriculture or recreational needs, has it been calculated what their daily/monthly and yearly needs are currently. Has there been an assessment of their future needs, for example the expansion of a cemetery site and what impacts that may have (With the expansion more irrigation will be required). Will the current and future water rights of an established pumper be preserved by their current standard? Does the board (Assuming there will be an oversight committee) have a right to dictate how much water can be pumped and will there be limits?

9. When existing wells need to be replaced, what kind of jurisdiction do the water providers have in the replacement procedures? Currently this is permitted by the County, will there be another approval process that will have oversight in this request?

10. Establishing the various base line quantity numbers that has been posted in the Notice of Preparation is critical to current and future assessments. Please provide the data that establishes the bases of:
    An estimate of how much water is currently being stored.
    How it was determined that 61,000 acre foot of groundwater storage is available in the West Side Basin?
    The 7.2 million gallons a day that would be pumped out in dry years, how was that determined?

How long will it take for the aquifer to be replenished or brought to the desired levels.

11. Is the water in the SWGB to be used for the purposes of supplying residential, commercial, agricultural and recreational needs of those who reside over the basin or are there plans to export the water to communities beyond the underlying limits of the SWGB? If so, will this affect the ability of existing users to access more of the resource in the Basin? Will those jurisdictions that are not Partner Agencies be able to review any agreement made with customers not directly over the Basin?

12. Is there a plan to assemble an agreement (Memorandum of Understanding) between the irrigators, water providers and legislative bodies in each jurisdiction to define the various limits and protections for current and future activities?

13. To replenish the aquifer to the assessed amounts stated in various publications (61,000 acre foot), will this harm or potentially damage whatever is above the basin? In turn when the water table is drawn down, will it potentially cause damage?

14. Will any contaminants that lie in stasis above the water table be disturbed with the possible infiltration of groundwater and will the raising of the groundwater table causing contamination of the water?

15. It was stated in the Scoping Meeting (Public Meeting in SSF) that the aquifer is replenished by rain, streams and irrigation through ground peculation. Since irrigation is very similar to rain and rain has a positive effect on replenishing the water table, have irrigation uses been factored into the calculations in replenishing the water table?

16. The project description has been impermissibly piecemealed by omitting the test wells that will be constructed and operated as part of the Regional Groundwater Storage and Recovery Project. In so far as the Project is already defined and proceeding forward to environmental review, it is not tenable to maintain that the test wells are to collect data for a project that may or may not be proposed in the future. Clearly, here the test wells and rest of the Project are all part of the same reasonably foreseeable "project" under CEQA. Thus, the construction impacts of the test wells should be described. How the test wells will be operated should also be discussed. For instance, will excessive rates of pumping be used to test the stability of the underlying aquifers, and will groundwater levels be "drawn down" to evaluate subsurface hydrogeological conditions? Will this result in a cone of depression affecting nearby groundwater users? Also, what will be done with the quantities of water pumped by the test wells?

17. The project description must include information on distribution system extensions necessary to connect Project facilities to existing distribution lines. Where will these lines be placed, and what aesthetic and construction impacts would result? Will there be lengthy street closures or closures of on-street parking along pipeline rights-of-way, affecting traffic, parking, and emergency response, and will economic impacts on local businesses result in indirect impacts on the physical environment?

18. The NOP mentions that "the Westlake Pump Station in Daly City may need to be upgraded and treatment facilities may need to be added to several well facility sites." Pursuant to CEQA, the environmental impacts of both of these additional Project components should be addressed in the EIR (i.e., the full possible extent of the Project's impacts must be analyzed).

BAWSCA

Bay Area Water Supply & Conservation Agency

July 31, 2008

Mr. Bill Wycko
Environmental Review Officer
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

Subject: **<u>Case No. 2005.0164E</u> – Response to Notice of Preparation (NOP) of an EIR for the SFPUC Regional Groundwater Storage and Recovery Project**

Dear Mr. Wycko,

Thank you for the opportunity to provide the following comments from the Bay Area Water Supply & Conservation Agency (BAWSCA). BAWSCA represents the interests of the 26 water utilities, including an investor-owned utility and a university, that purchase water on a wholesale basis from the San Francisco Regional Water System. These agencies, in turn, provide water to 1.7 million people, businesses and community organizations in Alameda, Santa Clara and San Mateo Counties. These comments are in response to the Notice of Preparation of an Environmental Impact Report (EIR) for the Regional Groundwater Storage and Recovery project dated June 24, 2009. They are intended as input to the scope and focus of the project.

The comments below follow the report organization and do not reflect the level or priority.

1. **Section 5.2 – Project Objectives**
   The EIR should repeat the clarification made on Page 1, Footnote 1 whenever the 8.5 year design drought cycle is discussed.

2. **Section 5.3 – Proposed Project**
   - The EIR should clarify what rules the SFPUC and Participating Pumpers have agreed to that will govern the operation of the proposed project during wet, normal, and dry periods as well as the development of additional groundwater capability to meet future local water supply reliability needs. The EIR should present the detailed operational strategy for the proposed project, including the individual facilities, along with a detailed hydrologic and environmental impact analysis of the proposed project and associated facilities based upon the known operational strategy.
   - The EIR should address the potential for other users of the basin, who are not participating in this project, to affect the overall storage level in the basin and the amount of water potentially available for withdrawal under this project. The EIR should discuss what mechanisms can be implemented to protect the Program Storage against withdrawal by other non-participating pumpers.

155 Bovet Road, Suite 302 • San Mateo, CA 94402 • *ph* 650 349 3000 • *fx* 650 349 8395 • www.bawsca.org

3. **Section 5.3.1 – Groundwater Storage and Recovery**
   - The NOP states "This new dry-year water supply would be made available to both the Partner Agencies and SFPUC wholesale customer under the terms of the Shortage Allocation Plan between the SFPUC and its wholesale customers." The EIR should clarify exactly how this new dry-year water supply would be incorporated into that Plan. If the intent is that the available Program Storage, as quantified by the SFPUC Storage Account, will be taken into consideration by the SFPUC when determining how much water is available for delivery to customer and whether a shortage condition exists, then the EIR should provide this clarity.
   - The EIR should address how the Program Storage and associated project facilities might be used during an emergency, what rules would be applied to such operations, and who the beneficiaries would potentially be.

4. **Section 5.3.2 – Production Wells and Associated Facilities**
   - The EIR should discuss the reason(s) for providing disinfection facilities at each well as disinfection is not necessarily required under Title 22 of the California Code of Regulations.
   - The EIR should specify the type of disinfection method to be used (chlorine or chloramines) and discuss any blending impacts or water quality compatibility issues.

5. **Section 5.3.4 – Operations and Maintenance**
   - The EIR should provide the water supply availability criteria to be used to determine the conditions of a "normal", "wet", and "dry" year associated with the proposed conjunctive use operation. Also, the definition of "excess surface water" that determines the amount of reduced groundwater pumping in normal and wet years needs to be provided.
   - The EIR should define the methods to determine the amount of groundwater in the storage account at any point in time. Also, the basis for estimating underground losses of stored water that is not subsequently available for recapture needs to be explained.

6. **Section 6.0 – Permits and Approvals Required**
   The California Department of Public Health (CDPH) should be added to the list of permitting agencies.

7. **Section 9.1.3 – Hydrology and Water Quality**
   - It is indicated in the documentation for this project that Drinking Water Source Assessments will be performed during pre-design. Will these assessments be available for use in the EIR analysis?
   - The EIR should include a groundwater recovery assessment.
   - The EIR should discuss the lake level management plan for Lake Merced.
   - The EIR should include the site-specific water quality testing data which is required in the pre-design.

- The EIR should include an assessment to determine the ability to meet water quality goals when blending under the planned operational scheme. Project documentation indicates this will be verified from water samples collected from the test wells in the pre-design phase. Will there be sufficient information available at the time of the EIR analysis to confirm that blending is a viable method to achieve water quality goals?
- The EIR should provide the details of the long term monitoring program which will be used to assess changes in local groundwater quality and levels within the South Westside Groundwater Basin as a whole. This program should include the development of a best practices plan to protect the groundwater basin if not already developed.
- Is there any plan for using recycled water in the groundwater basin? If so, then an assessment of potential impacts of this practice should be performed.

8. **Section 9.2 – Alternatives**
If there are alternatives that consider different well locations than those listed in Table 1, the EIR should discuss the siting criteria used to select an alternative well site.

Thank you for the opportunity to provide these comments on the Notice of Preparation dated June 24, 2009 regarding the Regional Groundwater Storage and Recovery project. If you have any questions, please contact me at (650) 349-3000.

Sincerely,

Nicole M. Sandkulla

Nicole M. Sandkulla, P.E.
Senior Water Resources Engineer

cc: G. Bartow, SFPUC Project Manager
A. Jensen, BAWSCA
R. McDevitt, Hanson Bridgett
D. Newkirk, Newkirk Environmental
T. Roberts, Terry Roberts Consulting
File

WRITTEN COMMENT #7

BOLD, POLISNER, MADDOW, NELSON & JUDSON
A PROFESSIONAL CORPORATION
500 YGNACIO VALLEY ROAD, SUITE 325
WALNUT CREEK, CALIFORNIA 94596-3840
TELEPHONE (925) 933-7777
TELEFAX (925) 933-7804

ROBERT B. MADDOW
CARL P. A. NELSON
CRAIG L. JUDSON

SHARON M. NAGLE
DOUGLAS E. COTY

FREDERICK BOLD, JR.
(1913-2003)

July 28, 2009

Mr. Bill Wycko
Environmental Review Officer
San Francisco Planning Department
1650 Mission Street, Suite 400
San Francisco, CA 94103

Re: Regional Groundwater Storage and Recovery Project – Scoping Comments

Dear Mr. Wycko:

This law firm represents the Green Hills Country Club, the Lake Merced Golf Club, the Olympic Club, and the San Francisco Golf Club (the Clubs) with regard to certain water-related matters, including the Regional Groundwater Storage and Recovery Project (Project) being proposed by the San Francisco Public Utilities Commission. This letter constitutes scoping comments by the Clubs for the anticipated environmental impact report (EIR) that will be prepared for the Project.

The Clubs are interested in the proposed Project because they each pump groundwater from the South Westside Basin Groundwater Basin (Aquifer) for a portion of their irrigation water supply, a recognized beneficial use of the available groundwater resource. As overlying property owners, the Clubs each have the legal right to pump that amount of water reasonably needed for their use for irrigation of their property, and their rights are protected against injury by California law. The Clubs recognize the efforts being made by the SFPUC to improve water supplies and water management for the utilities and communities in the region, including increased use of groundwater resources. The Clubs do not oppose the proposed Project, but believe that it should be the subject of full evaluation in the EIR before any portion of it is approved by the SFPUC. The Clubs' comments set forth below should be among the matters taken into account in preparing the EIR.

As the Clubs understand the proposed Project, the SFPUC will deliver imported Hetch Hetchy surface water supplies to municipal water utilities in Daly City, San Bruno, and other communities which pump all or a portion of their water supply from the Aquifer, in an effort to take the place of groundwater during normal and wet years. Approximately 5.4 million gallons per day (mgd) of surface supplies will be substituted for the approximately 6.7 mgd of groundwater that is currently extracted from the Aquifer by the municipal utilities. Irrigation well users will not get substitute supplies.

In dry years, the SFPUC would plan on extracting up to 7.2 mgd from the presumably fuller Aquifer, in addition to the 6.7 mgd that would be extracted by the municipal utilities which are the SFPUC's "partners" in the proposed Project. In other words, although current extractions from the Aquifer in dry years are at the rate of approximately 6.7 mgd, if the Project is approved and fully implemented, a total of 13.9 mgd of groundwater will be pumped. The SFPUC plans are for this higher rate of pumping to be made possible by removal of the increment of additional water that remained in the Aquifer rather than being pumped during the normal to wet years when surface water is provided to the municipal partners. This form of storage and recovery of water from a groundwater basin is commonly called "in-lieu recharge" or "conjunctive use."

Overall, the Clubs' understanding is that the SFPUC's fundamental Project idea is to utilize approximately 60,000 acre-feet (AF) of the estimated 70,000 AF of available groundwater storage in the Aquifer. In addition, the SFPUC apparently wishes to "recover" the estimated 15,000 AF which it asserts has been "stored" during a "pilot study" of this in-lieu process; that study began in approximately 2002. The Clubs understand that the proposed Project includes construction of up to sixteen new extraction wells from 19 preferred sites, which will be spread from Daly City to Millbrae, generally along El Camino Real (Hwy 82). No injection or recharge "spreading" of groundwater is planned as part of this Project. The Project will also include a number of monitoring wells, some of which have already been constructed.

Approximately three test wells will apparently be constructed in 2009-2010, and the SFPUC staff has indicated they will not be part of the EIR. Instead those test wells are deemed by the SFPUC to be categorically exempt from the need to do more detailed environmental documentation. However, the Clubs understand that the test wells will be constructed so as to function as operational wells (and will be at planned extraction well locations), so they will be more fully examined as part of the Project CEQA process. The Clubs believe that it is appropriate to include the test wells in the EIR so that they cannot be placed in full operation until the EIR is certified and the Project is approved.

The Clubs see the following as potentially important issues that should be addressed in the EIR:

1. Protection of Existing Water Rights – The EIR needs to address protection of existing overlying rights and protection of any existing overlying rights that are not currently utilized due to the use of recycled water for irrigation where that is done in areas served by the Aquifer. If the SFPUC seeks to recover the 15,000 AF they have already "stored," the EIR should indicate how the interests of

overlying owners will be protected—i.e., how will the SFPUC assure other pumpers that their water rights will not be impaired by this excess pumping?

2. Protection of Water Quality - Both extremes of this situation (high water levels and low water levels in the Aquifer) can negatively impact water quality. Higher water levels may mobilize minerals and potential contaminants that have been previously stationary. Conversely, the potential for water levels to decline, even temporarily, as a result of the dry year pumping may negatively impact water quality by concentrating contaminants and minerals. There may also be potential for mixing of waters (and minerals) that may not otherwise have occurred, which could be a cause for concern and should be analyzed..

3. Potential Impacts on Wells – Since historic pumping by the municipal utilities (and to a more limited degree by irrigators) has lowered water levels in the Aquifer, one challenge of the Project and especially the EIR is to analyze the potential impacts of refilling the Aquifer in the event of a series of wet or normal years. There is potential for negative impacts to the production wells of pumpers, including the Clubs, particularly during dry years. The Clubs understand that the initial modeling that has been done suggests that only a few municipal wells (1930's-vintage California Water Service Company wells) are expected to be impacted, but that modeling did not address impacts on irrigators. Should water levels be depressed below the screened intervals of the well casings, there is a possibility of long-term well damage. Energy costs for irrigation users of the Aquifer should also be analyzed. Adverse impacts on private wells may require mitigation by the SFPUC, and this needs to be analyzed and disclosed.

4. Location of Wells (Well Interference) - The locations of the new extraction wells proposed by the SFPUC, and any new wells planned by their municipal partners, need to be fully disclosed and analyzed, and included in the draft EIR, with detailed maps. The potential for direct impacts from the effects of the extraction wells is real and needs careful analysis. The results of the analysis to be determined by mutual interference modeling needs to be fully disclosed and analyzed in the EIR and the mitigation plan.

5. Available Aquifer Storage – In all aquifer storage and recovery projects, and particularly in the case of an in-lieu project such as this, there is always the possibility that the ratio of "stored" to future extracted water is not actually or even close to 1:1. There is always the potential for new users. There is also the potential that the "stored" water is simply lost (i.e., the stored water may not stay within the Aquifer, or at least within that portion of it utilized). The actual "usable" available storage may also not be accurate (i.e. the 70,000 AF estimate).

This issue is fraught with the potential for dispute, as many groundwater users experienced in the long fight over the Santa Maria Basin. Careful environmental and technical analysis of the actual storage capacity and the effects of its use are needed before the proposed Project is approved. None of the interested parties would be benefited if inadequate analysis leads to a project that results in conflict and controversy, particularly if it leads to the possibility of a basin adjudication.

6. Cumulative Impacts – The EIR needs to fully analyze the impacts of the proposed Project and other groundwater-related projects in the area, including but not limited to the SFPUC's proposed Lake level restoration project for Lake Merced, the project to pump groundwater at production rates from the North Westside Basin, and the variety of recycled water projects proposed in various portions of the lands overlying the Aquifer. Stormwater management projects being considered in the area, particularly by Daly City, also need to be taken into account, particularly to the extent they may involve detention basins. All of these related types of projects should be considered as elements of a comprehensive integrated water resources management approach to deal with the many challenges facing the SFPUC and the other water agencies in the area

The Clubs appreciate the opportunity to submit these comments on the proposed Project during the scoping phase. The Clubs hope to have the opportunity to participate in future phases of the Project, including possibly serving on an advisory committee of groundwater users if one is formed. If you have any questions about this letter, please contact me or Douglas E. Coty at the address and telephone number shown above.

Very truly yours,

Robert B. Maddow

Robert B. Maddow

RBM:b

cc: Clubs
Joshua D. Milstein, SF City Attorney's Office
Copy sent via e-mail to diana.sokolove@sfgov.org
Copy sent via fax to (415) 558-6409

WRITTEN COMMENT #8

"Mondy Lariz" <mlariz@comcast.net>
07/28/2009 04:17 PM
Please respond to
<mlariz@comcast.net> To
<diana.sokolove@sfgov.org>
cc

bcc

Subject
Regional Groundwater Storage and Recovery Project Scoping Comments

By email to diana.sokolove@sfgov.org

Bill Wycko, Environmental Review Officer
San Francisco Planning Department
1650 Mission St., #400
San Francisco, CA 94103

July 28, 2009

Re: Regional Groundwater Storage and Recovery Project Scoping Comments
--- Case No. 2005.0164E

Dear Mr. Wycho:

I was dismayed to find no mention of Lake Merced in the above referenced document.
Rather than supply additional comments I will simple say that I agree with the comments made by Mr. Cadagan for the Committee to Save Lake Merced.
Thank you considering these comments and working to ensure an adequate CEQA document and project.
Sincerely,

For California Trout
Mondy Lariz
2353 Venndale Ave
San Jose, CA 95124
(408) 358-6963

WRITTEN COMMENT #9

socialchr <socialchr@aol.com>
07/28/2009 04:01 PM To
"diana.sokolove@sfgov.org" <diana.sokolove@sfgov.org>
cc
"Peter Drekmeier" <Peter@Tuolumne.org>, "Bob Hackamack" <jdmack@jps.net>, "mike marshall" <mike@hetchhetchy.org>, "Mondy Lariz" <mlariz@comcast.net>, rrcollins@n-h-i.org, ajensen@bawsca.org, "Bartow, Greg" <GBartow@sfwater.org>
bcc

Subject
Regional Groundwater Storage, etc. Case No. 2005.0164E

Committee to Save Lake Merced
13225 Sylva Lane
Sonora CA 95370
Ph 209-536-9278
Fax 209-536-9378

By Fax to diana.sokolove@sfgov.org

Bill Wycko, Environmental Review Officer
San Francisco Planning Department
1650 Mission St., #400
San Francisco, CA 94103

July 28, 2009

Re: Regional Groundwater Storage and Recovery Project Scoping Comments --- Case No. 2005.0164E

Dear Mr. Wycho:

What follows are the comments of the Committee to Save Lake Merced (the "Committee") on the June 24, 2009 Notice of Preparation (and Project Description and related materials) of an Environmental Impact Report ("EIR") for the San Francisco Public Utilities Commission's Groundwater Storage and Recovery Project (the "Project"). The Committee is a coalition of users of Lake Merced formed in 1993 to address the declining water levels in the lake. The Committee has since 1993 remained active in the efforts to permanently reverse those declining water levels and anticipates remaining active until a final resolution of the lake level issue is reached. Thus, our comments here are primarily directed at matters that relate to Lake Merced water levels. However, we anticipate that one or more organizations concerned with issues affecting the Tuolumne River will also comment on the scope of the EIR for the Project. We are firm supporters of the goals of those organizations and in no fashion do we intend that our comments be inconsistent with the goals of those concerned with the health and welfare of the Tuolumne River.

The Project is a conjunctive use project and, as the NOP points out, was listed as the "Conjunctive Use Project" in the SFPUC's Water System Improvement Program and the related Program Environmental Impact Report. The Committee is fully supportive of conjunctive use of water, but also mindful of the old adage that "the devil is in the details". In this case it can't be determined if there is a devil in the details because there are far too few details in the project description found in the NOP. Some of the more important matters that need to be in the project description before meaningful environmental analysis can be done appear in the numbered paragraphs below.

The primary purpose of an EIR is to "identify significant effects on the environment of a project". The NOP lists in Section 9.1 some of the environmental issues to be addressed, including land use; geology, etc; hydrology and water quality; biological resources; cultural resources; traffic,etc; noise and vibration; and recreational resources. Surprisingly, nowhere in Section 9 of the NOP (or elsewhere in the project description or related material presented at the July 9 scoping meeting) is mention made whatsoever of "Lake Merced" or the "Tuolumne River". It is in those two bodies of water that the potentially truly significant negative environmental effects of the Project might materialize. Being specifically interested in Lake Merced, the Committee notes that it is fairly well acknowledged that a significant contributing factor to the environmentally damaging decline in lake levels during the 80's was excessive pumping from the Westside Basin aquifer. That resulted in an overdraft condition in the aquifer. The Committee does not find comfort in the material currently available that excessive aquifer pumping and resultant aquifer overdraft might not result from operation of the Project thereby causing significant and unnecessary harm to the environment.

It is fundamental to CEQA that an EIR must be prepared with "a sufficient degree of analysis to provide decision makers with information which enables them to make a decision which intelligently takes account of environmental consequences." CEQA Guidelines ¶ 15151. No citation should be needed for the proposition that an EIR cannot meet that test if the description of the project that is the subject of the EIR is fundamentally inadequate. It is possible that SFPUC plans to amplify the project description after the deadline for scoping comments has passed. That would seem inconsistent with the spirit of the scoping process and, in this case, the requirement that at least one scoping meeting be held in connection with projects of statewide, regional or areawide significance. CEQA Guidelines ¶ 15082(ç)(1). In other words, what is the point in having a mandatory scoping procedure if the project description in existence at the time of the scoping meeting and during the scoping comment period is so lacking in basic information?

Based on the foregoing, and taking into the specific comments below on the inadequacy of the detail in the project description, the Committee respectfully submits that the NOP should be withdrawn at this time and reissued only when an adequately detailed project description is submitted by the SFPUC.

A second important purpose of an EIR is to identify alternatives to the project. One possible alternative (maybe better characterized as a "supplement") would be to add as a project feature the injection of stormwater and/or recycled water to the aquifer. Upon informal preliminary inquiry in this regard we were told that geological conditions in the area do not lend themselves to effective use of injection wells. This issue needs to be examined (and discussed in the EIR) in much greater detail, including consideration of using the soon-to-be-made-public groundwater model to determine optimum locations for injecting stormwater and/or recycled water.

We submit the following specific comments, most of which are consistent with our belief that the existing project description in inadequate to allow for meaningful CEQA review in an EIR.

1. The project description lacks definitions of critical terms such as "excess surface water" (¶1.0; p.1), "dry, normal and wet" years (throughout the project description); "sufficient surface water supplies" (¶5.3.1; p.9).

2. The project description lacks adequate information regarding the aquifer in question to give meaning and context to the stated project purposes (¶5.2; p.8). It is stated more than once (e.g. ¶5. 3.1; p.10) that storage in the aquifer will be increased by 61,000 AF "eventually". But neither the total capacity or current storage volume in the aquifer (or relevant portion of the larger Westside Basin aquifer) is given. This project relates to just the South Westside Groundwater Basin which is a part of the larger Westside Groundwater Basin. An earlier study of the entire Westside Groundwater Basin estimated that "on the order of 75,000 acre-feet of available storage" would be available for possible conjunctive use. Luhdorff and Scalmanini, Update of the Conceptualization of the Lake-Aquifer System: Westside Ground-Water Basin, April 2004. These numbers may possibly be reconcilable, but it would be essential for those doing the current environmental study to have up-to-date information on total capacity of the South Westside Groundwater Basin, its current storage situation, and unused capacity for future conjunctive use storage.

3. Related to paragraph 2 immediately above is that fact that SFPUC has plans for groundwater development in the North Westside Groundwater Basin. The current project description should spell out how these two seemingly closely related projects are being integrated.

4. Many of the answers to the specific issues raised above may ultimately be found in the "groundwater storage and recovery agreement" cryptically mentioned in ¶5.3.1 (p.10) and slightly more prominently mentioned in footnote 5 to ¶5.3.4 (p.20). If that agreement is intended to spell out critical questions such as the missing definitions and even more basic questions ---- such as whether pumping in dry years may occur before recharge has occurred ---- then that agreement should be prepared and publicly disclosed before preparation of the EIR. (As noted above, the scoping process should occur after, not before, those critical details are revealed.)

5. The Committee cannot keep current on evolving CEQA law regarding the need to consider climate change in EIRs under CEQA. Regardless of the current state of the law, in this instance it seems essential that climate change be considered in detail given that the project is partially based on the premise that there will be undefined "excess" surface water (presumably referring to Tuolumne River water --- 85% of SFPUC's surface supply) available in the undefined "normal and wet years".

Respectfully Submitted,

Committee to Save Lake Merced

By s/ Jerry Cadagan
Jerry Cadagan

cc. CalTrout
Tuolumne River Trust
Restore Hetch Hetchy
SFPUC
BAWSCA

Tuolumne River Trust

July 28, 2009

Bill Wycko, Environmental Review Officer
San Francisco Planning Department
1650 Mission St., #400
San Francisco, CA 94103

Re: Regional Groundwater Storage and Recovery Project Scoping Comments

Dear Mr. Wycko:

The Tuolumne River Trust appreciates the opportunity to comment on the Notice of Preparation of an Environmental Impact Report for the Groundwater Storage and Recovery Project (Case No. 2005.0164E).

The purpose of the Project is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. The dry year water supply would be made available to the cities of Daly City and San Bruno, the California Water Company in its South San Francisco service area, and SFPUC wholesale water customers.

In general, the Tuolumne River Trust supports the concept of cooperative management of surface water and groundwater to optimize the water demand and supply balance. However, we have concerns that this project could harm the Tuolumne River by increasing diversions in normal and wet years.

Need to Study Impacts on the Tuolumne River

Figure 5 in the Notice of Preparation (Source of Water Supply for Partner Agencies) suggests that the SFPUC would provide an additional 5.4 million gallons of surface water per day (mgd) to its customers in normal and wet years to enable them to reduce groundwater pumping by an equal amount. The EIR needs to identify the source(s) of this additional surface water. It also should define wet, normal and dry years. Assuming most of the additional 5.4 mgd is expected to come from the Tuolumne River, the impacts of increasing diversions should be studied in the Project EIR.

Currently, 60% of the Tuolumne River is used for agricultural and urban uses, and even more water is diverted, causing significant impacts to the river ecosystem. For example, the population of Chinook salmon has declined from more than 100,000 individuals per year prior to dam building, to 18,000 in 2000, to less than 500 in 2008. In its comment letter on the Water System Improvement Program (WSIP) DPEIR dated October 1, 2007, the California Department of Fish and Game (CDFG) stated that lack of adequate instream flows was the primary cause of the decline in anadromous fish. Diverting more water from the Tuolumne would only exacerbate this problem.

The WSIP PEIR attempted to address the impacts on salmon and steelhead of diverting more water from the Tuolumne, however, the analysis was wholly inadequate. The Tuolumne River Trust and other conservation organizations did not issue a legal challenge to the PEIR because we did not want to delay the seismic upgrades to the Hetch Hetchy Water System.

New information about potential impacts to the Tuolumne River from increasing diversions should be included in the CEQA analysis for the Groundwater Storage and Recovery Project. For example, the SFPUC is currently conducting a study of biological resources in the stretch of the Tuolumne downstream of the Hetch Hetchy Reservoir to meet a condition of the 1987 Kirkwood Powerhouse Agreement. Because the study was not completed in time to be included in the WSIP PEIR, it is important that the results of this study be considered as soon as possible. This study is expected to be completed by the end of 2009.

On January 15, 2009, CDFG submitted comments on the San Joaquin Pipeline System Project. They stated:

> "We are concerned, however, that the addition of a new pipeline segment will provide conveyance capacity for increased diversions from the Tuolumne watershed. "To contribute toward meeting the overall program objectives of the WSIP, the SFPUC has designed the SJPL System Project to meet current and future water demand" (Pg. 1-2, DEIR). This implies the SJPL will be integral either now or in the future for conveying additional water supplies which would likely include diversions of about two million gallons per day (mgd) over existing conditions from the Tuolumne River. Be advised that for any activity that will divert or obstruct the natural flow…DFG may require a Lake and Streambed Alteration Agreement (LSAA), pursuant to Section 1600 et seq. of the Fish and Game Code, with the applicant."

CDFG went on to say:

> "In those documents (CDFG comments on the WSIP PEIR), we described in detail the critical and dire condition of native salmonids in the Tuolumne River. We thoroughly outlined the relationship between in-stream flows and native salmonid productivity, as well a the need for decreased, rather than increased, Tuolumne River diversions to sustain native salmonid populations at *high risk of extinction*. Increased diversions of two mgd would also likely worsen conditions for other fish species in the Tuolumne River, and would likely add to cumulative impacts to water quality of the San Joaquin River, that may further impact sensitive species including federally threatened steelhead (see Zimmerman et al. 2008), State and federally endangered Delta smelt (Hypomesus transpacificus), federally threatened southern distinct population segment (DPS) green sturgeon (Acipenser medirostris), and the State candidate longfin smelt (Spirinchus thaleichthys), currently petitioned for endangered status. DFG continues to respectfully request SFPUC consider all other

potential options for meeting increased customer demand until and after the year 2018."

These comments should be addressed in the Project EIR for the Groundwater Storage and Recovery Project.

It should be noted that wet years do not result in "wasted" water. Wet years can provide better flows for juvenile salmon and steelhead, enabling them to get flushed out into the Bay and Ocean in higher numbers. In big water years, such as 1982/83 and 1997/98, the two reservoirs on the Tuolumne River filled to capacity, causing spillage over the dams. As a result of the increased instream flows, the numbers of adult salmon and steelhead returning three years later increased dramatically. However, in 1994, despite the relative abundance of water, most of the River's flow was captured in the two reservoirs to fill them after several years of drought (see attached graph). As a result, the number of returning adult salmon three years later was much smaller than would otherwise have been expected.

The EIR for the Groundwater Storage and Recovery Project should study the impacts of diverting additional water from the Tuolumne on fish populations even in wet and normal years.

Furthermore, requirements for instream flows in the lower Tuolumne are likely to increase as a result of the FERC relicensing process that will begin in 2011 and be completed in 2016.

A recent FERC order on a rehearing request for the 1995 FERC Settlement Agreement acknowledged the existence of steelhead in the lower Tuolumne and the need for them to be addressed. It found that interim measures may be required prior to relicensing. It also determined that within four years an instream flow of 4,000 cfs in the spring would be needed for study purposes and that the instream flow study, including a plan for a temperature model, be developed by MID and TID in consultation with NMFS, FWS and CDFG.

This, and future FERC actions, must be considered in the CEQA analysis for the Groundwater Storage and Recovery Project.

Need to Study the Potential for Using Stormwater Runoff and/or Recycled Water to Enhance Recharge of the Groundwater Basin

In response to CDFG's request that "SFPUC consider all other potential options for meeting increased customer demand," the EIR for the Groundwater Storage and Recovery Project should study the potential for using stormwater runoff and/or recycled water to enhance the recharge of the groundwater basin. This would enable a higher sustainable rate of groundwater use in normal and wet years, thus reducing or eliminating increased diversions from the Tuolumne River.

We believe our concerns are shared by the SFPUC Commission and the San Francisco Planning Commission. SFPUC Resolution No. 08-0200, which approved the WSIP on October 30, 2008, states:

"Further resolved, the San Francisco Public Utilities Commission shall set aggressive water conservation and recycling goals, shall bring short and long-term conservation, recycling and groundwater programs on line at the earliest possible time, and shall undertake every effort to reduce demand and any further diversions from the San Francisco Public Utilities Commission watersheds…"

In a letter dated December 18, 2008 to SFPUC President, Ann Moller Caen and SFPUC General Manager, Ed Harrington, the San Francisco Planning Commission wrote:

"As you know, the Tuolumne River is a precious resource and the City and County of San Francisco should continue to protect it. Thus, the Commission urges the SFPUC to continue to find alternative ways to provide water supply to the service area that do not involve withdrawing additional water off the Tuolumne River."

Thank you for considering our comments.

Sincerely,

Peter Drekmeier

Peter Drekmeier
Bay Area Program Director

<u>Attachments</u>

CDFG WSIP DPEIR comments
CDFG letter dated January 15, 2009
1994 stream flow graph
FERC order on rehearing request
SFPUC Resolution #08-0200
SF Planning Dept. letter dated December 18, 2008

cc: CDFG
SFPUC
SF Planning Commission

RESTORE HETCH HETCHY
YOSEMITE NATIONAL PARK

Please reply to: PO Box 1886
Twain Harte CA 95383-1886
July 28, 2009

Mr. Bill Wycko
Environmental Review Officer
Regional Groundwater Storage and Recovery Project Scoping Comments
San Francisco Planning Department
Sent by email to diana.sokolove@sfgov.org submitted at 3:20 PM

Subject: South Westside Groundwater Basin EIR Scoping

Dear Mr. Wycko:

Restore Hetch Hetchy appreciates the opportunity to provide scoping input for the SFPUC WSIP Regional Groundwater Storage and Recovery Project EIR, Case No. 2005:0164E.

The use of this aquifer for domestic water supply during the design drought is good conjunctive-use, but the concept of replacing the present well water being pumping with surface supply to allow replenishment naturally during normal and wet years without listing the source of that surface water gives the impression that other watersheds will suffer impacts, which are not going to be addressed in this EIR. This is a serious omission that the EIR must address. Because you did not mention the specific source of the "surface water, when available" in your current Notice or Description, immediately makes those involved with the SFPUC source watersheds think the worst—that more water will be drawn from these watersheds for this project. The fear is that offsetting replenishment surface flow were not presented nor mitigation provided for in your department's 2008 PEIR for the WSIP, Case No. 2005.0159E referenced in your Description. They would want those sources to be acknowledged and their impacts shown and mitigation provided for in this project EIR. It would be a mistake not to do so if those assumptions are true.

To calm everyone we ask that you present a water balance in this EIR stating the source of this replacement water proposed and giving a

Tuolumne River at Moccasin in 2018 on a five-year rolling average; the same from Alameda Creek watershed to the Sunol Water Treatment Plant; from the Peninsular watersheds to Tracy WTP; from groundwater pumping inputs; purchases from other water suppliers; amount of Tuolumne River water put into and recovered from San Antonio Reservoir; amount of Tuolumne River diversion put into and recovered from Crystal Springs Reservoir; amount of Tuolumne River water put into and recovered from Pulgas Reservoir; amount traded to and from other water agencies (e.g. EBMUD); amount purchased from other agencies and delivered through the South Bay Aqueduct; the amount rejected from each of the two WTP as part of their normal operation; amount rejected at Livermore Lab water treatment facility; amount rejected by backwash from well water filtration; the amount sold to BAWSCA including "surface water, when available" "in lieu of pumping ground water" for this aquifer project as a separate item; sales within the City of SF; that sold to Lawrence Livermore Lab; that sold to GE nuclear power generation near Sunol; amount sold to or purchased from other government agencies not already included; evaporation from WTPs and storage; transmission losses; losses from meter failure in SF (delivered but not billed or over billed); accretions; water main flushing; fire fighting use and hydrant testing; and system operating spills and releases. The amount sold to GCSD and that served to Moccasin and Early Intake should be stated as separate diversions. Input flows will equal sales and outputs. The amount of 223 mgd total sales goal by 2018 was stated to your Planning Commission for the PEIR on Oct 30, 2008 by SFPUC General Manager, Ed Harrington, during the decision meeting for Case No. 2005.0159E. That amount has never appeared in print and this is the place for it to be stated and explained. That water balance will let everyone know where the surface water replacement flow is coming from for this project. Our expectation is that this water balance will show the well water replacement flow is part of the 223 mgd five-year rolling average goal for 2018.

A second reason we ask for this water balance is for you to explain how the goal of total sales got from 217.3 mgd (calculated from Figure 2.4 on page 2-18 of the DPEIR) to 223 mgd that the Commission accepted. Two mgd of the increase was noted in the WSIP Revision supplement (Chapter 13, Table 13.2, in the Phased WSIP column at page 13-13), but the purpose or reason for it was never given in print, nor was the other 3.7 mgd additional Tuolumne River diversion explained in print that was added by the General Manager just before October 30. This extra amount also needs to be explained. This EIR is the place to explain these increases as well as the source for the 4.5 mgd replacement surface (flow calculated from Figure 5 page 21 of this Description). Is the 4.5 mgd replacement flow part of the 223 mgd rolling average total sales as we expect? Or do you plan to purchase this replacement water from another source? A water balance will answer all these questions and restore our faith in your EIR process.

Although Lake Merced is just north of the study area of the South Westside Groundwater Basin, please discuss the "potential for flow from shallow aquifer/lake system toward the underlying

aquifer from which nearby production wells withdraw water" in the South Westside Groundwater Basin south of Lake Merced (quote from DPEIR page 5.6-15 paragraph two). Also discuss using recycled water, and urban storm runoff after the first flushing rain as sources to raise the level in Lake Merced for this recharge purpose.

The DPEIR lists several golf courses located atop this aquifer that are successfully using recycled water for irrigation (DPEIR page 5.6-8). Discuss the impact on aquifer recovery from conversion to using recycled water for additional golf courses and other irrigated landscapes located over this aquifer that still pump from this aquifer or use system water for irrigation.

Discuss the rate of aquifer refilling as related to less pumping and use of recycled water for irrigation above the aquifer.

Discuss what would be necessary to recharge more of the 75,000 acre feet vacant storage available in this aquifer for drought use (DPEIR p 5.6-25) and the time to accomplish refilling.

Explain how the high nitrate and manganese concentrations in water from this aquifer will be handled during drought when about 7.2 mgd will be added to the diminished surface supply (volume reference is from Section 5.3.2 of this Description and the minerals noted are in section 5.6.1.8 in DPEIR). Will wellhead treatment be used to accomplish reduction of these two chemicals or will blending with system water take care of these problems?

If this is a"Regional" Project, why is the North Basis not included?

Please acknowledging this submission from us at jdmack@jps.net Please mail the author a hard copy of this DEIR and FEIR when each is available.

Sincerely,

Bob Hackamack, P.E.
Chair Water, Power and Restoration Committee

Copy: BAWSCA
Committee to Save Lake Merced
SFPUC
Tuolumne River Trust

305 Fw RHH submissions to Regional Groundwater Storge Recovery Project scopinng
From: Diana Sokolove [diana.sokolove@sfgov.org]
Sent: Tuesday, July 28, 2009 5:36 PM
To: Pat Collins; Carol Kielusiak; schau@rmcwater.com; Lori Wider
Subject: Fw: RHH submissions to Regional Groundwater Storge & Recovery Project scopinng

FYI

----- Forwarded by Diana Sokolove/CTYPLN/SFGOV on 07/28/2009 05:35 PM -----

"Bob & Jean Hackamack" <jdmack@jps.net>

07/28/2009 05:22 PM

To
"'Diana Sokolove'" <diana.sokolove@sfgov.org>

cc
"'mike marshall'" <mike@hetchhetchy.org>, "Bob Hackamack" <jdmack@jps.net>

Subject
RE: RHH submissions to Regional Groundwater Storge & Recovery Project scopinng

Diana: Thanks for your reassuring response that my comments reached you before the deadline. You can tell from the typos in the subject line that I was worried that things might go wrong.

And thanks for your question about a few missing words at the bottom of page 1. Yes two lines dropped off. They are: "detailed water balance for the SFPUC delivery system as a whole. It should contain, as a minimum, how much the diversion goal is from the". Bob H

-----Original Message-----
From: Diana Sokolove [mailto:diana.sokolove@sfgov.org]
Sent: Tuesday, July 28, 2009 4:12 PM
To: Bob & Jean Hackamack
Cc: Bob Hackamack; 'mike marshall'
Subject: Re: RHH submissions to Regional Groundwater Storge & Recovery Project scopinng

Greetings,

Thank you for your comments. In reviewing the comments, it appears as though a few words or sentence may be missing in the transition from page one to page 2. Can you let me know? I combined the files into one Adobe Acrobat file (attached) in an effort to help you answer the question.

(See attached file: Restore Hetch Hetchy_072809.pdf)

Regards,
Diana

Diana Sokolove, Senior Environmental Planner City and County of San Francisco Planning Department Major Environmental Analysis Division 1650 Mission Street, Suite 400 San Francisco, CA 94103
t: 415.575.9046
f: 415.558.6409
e: diana.sokolove@sfgov.org

"Bob & Jean Hackamack" <jdmack@jps.net>

07/28/2009 03:19 PM

To
<diana.sokolove@sfgov.org>

cc
"'mike marshall'" <mike@hetchhetchy.org>, "Bob Hackamack" <jdmack@jps.net>

Subject
RHH submissions to Regional Groundwater Storge & Recovery Project scopinng

Bill Wycko: Attached are two files comprising Restore Hetch Hetchy scoping input for Case No. 2005:0164E. Bob H(See attached file: RHH S Westside Groundwater scopinng p 1, 7-28-09.doc)(See attached file: RHH S Westside Groundwater Scoping p 2 & 3, 7-28-09.doc)

Appendix F
Scoping Meeting Sign-In Sheet

SAN FRANCISCO PLANNING DEPARTMENT

Public Scoping Meeting
Proposed Regional Groundwater Storage and Recovery Project
South San Francisco, CA - July 9, 2009

SIGN-IN SHEET

(Please print)

NAME	AFFILIATION	ADDRESS	PHONE	EMAIL
Peter Drekmeier	TRT	111 New Montgomery St., #205 SF 94105	650-248-8025	Peter@Tuolumne.org
Matt Holt	MWH	2121 N. California Blvd Suite 600, Walnut Creek CA 94596		
Andy Tan	SSF	315 Maple Ave S.S.F CA 94080	(650) 829-6667	
James Carlson		1299 El Camino Real Colma 94014	755 4700	jcarlson@Emanuelsf.org

SAN FRANCISCO PLANNING DEPARTMENT

Public Scoping Meeting
Proposed Regional Groundwater Storage and Recovery Project
South San Francisco, CA - July 9, 2009

SIGN-IN SHEET

(Please print)

NAME	AFFILIATION	ADDRESS	PHONE	EMAIL
MARK ADDIEGO	City of SSF	400 GRAND AVE SSF	650-877-8500	
Steve Davis	City of San Bruno	216 Cypress Ave	650-616-7075	
GARY Batis	City of SSF	550 N Canal SSF	650-877-8550	
PAUL PERKOVIC	MONTARA WATER & SANITARY DISTRICT	P.O. BOX 371149 MONTARA, CA 94037-1149	415-370-3897	PAUL_PERKOVIC@YAHOO.COM
MR & MRS Pedro GONZALEZ	City COUNCIL	400 GRAND AVE	877-8500	
David Canepa	City Council	397 Innsbruck Way #2 DC CA 94015	(650) 992-1165	
BOB MADDOW	GOLF COURSES	ASK SUZANNE GAMBA	925 933 7777	MADDOW@BPMNJ.COM

SAN FRANCISCO PLANNING DEPARTMENT

Public Scoping Meeting
Proposed Regional Groundwater Storage and Recovery Project
South San Francisco, CA - July 9, 2009

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NAME	AFFILIATION	ADDRESS	PHONE	EMAIL
Diana Stephens	League of Women Voters	119 Shipley Ave Daly City 94015		
Rick Crump	DC Planning Com	396 Imperial #305 DC 94015		
LY TENGAN	PRIVATE CITIZEN	637 SPRUCE AVE SSF 94080		
Pradeep Gupta	SSF Plng Comm	68 Nursery Way SSF CA 94080	650-794-1417	
PATRICK SWEETLAND	CITY of DALY CITY	153 LAKE MERCED BLVD DALY CITY CA 94015	650 991-8201	PSWEETLAND@DALYCITY.ORG
Wayne Ross		609 Theresa Dr SSF Ca	650 8718194	
VICTOR WIN	CITY OF (CITIZEN) DALY CITY	56 MAYFIELD AVE DALY CITY 94015		

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NAME	AFFILIATION	ADDRESS	PHONE	EMAIL
Andrea Ouse	Town of Colma	1190 El Camino Real Colma, CA 94014	650 985 2590	andrea.ouse@colma.ca.gov
Brad Donohue	Town of Colma	1188 El Camino Real Colma, CA 94014	650 757-8888	brad.donohue@colma.ca.gov
Trevor Joseph	DWR	3500 Industrial Blvd West Sacramento	916-376 9019	tjoseph@water.ca.gov
[illegible]	SSF	449 Forest View	650-588 3704	
Jeanette Acosta	SSF	276 Country Club Dr	589-7874	-0-
Jim Stark	Lakeshire Acres Imp. Club	124 Country Club Dr SF	731-9600	jesplon@aol.com
[illegible]	Colma	816 Maddux Dr. Colma		

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NAME	AFFILIATION	ADDRESS	PHONE	EMAIL
Melissa Ross	SAN MATEO CO. PLANNING DEPT	455 COUNTY CENTER, 2ND FL REDWOOD CITY, CA 94063	(650) 599-1559	Mross@co.sanmateo.ca.us
Martha Ross		609 Theresa Drive S.S.F. CA 94080	(650) 891-8144	Tia1956@AOL.com
Kathryn Slater-Carter		PO 370321 Montara, CA 94037	650 346-5255	Kathryn.s.c@gmail.com
Steve Leonard	Black & Veatch	38 Westpark Redwood City	925 3242756	LeonardS@BV.com
Audrey Park	SFO Planning + Env. Affairs	PO BOX 8716 SF CA 94128	650.821.7844	audrey.park@flySFO.com
James Griffin		2104 Adeline Dr. Bgame 94010	344-3556	JAGTRMG@ATT.NET
Elizabeth Flegel	EKI	1870 Ogden Drive Burlingame CA 94010	650-292-9100	eflegel@ekiconsult.com

Appendix C

Summary of Impacts Table

Appendix C
Summary of Impacts and Mitigation Measures for the Groundwater Storage and Recovery Project

Impact Statement	Site 1	Site 2	Site 3	Site 4	WLPS	Site 5 (On-site)	Site 5 (Consol)	Site 6 (On-site)	Site 6 (Consol)	Site 7 (On-site)	Site 7 (Consol)	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17 (A)	Site 18 (A)	Site 19 (A)	Mitigation
Section 5.2 Land Use																								
Impact LU-1. Project construction would have a substantial impact on the existing character of the vicinity and could substantially disrupt or displace existing land uses or land use activities.	SUM	LS	SUM	SUM	NI	SUM	LSM	LS	LS	LS	LSM	LS	SUM	LSM	LSM	SUM	LSM	SUM	LSM	SUM	LSM	SUM	SUM	M-LU-1: Maintain Internal Cemetery Access (Site 7 [Consolidated Treatment at Site 6] and Site 14) M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-AQ-2a: BAAQMD Basic Construction Measures (All Sites) M-AQ-3: Construction Health Risk Mitigation (Site 5 On-site Treatment)
Impact LU-2. Project operations would result in substantial long-term or permanent impacts on the existing character or disrupt or displace land uses.	LSM	LS	LS	LS	LSM	LSM	LS	LS	LS	LS	LS	LS	LSM	LS	LS	LS	LS	LS	LS	LS	LS	LSM	LS	M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)
Impact C-LU-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to land use.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	SUM	LS	LS	SUM	LS	LS	LS	LS	LS	LS	SUM	M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)
Section 5.3 Aesthetics																								
Impact AE-1. Project construction would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.	LS	LS	LS	LSM	NI	LS	LS	LS	LS	SUM	SUM	LS	LS	LS	LS	LSM	LSM	LSM	LSM	LS	LS	LSM	LS	M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate]) M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]) M-AE-1c: Develop and Implement at Tree Replanting Plan (Site 12) M-AE-1d: Construction Area Screening (Site 15) M-AE-1e: Tree Removal and Replacement (Site 7) M-CR-1a: Minimize Construction-related Impacts on Elements of the Historical Resource at Site 14
Impact AE-2. Project construction would not create a new source of substantial light that would adversely affect day or nighttime views in the area.	LS	NI	LS	LS	NI	NI	NI	NI	NI	NI	NI	NI	LS	NI	NI	LS	NI	LS	LS	LS	NI	LS	LS	None required
Impact AE-3. Project operation would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings.	LS	LS	LS	LSM	NI	LS	NI	LS	LS	LSM	LSM	LS	LS	LS	LS	LS	LS	LSM	LSM	NI	LS	LSM	LS	M-AE-3a: Implement Landscape Screening (Sites 4, 7, and 18 [Alternate]) M-CR-5a: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14 M-CR-5b: Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 15
Impact AE-4. Project operation would not create a new source of substantial light that would adversely affect day or nighttime views in the area.	LS	LS	LS	LS	NI	LS	LS	NI	NI	NI	NI	NI	LS	LS	NI	LS	LS	LS	LS	LS	NI	LS	LS	None required
Impact C-AE-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to scenic resources and visual character.	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	LS	NI	LS	LSM	LSM	NI	NI	NI	LS	NI	LS	M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate]) M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13,, 14, 15, and 17 [Alternate]) M-AE-1c: Develop and Implement a Tree Planting Program (Site 12)
Section 5.4 Population & Housing - None. No impacts would occur.																								
Section 5.5 Cultural and Paleontological Resources																								
Impact CR-1. Project construction could cause an adverse change in the significance of a historical resource.	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	LS	NI	NI	NI	NI	NI	NI	LSM	LSM	NI	NI	NI	NI	M-CR-1a: Minimize Construction-related Impacts to Elements of the Historical Resources at Site 14 M-CR-1b: Minimize Construction-related Impacts on Elements of the Historical Resources at Site 15 M-NO-2: Reduce Vibration Levels during Construction of Pipelines (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)
Impact CR-2. Project construction could cause an adverse change in the significance of an archaeological resource.	LSM	LSM	LSM	LSM	NI	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-CR-2: Discovery of Archaeological Resources (All Sites except Westlake Pump Station)
Impact CR-3. Project construction could result in a substantial adverse effect by destroying a unique paleontological resource or site.	LSM	LSM	LSM	LSM	NI	LSM	LSM	LSM	LSM	LSM	LSM	LSM	NI	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-CR-3: Suspend Construction Work if a Paleontological Resource is Identified (All Sites except Site 9 and Westlake Pump Station)

Appendix C
Summary of Impacts and Mitigation Measures for the Groundwater Storage and Recovery Project

Impact Statement	Site 1	Site 2	Site 3	Site 4	WLPS	Site 5 (On-site)	Site 5 (Consol)	Site 6 (On-site)	Site 6 (Consol)	Site 7 (On-site)	Site 7 (Consol)	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17 (A)	Site 18 (A)	Site 19 (A)	Mitigation
Impact CR-4. Project construction could result in a substantial adverse effect related to the disturbance of human remains.	LSM	LSM	LSM	LSM	NI	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-CR-4: Accidental Discovery of Human Remains (All Sites except Westlake Pump Station)
Impact CR-5. Project facilities could cause an adverse change in the significance of a historical resource.	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	LS	NI	NI	NI	NI	NI	NI	LSM	LSM	NI	NI	NI	NI	M-CR-5a: Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 14 M-CR-5b: Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 15
Impact C-CR-1. Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains.	LSM	LSM	LSM	LSM	NI	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-CR-2: Discovery of Archaeological Resources (All Sites except Westlake Pump Station) M-CR-3: Suspend Construction Work if a Paleontological Resource is Identified (All Sites except Site 9 and Westlake Pump Station) M-CR-4: Accidental Discovery of Human Remains (All Sites except Westlake Pump Station)
Section 5.6 Transportation and Circulation																								
Impact TR-1. The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system.	LS	LS	LS	LSM	LS	LSM	LSM	LSM	LSM	LSM	LSM	LS	LS	LSM	LS	LSM	LSM	LSM	LSM	LS	LSM	LSM	LSM	M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
Impact TR-2. The Project would temporarily impair emergency access to adjacent roadways and land uses during construction.	NI	LSM	NI	LS	NI	LSM	LSM	LS	LS	LS	LS	NI	NI	LS	NI	LS	LSM	LS	LS	LS	LS	LS	LS	M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
Impact TR-3. The Project would temporarily decrease the performance and safety of public transit, bicycle, and pedestrian facilities during construction.	NI	LS	LS	LS	NI	LS	LS	LS	LS	LS	LS	NI	NI	LS	NI	LSM	LSM	LSM	LSM	LS	LS	LS	LSM	M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
Impact TR-4. Project operations and maintenance activities would not conflict with an applicable plan or policies regarding performance of the transportation system or alternative modes of transportation.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact C-TR-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to transportation and circulation.	LS	LSM	LS	LSM	LS	LSM	LSM	LSM	LSM	LSM	LSM	LS	LS	LSM	LS	LSM	LSM	LSM	LSM	LS	LSM	LSM	LSM	M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-C-TR-1: Coordinate Traffic Control Plan with other SFPUC Construction Projects (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
Section 5.7 Noise and Vibration																								
Impact NO-1. Project construction would result in noise levels in excess of local standards.	SUM	NI	LSM	SUM	NI	NI	NI	NI	NI	LS	LS	LSM	SUM	LSM	LSM	SUM	LSM	LSM	LS	SUM	LSM	SUM	SUM	M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
Impact NO-2. Project construction would result in excessive groundborne vibration.	LS	LS	LSM	LSM	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LSM	LS	LS	LSM	LS	LS	LSM	LS	M-NO-2: Reduce Vibration Levels during Construction of Pipelines (Sites 3, 4, 12, 15, and 18 [Alternate])
Impact NO-3. Project construction would result in a substantial temporary increase in ambient noise levels.	SUM	LS	SUM	SUM	LS	SUM	LSM	LS	LS	LS	LS	LS	SUM	LSM	LSM	SUM	LSM	SUM	LSM	SUM	LSM	SUM	SUM	M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate])
Impact NO-4. Project construction would not result in a substantial temporary increase in ambient noise levels along construction haul routes.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact NO-5. Operation of the Project would result in exposure of people to noise levels in excess of local noise standards or result in a substantial permanent increase in ambient noise levels in the Project vicinity.	LSM	NI	NI	NI	LSM	LSM	NI	LS	LS	LSM	NI	LS	LSM	LS	LS	LSM	LS	NI	NI	LS	LS	LSM	NI	M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)
Impact C-NO-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to noise.	LSM	LS	LS	LS	LSM	LSM	LS	LS	LS	LSM	LS	LSM	LSM	LS	LSM	SUM	LS	LS	LS	LS	LSM	LSM	SUM	M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-3: Expanded Noise Control Plan (1, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)
Section 5.8 Air Quality																								
Impact AQ-1. Construction of the Project would not conflict with or obstruct implementation of applicable air quality plans.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required

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Impact AQ-2. Emissions generated during construction activities would violate air quality standards and would contribute substantially to an existing air quality violation.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-AQ-2a: BAAQMD Basic Construction Measures (All Sites) M-AQ-2b: NOx Reduction during Construction of Alternate Sites
Impact AQ-3. Project construction would expose sensitive receptors to substantial pollutant concentrations.	Group 1: Site 1 = LS Group 2: Sites 2, 3 and 4 = LS Group 3: Sites 5, 6 and 7 (Consolidated Treatment at Site 6) = LS Group 3: Sites 5, 6 and 7 (On-site Treatment) = LSM Group 4: Site 8 and Site 17 (Alternate) = LS Group 5: 9 and 10 and Site 18 (alternate) = LS Group 6: Sites 11 and 12 and Site 19 (Alternate) = LS Group 7: Site 13 = LS Group 8: Sites 14 and 15 = LS Group 9: Site 16 = LS																							M-AQ-3: Construction Health Risk Mitigation (Site 5 [On-site Treatment])
Impact AQ-4. Project construction activities would not create objectionable odors affecting a substantial number of people.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact AQ-5. Project operations would not violate air quality standards or contribute substantially to an existing air quality violation.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact AQ-6. Project operations would not expose sensitive receptors to substantial pollutant concentrations.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact AQ-7. Project operations would not create objectionable odors affecting a substantial number of people.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact C-AQ-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-AQ-2a: BAAQMD Basic Construction Measures (All Sites) M-AQ-2b: NOx Reduction during Construction of Alternate Sites
Section 5.9 Greenhouse Gas Emissions																								
Impact GG-1. Project construction would generate GHG emissions, but not at levels that would have a significant impact on the environment.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact GG-2. Project operations would generate GHG emissions, but not at levels that would result in a significant impact on the environment.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact C-GG. The proposed Project would not result in a cumulatively considerable contribution to GHG emissions.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Section 5.10 Wind & Shadow - None. No impacts would occur.																								
Section 5.11 Recreation																								
Impact RE-1. The Project would not remove or damage existing recreational resources during construction.	LS	NI	LS	LS	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	None required
Impact RE-2. The Project would deteriorate the quality of the recreational experience during construction.	LSM	LSM	LS	LSM	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	NI	LS	NI	NI	NI	NI	NI	NI	M-AQ-2a: BAAQMD Basic Construction Measures (All Sites)
Impact RE-3. The Project would not impair access to recreational resources during construction.	NI	LS	LS	LS	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	NI	LS	NI	NI	NI	NI	NI	NI	None required
Impact RE-4. The Project would not damage recreational resources during operation.	NI	NI	LS	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	None required
Impact RE-5. The Project would not deteriorate the quality of the recreational experience during operation.	LS	NI	LS	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	NI	LS	NI	NI	NI	NI	NI	NI	None required
Impact RE-6. Operation of the Project would not remove or damage recreational resources, impair access to, or deteriorate the quality of the recreational experience at Lake Merced.	LS																							None required
Impact C-RE-1. Construction and operation of the proposed Project would not result in significant cumulative impacts on recreational resources.	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	NI	LS	NI	NI	NI	NI	NI	NI	None required
Impact C-RE-2. Operation of the Project would not result in significant cumulative impacts on recreational resources at Lake Merced.	LS																							None required

Appendix C

Summary of Impacts and Mitigation Measures for the Groundwater Storage and Recovery Project

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Section 5.12 Utilities & Service Systems																								
Impact UT-1. Project construction could result in potential damage to or temporary disruption of existing utilities during construction.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-UT-1a: Confirm Utility Line Information (All Sites) M-UT-1b: Safeguard Employees from Potential Accidents Related to Underground Utilities (All Sites) M-UT-1c: Notify Local Fire Departments (All Sites) M-UT-1d: Emergency Response Plan (All Sites) M-UT-1e: Advance Notification (All Sites) M-UT-1f: Protection of Other Utilities during Construction (All Sites) M-UT-1g: Ensure Prompt Reconnection of Utilities (All Sites) M-UT-1h: Avoidance of Utilities Constructed or Modified by Other SFPUC Projects (All Sites) M-UT-1i: Coordinate Final Construction Plans with Affected Utilities (All Sites)
Impact UT-2. Project construction would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact UT-3. Project construction would not result in adverse effects on solid waste landfill capacity.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact UT-4. Project construction could result in a substantial adverse effect related to compliance with federal, State and local statutes and regulations pertaining to solid waste.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-UT-4: Waste Management Plan (All Sites)
Impact UT-5. Project operation would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact C-UT-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to utilities and service systems.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-UT-1a: Confirm Utility Line Information M-UT-1b: Safeguard Employees from Potential Accidents Related to Underground Utilities M-UT-1c: Notify Local Fire Departments M-UT-1d: Emergency Response Plan M-UT-1e: Advance Notification M-UT-1f: Protection of Other Utilities during Construction M-UT-1g: Ensure Prompt Reconnection of Utilities M-UT-1h: Avoidance of Utilities Constructed or Modified by Other SFPUC Projects M-UT-1i: Coordinate Final Construction Plans with Affected Utilities M-UT-4: Waste Management Plan
Section 5.13 Public Services - None. No impacts would occur.																								
Section 5.14 Biological Resources																								
Impact BR-1. Project construction would adversely affect candidate, sensitive or special-status species.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-BR-1a: Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors (All Sites) M-BR-1b: Protection Measures for Special-status Bats during Tree Removal or Trimming (Sites 1, 3, 4, 7, 10, 11, 12, 15, and 16) M-BR-1c: Protection Measures during Structure Demolition for Special-status Bats (Site 1) M-BR-1d: Monarch Butterfly Protection Measures (Sites 1, 3, 7, 10, and 12)
Impact BR-2. Project construction could adversely affect riparian habitat or other sensitive natural communities.	LSM	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites) M-BR-2 Avoid Disturbance to Riparian Habitat (Site 1)
Impact BR-3. The Project would impact jurisdictional wetlands or waters of the United States	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	LSM	LSM	NI	LSM	NI	NI	NI	NI	NI	NI	NI	NI	M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)
Impact BR-4. Project construction would conflict with local tree preservation ordinances.	NI	NI	LSM	LSM	NI	NI	NI	NI	NI	LSM	LSM	NI	LSM	LSM	LSM	LSM	LSM	LSM	LSM	NI	LSM	LSM	NI	M-BR-4a: Identify Protected Trees (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]) M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]) M-BR-4b: Protected Tree Replacement (Sites 4, 7, 9, 12, 15, and 18 [Alternate])

Appendix C
Summary of Impacts and Mitigation Measures for the Groundwater Storage and Recovery Project

Impact Statement	Site 1	Site 2	Site 3	Site 4	WLPS	Site 5 (On-site)	Site 5 (Consol)	Site 6 (On-site)	Site 6 (Consol)	Site 7 (On-site)	Site 7 (Consol)	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17 (A)	Site 18 (A)	Site 19 (A)	Mitigation
Impact BR-5. Project operations could adversely affect candidate or sensitive special-status species.	LSM	NI	LS	LS	LSM	NI	NI	NI	NI	LSM	LS	NI	NI	LS	LS	LSM	LS	NI	LS	LS	LS	LSM	NI	M-NO-5: Operational Noise Control Measures (Sites 1, 5 [On-site Treatment], 7 [On-site Treatment], 9, 12, 18 [Alternate], and the Westlake Pump Station)
Impact BR-6. Operation of the Project would adversely affect species identified as candidate, sensitive, or special-status wildlife species in local or regional plans, policies, or regulations, or by the CDFW or USFWS.	LS																							None required
Impact BR-7. Operation of the Project could adversely affect sensitive habitat types associated with Lake Merced.	LSM																							M-BR-7: Lake Level Management for Water Level Increases for Lake Merced M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced M-HY-9b: Lake Level Management for Lake Merced
Impact BR-8. Operation of the Project could adversely affect wetland habitats and other waters of the United States associated with Lake Merced.	LSM																							M-BR-8: Lake Level Management for No-Net-Loss of Wetlands for Lake Merced M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced M-HY-9b: Lake Level Management for Lake Merced
Impact BR-9. Operation of the Project could adversely affect native wildlife nursery sites associated with Lake Merced.	LSM																							M-BR-7: Lake Level Management for Water Level Increases for Lake Merced M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced
Impact C-BR-1. Construction and operation of the proposed Project could result in significant cumulative impacts related to biological resources.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-BR-1a: Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors (All Sites) M-BR-1b: Protection Measures for Special-status Bats during Tree Removal or Trimming (Sites 1, 3, 4, 7, 10, 11, 12, 15, and 16) M-BR-1c Protection Measures during Structure Demolition for Special-status Bats (Site 1) M-BR-1d: Monarch Butterfly Protection Measures (Sites 1, 3, 7, 10, 12) M-BR-2: Avoid Disturbance to Riparian Habitat (Site 1) M-BR-4a: Identify Protected Trees (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]) M-AE-1b: Tree Protection Measures (Sites 3, 4, 7, 10. 11, 12, 13, 14, 15, and 17 [Alternate]) M-BR-4b: Protected Tree Replacement (Sites 4, 7, 9, 12, 15, and 18 [Alternate]) M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)
Impact C-BR-2. The Project would result in cumulative construction or operational impacts related to special-status species, riparian habitat, sensitive communities, wetlands, or waters of the United States, or compliance with local policies and ordinances protecting biological resources.	LSM																							M-BR-7: Lake Level Management for Water Level Increases for Lake Merced M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced M-HY-9b: Lake Level Management for Lake Merced
Section 5.15 Geology and Soils																								
Impact GE-1. The Project would not be located on a geologic unit or soil that is unstable, or that would become unstable during construction.	NI	NI	NI	LS	NI	NI	NI	LS	LS	LS	LS	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	LS	NI	None required
Impact GE-2. The Project would not substantially change the topography or any unique geologic or physical features of the site(s).	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact GE-3. The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-GE-3: Conduct Site-Specific Geotechnical Investigations and Implement Recommendations (All Sites)
Impact GE-4. The Project would be located on a geologic unit or soil that is unstable, or that would become unstable.	LSM	LS	LS	LS	LS	LSM	LSM	LS	LS	LS	LS	LSM	LS	LS	LS	LSM	LSM	LSM	LSM	LSM	LSM	LS	LSM	M-GE-3: Conduct Site-Specific Geotechnical Investigation and Implement Recommendations (All Sites)
Impact GE-5. The Project would not be located on corrosive or expansive soil, creating substantial risks to life or property.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact C-GE-1. Construction and operation of the proposed Project could result in significant impacts related to soils and geology.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Section 5.16 Hydrology & Water Quality																								
Impact HY-1. Project construction activities would degrade water quality as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals during construction.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)
Impact HY-2. Discharge of groundwater could result in minor localized flooding, violate water quality standards, and/or otherwise degrade water quality.	LSM	LSM	LSM	LSM	NI	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-HY-2: Management of Well Development and Pump Testing Discharges (All Sites, Except Westlake Pump Station)

Appendix C
Summary of Impacts and Mitigation Measures for the Groundwater Storage and Recovery Project

Impact Statement	Site 1	Site 2	Site 3	Site 4	WLPS	Site 5 (On-site)	Site 5 (Consol)	Site 6 (On-site)	Site 6 (Consol)	Site 7 (On-site)	Site 7 (Consol)	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17 (A)	Site 18 (A)	Site 19 (A)	Mitigation
Impact HY-3. Project operation would not alter drainage patterns in such a manner that could result in degraded water quality or cause on- or off-site flooding.	LS	LS	LS	LS	NI	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact HY-4. Project operations would not impede or redirect flood flows.	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	None required
Impact HY-5. Project operations would not result in a violation of water quality standards or in the degradation of water quality from the discharge of groundwater during well maintenance.	LS	LS	LS	LS	NI	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact HY-6. Project operations would decrease the production rate of existing nearby irrigation wells due to localized groundwater drawdown within the Westside Groundwater Basin such that existing or planned land use(s) may not be fully supported.	SUM																							M-HY-6: Ensure Existing Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation
M-HY-6. Mitigation Action #1: Improve Irrigation Efficiency, and Mitigation Action #2: Modify Irrigation Operations	NI = Land Use, Aesthetics, Population and Housing, Cultural and Paleontological Resources, Transportation and Circulation, Noise and Vibration, Air Quality, Greenhouse Gas Emissions, Wind and Shadow, Recreation, Utilities and Service Systems, Public Services, Biological Resources, Geology and Soils, Hydrology and Water Quality, Hazards and Hazardous Materials, Mineral and Energy Resources, Agriculture and Forest Resources																							None required
M-HY-6. Mitigation Action #3: Redistribute GSR Pumping	NI = Land Use, Aesthetics, Population and Housing, Cultural and Paleontological Resources, Transportation and Circulation, Noise and Vibration, Air Quality, Greenhouse Gas Emissions, Wind and Shadow, Recreation, Utilities and Service Systems, Public Services, Biological Resources, Geology and Soils, Hazards and Hazardous Materials, Mineral and Energy Resources, Agriculture and Forest Resources LS = Hydrology and Water Quality																							None required
M-HY-6. Mitigation Action #4: Reduce GSR Pumping	NI = Land Use, Aesthetics, Population and Housing, Cultural and Paleontological Resources, Transportation and Circulation, Noise and Vibration, Air Quality, Greenhouse Gas Emissions, Wind and Shadow, Recreation, Utilities and Service Systems, Public Services, Biological Resources, Geology and Soils, Hydrology and Water Quality, Hazards and Hazardous Materials, Mineral and Energy Resources, Agriculture and Forest Resources																							None required
M-HY-6. Mitigation Action #5: Lower Pump in Irrigation Well and Mitigation Action #6: Lower and Change Pump in Irrigation Well	NI = Population and Housing, Cultural and Paleontological Resources, Wind and Shadow, Utilities and Service Systems, Public Services, Biological Resources, Geology and Soils, Hydrology and Water Quality, Mineral and Energy Resources, Agriculture and Forest Resources LS = Land Use, Transportation and Circulation, Noise and Vibration, Greenhouse Gas Emissions, Recreation LSM = Aesthetics, Air Quality, Hazards and Hazardous Materials																							M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate]) M-AQ-2a: BAAQMD Basic Construction Measures (All Sites) M-HY-1: Develop and Implement a Stormwater Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)

Appendix C

Summary of Impacts and Mitigation Measures for the Groundwater Storage and Recovery Project

Impact Statement	Site 1	Site 2	Site 3	Site 4	WLPS	Site 5 (On-site)	Site 5 (Consol)	Site 6 (On-site)	Site 6 (Consol)	Site 7 (On-site)	Site 7 (Consol)	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17 (A)	Site 18 (A)	Site 19 (A)	Mitigation
M-HY-6. Mitigation Action #7: Add Storage Capacity for Irrigation Supply	NI = Population and Housing, Wind and Shadow, Public Services LS = Transportation and Circulation, Greenhouse Gas Emissions, Recreation, and Agriculture and Forest Resources, Mineral and Energy Resources LSM = Land Use, Aesthetics, Cultural and Paleontological Resources, Noise and Vibration Air Quality, Utilities and Service Systems, Biological Resources, Geology and Soils, Hydrology and Water Quality, Hazards and Hazardous Materials																							M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate]) M-AE-3a: Implement Landscape Screening (Sites 4, 7, and 18 [Alternate]) M-AQ-2a: BAAQMD Basic Construction Measures (All Sites) M-CR-2: Discovery of Archaeological Resources (All Sites except Westlake Pump Station) M-CR-3: Suspend Construction Work if a Paleontological Resource is Identified (All Sites except Site 9 and Westlake Pump Station) M-CR-4: Accidental Discovery of Human Remains (All Sites Except Westlake Pump Station) M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-2: Reduce Vibration Levels during Construction of Pipelines (Sites 3, 4, 12, 15, and 18 [Alternate]) M-UT-1a: Confirm Utility Line Information (All Sites) M-UT-1b: Safeguard Employees from Potential Accidents Related to Underground Utilities (All Sites) M-UT-1c: Notify Local Fire Departments (All Sites) M-UT-1d: Emergency Response Plan (All Sites) M-UT-1e: Advance Notification (All Sites) M-UT-1f: Protection of Other Utilities during Construction (All Sites) M-UT-1g: Ensure Prompt Reconnection of Utilities (All Sites) M-UT-1h: Avoidance of Utilities Constructed or Modified by Other SFPUC Projects (All Sites) M-UT-1i: Coordinate Final Construction Plans with Affected Utilities (All Sites) M-UT-4: Waste Management Plan (All Sites) M-BR-1a: Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors (All Sites) M-BR-1b: Protection Measures for Special-status Bats during Tree Removal or Trimming (Sites 1, 3, 4, 7, 10, 11, 12, 15, and 16) M-BR-4a: Identify Protected Trees (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]) M-BR-4b: Protected Tree Replacement (Sites 4, 7, 9, 12, 15, and 18 [Alternate]) M-HY-1: Develop and Implement a Stormwater Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites) M-GE-3: Conduct Site-Specific Geotechnical Investigations and Implement Recommendations (All Sites) M-HZ-2a: Preconstruction Hazardous Materials Assessment (All Sites) M-HZ 2b: Health and Safety Plan (All Sites) M-HZ-2c: Hazardous Materials Management Plan (All Sites)
M-HY-6. Mitigation Action #8: Replace Irrigation Well	NI = Population and Housing, Wind and Shadow, Public Services LS = Transportation and Circulation, Greenhouse Gas Emissions, Recreation, Agriculture and Forest Resources, Geology and Soils, Mineral and Energy Resources LSM = Land Use, Aesthetics, Cultural and Paleontological Resources, Air Quality, Utilities and Service Systems, Biological Resources, Hydrology and Water Quality, Hazards and Hazardous Materials SUM = Noise and Vibration																							M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate]) M-AE-3a: Implement Landscape Screening (Sites 4, 7, and 18 [Alternate]) M-AQ-2a: BAAQMD Basic Construction Measures (All Sites) M-CR-2: Discovery of Archaeological Resources (All Sites except Westlake Pump Station) M-CR-3: Suspend Construction Work if a Paleontological Resource is Identified (All Sites Except Site 9 and Westlake Pump Station) M-CR-4: Accidental Discovery of Human Remains (All Sites Except Westlake Pump Station) M-TR-1: Traffic Control Plan (Sites 2, 4, 5, 6, 7, 10, 12, 13, 14, 15, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-1: Noise Control Plan (1, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 [Alternate], 18 [Alternate], and 19 [Alternate]) M-NO-2: Reduce Vibration Levels during Construction of Pipelines (Sites 3, 4, 12, 15, and 18 [Alternate]) M-UT-1a: Confirm Utility Line Information (All Sites) M-UT-1b: Safeguard Employees from Potential Accidents Related to Underground Utilities (All Sites) M-UT-1c: Notify Local Fire Departments (All Sites) M-UT-1d: Emergency Response Plan (All Sites) M-UT-1e: Advance Notification (All Sites) M-UT-1f: Protection of Other Utilities during Construction (All Sites) M-UT-1g: Ensure Prompt Reconnection of Utilities (All Sites) M-UT-1h: Avoidance of Utilities Constructed or Modified by Other SFPUC Projects (All Sites) M-UT-1i: Coordinate Final Construction Plans with Affected Utilities (All Sites) M-UT-4: Waste Management Plan (All Sites) M-BR-1a: Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors (All Sites) M-BR-1b: Protection Measures for Special-status Bats during Tree Removal or Trimming (Sites 1, 3, 4, 7, 10, 11, 12, 15, and 16) M-BR-4a: Identify Protected Trees (Sites 3, 4, 7, 10, 11, 12, 13, 14, 15, and 17 [Alternate]) M-BR-4b: Protected Tree Replacement (Sites 4, 7, 9, 12, 15, and 18 [Alternate]) M-HY-1: Develop and Implement a Stormwater Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites) M-HZ-2a: Preconstruction Hazardous Materials Assessment (All Sites) M-HZ 2b: Health and Safety Plan (All Sites) M-HZ-2c: Hazardous Materials Management Plan (All Sites)

Appendix C
Summary of Impacts and Mitigation Measures for the Groundwater Storage and Recovery Project

Impact Statement	Site 1	Site 2	Site 3	Site 4	WLPS	Site 5 (On-site)	Site 5 (Consol)	Site 6 (On-site)	Site 6 (Consol)	Site 7 (On-site)	Site 7 (Consol)	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17 (A)	Site 18 (A)	Site 19 (A)	Mitigation
M-HY-6. Mitigation Action #9: Replace Irrigation Water Source	NI = Population and Housing, Cultural and Paleontological Resources, Wind and Shadow, Utilities and Service Systems, Public Services, Biological Resources, Geology and Soils, Hydrology and Water Quality, Hazards and Hazardous Materials, Mineral and Energy Resources, Agriculture and Forest Resources LS = Land Use, Transportation and Circulation, Noise and Vibration, Greenhouse Gas Emissions, Recreation LSM = Aesthetics, Air Quality																							M-AE-1a: Site Maintenance (Sites 4, 7, 12, 13, 14, 15, and 18 [Alternate]) M-AQ-2a: BAAQMD Basic Construction Measures (All Sites)
Impacts of M-HY-9b: Lake Level Management for Lake Merced	LS = Well Interference, Subsidence, Seawater Intrusion, Adverse Effects on Beneficial Uses of Lake Merced, Water Quality Standards, Groundwater Depletion																							None required
Impact HY-7. Project operations would not result in substantial land subsidence due to decreased groundwater levels in the Westside Groundwater Basin where the historical low water levels are exceeded.	LS																							None required
Impact HY-8. Project operations could result in seawater intrusion due to decreased groundwater levels in the Westside Groundwater Basin.	LS																							None required
Impact HY-9. Project operations could have a substantial, adverse effect on water quality that could affect the beneficial uses of Lake Merced.	LSM																							M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced M-HY-9b: Lake Level Management for Lake Merced
Impact HY-10. Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Pine Lake.	LS																							None required
Impact HY-11. Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Colma Creek, San Bruno Creek, Lomita Channel, or Millbrae Creek.	LS																							None required
Impact HY-12. Project operation would not cause a violation of water quality standards due to mobilization of contaminants in groundwater from changing groundwater levels in the Westside Groundwater Basin.	LS																							None required
Impact HY-13. Project operation would not result in degradation of drinking water quality or groundwater quality relative to constituents for which standards do not exist.	LS																							None required
Impact HY-14. Project operation may have a substantial adverse effect on groundwater depletion in the Westside Groundwater Basin over the very long term.	LSM																							M-HY-14: Prevent Groundwater Depletion
Impact C-HY-1. Project construction could result in a cumulatively considerable contribution to cumulative impacts on surface water hydrology and water quality.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites) M-HY-2: Management of Well Development and Pump Testing Discharges (All Sites except Westlake Pump Station)
Impact C-HY-2. Operation of the proposed Project would result in a cumulatively considerable contribution to cumulative impacts related to well interference.	SUM																							M-HY-6: Ensure Irrigators' Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation
Impact C-HY-3. Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to subsidence.	LS																							None required
Impact C-HY-4. Operation of the proposed Project would not have a cumulatively considerable contribution to seawater intrusion.	LS																							None required
Impact C-HY-5. Operation of the proposed Project could have a cumulatively considerable contribution to cumulative impacts on beneficial uses of surface waters.	LSM																							M-HY-9a: Lake Level Monitoring and Modeling for Lake Merced M-HY-9b: Lake Level Management for Lake Merced
Impact C-HY-6. Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality standards	LS																							None required

Impact Statement	Site 1	Site 2	Site 3	Site 4	WLPS	Site 5 (On-site)	Site 5 (Consol)	Site 6 (On-site)	Site 6 (Consol)	Site 7 (On-site)	Site 7 (Consol)	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17 (A)	Site 18 (A)	Site 19 (A)	Mitigation
Impact C-HY-7. Operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to water quality degradation.	LS																							None required
Impact C-HY-8. Operation of the proposed Project would have a cumulatively considerable contribution to a cumulative impact related to groundwater depletion effect.	LSM																							M-HY-14: Prevent Groundwater Depletion
Section 5.17 Hazards and Hazardous Materials																								
Impact HZ-1. The Project would not create a significant hazard to the public or the environment related to transport, use, or disposal of hazardous materials during construction.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact HZ-2. The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-HZ-2a: Preconstruction Hazardous Materials Assessment (All Sites) M-HZ 2b: Health and Safety Plan (All Sites) M-HZ-2c: Hazardous Materials Management Plan (All Sites) M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)
Impact HZ-3. The Project would result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during construction.	NI	LSM	LSM	LSM	LSM	LS	LS	LS	LS	NI	NI	NI	LS	LS	NI	LS	LS	NI	NI	NI	NI	LS	LSM	M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites) M-HZ-2c: Hazardous Materials Management Plan (All Sites)
Impact HZ-4. The Project would not create a hazard to the public or environment from the routine transport, use, or disposal of hazardous materials or accidental release of hazardous materials during operation.	LS	NI	NI	NI	LS	LS	NI	LS	LS	LS	NI	LS	LS	LS	LS	LS	LS	NI	LS	LS	LS	LS	NI	None required
Impact HZ-5. The Project would not result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during operation.	NI	NI	NI	NI	LS	LS	NI	NI	NI	NI	NI	NI	LS	LS	NI	LS	LS	NI	NI	NI	NI	LS	NI	None required
Impact HZ-6. The Project would not result in a safety hazard for people residing or working in the vicinity of a public use airport.	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	LS	LS	LS	LS	LS	LS	LS	LS	NI	LS	LS	None required
Impact HZ-7. The Project would not expose people or structures to a significant risk of loss, injury, or death involving fires.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact C-HZ-1. Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials.	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	LSM	M-HZ-2a: Preconstruction Hazardous Materials Assessment (All Sites) M-HZ 2b: Health and Safety Plan (All Sites) M-HZ-2c: Hazardous Materials Management Plan (All Sites) M-HY-1: Develop and Implement a Storm Water Pollution Prevention Plan (SWPPP) or an Erosion and Sediment Control Plan (All Sites)
Section 5.18 Mineral and Energy Resources																								
Impact ME-1. The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during construction.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact ME-2. The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during operation.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Impact C-ME-1. Construction and operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to mineral and energy resources.	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	LS	None required
Section 5.19 Agriculture and Forest Resources - None. No impacts would occur.																								

Appendix D

Mitigation Measure Consistency with the WSIP PEIR

APPENDIX D:
WSIP PEIR WATER SUPPLY IMPACT AND MITIGATION AND CONSISTENCY ANALYSIS

SFPUC REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT (CASE NO. 2008.1396E)

The Regional Groundwater Storage and Recovery project (GSR or proposed Project) was analyzed at a program-level in the Water System Improvement Program (WSIP) Program Environmental Impact Report (PEIR)[1] as one of the facility improvement projects under the WSIP. The project details presented in the PEIR were based on the best information available at that time with respect to project design and construction. Details regarding project design, facility layout, construction, staging areas, and other project elements were not available at the time the PEIR was prepared.

The GSR EIR provides a detailed, project-level analysis of the proposed Project based on site-specific and up-to-date information developed subsequent to the preparation of the PEIR. Subsequent to publication of the PEIR, several modifications were made to the GSR Project as more detailed information regarding Project impacts was developed during Project design and site-specific analyses. Although the use of the Westside Groundwater Basin for the GSR Project was identified and analyzed in the PEIR, the location of each proposed well was not specifically identified in the PEIR. Additionally, the analysis of potential impacts of three alternate well sites is included in the project-level EIR to ensure that a total 16 out of 19 possible well sites could be operated, in the case where up to three of the preferred sites were found to be infeasible. However, the Project would only operate a total of 16 wells. Alternate pipeline connections, as well as on-site and consolidated treatment options for three well facilities, are also addressed in the EIR.

Tables D-1a through D-1e summarize the WSIP water supply and system operations impacts and the associated mitigation measures for each geographic region as presented in the PEIR. The reader is referred to the complete WSIP PEIR for a detailed explanation of these summary tables. Note that the categories of significance used in the PEIR are slightly different than those used in this EIR (see table footnotes in Tables D-1a through D-1e).

Table D-2 evaluates the consistency of the project-level impact analysis in the Groundwater Storage and Recovery EIR with the program-level impact analysis previously conducted in the PEIR. Where significance determinations vary between these documents, a brief explanation of the rationale for this determination is provided.

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[1] San Francisco Planning Department, Final Program Environmental Impact Report for the San Francisco Public Utilities Commission's Water System Improvement Program, File No. 2005-0159E, State Clearinghouse No. 2005092026. Certified October 30, 2008.

Table D-3 lists the programmatic mitigation measures identified in the WSIP PEIR and indicates which of these mitigation measures are applicable to the GSR Project. For the programmatic mitigation measures that are applicable, the table identifies the comparable project-level mitigation measure identified in the GSR Project EIR that either relies on the programmatic measures or identified an equivalent or better site-specific mitigation measure to address the programmatic mitigation measure. The table also provides an explanation for those programmatic mitigation measures that are not applicable to the GSR Project.

TABLE D-1a
Summary of Water Supply Impacts and Mitigation Measures—Tuolumne River System and Downstream Water Bodies

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
STREAM FLOW						
Impact 5.3.1-1: Effects on flow along the Tuolumne River below O'Shaughnessy Dam.	LS					None required.
Impact 5.3.1-2: Effects on flow along Cherry Creek below Cherry Dam.	LS					None required.
Impact 5.3.1-3: Effects on flow along Eleanor Creek below Eleanor Dam.	LS					None required.
Impact 5.3.1-4: Effects on flow along the Tuolumne River below La Grange Dam.	LS					None required.
Impact 5.3.1-5: Effects on flow along the San Joaquin River and the Sacramento–San Joaquin Delta.	LS					None required.
GEOMORPHOLOGY						
Impact 5.3.2-1: Effects on sediment transport and channel characteristics between O'Shaughnessy Dam and Don Pedro Reservoir.	LS					None required.

TABLE D-1a
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Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
Impact 5.3.2-2: Effects on sediment transport and channel characteristics below La Grange Dam.	LS					None required.
SURFACE WATER QUALITY						
Impact 5.3.3-1: Effects on water quality in Hetch Hetchy Reservoir and along the Tuolumne River below O'Shaughnessy Dam.	LS					None required.
Impact 5.3.3-2: Effects on water quality in Don Pedro Reservoir and along the Tuolumne River below La Grange Dam.	LS					None required.
Impact 5.3.3-3: Effects on water quality along the San Joaquin River and the Sacramento–San Joaquin Delta.	LS					None required.
SURFACE WATER SUPPLIES						
Impact 5.3.4-1: Effects on Tuolumne River, San Joaquin River, and Stanislaus River water users.	LS					None required.
Impact 5.3.4-2: Effects on Delta water users.	LS					None required.

TABLE D-1a
Summary of Water Supply Impacts and Mitigation Measures—Tuolumne River System and Downstream Water Bodies

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
GROUNDWATER						
Impact 5.3.5-1: Alteration of stream flows along the Tuolumne River, which could affect local groundwater recharge and groundwater levels.	LS					None required.
Impact 5.3.5-2: Alteration of stream flows along the Tuolumne River, which could affect local groundwater quality.	LS					None required.
FISHERIES						
Impact 5.3.6-1: Effects on fishery resources in Hetch Hetchy Reservoir.	LS					None required.
Impact 5.3.6-2: Effects on fishery resources along the Tuolumne River between Hetch Hetchy Reservoir and Don Pedro Reservoir.	LS					None required.
Impact 5.3.6-3: Effects on fishery resources in Don Pedro Reservoir.	LS					None required.

TABLE D-1a
Summary of Water Supply Impacts and Mitigation Measures—Tuolumne River System and Downstream Water Bodies

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
Impact 5.3.6-4: Effects on fishery resources along the Tuolumne River below La Grange Dam.	LS when average annual deliveries from the watersheds are maintained at 265 mgd or less; PSM if deliveries exceed 265 mgd					**Measure 5.3.6-4a, Avoidance of Flow Changes by Reducing Demand for Don Pedro Reservoir Water:** The SFPUC will pursue a water transfer arrangement with MID/TID and/or other water agencies which would offset the WSIP's effects on water storage in Don Pedro Reservoir and minimize WSIP-induced changes in releases from La Grange Dam. **If Measure 5.3.6-4a proves to be infeasible, the SFPUC will implement Measure 5.3.6-4b. **Measure 5.3.6-4b, Fishery Habitat Enhancement:** The SFPUC will implement or fund one of two fishery habitat enhancement projects that are consistent with the Lower Tuolumne River Restoration Plan; augmentation of spawning gravel at three selected sites or the filling or isolation from the river of one of the existing inactive quarry pits.
Impact 5.3.6-5: Effects on fishery resources along the San Joaquin River.	LS					None required.

TABLE D-1a
Summary of Water Supply Impacts and Mitigation Measures—Tuolumne River System and Downstream Water Bodies

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
TERRESTRIAL BIOLOGY						
Impact 5.3.7-1: Impacts on riparian habitat and related biological resources in Hetch Hetchy Reservoir and along the bedrock channel portions of the Tuolumne River from O'Shaughnessy Dam to Don Pedro Reservoir.		LS	LS	LS	LS	None required.
Impact 5.3.7-2: Impacts on alluvial features that support meadow and riparian habitat along the Tuolumne River from O'Shaughnessy Dam to Don Pedro Reservoir.		PSM	PSM	PSM	PSM	The SFPUC will implement Measure 5.3.7-2 to reduce adverse impacts on sensitive habitats, key special-status species, other species of concern, and common habitats and species to a less-than-significant level. **Measure 5.3.7-2, Controlled Releases to Recharge Groundwater in Streamside Meadows and Other Alluvial Deposits:** The SFPUC will manage releases to the Tuolumne River from Hetch Hetchy Reservoir during the spring with the goal of recharging groundwater that supports meadow and riparian habitat. The SFPUC will periodically survey meadow habitat to determine the efficacy of release management and will modify releases as necessary to sustain meadow habitat.
Impact 5.3.7-3: Impacts on biological resources in Lake Eleanor and along Eleanor Creek.		LS	LS	LS	LS	None required.

TABLE D-1a
Summary of Water Supply Impacts and Mitigation Measures—Tuolumne River System and Downstream Water Bodies

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
Impact 5.3.7-4: Impacts on biological resources in Lake Lloyd and along Cherry Creek.		LS	LS	LS	LS	None required.
Impact 5.3.7-5: Impacts on biological resources in Don Pedro Reservoir.		LS	LS	LS	LS	None required.
Impact 5.3.7-6: Impacts on biological resources along the Tuolumne River below La Grange Dam.		LS when average annual deliveries from the watersheds are maintained at 265 mgd or less; PSM if deliveries exceed 265 mgd	LS when average annual deliveries from the watersheds are maintained at 265 mgd or less; PSM if deliveries exceed 265 mgd	LS when average annual deliveries from the watersheds are maintained at 265 mgd or less; PSM if deliveries exceed 265 mgd	LS when average annual deliveries from the watersheds are maintained at 265 mgd or less; PSM if deliveries exceed 265 mgd	The SFPUC will implement Measures 5.3.6-4a or 5.3.7-6 to reduce adverse impacts on sensitive habitats, key special-status species, other species of concern, and common habitats and species to a less-than-significant level. **Measure 5.3.6-4a, Avoidance of Flow Changes by Reducing Demand for Don Pedro Reservoir Water** – see description above. **If Measure 5.3.6-4a proves to be infeasible, the SFPUC will implement Measure 5.3.7-6. **Measure 5.3.7-6, Lower Tuolumne River Riparian Habitat Enhancement:** Consistent with the Lower Tuolumne River Restoration Plan, the SFPUC will protect and enhance one mile of riparian vegetation within the contemporary floodplain.
Impact 5.3.7-7: Conflicts with the provisions of adopted conservation plans or other approved biological resources plans for the Tuolumne Wild and Scenic River.		LS				None required.

TABLE D-1a

Summary of Water Supply Impacts and Mitigation Measures—Tuolumne River System and Downstream Water Bodies

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
RECREATIONAL AND VISUAL RESOURCES						
Impact 5.3.8-1: Effects on reservoir recreation due to changes in water system operations.	LS					None required.
Impact 5.3.8-2: Effects on river recreation due to changes in water system operations.	LS					None required.
Impact 5.3.8-3: Effects on the aesthetic values of the Tuolumne Wild and Scenic River.	LS					None required.
ENERGY RESOURCES						
Impact 5.3.9-1: Effects on hydropower generation at facilities along the Tuolumne River	B					None required.

NI = No Impact

LS = Less than Significant Impact

PSM = Potentially Significant Impact, Mitigable

SU= Significant Unavoidable Impact

B = Beneficial effect

NA = Not Applicable

TABLE D-1b
Summary of Water Supply Impacts and Mitigation Measures—Alameda Creek Watershed

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
STREAM FLOW						
Impact 5.4.1-1: Effects on flow along Calaveras Creek below Calaveras Reservoir.	LS					None required
Impact 5.4.1-2: Effects on flow along Alameda Creek below the diversion dam.	SU **(Note: subsequent to certification of the WSIP PEIR, this determination was changed to LS[2])**					**Measure 5.4.1-2, Diversion Tunnel Operation:** The SFPUC will implement operational criteria for the diversion dam which will require that water not needed to fill Calaveras Reservoir would be released to Alameda Creek below the diversion dam. **(Note: because Impact 5.4.1-2 was determined to be LS subsequent to certification of the WSIP PEIR, this mitigation measure is no longer required for program implementation.)**
Impact 5.4.1-3: Effects in San Antonio Reservoir and along San Antonio Creek.	LS					None required.

[2] Based on the best available information at that time, the WSIP PEIR made the conservative determination that the WSIP would result in a significant and unavoidable impact related to flow along Alameda Creek below the Alameda Creek Diversion Dam ("Alameda Creek Hydrologic Impact") (see PEIR Chapter 4, Section 5.4.1, Impact 5.4.1-2). Based upon more detailed site-specific data and analysis, the project-level analysis in the Calaveras Dam Replacement Project EIR modified this PEIR impact determination to be less than significant (San Francisco Planning Department 2011).

TABLE D-1b
Summary of Water Supply Impacts and Mitigation Measures—Alameda Creek Watershed

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
Impact 5.4.1-4: Effects on flow along Alameda Creek below the confluence of San Antonio Creek.	LS					None required.
GEOMORPHOLOGY						
Impact 5.4.2-1: Effects on channel formation and sediment transport along Calaveras Creek.	LS					None required.
Impact 5.4.2-2: Effects on channel formation and sediment transport along Alameda Creek downstream of the diversion dam and downstream of the San Antonio Creek confluence.	LS					None required.
Impact 5.4.2-3: Effects on channel formation and sediment transport along San Antonio Creek downstream of San Antonio Reservoir.	LS					None required.
SURFACE WATER QUALITY						
Impact 5.4.3-1: Effects on water quality in Calaveras Reservoir.	LS					None required.
Impact 5.4.3-2: Effects on water quality in San Antonio Reservoir.	LS					None required.
Impact 5.4.3-3: Changes in water quality along Calaveras, San Antonio, and Alameda Creeks.	LS					None required.

TABLE D-1b
Summary of Water Supply Impacts and Mitigation Measures—Alameda Creek Watershed

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
GROUNDWATER BODIES						
Impact 5.4.4-1: Changes in groundwater levels, flows, quality, and supplies.	LS					None required.
FISHERIES						
Impact 5.4.5-1: Effects on fishery resources in Calaveras Reservoir.	B					None required.
Impact 5.4.5-2: Effects on fishery resources along Calaveras Creek below Calaveras Dam and along Alameda Creek below confluence with Calaveras Creek.	B					None required.
Impact 5.4.5-3: Effects on fishery resources along Alameda Creek downstream of Alameda Creek Diversion Dam.	PSM					**Measure 5.4.5-3a, Minimum Flows for Resident Trout on Alameda Creek:** The SFPUC will release a minimum flow of approximately 10 cubic feet per second from the diversion dam and monitor the effects of the release on resident trout spawning and egg incubation. ** If monitoring results for Measure 5.4.5-3a indicate the measure is unsuccessful, the SFPUC will implement Measure 5.4.5-3b. **Measure 5.4.5-3b, Alameda Diversion Dam Restrictions or Fish Screens:** If after 10 years the minimum release does

TABLE D-1b
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Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
						not sustain the resident trout population, the SFPUC will either increase releases from the diversion dam or install a fish passage barrier on the diversion tunnel.
Impact 5.4.5-4: Effects on fishery resources in San Antonio Reservoir.	B					None required.
Impact 5.4.5-5: Effects on fishery resources along San Antonio Creek below San Antonio Reservoir.	LS					None required.
Impact 5.4.5-6: Effects on fishery resources along Alameda Creek below confluence with San Antonio Creek.	LS					None required.
TERRESTRIAL BIOLOGY						
Impact 5.4.6-1: Effects on riparian habitat and related biological resources in Calaveras Reservoir.		PSM	PSM	LS	LS	The SFPUC will implement Measure 5.4.6-1 to reduce adverse impacts on sensitive habitats and key special-status species to a less-than-significant level. **Measure 5.4.6-1, Compensation for Impacts on Terrestrial Biological Resources:** The SFPUC will protect, restore, and enhance existing riparian habitat and/or create new habitat that compensates for WSIP-induced habitat losses at Calaveras Reservoir. Compensatory habitat may be provided

TABLE D-1b
Summary of Water Supply Impacts and Mitigation Measures—Alameda Creek Watershed

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
						as part of the SFPUC's Habitat Reserve Program.
Impact 5.4.6-2: Effects on riparian habitat and related biological resources along Alameda Creek, from below the diversion dam to the confluence with Calaveras Creek.		LS	PSM	LS	NA	The SFPUC will implement Measures 5.4.1-2 and 5.4.5-3a to reduce adverse impacts on key special-status species to a less-than-significant level. **Measure 5.4.1-2, Diversion Tunnel Operation** – see description above. **Measure 5.4.5-3a, Minimum Flows for Resident Trout on Alameda Creek** – see description above.
Impact 5.4.6-3: Effects on riparian habitat and related biological resources along Calaveras Creek, from Calaveras Reservoir to the confluence with Alameda Creek.		LS	PSM	LS	LS	The SFPUC will implement Measure 5.4.6-3 to reduce adverse impacts on key special-status species to a less-than-significant level. **Measure 5.4.6-3, Operational Procedures for Calaveras Dam Releases:** The SFPUC will manage releases from Calaveras Reservoir to mimic a more natural hydrologic regime in the creek for the benefit of terrestrial biological resources. The specifics of this mitigation measure will be determined as part of project-level CEQA review.

TABLE D-1b
Summary of Water Supply Impacts and Mitigation Measures—Alameda Creek Watershed

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
Impact 5.4.6-4: Effects on riparian habitat and related biological resources along Alameda Creek, from the confluence with Calaveras Creek to the confluence with San Antonio Creek.		LS	PSM	LS	LS	The SFPUC will implement Measures 5.4.6-3 and 5.4.5-3a to reduce adverse impacts on key special-status species to a less-than-significant level. **Measure 5.4.6-3, Operational Procedures for Calaveras Dam Releases** – see description above. **Measure 5.4.5-3a, Minimum Flows for Resident Trout on Alameda Creek** – see description above.
Impact 5.4.6-5: Effects on riparian habitat and related biological resources in San Antonio Reservoir.		LS	LS	LS	LS	None required.
Impact 5.4.6-6: Effects on riparian habitat and related biological resources along San Antonio Creek between Turner Dam and the confluence with Alameda Creek.		LS	LS	LS	NA	None required.
Impact 5.4.6-7: Effects on riparian habitat and related biological resources along Alameda Creek below the confluence with San Antonio Creek.		LS	LS	LS	NA	None required.

TABLE D-1b
Summary of Water Supply Impacts and Mitigation Measures—Alameda Creek Watershed

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
Impact 5.4.6-8: Conflicts with the provisions of adopted conservation plans or other approved biological resources plans.		LS				None required.
RECREATION AND VISUAL						
Impact 5.4.7-1: Effects on recreational facilities and/or activities.	LS					None required.
Impact 5.4.7-2: Visual effects on scenic resources or visual character of the water bodies.	LS					None required.

NI = No Impact
LS = Less than Significant
PSM = Potentially Significant, Mitigable
SU= Significant and Unavoidable
B = Beneficial
NA = Not Applicable

TABLE D-1c
Summary of Water Supply Impacts and Mitigation Measures—Peninsula Watersheds

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
STREAM FLOW						
Impact 5.5.1-1: Effects on flow along San Mateo Creek.	LS					None required.
Impact 5.5.1-2: Effects on flow along Pilarcitos Creek.	LS					None required.
GEOMORPHOLOGY						
Impact 5.5.2-1: Changes in sediment transport and channel morphology in the Peninsula watershed.	LS					None required.
WATER QUALITY						
Impact 5.5.3-1: Effects on water quality in Crystal Springs Reservoir, San Andreas Reservoir, and San Mateo Creek.	LS					None required.
Impact 5.5.3-2: Effects on water quality in Pilarcitos Reservoir and along Pilarcitos Creek.	PSM					**Measure 5.5.3-2a, Low-head Pumping Station at Pilarcitos Reservoir:** The SFPUC will install a permanent low-head pumping station at Pilarcitos Reservoir which would enable the SFPUC to access and use an additional 350 acre-feet of water from Pilarcitos Reservoir. In years when the WSIP would cause releases from Pilarcitos Reservoir to Pilarcitos Creek to be reduced to reservoir inflow earlier in the summer than under the existing condition (about 25 percent of years in the

TABLE D-1c
Summary of Water Supply Impacts and Mitigation Measures—Peninsula Watersheds

Impact	Significance Determination: All Impacts (except Biological Resources)	Biological Resource Impacts: Sensitive Habitats	Biological Resource Impacts: Key Special-Status Species	Biological Resource Impacts: Other Species of Concern	Biological Resource Impacts: Common Habitats and Species	Mitigation Measures
						hydrologic record), the SFPUC will use the pumping station to augment flow in Pilarcitos Creek with water from the reservoir. The pumping station will draw water from the cool pool of water below the thermocline during times when the reservoir is stratified. The pumping station outlet will be designed to ensure that water discharged to the creek is adequately aerated. **Measure 5.5.3-2b, Aeration System at Pilarcitos Reservoir:** The SFPUC will install a permanent aeration system at Pilarcitos Reservoir. The SFPUC will operate the aeration system as necessary to avoid anoxic conditions and maintain good water quality conditions at the reservoir.
GROUNDWATER						
Impact 5.5.4-1: Alteration of stream flows along Pilarcitos Creek, which could affect groundwater levels and water quality.	LS					None required.

TABLE D-1c
Summary of Water Supply Impacts and Mitigation Measures—Peninsula Watersheds

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
FISHERIES						
Impact 5.5.5-1: Effects on fishery resources in Crystal Springs Reservoir (Upper and Lower).	PSU **(Note: subsequent to certification of the WSIP PEIR, this determination was changed to LS[3])**					**Measure 5.5.5-1, Create New Spawning Habitat Above Crystal Springs Reservoir:** The SFPUC will survey the extent and quality of fish spawning habitat lost due to inundation and, if feasible, create new spawning habitat at a higher elevation. The specifics of this mitigation measure will be determined as part of project-level CEQA review. **(Note: because Impact 5.5.5-5 was determined to be LS subsequent to certification of the WSIP PEIR, this mitigation measure is no longer required for program implementation).**
Impact 5.5.5-2: Effects on fishery resources in San Andreas Reservoir.	LS					None required.
Impact 5.5.5-3: Effects on fishery resources along San Mateo Creek.	LS					None required.

3 Based on the best available information at that time, the WSIP PEIR made the conservative determination that the WSIP could result in a significant and unavoidable impact on fishery resources in Crystal Springs Reservoir related to inundation of spawning habitat upstream of the reservoir (see PEIR Chapter 5, Section 5.5.5, Impact 5.5.5-1). Project-level review of updated, site-specific information that was developed following certification of the PEIR was incorporated into the project-level EIR for the Lower Crystal Springs Dam Improvements Project, and the project-level analysis determined that impacts on fishery resources due to inundation effects would be less than significant (San Francisco Planning Department 2010).

TABLE D-1c
Summary of Water Supply Impacts and Mitigation Measures—Peninsula Watersheds

	Significance Determination					
		Biological Resource Impacts				
Impact	**All Impacts (except Biological Resources)**	**Sensitive Habitats**	**Key Special-Status Species**	**Other Species of Concern**	**Common Habitats and Species**	**Mitigation Measures**
Impact 5.5.5-4: Effects on fishery resources in Pilarcitos Reservoir.	PSM					**Measure 5.5.3-2b, Aeration System at Pilarcitos Reservoir –** see description above.
Impact 5.5.5-5: Effects on fishery resources along Pilarcitos Creek below Pilarcitos Reservoir.	PSM					**Measure 5.5.3-2a, Low-head Pumping Station at Pilarcitos Reservoir –** see description above. **Measure 5.5.5-5 Establish Flow Criteria, Monitor and Augment Flow –** The SFPUC will develop a monitoring and operations plan for Stone Dam to ensure WSIP-related flow reductions downstream of Stone Dam do not impair steelhead passage and spawning during the winter months of normal and wetter hydrologic years.
TERRESTRIAL BIOLOGY						
Impact 5.5.6-1: Impacts on biological resources in Upper and Lower Crystal Springs Reservoirs.		PSM	PSM	PSM	PSM	The SFPUC will implement Measures 5.5.6-1a and 5.5.6-1b to reduce adverse impacts on sensitive habitats, key special-status species, other species of concern, and common habitats and species to a less-than-significant level. In addition, the SFPUC will implement Measure 5.5.6-1c to mitigate adverse impacts on key special-status plant species (i.e., fountain thistle) adapted to serpentine seeps.

TABLE D-1c
Summary of Water Supply Impacts and Mitigation Measures—Peninsula Watersheds

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
						Measure 5.5.6-1a, Adaptive Management of Freshwater Marsh and Wetlands at Upper and Lower Crystal Springs Reservoirs: The SFPUC will develop an adaptive management plan to minimize adverse effects of the WSIP-induced rise in average water levels, and periodic drawdown of reservoir water levels for maintenance, on San Francisco garter snakes and red-legged frogs. **Measure 5.5.6-1b, Compensation for Impacts on Terrestrial Biological Resources:** The SFPUC will protect, restore, and enhance existing wetland and upland habitat and/or create new habitat that compensates for WSIP-induced habitat losses at Crystal Springs Reservoir. Compensatory habitat may be provided as part of the SFPUC's Habitat Reserve Program. **Measure 5.5.6-1c, Compensation for Serpentine Seep-Related Special-Status Plants:** The SFPUC will protect, restore, and enhance existing habitat and/or create new habitat that compensates for WSIP-induced habitat losses for plant species adapted to serpentine seeps.

TABLE D-1c
Summary of Water Supply Impacts and Mitigation Measures—Peninsula Watersheds

Impact	Significance Determination					Mitigation Measures
	All Impacts (except Biological Resources)	Biological Resource Impacts				
		Sensitive Habitats	Key Special-Status Species	Other Species of Concern	Common Habitats and Species	
Impact 5.5.6-2: Impacts on biological resources in San Andreas Reservoir.		LS	LS	LS	LS	None required.
Impact 5.5.6-3: Impacts on biological resources along San Mateo Creek below Lower Crystal Springs Dam.		LS	LS	LS	LS	None required.
Impact 5.5.6-4: Impacts on biological resources in Pilarcitos Reservoir.		LS	PSM	LS	LS	**Measure 5.5.3-2c, Habitat monitoring and Compensation:** The SFPUC will protect, restore, and enhance existing habitat and/or create new habitat that compensates for WSIP-induced habitat losses at Pilarcitos Reservoir. Compensatory habitat may be provided as part of the SFPUC's Habitat Reserve Program.
Impact 5.5.6-5: Impacts on biological resources along Pilarcitos Creek below Pilarcitos Reservoir.		LS	LS	LS	LS	None required.
Impact 5.5.6-6: Impacts along Pilarcitos Creek below Stone Dam.		LS	LS	LS	LS	None required.
Impact 5.5.6-7: Conflicts with the provisions of adopted conservation plans or other approved biological resource plans.		LS				None required.

TABLE D-1c
Summary of Water Supply Impacts and Mitigation Measures—Peninsula Watersheds

Impact	Significance Determination: All Impacts (except Biological Resources)	Biological Resource Impacts: Sensitive Habitats	Biological Resource Impacts: Key Special-Status Species	Biological Resource Impacts: Other Species of Concern	Biological Resource Impacts: Common Habitats and Species	Mitigation Measures
RECREATIONAL AND VISUAL RESOURCES						
Impact 5.5.7-1: Effects on recreational facilities and/or activities.	LS					None required.
Impact 5.5.7-2: Visual effects on scenic resources or the visual character of water bodies.	LS					None required.

NI = No Impact
LS = Less than Significant
PSM = Potentially Significant, Mitigable
SU= Significant and Unavoidable
B = Beneficial
NA = Not Applicable

TABLE D-1d
Summary of Water Supply Impacts and Mitigation Measures—Westside Groundwater Basin

Impact	Significance Determination		Mitigation Measures
	North Westside Groundwater Basin	South Westside Groundwater Basin	
RECREATIONAL AND VISUAL RESOURCES			
Impact 5.6-1: Basin overdraft due to pumping from the Westside Groundwater Basin.	PSM	LS	The SFPUC will implement Measure 5.6.1 to reduce adverse impacts on the North Westside Groundwater Basin to a less-than-significant level. **Measure 5.6-1, Groundwater Monitoring to Determine Basin Safe Yield:** The SFPUC will continue ongoing groundwater and lake level monitoring programs to determine the safe yield of the North Westside Groundwater Basin in order to avoid overdraft and associated effects including adverse effects on surface water features and seawater intrusion.
Impact 5.6-2: Changes in water levels in Lake Merced and other surface water features, including Pine Lake, due to decreased groundwater levels in the Westside Groundwater Basin.	PSM	NA	The SFPUC will implement Measures 5.6.1 and 5.6-2 to reduce adverse impacts on the North Westside Groundwater Basin to a less-than-significant level. **Measure 5.6-1, Groundwater Monitoring to Determine Basin Safe Yield** – see description above. **Measure 5.6-2, Implementation of a Lake Level Management Plan:** The SFPUC will develop and implement a lake level management plan identifying strategies for altering pumping patterns or lake augmentation to maintain Lake Merced water levels within the desired long-term range.
Impact 5.6-3: Seawater intrusion due to decreased groundwater levels in the Westside Groundwater Basin.	PSM	LS	The SFPUC will implement Measure 5.6.1 to reduce adverse impacts on the North Westside Groundwater Basin to a less-than-significant level. **Measure 5.6-1, Groundwater Monitoring to Determine Basin Safe Yield** – see description above.
Impact 5.6-4: Land subsidence due to decreased groundwater levels in the Westside Groundwater Basin if the historical low water levels are exceeded.	LS	LS	None required.
Impact 5.6-5: Contamination of drinking water due to groundwater pumping in the Westside Groundwater Basin.	PSM	PSM	The SFPUC will implement Measure 5.6.5 to reduce adverse impacts on the North Westside and South Westside Groundwater Basins to a less-than-significant level. **Measure 5.6.5, Drinking Water Source Assessments for Groundwater Wells:** The SFPUC will develop and implement a source water protection program for wells constructed under the Local and Regional Groundwater Projects that are considered vulnerable to contamination on the basis of the drinking water source assessment prepared in accordance with Department of Public Health Services regulations.

TABLE D-1d
Summary of Water Supply Impacts and Mitigation Measures—Westside Groundwater Basin

Impact	Significance Determination		Mitigation Measures
	North Westside Groundwater Basin	South Westside Groundwater Basin	
Impact 5.6-6: Drinking water contaminants above maximum contaminant levels and adverse effects of adding treated groundwater to the distribution system.	LS	LS	None required.

NI = No Impact

LS = Less than Significant

PSM = Potentially Significant , Mitigable

SU= Significant and Unavoidable

B = Beneficial

NA = Not Applicable

TABLE D-1e
Summary of Water Supply Impacts and Mitigation Measures—Cumulative Water Supply

Cumulative Water Supply Impact	Cumulative Impact Significance Determination							Mitigation Measures
	Hydrology	Geomorphology	Surface Water Quality	Groundwater	Fisheries	Terrestrial Biology	Recreation / Visual Quality	
Impact 5.7.2-1: Tuolumne River – Hetch Hetchy Reservoir to Don Pedro Reservoir.	LS	LS	LS	LS	LS	LS	LS	None required.
Impact 5.7.2-2: Tuolumne River – Don Pedro Reservoir to the San Joaquin River.	LS	LS	LS	LS	LS	LS	LS	None required.
Impact 5.7.2-3: San Joaquin River, Stanislaus River, and the Delta.	LS	LS	LS	LS	LS	LS	LS	None required.
Impact 5.7.3-1: Alameda Creek watershed.	NA	LS	LS	LS	LS	LS	LS	None required.
Impact 5.7.4-1: San Mateo Creek watershed.	LS	LS	LS	LS	LS	LS	LS	None required.
Impact 5.7.4-2: Pilarcitos Creek watershed.	LS	LS	LS	LS	LS	LS	LS	None required.
Impact 5.7.5-1: North Westside Groundwater Basin.	LS							None required.
Impact 5.7.5-2: South Westside Groundwater Basin.	LS							None required.

NOTE: Significance determinations presented in this table assume implementation of all mitigation measures as they are presented in PEIR Chapter 5, Section 5.6, and described in Chapter 6.

NI = No Impact

LS = Less than Significant

PSM = Potentially Significant, Mitigable

SU= Significant and Unavoidable

B = Beneficial

NA = Not Applicable

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Land Use				
Impact 4.3-1: Temporary disruption or displacement of existing land uses during construction.	PSM	SUM	N	See Impact LU-1: Project construction would have a substantial impact on the existing character of the vicinity and could substantially disrupt or displace existing land uses or land use activities. The PEIR assumed that the 24-hour construction activities would be required for well facility construction and assumed that a new well would be constructed at the Francis Scott Key Elementary School. The analysis assumed that construction activities could disrupt sensitive land uses such as schools and nearby residential uses but implementation of SFPUC Construction Measures #1, #3, #5, #6, #10 and mitigation measures identified in PEIR Chapter 6, would reduce the impact to less than significant. The project-level analysis determined that nighttime construction associated with well drilling would, at some sites, cause temporary construction-noise impacts which feasible mitigation measures cannot reduce to less-than-significant levels. Therefore, the project-level impact would be significant and unavoidable.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.3-2: Permanent displacement or long-term disruption of existing land uses.	PSU	LSM	N	See Impact LU-2: Project operations would result in substantial long-term or permanent impacts on the existing character or disrupt or displace land uses. The PEIR conservatively assumed that the PEIR Regional Groundwater Projects could include sites adjacent to Francis Scott Key School or other sites in San Francisco and northern San Mateo County, which could have resulted in significant and unavoidable impacts on these sensitive land uses even with implementation of SFPUC Construction Measures #6 (compliance with local noise ordinances to the extent feasible) and #10 (locating staging areas away from public view and directing nighttime lighting away from residential areas) as well as recommendations of facility siting studies (Measure 4.3-2). The project-level analysis determined that operation of some of the well facilities would generate nighttime noise levels that could be significant at nearby residences. Implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce noise levels to less-than-significant levels.
Impact 4.17-1: Cumulative disruption of established communities, changes in existing land use patterns, and impacts on the existing visual character.	LS	Land Use - SUM	N	See Impact C-LU-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to land use. The PEIR determined that cumulative development in the vicinity of WSIP projects could disrupt established communities and significantly alter existing land use patterns. However, implementation of SFPUC construction measures and PEIR Measure 4.3-2 would reduce the WSIP's land use and visual impact to less than significant. The project-level analysis determined that both nighttime and daytime construction noise at some well sites would result in significant disruptions to land use, and that combined with impacts of cumulative projects, cumulative land use impacts would be significant and unavoidable.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
		Visual Character - LSM	N	See Impact C-AE-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to scenic resources and visual character. The PEIR determined that cumulative development in the vicinity of WSIP projects could disrupt established communities and significantly alter existing land use patterns. However, implementation of SFPUC construction measures and PEIR Measure 4.3-2 would reduce the WSIP's land use and visual impact to less than significant. The project-level analysis identified the potential for cumulative impacts to visual character from multiple construction projects in the same geographic area. Implementation of mitigation would reduce the impact such that the GSR Project's contribution to cumulative impacts would not be cumulatively considerable.
Visual				
Impact 4.3-3: Temporary construction impacts on scenic vistas or visual character.	LS	SUM	N	See Impact AE-1: The Project would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings. The PEIR assumed that temporary effects on visual character would be less than significant with implementation of SFPUC Construction Measure #10 (Project Site). The project-level analysis determined that at one site, removal of trees within the SFPUC right-of-way would have a significant and unavoidable impact on the visual character of the site and to a tree mass specifically identified in a local General Plan.
Impact 4.3-4: Permanent adverse impacts on scenic vistas or visual character.	PSM	LSM	Y	See Impact AE-3: The Project would have a substantial adverse impact on a scenic vista, resource, or on the visual character of a site or its surroundings. There is no difference in the impact determination.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.3-5: New permanent sources of light glare.	PSM	LS	Y	See Impact AE-4: The Project would not create a new source of substantial light that would adversely affect day or nighttime views in the area. Also see Impact AE-2: The Project would not create a new source of substantial light that would adversely affect day or nighttime views in the area. The PEIR conservatively assumed that all WSIP projects that include aboveground improvements could include a new source of light or glare and required implementation of design measures (Mitigation Measure 4.3-5) to reduce this impact to a less-than-significant level. Other well facilities would not result in substantial view blockage and therefore would not result in a substantial adverse effect on the site's visual quality. The project-level analysis determined that implementation of the proposed Project would result in additional temporary and permanent lighting; however, new permanent lighting would be in compliance with Title 24 of the California Code of Regulations, would be shielded to direct light downward, and would be controlled by motion sensors with automatic shut-offs. The GSR Project also includes development of a Lighting Plan that would ensure that temporary lighting is focused downward and inward and includes glare control. Therefore, the impact would be less than significant.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Geology, Soils, and Seismicity				
Impact 4.4-1: Slope instability during construction.	PSM	LS	Y	See Impact GE-1: The Project would not be located on a geologic unit or soil that is unstable, or that would become unstable during construction. The WSIP PEIR assumed that the pipelines associated with the PEIR Regional Groundwater Projects could cross areas of potential landslide susceptibility in San Mateo County but implementation of SFPUC Construction Measure #2 Seismic and Geotechnical Studies) as well as a quantified landslide analysis (Measure 4.4-1) would reduce this impact to a less-than-significant level. The project-level analysis included several site-specific geotechnical investigations to assess slope stability hazards. The potential for slopes at the sites to become destabilized during construction was determined to be less than significant, due to the mapped and documented presence of generally dense granular materials, the absence of shallow groundwater, and the presence of vegetation that provides additional strengthening of the near surface soils.
Impact 4.4-2: Erosion during construction.	LS	LSM	N	See Impact HY-1: Project construction activities would degrade water quality as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals during construction. The WSIP PEIR noted that all construction sites would be subject to soil loss and erosion and that implementation of the SFPUC Construction Measure #3 (on-site air and water quality measures) would result in less than significant impacts for all WSIP projects. The project-level EIR does not assume implementation of SFPUC Construction Measure #3. Elements of the SFPUC Standard Construction Measure #3 are included in Mitigation Measure M-HY-1 (Develop and Implement and Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan), which would reduce the GSR Project impact to a less-than-significant level.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.4-3: Substantial alteration of topography.	LS	LS	Y	See Impact GE-2: The Project would not substantially change the topography or any unique geologic or physical features of the site(s). There is no difference in the impact determination.
Impact 4.4-4: Squeezing ground and subsidence during tunneling.	N/A	N/A	Y	Tunneling is not included in the GSR Project. Thus, the significance criterion related to subsidence during tunneling is not applicable.
Impact 4.4-5: Surface fault rupture.	LS	LS	Y	See Impact GE-3: The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides. The well facility sites, including pipelines, would not be located within the San Andreas Fault Zone and no other active or potentially active faults are known to cross the sites. There is no difference in the impact determination.
Impact 4.4-6: Seismically induced groundshaking.	LS	LSM	N	See Impact GE-3: The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides. The WSIP PEIR evaluated the potential impacts of seismically induced groundshaking on WSIP facilities and concluded that all potential facilities would experience strong groundshaking from a seismic event, but that the impact would be less than significant. The project-level analysis included the implementation of several site-specific geotechnical investigations to assess groundshaking hazards. Assuming compliance with all applicable building codes and standards, and the recommendations of the site-specific geotechnical investigations as required in Mitigation Measure M-GE-3 (Conduct Site-Specific Geotechnical Investigations and Implement Recommendations), groundshaking risks to GSR facilities and operations would be reduced to a less-than-significant level.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.4-7: Seismically induced ground failure, including liquefaction and settlement.	LS	LSM	N	See Impact GE-4: The Project would be located on a geologic unit or soil that is unstable, or that would become unstable. The WSIP PEIR evaluated the potential impacts of seismically induced ground failure and concluded that all potential facilities would be designed in accordance with the General Seismic Design Requirements and that impacts related to liquefaction and other seismically induced ground failures would be less than significant. The project-level analysis determined that the underlying soil at some of the sites have a moderately high hazard from settlement. Implementation of Mitigation Measure M-GE-3 (Conduct Site-Specific Geotechnical Investigations and Implement Recommendations) which incorporates site-specific geotechnical recommendations to reduce the GSR Project impact to a less-than-significant level.
Impact 4.4-8: Seismically induced landslides or other slope failures.	LS	LS	Y	See Impact GE-3: The Project would expose people or structures to substantial adverse effects related to the risk of property loss, injury, or death due to fault rupture, seismic groundshaking, or landslides. The project-level analysis determined that the potential for seismically induced landslides or slope failures would be less than significant for all sites. There is no difference in the impact determination.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.4-9: Expansive or corrosive soils.	PSM	LS	N	See Impact GE-5: The Project would not be located on corrosive or expansive soil, creating substantial risks to life or property. Based on regional mapping reviewed for the WSIP PEIR, expansive and corrosive soils are mapped in the GSR Project area, and impacts related to these soils were considered potentially significant. The project-level analysis determined that site specific soils are not considered expansive, and that cathodic protection measures that have been incorporated into the design of the GSR Project would ensure that potential impacts related to corrosive soils are less than significant.
Impact 4.17-2: Cumulative exposure of people or structures to geologic and seismic hazards.	LS	LS	Y	See Impact C-GE-1: Construction and operation of the proposed Project could result in significant impacts related to soils and geology. There is no difference in the impact determination.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Hydrology and Water Quality				
Impact 4.5-1: Degradation of water bodies as a result of erosion and sedimentation or a hazardous materials release during construction.	LS	LSM	N	See Impact HY-1: Project construction activities would degrade water quality as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals during construction. Although final locations of the well facilities were not determined at the time of publication of the WSIP PEIR, the PEIR indicated that implementation of SFPUC Construction Measure #3 (onsite air and water quality measures during construction), and implementation of control measures in compliance with NPDES permit requirements for projects disturbing more than one acre, would ensure that this impact is less than significant. The project-level EIR does not assume implementation of SFPUC Construction Measures. Implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) is included and would reduce the Project impact to a less-than-significant level.
Impact 4.5-2: Depletion of groundwater resources.	N/A	N/A	Y	The PEIR and project-level EIR determined that construction dewatering would not be required such that depletion of groundwater resources would occur. See PEIR Impacts 5.6-1 through 5.6-6 below for analysis of operational impacts on groundwater resources.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.5-3a: Degradation of water quality due to construction dewatering discharges.	N/A	LSM	N	See Impact HY-1: Project construction activities would degrade water quality as a result of erosion or siltation caused by earthmoving activities or by the accidental release of hazardous construction chemicals during construction. The PEIR assumed that the PEIR Regional Groundwater Projects would not involve dewatering. The project-level analysis determined that the discharge of sediment-laden groundwater to the storm drain system during excavation dewatering could degrade water quality and violate water quality standards, however, implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would reduce the impact to a less-than-significant level.
Impact 4.5-3b: Degradation of water quality due to construction-related discharges of treated water.	N/A	LSM	N	See Impact HY-2: Discharge of groundwater could result in minor localized flooding, violate water quality standards, and/or otherwise degrade water quality. The PEIR assumed that the PEIR Regional Groundwater Projects would not involve construction-related discharges of water; therefore this impact was determined to not be applicable. The project-level analysis determined that the discharge of sediment-laden groundwater to the storm drain system during well development and pumping tests could degrade water quality and violate water quality standards. Implementation of Mitigation Measure M-HY-2 (Management of Well Development and Pump Testing Discharges) would reduce GSR Project impacts to less-than-significant levels.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.5-4: Flooding and water quality impacts associated with impeding or redirecting flood flows.	PSM	LS	N	See Impact HY-4: Project operations would not impede or redirect flood flows. At the time the PEIR was prepared, the project design conservatively assumed that some Groundwater Project components could be constructed in San Mateo County and could be constructed in a flood zone. Thus, the PEIR determined that impacts related to flooding would be potentially significant but implementation of flood flow protection measures (Measure 4.5-4a), which would be prepared for the project, would reduce impacts to a less-than-significant level. The project-level analysis determined that only one of the proposed project sites is located within a special flood hazard zone. Given that the chemical treatment building at the site would be elevated above the 100-year flood elevation, and because the presence of an at-grade parking area would have a negligible effect on impeding or redirecting flood flows, this impact would be less than significant.
Impact 4.5-5: Degradation of water quality and increased flows due to discharges to surface water during operation.	PSM	LS	N	See Impact HY-5: Project operations would not result in a violation of water quality standards or in the degradation of water quality from the discharge of groundwater during well maintenance. The PEIR analysis determined that the use of treated stormwater for groundwater recharge could affect groundwater quality if the bacterial standards for the source water were less stringent than those for drinking water, a potentially significant impact. Implementation of Measure 4.5-5, which requires treatment to remove nutrients from stormwater and implementation of groundwater monitoring in the vicinity of Lake Merced, would reduce this impact to less than significant. The project-level analysis determined that discharge water would be sent to either the sanitary sewer or the storm drain system; therefore, the discharge water associated with operations of the GSR Project would not violate water quality standards or degrade water quality and any such potential impacts on surface water would be less than significant.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.5-6: Degradation of water quality as a result of alteration of drainage patterns or an increase in impervious surfaces.	LS	LS	Y	See Impact HY-3: Project operation would not alter drainage patterns in such a manner that could result in degraded water quality or cause on- or off-site flooding. Also see Impact HY-5: Project operations would not result in a violation of water quality standards or in the degradation of water quality from the discharge of groundwater during well maintenance. There is no difference in the impact determination.
Impact 4.17-3: Cumulative impacts related to the degradation of water quality, alteration of drainage patterns, increased surface runoff, and flooding hazards.	LS	LSM	N	See Impact C-HY-1: Project construction could result in a cumulatively considerable contribution to cumulative impacts on surface water hydrology and water quality. The PEIR determined that the WSIP projects in conjunction with other projects would not result in cumulative water quality and hydrology effects related to increased erosion and sedimentation, construction-related discharges of treated water or groundwater produced during dewatering, or operational discharges of treated water with implementation of proper BMPs for temporary and permanent erosion control The project-level analysis identified the potential for cumulative impacts to hydrology and water quality from multiple construction projects in the same geographic area. With implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) and Mitigation Measure M-HY-2 (Management of Well Development and Pump Testing Discharge) and compliance with the Waste Discharge Requirements for the SFPUC Drinking Water Transmission System, the GSR Project's contribution to any such cumulative water quality impacts would not be cumulatively considerable.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 5.6-1: Basin overdraft due to pumping from the Westside Groundwater Basin.	LS	SUM	N	See Impact HY-14: Project operation may have a substantial adverse effect on groundwater depletion in the Westside Groundwater Basin over the very long term. Also, see Impact HY-6: Project operation would decrease the production rate of existing nearby irrigation wells due to localized groundwater drawdown within the Westside Groundwater Basin such that existing or planned land use(s) may not be fully supported. The PEIR determined that impacts related to basin overdraft and associated adverse conditions in the South Westside Groundwater Basin would be less than significant, given that the overall conjunctive-use program would be designed to take advantage of vacated aquifer storage that has become available as a result of historical groundwater pumping in the basin. The project-level analysis also determined that the GSR Project may cause an incremental depletion of groundwater storage over the long-term, which is conservatively deemed a significant impact because over the very long-term this could result in a substantial regional deficit in aquifer storage that would may not fully support existing or planned land uses. Implementation of Mitigation Measure M-HY-14 (Prevent Groundwater Depletion) would reduce impacts of the Project on long-term depletion of groundwater storage to less-than-significant levels.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 5.6-2: Changes in water levels in Lake Merced and other surface water features, including Pine Lake, due to decreased groundwater levels in the Westside Groundwater Basin.	N/A	LSM	N	See Impact HY-9: Project operation could have a substantial, adverse effect on water quality that could affect the beneficial uses of Lake Merced. Also see Impact HY-10: Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Pine Lake, and Impact HY-11: Project operation would not have a substantial adverse effect on water quality that could affect the beneficial uses of Colma Creek, San Bruno Creek, Lomita Channel, or Millbrae Creek. The PEIR determined that there are no major surface water features in the South Westside Groundwater Basin that would be affected. The project-level analysis determined that significant impacts could occur to Lake Merced, and Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) is provided to reduce impacts to a less-than-significant level. The project-level analysis determined that the impact on the beneficial uses of Pine Lake and other surface water bodies would be less than significant.
Impact 5.6-3: Seawater intrusion due to decreased groundwater levels in the Westside Groundwater Basin.	LS	LS	Y	See Impact HY-8: Project operation would not result in seawater intrusion due to decreased groundwater levels in the Westside Groundwater Basin. The PEIR determined that impacts related to the potential to cause seawater intrusion the South Westside Groundwater Basin would be less than significant. The project-level analysis determined that the GSR Project would not cause lower average groundwater levels that would induce seawater intrusion in either the North or South Westside Groundwater Basin.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 5.6-4: Land subsidence due to decreased groundwater levels in the Westside Groundwater Basin if the historical low water levels are exceeded.	LS	LS	Y	See Impact HY-7: Project operation would not result in substantial land subsidence due to decreased groundwater levels in the Westside Groundwater Basin where the historical low water levels are exceeded. The PEIR determined that the potential for land subsidence would be less than significant, given the formations comprising the aquifers of the North Westside Groundwater Basin, and because groundwater levels associated with the PEIR Regional Groundwater Projects would likely be higher than historical flows in the South Westside Groundwater Basin. The project-level analysis estimated subsidence due to GSR Project operations at three representative locations. The estimated subsidence was less than the significance thresholds established for the analysis, therefore, subsidence due to Project operation was determined to be less than significant.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 5.6-5: Contamination of drinking water due to groundwater pumping in the Westside Groundwater Basin.	PSM	LS	N	See Impact HY-12: Project operation would not cause a violation of water quality standards due to mobilization of contaminants in the groundwater from changing groundwater levels in the Westside Groundwater Basin. The PEIR noted that until production well locations were selected and a drinking water source assessment performed, the potential for contamination of a drinking water well could not be fully evaluated. Therefore, the PEIR considered impacts related to potential contamination of a drinking water source as potentially significant, which would be reduced to a less-than-significant level with implementation of Measure 5.6-5, Drinking Water Source Assessments for Groundwater Wells. The project-level analysis included preliminary Drinking Water Assessment and Protection Program reports used to characterize the vulnerability of proposed wells sites to possible contaminating activities. The analysis determined that potential GSR Project impacts on groundwater from possible contaminating activities would be less than significant, given that wells would be protected against contamination by the construction of an annular seal composed of sand/cement grout, water would be blended or treated to ensure all drinking water standards are met. The analysis also determined that the potential impact from mobilization or spreading of contaminants in groundwater as a result of increased pumping would be less than significant.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 5.6-6: Drinking water contaminants above maximum contaminant levels and adverse effects of adding treated groundwater to the distribution system.	LS	LS	N	See Impact HY-12: Project operation would not cause a violation of water quality standards due to mobilization of contaminants in groundwater from changing groundwater levels in the Westside Groundwater Basin. Also see Impact HY-13: Project operation would not result in degradation of drinking water quality or groundwater quality relative to constituents for which standards do not exist. The PEIR determined the groundwater developed for potable uses under the WSIP would be treated or blended with system water to meet all primary and secondary drinking water standards. Therefore, programmatic impacts related to exceedances in drinking water standards would be less than significant. The project-level analysis determined that potential GSR Project impacts on drinking water quality from regulated and non-regulated constituents would be less than significant. As described in GSR Chapter 3, Project Description, Section 3.4.2.2 (Well Facility Types), any violation of drinking water standards at production wells resulting from Project operation would be addressed by proposed treatment and/or blending.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 5.7.5-1: Cumulative impacts on the North Westside Groundwater Basin.	LS	LSM	N	See Impacts C-HY-2, C-HY-3, C-HY-4, C-HY-5, and C-HY-8. The PEIR did not evaluate cumulative impacts of the GSR Project in the North Westside Groundwater Basin The project-level analysis concludes that implementation of Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) would reduce the GSR Project's impact in the North Westside Groundwater Basin at Lake Merced on long-term lake-level declines to a less-than-cumulatively considerable level. The project-level analysis determined that the GSR Project would not have a considerable contribution to the cumulative impact relative to seawater intrusion in the North Westside Groundwater Basin, and the estimated subsidence due to operation of the cumulative conditions scenario in the North Westside Groundwater Basin was also determined to be less than significant. Implementation of Mitigation Measure M-HY-14 (Prevent Groundwater Depletion), which addresses impacts in both the North and South Westside Groundwater Basins would reduce the Project's impact on long-term depletion of groundwater storage to less-than-cumulatively considerable levels.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 5.7.5-2: Cumulative impacts on the South Westside Groundwater Basin.	LS	SUM	N	See Impacts C-HY-2, C-HY-3, C-HY-4, C-HY-5, C-HY-6, C-HY-7, and C-HY-8. The PEIR determined that implementation of the proposed conjunctive-use program should result in higher average groundwater levels in the northern portion of the South Westside Groundwater Basin as a result of the coordinated use of surface water and groundwater. The PEIR determined that implementation of the operating agreement(s) would ensure that impacts related to basin overdraft, saltwater intrusion, and land subsidence would be less than significant, and that because there are no other planned future uses of groundwater in this portion of the basin, cumulative groundwater impacts would be less than significant. The project-level analysis determined implementation of Mitigation Measure M-HY-6 (Ensure Existing Irrigator's Wells Are Not Prevented from Supporting Existing or Planned Land Use Due to Project Operation) would reduce the GSR Project's contribution to cumulative impacts on well interference. However, because the feasibility of the mitigation measure cannot be assured until the existing irrigation well owners have agreed to allow mitigation to take place on their property, the Project's impact is conservatively deemed to be cumulatively considerable. Implementation of Mitigation Measure M-HY-14 (Prevent Groundwater Depletion) would reduce the Project's impact on long-term depletion of groundwater storage to less-than-cumulatively considerable levels in the South Westside Groundwater Basin. The Project-level analysis determined that the Project would not have a considerable contribution to the cumulative impact relative to seawater intrusion or subsidence in the South Westside Groundwater Basin.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Biological Resources				
Impact 4.6-1: Impacts on wetlands and aquatic resources.	PSM	LSM	Y	See Impact BR-3: The Project would impact jurisdictional wetlands or waters of the United States. There is no difference in the impact determination.
Impact 4.6-2: Impacts on sensitive habitats, common habitats, and heritage trees.	PSM	LSM	Y	See Impact BR-2: Project construction would adversely affect riparian habitat or other sensitive natural communities. Also see Impact BR-4: Project construction would conflict with local tree preservation ordinances. There is no difference in the impact determination.
Impact 4.6-3: Impacts on key special-status species – direct mortality and/or habitat effects.	LS	LSM	N	See Impact BR-1: Project construction would adversely affect candidate, sensitive, or special-status species. Also see Impact BR-5: Project operation would adversely affect candidate, sensitive, or special-status species. The PEIR analysis assumed that the PEIR Regional Groundwater Project facilities would be located in previously disturbed areas that do not support key special-status species; therefore, the impact in the PEIR was determined to be less than significant. The project-level analysis determined that vegetation removal and operational noise of the GSR Project at some sites could result in significant impacts to special-status birds, migratory passerines and raptors, special status bats, and monarch butterflies. Implementation of Mitigation Measures M-BR-1a, -1b, -1c, -1d and Mitigation Measure M-NO-5 would reduce impacts to a less-than-significant level.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.6-4: Water discharge effects on riparian and/or aquatic resources.	N/A	LSM	N	See Impact BR-3: The Project would impact jurisdictional wetlands or waters of the United States. The PEIR assumed that the Groundwater Projects would not involve dewatering. The Project-level analysis determined that construction at some sites could result in impacts due potential uncontrolled runoff and sedimentation to jurisdictional wetlands and waters. Implementation of Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would reduce the Project impact a less-than-significant level.
Impact 4.6-5: Conflicts with adopted conservation plans or other approved biological resources plans.	N/A	NI	Y	See GSR Section 5.14.3.2 (Approach to Analysis), under the heading "Areas of No Project Impact." The PEIR noted that there are no adopted plans in the area proposed for the PEIR Regional Groundwater Projects. The project-level analysis also determined that no such plans have been adopted in the areas that would be affected by the GSR Project.
Impact 4.17-4: Cumulative loss of sensitive biological resources.	LS	LSM	N	See Impact C-BR-1: Construction and operation of the proposed Project could result in significant cumulative impacts related to biological resources. The PEIR determined that cumulative impacts on biological resources would be less than significant through implementation of PEIR Measures 4.6-1 through 4.6-3 as well as Measure 4.16-4a. The project-level analysis identified the potential under the GSR Project for cumulative impacts to biological resources from multiple construction projects in the same geographic area. Implementation of mitigation measures would reduce the impact such that the GSR Project's contribution to cumulative impacts would not be cumulatively considerable.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
	N/A	LSM	N	Impacts BR-6 through BR-9 and C-BR-2 evaluate potential Project impacts on biological resources at Lake Merced. The PEIR did not evaluate the potential for adverse effects on biological resources at Lake Merced related to project operation. The project-level analysis determined that significant impacts could occur under the GSR Project to biological resources at Lake Merced, and mitigation is provided to reduce impacts to a less-than-significant level. Implementation of mitigation would also reduce the impact such that the GSR Project's contribution to cumulative impacts would not be cumulatively considerable.
Cultural Resources				
Impact 4.7-1: Impacts on paleontological resources.	PSM	LSM	Y	See Impact CR-3: Project construction could result in a substantial adverse effect by destroying a unique paleontological resource or site. There is no difference in the impact determination.
Impact 4.7-2: Impacts on archaeological resources.	PSM	LSM	Y	See Impact CR-2: Project construction could cause an adverse change in the significance of an archaeological resource. Also see Impact CR-4: Project construction could result in a substantial adverse effect related to the disturbance of human remains. There is no difference in the impact determination.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.7-3: Impacts on historical significance of a historic district or a contributor to a historic district.	N/A	LSM	N	See Impact CR-1: Project construction could cause an adverse change in the significance of a historical resource. Also see Impact CR-5: Project facilities could cause an adverse change in the significance of a historical resource. The WSIP PEIR concluded that the PEIR Regional Groundwater Projects would add new facilities to the WSIP system or upgrade existing non-historic facilities, and therefore, would not affect historic components of the regional system. The project-level analysis determined that construction and operation of the GSR Project could affect the eligibility of listing the Golden Gate National Cemetery to the National Register. Implementation of mitigation is therefore included to reduce the Project impact to a less-than-significant level.
Impact 4.7-4: Impacts on the historical significance of individual facilities resulting from demolition or alteration.	N/A	LSM	N	See Impact CR-1: Project construction could cause an adverse change in the significance of a historical resource. Also see Impact CR-5: Project facilities could cause an adverse change in the significance of a historical resource. The PEIR assumed that demolition under the PEIR Regional Groundwater Projects would be limited to paved areas and playgrounds at the Francis Scott Key School Annex, and West and South Sunset Playgrounds. The project-level analysis determined that construction and operation of the GSR Project could affect the eligibility of listing the Golden Gate National Cemetery to the National Register. Implementation of mitigation is therefore included to reduce the Project impact to a less-than-significant level.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.7-5: Impacts on adjacent historic architectural resources.	LS	LSM	N	See Impact CR-1: Project construction could cause an adverse change in the significance of a historical resource. Also see Impact CR-5: Project facilities could cause an adverse change in the significance of a historical resource. The WSIP PEIR noted that under the PEIR Regional Groundwater Projects new facilities would be added to existing, non-historic facilities. The project-level analysis determined that construction and operation of the GSR Project could affect the eligibility of listing the Golden Gate National Cemetery to the National Register. Implementation of mitigation is therefore included to reduce the Project impact to a less-than-significant level.
Impact 4.17-5: Cumulative increase in impacts on archaeological, paleontological, and historical resources.	PSU	LSM	N	See Impact C-CR-1: Construction of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts on historical, archaeological, or paleontological resources, or human remains. The PEIR conservatively assumed that, in combination, projects in the Sunol Valley and Peninsula regions could result in significant impacts on individual historical resources or on potential historic districts (if historic districts were determined to be present). The PEIR did not describe cumulative impacts on cultural resources in the San Francisco region. The project-level analysis identified the potential under the GSR Project for cumulative impacts to cultural resources from multiple construction projects in the same geographic area. Implementation of mitigation would reduce the impact such that the GSR Project's contribution to cumulative impacts would not be cumulatively considerable.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Traffic, Transportation, and Circulation				
Impact 4.8-1: Temporary reduction in roadway capacity and increased traffic delays.	PSM	LSM	Y	See Impact TR-1: The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system. There is no difference in the impact determination.
Impact 4.8-2: Short-term traffic increases on roadways.	LS	LS	Y	See Impact TR-1: The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system. There is no difference in the impact determination.
Impact 4.8-3: Impaired access to adjacent roadways and land uses.	PSM	LSM	Y	See Impact TR-2: The Project would temporarily impair emergency access to adjacent roadways and land uses during construction. There is no difference in the impact determination.
Impact 4.8-4: Temporary displacement of on-street parking.	PSM	NI	N	Since publication of the PEIR, the significance criterion specifically pertaining to displacement of on-street parking has been deleted from the San Francisco Planning Department's initial study checklist (San Francisco Planning Department 2010). The GSR Project EIR did not identify any secondary impacts associated with loss of parking.
Impact 4.8-5: Increased traffic safety hazards during construction.	PSM	LSM	Y	See Impact TR-1: The Project would conflict with an applicable plan, ordinance or policy establishing measures of effectiveness for the performance of the circulation system. Also see Impact TR-3: The Project would temporarily decrease the performance and safety of public transit, bicycle, and pedestrian facilities during construction. There is no difference in the impact determination.

TABLE D-2
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PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.8-6: Long-term traffic increases during facility operation.	LS	LS	Y	See Impact TR-4: Project operations and maintenance activities would not conflict with an applicable plan or policies regarding performance of the transportation system or alternative modes of transportation. There is no difference in the impact determination.
Impact 4.17-6: Cumulative traffic increases on local and regional roads.	PSU	LSM	N	See Impact C-TR-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to transportation and circulation. The WSIP PEIR cumulative analysis determined that significant cumulative impacts could occur during concurrent construction of nearby projects, including non-SFPUC projects, and based on the conservative assumption that interagency coordination of construction traffic might not always be possible; this impact was determined to be potentially significant and unavoidable. The project-level analysis identified the potential under the GSR Project for cumulative impacts from multiple construction projects in the same geographic area. Implementation of mitigation would reduce the impact such that the GSR Project's contribution to cumulative impacts would not be cumulatively considerable.

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PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Air Quality				
Impact 4.9-1: Construction emissions of criteria pollutants.	LS	LSM	N	See Impact AQ-2: Emissions generated during construction activities would violate air quality standards and would contribute substantially to an existing air quality violation. The WSIP PEIR identified the requirement for a dust control plan and implementation of dust control measures as part of the SFPUC Construction Measures. The project-level EIR does not assume implementation of SFPUC Construction Measures. The project-level analysis determined that the generation of fugitive dust during construction would result in a significant impact. Implementation of Mitigation Measures M-AQ-2a (BAAQMD Basic Construction Measures) and Mitigation Measure M-AQ-2b (NOx Reduction during Construction of Alternate Sites) would reduce this impact to a less-than-significant level.
Impact 4.9-2: Exposure to diesel particulate matter during construction.	LS	LSM	N	See Impact AQ-3: Project construction would expose sensitive receptors to substantial pollutant concentrations. Also see Impact AQ-6: Project operations would not expose sensitive receptors to substantial pollutant concentrations. The PEIR assumed a determination of less than significant due to the relatively low amount of diesel particulate emissions expected to be generated by haul truck traffic. The project-level analysis determined that under the GSR Project the BAAQMD thresholds utilized as significance thresholds in the EIR would be exceeded for one of the modeling groups evaluated. Implementation of Mitigation Measure M-AQ-3 (Construction Health Risk Mitigation) would reduce this temporary impact to a less-than-significant level. The project-level analysis determined that operational impacts would be less than significant.

TABLE D-2
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Impact 4.9-3: Exposure to emissions (possibly including asbestos) from tunneling.	PSM	N/A	N	The PEIR analysis was based on a project design that could require tunneling using jack-and-bore construction at roadway crossings. Updated Project design information indicates that tunneling is not included in the GSR Project. Thus, the significance criterion related to exposure to emissions in tunnels is not applicable.
Impact 4.9-4: Air pollutant emissions during project operation.	LS	LS	Y	See Impact AQ-5: Project operations would not violate air quality standards or contribute substantially to an existing air quality violation. There is no difference in the impact determination.
Impact 4.9-5: Odors generated during project operation.	LS	LS	Y	See Impact AQ-7: Project operations would not create objectionable odors affecting a substantial number of people. There is no difference in the impact determination.
Impact 4.9-6: Secondary emissions at power plants.	LS	LS	Y	See Impact ME-2: The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during operation. For all WSIP facility improvement projects, the PEIR analysis assumed any incremental increase in power demand would not result in significant secondary air quality impacts. The project-level analysis is consistent with the PEIR analysis and determined that the GSR Project would not increase energy demands. Thus, this PEIR impact was not specifically called out in the project-level analysis.

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Impact 4.9-7: Conflict with implementation of applicable regional air quality plans addressing criteria air pollutants and state goals for reducing emissions.	LS	LS	Y	See Impact AQ-1: Construction of the Project would not conflict with or obstruct implementation of applicable air quality plans. There is no difference in the impact determination.
Impact 4.17-7: Cumulative increases in construction and/or operational emissions in the region.	PSU	LSM	N	See Impact C-AQ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to air quality. The PEIR determined that cumulative impacts due to emissions of criteria pollutants would be PSU because the WSIP projects in combination with the cumulative projects would result in regionwide cumulative increases in air emissions during project operations and the residual contribution from each project would contribute to the region's nonattainment status for ozone and particulate matter. Cumulative impacts related to exposure to diesel particulate matter would also be potentially significant and unavoidable because of the lack of certainty about the timing of many of the cumulative projects that might use common haul routes. The project-level analysis identified the potential under the GSR Project for cumulative impacts to NOx emissions if all sites, including alternate sites, were constructed. Implementation of Mitigation Measure M-AQ-2b (NOx Reduction during Construction of Alternate Sites) would reduce NOx emissions to less-than-cumulatively considerable (less than significant) levels by requiring construction contractors to use newer equipment or retrofitted equipment that would create fewer emissions of NOx.

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PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Noise and Vibration				
Impact 4.10-1: Disturbance from temporary construction-related noise increases.	PSU	SUM	Y	See Impact NO-1: Project construction would result in noise levels in excess of local standards. Also see Impact NO-3: Project construction would result in a substantial temporary increase in ambient noise levels. There is no difference in the impact determination.
Impact 4.10-2: Temporary noise disturbance along construction haul routes.	PSU	LS	N	See Impact NO-4: Project construction would not result in a substantial temporary increase in ambient noise levels along construction haul routes. The PEIR assumed that any nighttime truck operations greater than 1 truck per hour could exceed the sleep interference criterion during construction of the PEIR Regional Groundwater Projects. Implementation Mitigation Measures 4.10-2a (limiting hourly truck volumes during the day) and 4.10-2b (restricting of nighttime truck operations) could reduce the impact, but even with implementation of this measure, the PEIR determined that the impact would be potentially significant and unavoidable. The project-level analysis for the GSR Project determined that truck deliveries would not occur at nighttime, and estimated noise levels would fall below the daytime construction threshold. Therefore, the impacts from noise along construction haul routes would be less than significant.

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PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.10-3: Disturbance due to construction-related vibration.	PSU	LSM	N	See Impact NO-2: Project construction would result in excessive groundborne vibration. The PEIR assumed that potentially significant vibration effects could result if there are any sensitive receptors located within 100 feet of proposed facilities but implementation of vibration controls (Measures 4.10-31 and 4.10-3b) would help reduce impacts. The analysis conservatively assumed that construction could occur during nighttime hours; therefore, the impact was considered potentially significant and unavoidable. The project-level analysis determined that construction-related vibration at some GSR sites could result in significant impacts on adjacent structures. Implementation of Mitigation Measure M-NO-2 (Reduce Vibration Levels during Construction of Pipelines) would reduce the Project impact to a less-than-significant level.
Impact 4.10-4: Disturbance due to long-term noise increases.	LS	LSM	N	See Impact NO-5: Operation of the Project would result in exposure of people to noise levels in excess of local noise standards or result in a substantial permanent increase in ambient noise levels in the Project vicinity. The PEIR evaluation of long-term noise increases concluded that noise associated with standby power would be less than significant. The evaluation in the PEIR for other operational noise noted that the project-specific evaluations would define design measures needed to ensure that operational noise levels are maintained at acceptable levels. The project-level analysis determined that under the GSR Project operational noise levels at some sites would exceed established sleep interference thresholds. Implementation of Mitigation Measure M-NO-5 (Operational Noise Control Measures) would reduce the Project impact to a less-than-significant level.

TABLE D-2
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Impact 4.17-8: Cumulative increases in construction-related and operational noise.	PSU	SUM	Y	See Impact C-NO-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to noise. There is no difference in the impact determination.
Public Services and Utilities				
Impact 4.11-1: Potential temporary damage to or disruption of existing regional or local public utilities.	PSM	LSM	Y	See Impact UT-1: Project construction could result in potential damage to or temporary disruption of existing utilities during construction. There is no difference in the impact determination.
Impact 4.11-2: Temporary adverse effects on solid waste landfill capacity.	PSM	LS	N	See Impact UT-3: Project construction would not result in adverse effects on solid waste landfill capacity. The WSIP PEIR determined that solid waste could impact permitted landfill capacity and noted that potential impacts from individual WSIP projects would be evaluated in more detail in a separate project-level CEQA review. The project-level analysis determined that there is sufficient landfill capacity for GSR Project spoils and the impact would be less than significant with no mitigation required.
Impact 4.11-3: Impacts related to compliance with statutes and regulations related to solid waste.	PSM	LSM	Y	See Impact UT-4: Project construction could result in a substantial adverse effect related to compliance with federal, State, and local statutes and regulations pertaining to solid waste. There is no difference in the impact determination.
Impact 4.11-4: Impacts related to the relocation of utilities.	PSM	LSM	Y	See Impact UT-1: Project construction could result in potential damage to or temporary disruption of existing utilities during construction. There is no difference in the impact determination.

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Impact 4.17-9: Cumulative impacts related to disruption of utility service or relocation of utilities.	LS	LSM	N	See Impact C-UT-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to utilities and service systems. The PEIR determined that construction of the WSIP projects could disrupt utility services or require temporary or permanent relocation of utilities. However, the PEIR determined that these potential impacts would be site-specific rather than additive and would be mitigated on a site-specific basis and, thus, this cumulative impact was considered less than significant. The project-level analysis identified the potential under the GSR Project for cumulative impacts from multiple construction projects in the same geographic region. The analysis determined that implementation of mitigation would reduce the impact such that the GSR Project's contribution to cumulative impacts would not be considerable.
	N/A	LS	N	See Impact UT-2: Project construction would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects. Also see Impact UT-5: Project operation would not exceed the capacity of wastewater treatment facilities, exceed wastewater treatment requirements, require or result in the construction of new or expansion of existing wastewater treatment facilities or stormwater drainage facilities, the construction of which could cause significant environmental effects. The WSIP PEIR did not evaluate impacts related to the potential exceedance of wastewater treatment facilities, wastewater treatment requirements, or the construction of new wastewater or storm drainage facilities.

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Recreational Resources				
Impact 4.12-1: Temporary conflicts with established recreational uses during construction.	PSM	LSM	Y	See Impacts RE-1 through RE-3 for a discussion of temporary conflicts with recreational uses during construction. There is no difference in the impact determination.
Impact 4.12-2: Conflicts with established recreational uses due to facility siting and project operation.	PSM	LS	N	See Impact RE-4: The Project would not damage recreational resources during operation. Also see Impact RE-5: The Project would not deteriorate the quality of the recreational experience during operation. The PEIR analysis assumed that operation of groundwater facilities constructed in City-owned parks and recreational facilities would result in potentially significant impacts on recreational resources but implementation of architectural design, landscaping, and tree removal measures (Measures 4.3-4a, 4.3-4b, 4.3-4c, and 4.3-4d), as well as appropriate siting of proposed facilities (Measure 4.12-2), would reduce potential impacts to a less-than-significant level. The project-level analysis concluded that no significant recreational conflicts would occur from GSR Project operation, and that the Project impact would be less than significant.

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PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.17-10: Cumulative effects on recreational resources during construction.	LS	LS	Y	See Impact C-RE-1: Construction and operation of the proposed Project would not result in significant cumulative impacts on recreational resources. There is no difference in the impact determination.
	N/A	LS	N	Impact RE-6 evaluates potential Project impacts on recreational resources at Lake Merced. The PEIR did not directly evaluate the potential for adverse effects on recreational resources at Lake Merced related to GSR Project operation. The PEIR did evaluate changes in water levels in Lake Merced due to proposed pumping under the Local Groundwater Projects (SF-2), and determined that while direct effects on lake levels are not expected, indirect effects could occur. The PEIR analysis included implementation of Measures 5.6-1 and 5.6-2, and noted that a more detailed analysis of the lake-aquifer relationship would be required as part of project-level CEQA reviews. The project-level analysis determined that the GSR Project would result in minor changes in lake depth and surface area that would have a negligible effect on the scenic quality of the lake and which would not encroach on trails or access areas. In addition, the Project would be consistent with the *Western Shoreline Area Plan* policies for Lake Merced. Therefore, the Project impact on recreational resources was found to be less than significant.
Agricultural Resources				
Impact 4.13-1: Temporary conflicts with established agricultural resources.	N/A	NI	Y	See GSR Section 5.19 (Agriculture and Forest Resources).

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.13-2: Conversion of farmlands to nonagricultural uses.	N/A	NI	Y	See GSR Section 5.19 (Agriculture and Forest Resources).
Hazards				
Impact 4.14-1: Potential to encounter hazardous materials in soil or and groundwater.	PSM	LSM	Y	See Impact HZ-2: The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction. There is no difference in the impact determination.
Impact 4.14-2: Exposure to naturally occurring asbestos during construction.	LS	NI	N	See GSR Section 5.17.1.4 (Potential Presence of Naturally Occurring Asbestos). The PEIR found that the PEIR Regional Groundwater Projects would have a low likelihood of encountering asbestos because there is not ultramafic rock units mapped in the area. The project-level analysis determined that under the GSR Project no ultramafic rock units occur in the areas of the proposed facility sites, therefore, naturally occurring asbestos is not likely to be encountered.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.14-3: Risk of fires during construction.	LS	LS	N	See GSR Section 5.17.1.5 (Fire Hazards). Also see Impact HZ-7: The Project would not expose people or structures to a significant risk of loss, injury, or death involving fires At the time the WSIP PEIR was prepared, the locations of specific PEIR Regional Groundwater Project components had not been determined. Therefore, the PEIR conservatively assumed that the projects could be located within high fire hazard zones in San Francisco. As described in GSR Section 5.17.1.5 (Fire Hazards) of the project-level EIR, the facility sites are located on urban land in non-fire hazard severity zones. The project-level analysis also determined that impacts on the exposure of people or structures to fire risk due to changes in Lake Merced water levels would be less than significant.
Impact 4.14-4: Gassy conditions in tunnels.	LS	N/A	N	The PEIR analysis was based on a project design that could require tunneling using jack-and-bore construction at roadway crossings. Updated Project design information indicates that tunneling is not included in the GSR Project. Thus, the significance criterion related to gassy conditions in tunnels is not applicable.
Impact 4.14-5: Exposure to hazardous building materials.	PSM	LSM	Y	See Impact HZ-2: The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction. There is no difference in the impact determination.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.14-6: Accidental hazardous materials release from construction equipment.	LS	LSM	N	See Impact HZ-2: The Project would result in a substantial adverse effect related to reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment during construction. The PEIR assumed that impacts related to accidental releases of hazardous materials from construction equipment would be less than significant with implementation of SFPUC Construction Measure #7 (Hazardous Materials). The project-level EIR does not assume implementation of SFPUC Construction Measure #10. The project-level analysis identified potential significant impacts, and includes implementation of mitigation that would reduce the GSR Project impact to a less-than-significant level.
Impact 4.14-7: Increased use of hazardous materials during operation.	LS	LS	Y	See Impact HZ-4: The Project would not create a hazard to the public or environment from the routine transport, use, or disposal of hazardous materials or accidental release of hazardous materials during operation. There is no difference in the impact determination.
Impact 4.14-8: Emission or use of hazardous materials within 1/4 mile of a school.	LS	LSM	N	See Impact HZ-3: The Project would result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during construction. Also see Impact HZ-5: The Project would not result in impacts from the emission or use of hazardous materials within 0.25 mile of a school during operation. The WSIP PEIR assumed that impacts related to accidental release of hazardous materials from construction equipment would be less than significant with implementation of SFPUC Construction Measure #7 (Hazardous Materials). The project-level analysis concluded that under the GSR Project significant impacts could occur during construction at sites on or immediately adjacent to schools, and operational impacts would be less than significant. Implementation of mitigation would reduce the construction-related Project impact to a less-than-significant level.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.17-12: Cumulative effects related to hazardous conditions and exposure to or release of hazardous materials.	LS	LSM	N	See Impact C-HZ-1: Construction and operation of the proposed Project could result in a cumulatively considerable contribution to cumulative impacts related to hazards and hazardous materials. The PEIR determined that due to the site-specific nature of hazardous materials impacts and mitigation measures, there would be no potential for cumulative effects from construction of WSIP projects in conjunction with other cumulative developments. The PEIR determined that compliance with applicable laws and regulations and with implementation of SFPUC construction measures, this cumulative impact would be less than significant. The project-level analysis identified the potential for cumulative impacts from multiple construction projects in the same geographic region. Implementation of mitigation would reduce the impact such that the GSR Project's contribution to cumulative impacts would not be cumulatively considerable.
Minerals and Energy Resources				
Impact 4.15-1: Construction-related energy use.	PSM	LS	Y	See Impact ME-1: The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during construction. The PEIR identified a potentially significant impact related to energy use during construction. Because the GSR Project would not use large amounts of fuel and energy in a wasteful manner, the project-level analysis identified a less-than-significant impact.

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.15-2: Long-term energy use during operation.	PSM	LS	N	See Impact ME-2: The Project would not encourage activities that result in the use of large amounts of fuel and energy in a wasteful manner during operation. The PEIR estimated that the PEIR Regional Groundwater Projects would require up to 5,100,000 kWh for operation. The PEIR determined that implementation in addition to other WSIP projects in the San Francisco region (e.g., San Andreas Pipeline 3 Installation and Recycled Water Project) would increase energy use in the San Francisco region by approximately 87 percent, a potentially significant impact. The project-level analysis determined that the collective change in energy demand of the new well facilities and Westlake Pump Station, the Partner Agencies' wells, and the regional water system would be negligible, and the GSR Project would not cause a substantial increase in energy use on a long-term basis. The impact was determined to be less than significant.
Impact 4.17-13: Cumulative increases in the use of nonrenewable energy resources.	LS	LS	N	See Impact C-ME-1: Construction and operation of the proposed Project would not result in a cumulatively considerable contribution to cumulative impacts related to mineral and energy resources. The PEIR determined that the WSIP's contribution to cumulative increases in long-term energy demand would not be considerable. The PEIR also determined that with implementation of exhaust control measures required in the Air Quality Section of the PEIR, the WSIP's contribution to the regionwide cumulative increase in construction-related energy consumption would not be considerable. The project-level analysis identified the potential for cumulative impacts from multiple construction projects in the same geographic region. The GSR Project's contribution to cumulative impacts would not be cumulatively considerable, as large amounts of fuel and energy would not be used in a wasteful manner during construction (less than significant).

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Collective Facilities Impacts (Consider these to be potential cumulative impacts)				
Impact 4.16-1a: Collective temporary and permanent impacts on existing land uses in the vicinity of proposed facility sites.	N/A	N/A	N/A	
Impact 4.16-1b: Collective temporary and permanent impacts on the visual character of the surrounding area.	LSM	N/A	N/A	
Impact 4.16-2: Collective exposure of people or structures to geologic and seismic hazards.	N/A	N/A	N/A	
Impact 4.16-3: Collective WSIP impacts related to flooding hazards and the degradation of surface waters.	LSM	N/A	N/A	
Impact 4.16-4: Collective loss of sensitive biological resources.	N/A	N/A	N/A	

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.16-5: Collective increase in impacts related to archaeological, paleontological, and historic resources.	N/A	N/A	N/A	
Impact 4.16-6: Collective traffic increases on local and regional roads.	PSM	N/A	N/A	
Impact 4.16-7: Collective increases in construction and operational emissions in the region.	LS	N/A	N/A	
Impact 4.16-8: Collective increases in construction-related and operational noise.	PSU	N/A	N/A	
Impact 4.16-9: Collective impacts on utilities and landfill capacity.	N/A	N/A	N/A	
Impact 4.16-10: Collective effects on recreational resources during construction.	LSM	N/A	N/A	

TABLE D-2
WSIP PEIR Impacts Consistency

PEIR Impact	PEIR Significance Determination for San Francisco Region Groundwater Project SF-2	GSR Project-level Significance Determination	Same Rationale for Significance Determination as PEIR? (Y/N)	Notes: (Explain difference in significance determinations and/or rationale for determinations)
Impact 4.16-11: Collective conversion of farmland to nonagricultural uses.	N/A	N/A	N/A	

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Land Use		
Measure 4.3-2, Facility Siting Studies: Conduct project-specific facility siting studies for non-SFPUC land and implement these studies' recommendations to avoid or minimize impacts on existing land uses.	Y	This measure has been implemented. The SFPUC completed project-specific siting studies in the Final Alternatives Analysis Report to determine the most appropriate location of the 16 proposed and 3 alternate well facility sites. Wells would be located both on lands owned by the SFPUC or owned by others. Land use criteria used in the Alternatives Analysis Report included ownership and compatibility with local zoning were used to avoid or minimize impacts to existing nearby land uses.
Measure 4.3-4a, Architectural Design: Design permanent new, aboveground facilities to be compatible with existing visual character of the site and surrounding area.	Y	The proposed aboveground facilities would have a similar appearance as other SFPUC water supply facilities. Most well facilities are not visible from scenic resources and would not alter the visual character of the surrounding areas. Further, existing topography and vegetation would provide partial screening of many proposed aboveground facilities. Additional mitigation measures are included in the GSR EIR to reduce potential impacts to scenic resources and visual character. These measures include Mitigation Measures M-AE-1b (Tree Protection Measures), M-AE-1c (Develop and Implement at Tree Replanting Plan), M-AE-3a (Implement Landscape Screening), M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 14), and M-CR-5b (Minimize Facilities Siting Impacts on Elements of the Historical Resource at Site 15). These measures provide site-specific requirements in accordance with the PEIR mitigation measure.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.3-4b, Landscaping Plans: Prepare and implement landscaping plans to restore (recontour, revegetate, landscape) sites to preconstruction conditions. Monitor landscape plantings.	Y	This measure is implemented as part of the GSR Project for all proposed well facility sites. After construction is complete, well facility sites would be restored to their general pre-construction conditions, but in accordance with the SFPUC's Vegetation Management Policy (SFPUC 2007), they may be revegetated with alternate plantings. This approach replaces the requirement for preparation and implementation of a landscaping plan in accordance with the PEIR mitigation measure, except for Sites 4, 7, and 18 (Alternate) which require implementation of Mitigation Measure M-AE-3a (Implement Landscape Screening) to reduce impacts to less than significant levels. The Project Description for Sites 10 and 13 includes landscape plan requirements.
Measure 4.3-4c, Landscape Screens: Include new plantings and landscape berms to screen views of new structures and equipment from scenic roads.	Y	The proposed aboveground facilities would be similar in appearance as other SFPUC water infrastructure facilities in San Francisco and San Mateo counties. Most well facility sites would not be visible from scenic resources or from scenic roadways. Existing topography and vegetation would provide partial screening of many proposed aboveground facilities. The well facility at Site 15 (in Golden Gate National Cemetery) would be located along Sneath Lane which is designated as a scenic roadway by the City of San Bruno. Mitigation Measure M-AE-1d (Construction Area Screening) would screen the construction activities from views along Sneath Lane. Likewise, M-AE-3a (Implement Landscape Screening) would screen views of these sites from adjacent residences or cemeteries.
Measure 4.3-4d, Minimize Tree Removal: Minimize or avoid the removal of trees that screen existing and proposed WSIP facility sites; implement tree replacement plan.	Y	See GSR Mitigation Measures M-BR-4a (Identify Protected Trees) and BR-4b (Protected Tree Replacement). Additionally, M-AE-1b (Tree Protection Measures) and M-AE-1c (Develop and Implement a Tree Replanting Plan) would minimize tree removal along El Camino Real during construction of the pipeline for Site 12.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.3-5, Reduce Lighting Effects: Use cut-off shields and nonglare fixture design, direct lighting onsite and downward, prevent use of highly reflective building materials or finishes.	Y	As part of the GSR Project Description nighttime lighting during construction would be placed away from surrounding residences and light sensitive land uses. The Project includes the development of a site-specific construction lighting plan for sites where nighttime construction lighting would be needed. The site-specific lighting plans would include elements that would be in accordance with the PEIR mitigation measure.
Geology		
Measure 4.4-1, Quantified Landslide Analysis: Avoid sites with landslide hazards; where they cannot be avoided, conduct site-specific slope stability analyses and implement recommendations.	Y	Site-specific geotechnical evaluations were completed for most sites during conceptual design of the GSR Project. Mitigation Measure M-GE-3 (Conduct Site-Specific Geotechnical Investigations and Implement Recommendations) requires that the SFPUC conduct a site-specific design-level geotechnical study for all sites selected for construction as described in Impact GE-3 and GE-4. The measure requires that facilities be designed and constructed in conformance with the specific recommendations contained in the design-level geotechnical studies. This mitigation measure meets the requirement for preparation and implementation of an individual landslide analysis in accordance with the PEIR mitigation measure.
Measure 4.4-4, Subsidence Monitoring Program: Monitor subsidence and implement corrective actions as warranted.	N	The PEIR mitigation applies to ground subsidence related to tunneling. Although the GSR Project does not include tunneling, the Project EIR included an evaluation of the potential impacts from subsidence associated with groundwater pumping. GSR Project operations would not result in substantial land subsidence due to decreased groundwater levels in the Westside Groundwater Basin, and no mitigation would be needed to address subsidence impacts, as evaluated in Impact HY-7.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.4-9, Characterize Extent of Expansive and Corrosive Soil: Characterize the presence of expansive/corrosive soils; implement recommendations.	N	The presence of expansive and corrosive soils was evaluated as part of the site-specific geotechnical reports. The GSR Project would be constructed and designed in accordance with the recommendations of the site-specific geotechnical investigations to minimize the effects of any expansive soils. With incorporation of these design features, impacts related to expansive and corrosive soils would be less than significant and no mitigation is required. See Impact GE-5, The Project would not create significant risks to life or property due to expansive or corrosive soil; no mitigation would be required based on the site-specific geotechnical evaluations.
Hydrology and Water Quality		
Measure 4.5-2, Site-Specific Groundwater Analysis and Identified Measures: Conduct project-specific analysis of dewatering and implement measures to ensure that groundwater resources and the beneficial uses of groundwater are not adversely affected.	Y	See Impact HY-2. Mitigation Measure M-HY-2 (Management of Well Development and Pump Testing Discharges) would be necessary to address potential impacts to receiving waters from the discharge of dewatering effluent from well testing, including groundwater protection.
Measure 4.5-4a, Flood Flow Protection Measures: Preclude exposure of stockpiled soils, hazardous materials, and construction materials to flood flows.	Y	The proposed GSR Project construction staging areas are located outside of the designated 100-year FEMA flood hazard zone. Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would require that the construction contractor implement site-specific BMPs to protect water quality during project construction activities. No additional mitigation is necessary.
Measure 4.5-4b, Site-Specific Flooding Analysis and Identified Measures: Implement design measures to preclude projects from causing flooding or damage from redirected flood flows.	Y	GSR Project construction would not result in flooding impacts associated with impeding or redirecting flood flows as the Project would be located outside of the designated 100-year FEMA flood hazard zone, as analyzed in the evaluation of impacts under Impact HY-3.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.5-5, **Stormwater Treatment and Groundwater Monitoring:** If treated stormwater is used to maintain Lake Merced water levels, monitor surface water and groundwater quality in the vicinity of Lake Merced. Identify and implement corrective actions (e.g., treatment).	Y	The GSR Project would not discharge treated stormwater into a lake directly, however implementation of Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) would require the SFPUC to implement a lake level management program, including lake level and water quality monitoring and groundwater level elevations. The measures would require the addition of supplemental water to augment lake levels if available; and alter pumping as necessary to avoid adverse effects on Lake Merced should a supplemental water source be unavailable. Supplemental water may include treated stormwater. Mitigation Measure M-HY-9a requires monitoring for both surface water and groundwater quality at Lake Merced.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.5-6, Appropriate Source Controls and Site Design Measures: For projects located in areas not covered by a municipal stormwater permit and disturbing less than one acre of land during construction, implement appropriate source control and site design measures. These measures will ensure compliance with applicable water quality criteria and goals and protect the beneficial uses of the receiving water.	Y	Earthmoving activities associated with GSR Project construction would temporarily alter existing drainage patterns at well facility sites, including vegetation removal, grading, excavation and soil stockpiling. Construction activities could also result in the accidental release of hazardous construction chemicals, such as adhesives, solvents and fuels. If not managed appropriately, these chemicals could adhere to soil particles, become mobilized by rain or runoff, or infiltrate into groundwater, degrading water quality. Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would reduce water quality impacts during Project construction activities. Consistent with the requirements of the NPDES General Permit for Storm Water Discharges Associated with Construction Activity, at sites where more than one acre of land disturbance would occur (Sites 3, 4, 5, 6, 7, 12, 13, and 14), the SFPUC or its contractor(s) would develop a Storm Water Pollution Prevention Plan (SWPPP), submit a notice of intent to the SWRCB's Division of Water Quality and implement site-specific BMPs to prevent discharges of nonpoint-source pollutants in construction-related stormwater runoff into downstream water bodies. At sites where less than one acre of land disturbance would occur (Sites 1, 2, 8, 9, 10, 11, 15, 16, 17 Alternate, 18 Alternate, and 19 Alternate), the SFPUC or its contractor(s) would prepare and implement Erosion and Sediment Control Plans (ESCPs). The ESCP would include measures to address the overall construction of the Project and to minimize any adverse effects on water quality. This mitigation measure meets the requirement for compliance with water quality standards and to protect the beneficial uses of receiving waters in accordance with the PEIR mitigation measure.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 5.6-1, Groundwater Monitoring to Determine Basin Safe Yield: The SFPUC will continue ongoing studies, including the existing groundwater and lake level monitoring programs, to determine the safe yield of the North Westside Groundwater Basin in order to avoid overdraft and associated effects including adverse effects on surface water features and seawater intrusion. Using this data, the SFPUC will develop and implement a plan identifying appropriate pumping patterns to avoid overdraft and the undesirable effects associated with overdraft. The plan will establish both a regular (average annual) and an intermittent (dry year or emergency) yield as well as a strategy for modifying pumping patterns such that the pumping levels can be sustained as an ongoing reliable water supply without depletion of groundwater storage or degradation of water quality.	N	This mitigation measure only applies to projects in the North Westside Groundwater Basin. The GSR Project would be in the South Westside Groundwater Basin. Nevertheless, the GSR Project may cause significant impacts relative to groundwater depletion, which would be reduced to less than significant through implementation of Mitigation Measures M-HY-14 (Prevent Groundwater Depletion). The mitigation measure includes provisions that GSR wells shall only be pumped when there is a positive balance in the SFPUC Storage Account, which will be adjusted for losses from the Basin due to leakage caused as a result of the Project.
Measure 5.6-2, Implementation of a Lake Level Management Plan: The SFPUC will develop and implement a lake level management plan identifying strategies for altering pumping patterns or lake augmentation to maintain Lake Merced water levels within the desired long-term range should monitoring conducted under Measure 5.6-1 indicate the potential for adverse effects on lake levels due to groundwater pumping. The SFPUC will coordinate the implementation of this measure with Measure 5.6-1.	N	This mitigation measure is only applicable to projects in the North Westside Groundwater Basin. The GSR Project would be in the South Westside Groundwater Basin. Nevertheless, the GSR Project may cause significant impacts on Lake Merced water levels, which would be reduced to less than significant through implementation of Mitigation Measures M-BR-7 (Lake Level Management for Water Levels Increases for Lake Merced), M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced). These mitigation measures include monitoring and provisions to manage both increasing and decreasing Lake Merced lake levels to the extent such lake level changes are caused by the Project.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 5.6-5, Drinking Water Source Assessments for Groundwater Wells: As required by the California Department of Health Services and incorporated as part of the WSIP, the SFPUC will prepare drinking water source assessments for groundwater wells constructed under the Local and Regional Groundwater Projects (SF-2) and will update these assessments every five years. If the assessment indicates no potential for contamination, then no mitigation is required. However, for wells that are considered vulnerable to contamination on the basis of the drinking water source assessment, the SFPUC will develop and implement a source water protection program specifying actions and a program to be implemented to prevent contamination of the drinking water source. The source water protection program could include nonregulatory components such as watershed restoration, stormwater monitoring, groundwater monitoring, and public education to protect drinking water quality. Land use planning, permitting, and possibly more restrictive regulatory methods may also be implemented by the local municipality where a threat to drinking water quality is indicated, and management of potential sources of microbiological or direct chemical contamination to eliminate or reduce the risk of contamination of the water supply may be considered. The SFPUC will encourage public participation in the development of the program and will update the program every five years along with the drinking water source assessments.	Y	Preliminary Drinking Water Source Assessment and Protection Program (DWSAP) reports for most well sites were prepared by the SFPUC as part of the conceptual design of the GSR Project. The preliminary DWSAPs indicate that groundwater at these sites may be vulnerable to contamination from nearby land use activities. However, the analysis of the site-specific conditions in Impact HY-12 concluded that, in the South Westside Groundwater Basin, known contamination is located near the ground surface, the GSR wells would be screened from 240 feet to 700 feet below ground surface, and the Primary Production Aquifer where the GSR wells would be pumping from is generally disconnected hydraulically from most occurrences of shallow groundwater zones. In addition, the GSR Project would decrease the downward gradient over the long term, therefore decreasing the risk of contamination. Therefore, the analysis concludes that impacts relative to contamination of the drinking water source would be less than significant, and no mitigation would be required.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Biology		
Measure 4.6-1a, Wetlands Assessment: Wetland scientist will determine whether wetlands could be affected by the project, and, if so, perform a wetland delineation and develop mitigation.	N	See Impacts BR-3 and BR-8. A wetlands assessment was performed in support of the Project-level analysis, which included an evaluation of potential effects on wetland habitats at Lake Merced. Although no wetlands or open waters regulated under federal or State law would be directly impacted by the Project, Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would be implemented to protect surrounding waterways from construction-related runoff and sedimentation, reducing potential indirect impacts to less than significant. Implementation of Mitigation Measures M-BR-8 (Lake Level Management for No-Net-Loss of Wetlands for Lake Merced), and Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) would reduce potential Project impacts on wetlands at Lake Merced to less-than-significant levels.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.6-1b, Compensation for Wetlands and Other Biological Resources: If a WSIP project will affect jurisdictional wetlands, implement avoidance measures, restoration procedures, and compensatory creation or enhancement to ensure no net loss of wetland extent or function. Compensate for sensitive riparian and upland habitats supporting key special-status species. Obtain permits for each project and comply with applicable regulations addressing sensitive habitats and species. The Habitat Reserve Program is an alternative for implementing offsite habitat compensation.	Y	No wetlands or open waters regulated under federal or State law would be directly impacted by the GSR Project; however, Mitigation Measure M-HY-1 (Develop and Implement a Storm Water Pollution Prevention Plan [SWPPP] or an Erosion and Sediment Control Plan) would be implemented to protect surrounding waterways from construction-related runoff and sedimentation, reducing potential indirect impacts to less than significant. Implementation of Mitigation Measures M-BR-8 (Lake Level Management for No-Net-Loss of Wetlands for Lake Merced), and Mitigation Measures M-HY-9a (Lake Level Monitoring and Modeling for Lake Merced) and M-HY-9b (Lake Level Management for Lake Merced) would reduce potential Project impacts on wetlands at Lake Merced to less-than-significant levels. See also Mitigation Measure M-BR-2 (Avoid Disturbance to Riparian Habitat), which would require the avoidance of riparian habitat. The mitigation measure requires installation of temporary fencing to demarcate the boundary for construction at these sites. This mitigation measure is consistent with the PEIR mitigation measure and is specific to the Project requirements. Therefore, no wetland impacts would require compensatory mitigation.
Measure 4.6-2, Habitat Restoration/Tree Replacement: Restore temporarily affected sensitive habitats. Replace trees designated as heritage trees (or similar local designation) consistent with requirements of local ordinances. Minimize loss of sensitive habitats by coordinating WSIP projects.	Y	See Mitigation Measures M-BR-4a (Identify Protected Trees) Mitigation Measure M-AE-1b (Tree Protection Measures), and Mitigation Measure M-BR-4b (Protected Tree Replacement). The project-level mitigation measures require implementation of protective measures to avoid or minimize impacts on mature native trees during construction, and if removal is necessary, to plant replacement trees at or in close proximity to the removal sites to the extent feasible. If replanting trees on the same location is not feasible or could result in damage to the proposed improvements, the SFPUC shall designate a suitable planting site elsewhere in the Project area. These mitigation measures are consistent with the PEIR mitigation measure and are specific to the GSR Project requirements.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)		Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.6-3a, Protection Measures During Construction for Key Special-Status Species and Other Species of Concern: Where key special-status species and other species of concern are potentially present, implement general practice measures (preconstruction surveys, worker awareness program, environmental inspector, minimization of habitat loss).		Y	See Mitigation Measures M-BR-1a (Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors), M-BR-1b (Protection Measures for Special-status Bats during Tree Removal or Trimming), and M-BR-1d (Monarch Butterfly Protection Measures). The project-level measures are consistent with the PEIR measure and provide additional site- and project-specific details where key special-status species and other species of concern are potentially present. These mitigation measures are consistent with the PEIR mitigation measure and are specific to the GSR Project requirements.
Measure 4.6-3b, Standard Mitigation Measures for Key Special-Status Plants and Animals: Implement measures to reduce impacts on key special-status species. *See below for specific species and corresponding sub-PEIR mitigation number.*			
Invertebrates			
Valley Elderberry Longhorn Beetle	I.1	N	Species not identified in GSR Project vicinity.
Vernal Pool Crustaceans (Vernal Pool Fairy Shrimp; Conservancy Fairy Shrimp; Vernal Pool Tadpole Shrimp)	I.2	N	Species not identified in GSR Project vicinity.
Bay Checkerspot Butterfly; Callippe Silverspot Butterfly	I.3	N	Species not identified in GSR Project vicinity.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)		Applicable to Proposed Project (Y/N)?	Discussion
Fish			
Central Valley Fall- and Late-Fall-Run DPS Chinook Salmon; Central Valley DPS Steelhead; Green Sturgeon Southern District DPS; Central Coast DPS Steelhead; Rainbow Trout	F.1	N	Species not identified in GSR Project vicinity.
Reptiles and Amphibians			
California Red-Legged Frog; Foothill Yellow-Legged Frog	RA.1	N	Species not identified in GSR Project vicinity.
California Tiger Salamander	RA.2	N	Species not identified in GSR Project vicinity.
San Francisco Garter Snake	RA.3	N	Species not identified in GSR Project vicinity.
Alameda Whipsnake	RA.4	N	Species not identified in GSR Project vicinity.
Birds			
Swainson's Hawk	B.1	N	Species not identified in GSR Project vicinity.
Western Burrowing Owl	B.2 and B.3	N	Species not identified in GSR Project vicinity.
Raptors (including Bald Eagle)	B.4	Y	See Mitigation Measure M-BR-1a (Protection Measures during Construction for Special-status Birds and Migratory Passerines and Raptors).
Least Bell's Vireo	B.5	N	Species not identified in GSR Project vicinity.
California Black Rail, California Clapper Rail	B.6	N	Species not identified in GSR Project vicinity.
Western Snowy Plover	B.7	N	Species not identified in GSR Project vicinity.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)		Applicable to Proposed Project (Y/N)?	Discussion
Mammals			
Salt Marsh Harvest Mouse	M.1	N	Species not identified in GSR Project vicinity.
San Joaquin Kit Fox	M.2	N	Species not identified in GSR Project vicinity.
Riparian Woodrat	M.3	N	Species not identified in GSR Project vicinity.
Vernal Pool Plants			
Succulent Owl's Clover; Hoover's Spurge; Colusa Grass; San Joaquin Valley Orcutt Grass; Greene's Tuctoria; Hairy Orcutt Grass)	P.1	N	Species not identified in GSR Project vicinity.
Riparian Plants			
Delta Button-Celery	P.2	N	Species not identified in GSR Project vicinity.
Large-Flowered Fiddleneck	P.3	N	Species not identified in GSR Project vicinity.
San Francisco Woolly Sunflower; Marin Western Flax; Fountain Thistle	P.4	N	Species not identified in GSR Project vicinity.
Measure 4.6-4, Pipeline and Water Treatment Plant Treated Water Discharge Restrictions: Design planned discharges from the WSIP pipelines and water treatment plants to natural water bodies to minimize impacts on riparian and aquatic resources and to avoid or minimize temperature effects on aquatic resources.		N	The project-level analysis determined that mandatory compliance with the Waste Discharge Requirements for the SFPUC Drinking Water Transmission System and SFPUC Standard Operating Protocols would ensure that water quality impacts due to discharges of treated water from existing and newly installed pipelines during construction would be less than significant. Planned discharges of groundwater during well maintenance activities would be sent to either the local sanitary sewer system or the storm drain system. Planned discharges to the storm drain system would be dechlorinated and pH adjusted prior to discharge, so that eventual discharge to a surface water from the storm drain would not impact riparian and aquatic resources.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Cultural		
Measure 4.7-1, Suspend Construction Work if Paleontological Resource Is Identified: Suspend work and notify a qualified paleontologist when a paleontological resource is discovered at any of the project sites. The paleontologist will document the discovery as needed, evaluate the potential resource, and assess the significance of the find under CEQA criteria. Temporarily halt or divert excavation within 50 feet of a fossil find until the discovery is examined by a paleontologist. If avoidance is not feasible, the paleontologist will prepare an excavation plan.	Y	The project-level measures specify more stringent requirements than the PEIR measure due to the high potential to encounter paleontological resources during construction. Specific requirements include a paleontological resources training for construction workers, a paleontological resources monitoring program, and assessment and salvage of fossil finds, as applicable. See Mitigation Measure M-CR-3 (Suspend Construction Work if a Paleontological Resource is Identified).
Measure 4.7-2a, Archaeological Testing, Monitoring, and Treatment of Human Remains: Determine if implementation of an archaeological testing or archaeological monitoring program or both is the appropriate strategy for avoidance of potential adverse effects on significant archaeological resources. Review any requirements approved by the State Historic Preservation Officer. Prepare an archaeological testing plan, archaeological monitoring plan, final archeological resources report and, if applicable, an archaeological data recovery plan. The treatment of human remains and of associated or unassociated funerary objects discovered during any soil-disturbing activity will comply with applicable state laws.	Y	Although no known human burial locations have been identified within the GSR Project area, the EIR measure addresses the possibility of discovery during construction activities. See Mitigation Measure M-CR-4 (Accidental Discovery of Human Remains).

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.7-2b, Accidental Discovery Measures: Distribute archaeological resource "ALERT" sheet to contractors. If an archaeological resource may be present within the project site, an archaeological consultant will evaluate it and make a recommendation as to what action (e.g., preservation in situ) is warranted. The SFPUC will implement appropriate measures.	Y	No archaeological sites were identified within any of the GSR Project construction areas. However, at Site 11, there is some potential that remnants of a known archaeological site may still exist. See Mitigation Measure M-CR-2 (Discovery of Archaeological Resources). This mitigation measure requires the SFPUC and its contractors to adhere to appropriate procedures and protocols for minimizing impacts on any previously unrecorded and buried (or otherwise obscured) archaeological deposits, in the event that a possible archaeological resource is discovered during construction activities. This mitigation measure is consistent with the PEIR mitigation measure and is specific to the Project requirements.
Measure 4.7-3, Protection of Historic Districts: A qualified historian will assess the city's water system facilities affected by WSIP facility projects for their potential contribution to a historic district. If a historic district would be affected by one or more proposed WSIP facility project(s), develop and implement mitigation measures for effects with attention to the potential district as a whole. If a historic district is identified at the project level, it should be recorded as such, using National/California Register criteria of significance. Document the district by completing the State of California Department of Parks and Recreation Form 523 and submit to the State Historic Preservation Officer.	N	The GSR Project would not affect any portion of the City's water system facilities, except connection to underground pipelines, which would have no adverse effect on any potential historic district associated with the City's water system facilities.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.7-4a, Alternatives Identification and Resource Relocation: Identify feasible project alternatives to eliminate or reduce the need for demolition or removal of a historic resource to the greatest extent possible. If preservation of the affected historical resource at the current site is determined to be infeasible, the structure will be stabilized and relocated to other appropriate nearby sites, if feasible. After relocation, the resource will be treated according to the Secretary of the Interior's *Standards for the Treatment of Historic Properties*. If the affected historic resource is to be demolished, consult with local historical societies and governmental agencies regarding salvage of materials for public information or reuse in other locations.	N	The project-level measures are consistent with the PEIR measure and provide additional site- and project-specific details to protect historic resources at Sites 14 and 15. No other proposed GSR well facility sites would have significant impacts on historic resources. These mitigation measures are consistent with the PEIR mitigation measure and are specific to the Project requirements. See Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 14) and Mitigation Measure M-CR-5b (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 15).
Measure 4.7-4b, Historical Resources Documentation: Prepare documentation of historic resources prior to any construction work associated with demolition or removal. The appropriate level of documentation will be selected by a qualified professional who meets the standards for history, architectural history, and/or architecture (as appropriate) set forth by the Secretary of the Interior's *Professional Qualification Standards* (36 CFR 61) in consultation with a preservation specialist assigned by the San Francisco Planning Department and the local jurisdiction, if deemed appropriate by the Planning Department.	N	As part of the GSR EIR analysis, an architectural historian, who meets the standards set for by the Secretary of Interior's Standards, was retained to evaluate impacts to historic resources. The evaluation identified significant impacts only at Sites 14 and 15. See Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 14) and Mitigation Measure M-CR-5b (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 15).

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.7-4c, Secretary of the Interior's Standards for the Treatment of Historic Properties: Prepare materials describing and depicting the proposed project. Review the proposed project for compliance with the Secretary of the Interior's *Standards for the Treatment of Historic Properties*. If a project is determined to be inconsistent with the *Standards for the Treatment of Historic Properties*, pursue and implement redesign of the project such that consistency with the standards is achieved.	Y	The project-level measures are consistent with the PEIR measure and provide additional site- and project-specific details to protect historic resources at Sites 14 and 15. No other proposed GSR well facility sites would have significant impacts on historic resources. These mitigation measures are consistent with the PEIR mitigation measure, are specific to the Project requirements, and reduce impacts to less than significant under CEQA. See Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 14) and Mitigation Measure M-CR-5b (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 15).
Measure 4.7-4d, Historic Resources Survey and Redesign: Undertake a historic resources survey to identify and evaluate potential historic resources that may exist in the project's area of potential effect. If a survey identifies one or more historical resources, assess the impact the project may have on those historical resources. If the project will cause a substantial adverse change to a historic resource, assign a preservation specialist to review the proposed project for compliance with the Secretary of the Interior's *Standards for the Treatment of Historic Properties*. If the project is determined to be inconsistent with those standards, pursue and implement redesign of the project such that consistency with the standards is achieved.	Y	As part of the GSR EIR analysis, a historic resources survey was undertaken within the Project's area of potential effect. The resources that were identified were evaluated, and significant impacts were identified at Sites 14 and 15. These mitigation measures are consistent with the PEIR mitigation measure, are specific to the Project requirements, and reduce impacts to less than significant under CEQA. See Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 14) and Mitigation Measure M-CR-5b (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 15).

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.7-4e, Historic Resources Protection Plan: A qualified historian will prepare a plan that specifies procedures for protecting and monitoring historic resources during construction.	Y	The project-level measures are consistent with the PEIR measure and provide additional site- and project-specific details to protect historic resources at Sites 14 and 15. No other proposed GSR well facility sites would have significant impacts on historic resources. These mitigation measures are consistent with the PEIR mitigation measure and are specific to the Project requirements. See Mitigation Measure M-CR-5a (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 14) and Mitigation Measure M-CR-5b (Minimize Facilities Siting Impacts on Elements of the Historical Resources at Site 15), which include monitoring of potential impacts on historic resources during construction.
Measure 4.7-4f, Preconstruction Surveys and Vibration Monitoring: Include geotechnical investigations if vibration-related impacts could affect historic resources. Follow recommendations of the final geotechnical reports. Conduct a preconstruction survey of existing conditions and monitor the adjacent buildings for damage during construction, if recommended.	Y	See Impact NO-2. The project-level analysis determined that construction-related groundborne vibration would be below the significance thresholds, except at Site 15, which is located within a potential historic district, because of nearby pipeline construction. See Mitigation Measure M-NO-2 (Reduce Vibration Levels during Construction of Pipelines).

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Traffic		
Measure 4.8-1a, Traffic Control Plan Measures: Elements of the traffic control plan could include: circulation and detour plans, designated truck routes, sufficient staging area, access to driveways, use of standard construction specifications for controlling construction vehicle movements, restrictions on truck trips during peak morning and evening commute hours, lane closure restrictions, maintenance of alternate one-way traffic flow, detour signing, pedestrian and bicycle access and circulation, equipment and materials storage, construction worker parking, roadside safety protocols, considerations for sensitive land uses, coordination with local transit service providers, roadway repair, and conformance with the state's *Manual of Traffic Controls for Construction and Maintenance Work Areas*.	Y	See Mitigation Measure M-TR-1 (Traffic Control Plan). The project-level mitigation measure has been tailored to specify those elements appropriate to the proposed Project. The mitigation measure specifies that traffic control plans conform to the applicable provisions of the state's *Manual of Traffic Controls for Construction and Maintenance Work Areas.*
Measure 4.8-1b, Coordination of Individual Traffic Control Plans: In the event that more than one construction contract is issued for work along existing or new pipelines, and where construction could occur within and/or across multiple streets in the same vicinity, coordinate the traffic control plans in order to mitigate the impact of traffic disruption by including measures that address overlapping construction schedules and activities, truck arrivals and departures, lane closures and detours, and the adequacy of on-street staging requirements.	Y	See Mitigation Measure M-C-TR-1 (Coordinate Traffic Control Plan with other SFPUC Construction Projects). The mitigation measure specifies that the SFPUC and its construction contractors shall coordinate traffic control plans for overlapping construction.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.8-4, Accommodation of Displaced Public Parking Supply for Recreational Visitors: Include an additional measure in the traffic control plans to accommodate any anticipated visitor parking demand that would be displaced by proposed projects at public recreational facilities.	N	No recreational parking would be displaced under the GSR Project.
Air Quality		
Measure 4.9-1a, SJVAPCD Dust Control Measures: Include San Joaquin Valley Air Pollution Control District (SJVAPCD) Basic Control Measures in contract specifications for all construction sites. Include SJVAPCD Enhanced Control Measures in contract specifications when required to mitigate significant PM10 impacts. Include SJVAPCD Additional Control Measures in contract specifications for construction sites that are large in area, located near sensitive receptors, or which for any other reason warrant additional emissions reductions. Include SJVAPCD Rule 9510, Indirect Source Review, Section 6.1, Construction Equipment Emissions in contract specifications for any project subject to discretionary approval by a public agency that ultimately results in the construction of a new building, facility, or structure or reconstruction of a building, facility, or structure for the purpose of increasing capacity or activity and also involving 9,000 square feet of space.	N	The GSR Project would not be located within the jurisdiction of the SJVAPCD.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.9-1b, SJVAPCD Exhaust Control Measures: Include SJVAPCD Exhaust Control Measures in contract specifications, where applicable, for heavy-duty equipment to limit exhaust emissions within the San Joaquin Region.	N	The GSR Project would not be located within the jurisdiction of the SJVAPCD.
Measure 4.9-1c, BAAQMD Dust Control Measures: For projects in the Sunol Valley, Bay Division, Peninsula, and San Francisco Regions, include Bay Area Air Quality Management District (BAAQMD) Basic Control Measures in contract specifications for all construction sites. Include BAAQMD Enhanced Control Measures in contract specifications for sites over four acres. Include BAAQMD Optional Control Measures in contract specifications for sites that are large in area, located near sensitive receptors, or which for any other reason warrant additional emissions reductions.	Y	See Mitigation Measure M-AQ-2a (BAAQMD Basic Construction Measures [All Sites]). The project-level mitigation is consistent with the BAAQMD guidelines and significance thresholds utilized in the GSR Project EIR for assessing and mitigating air quality impacts.
Measure 4.9-1d, BAAQMD Exhaust Control Measures: For projects in the Sunol Valley, Bay Division, Peninsula, and San Francisco Regions, include BAAQMD Exhaust Control Measures to limit exhaust emissions, where applicable.	Y	See Mitigation Measure M-AQ-2b (NOx Reduction during Construction of Alternate Sites). The project-level mitigation is consistent with the BAAQMD guidelines and the significance thresholds utilized in the GSR Project EIR for assessing and mitigating air quality impacts.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.9-2a, Health Risk Screening or Use of Soot Filters: Complete a health risk screening if truck volumes associated with a particular project along a particular haul route exceed 40,000 truck trips over the entire construction period. If a potentially significant impact is indicated, complete a site-specific health risk assessment. Consider diesel particulate matter (DPM) emission rates in separate project-level analysis at the time of construction. Develop a mitigation program based on the site-specific health risk assessment implementing methods of reducing DPM emission or exposure to a less-than-significant level.	Y	The health risk assessment conducted as part of the GSR EIR analysis determined that DPM exposure exceeded the BAAQMD's cancer and non-cancer risk thresholds, utilized as significance in the GSR EIR, at Group 3 for Sites 5, 6, and 7 (On-site Treatment). Mitigation Measure M-AQ-3 (Construction Health Risk Mitigation) would be implemented to reduce construction emissions to less-than-significant levels, as discussed in GSR Section 5.8, Air Quality under Impact AQ-3.
Measure 4.9-2b, Vacate SFPUC Land Managers' Residences in Sunol Valley: Vacate the two SFPUC Land Managers' residences in the Sunol Valley during construction of the Calaveras Dam or SVWTP – Treated Water Reservoirs projects or complete a health risk screening (and, if warranted, a health risk assessment) to determine health risks at these residences from either of these two projects.	N	The GSR Project would not be located in Sunol Valley.
Measure 4.9-3, Tunnel Gas Odor Control: Add water scrubbers and appropriate chemicals to tunnel ventilation systems if odorous gases become a nuisance odor problem (i.e., odor complaints are received).	N	The GSR Project would not include tunneling.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Noise/Vibration		
Measure 4.10-1a, Noise Controls: For all WSIP projects located within 500 feet of any noise-sensitive receptors, implement appropriate noise controls to reduce daytime construction noise levels to meet the 70-dBA daytime speech interference criterion to the extent feasible. For all WSIP projects involving nighttime construction and located within 3,000 feet of any noise-sensitive receptors, implement appropriate noise controls to maintain noise levels at or below any applicable ordinance nighttime noise limits or the 50-dBA nighttime sleep interference criterion to the extent feasible.	Y	See Impact NO-1. Mitigation Measure M-NO-1 (Noise Control Plan) requires the SFPUC to retain a qualified noise consultant to prepare a Noise Control Plan and the SFPUC will approve the Noise Control Plan and ensure that it is implemented to ensure compliance with local noise ordinances to the extent feasible. However, under the GSR Project, even with implementation of this mitigation measure, the conflict with a local ordinance from required daytime construction and nighttime drilling and pump-testing at some well sites would be significant and unavoidable. See also Impact NO-3. Mitigation Measure M-NO-3 (Expanded Noise Control Plan) requires the SFPUC to retain a qualified noise consultant to prepare a Noise Control Plan and the SFPUC will approve the Noise Control Plan and ensure that it is implemented to reduce construction noise levels at nearby noise-sensitive land uses to meet the 70-dBA daytime and 50-dBA nighttime criteria to the extent feasible. However, even with implementation of this mitigation measure, the impact from required daytime construction and nighttime drilling and pump-testing at some well sites would be significant and unavoidable.
Measure 4.10-1b, Vacate SFPUC Caretaker's Residence at Tesla Portal: Vacate caretaker's residence at Tesla Portal during construction of the Advanced Disinfection and Tesla Portal Disinfection Station projects as well as those portions of the San Joaquin Pipeline System and Rehabilitation of Existing San Joaquin Pipelines projects located at Tesla Portal.	N	The GSR Project would not be located at the Tesla Portal.
Measure 4.10-2a, Limit Hourly Truck Volumes: Haul and delivery truck routes for all WSIP projects will, to the extent feasible, avoid local residential streets and follow local designated truck routes. Total project-related haul and delivery truck volumes on any particular haul truck route will be limited to 80 trucks per hour.	N	See Impact NO-4. Construction-related vehicle trips would not result in substantial temporary increases in ambient noise levels along construction access routes. Although the GSR Project requires construction in residential areas and along residential streets, anticipated hourly truck volumes would not result in a significant impact, and no mitigation would be needed.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.10-2b, Restrict Truck Operations: Prohibit haul and delivery trucks from operating within 200 feet of any residential uses during the nighttime hours. For receptors beyond 200 feet from a haul route, limit noise levels to the 50-dBA sleep interference criterion at the closest receptor.	N	See Impact NO-4. Although there are residential uses within 200 feet of several proposed GSR sites, construction-related vehicle trips would not result in substantial temporary increases in ambient noise levels along construction access routes, because haul and delivery trucks would not be used during nighttime hours.
Measure 4.10-2c, Vacate SFPUC Land Manager's Residence: Vacate Land Manager's residence adjacent to Alameda East Portal during offsite truck operations associated with the New Irvington Tunnel project, if truck operations occur during the nighttime hours (10 p.m. to 7 a.m.) and are estimated to exceed the 50-dBA sleep interference criterion at this residence.	N	The GSR Project would not be located near the SFPUC Land Manager's Residence.
Measure 4.10-3a, Vibration Controls to Prevent Cosmetic or Structural Damage: Incorporate restrictions into all contract specifications (primarily for sheetpile driving, pile driving, or tunnel construction activities), whereby surface vibration will be limited to 0.2 inch/second peak particle velocity (PPV) for continuous vibration (e.g., vibratory equipment and impact pile drivers) and 0.5 inch/second PPV for controlled detonations at the closest receptors to ensure that cosmetic or structural damage does not occur.	Y	See Impact NO-2. The project-level analysis determined that construction-related groundborne vibration would be below the significance thresholds except for Sites 3, 4, 12, 15, and 18 (Alternate). Mitigation Measure M-NO-2 (Reduce Vibration Levels during Construction of Pipelines) would apply to these sites.
Measure 4.10-3b, Limit Vibration Levels At or Below Vibration Perception Threshold: Maintain vibration levels at or below the vibration perception threshold at adjacent properties to the extent feasible during nighttime. If vibration complaints are received, operational adjustments will be made to reduce vibration annoyance effects.	Y	See Impact NO-2. The project-level analysis determined that construction-related groundborne vibration would be below the significance thresholds except for Sites 3, 4, 12, 15, and 18 (Alternate). Mitigation Measure M-NO-2 (Reduce Vibration Levels during Construction of Pipelines) would apply to these sites.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.10-3c, Limit Tunnel-Related Detonation to Daylight Hours: Limit controlled detonation associated with tunnel construction to daylight hours, Monday through Saturday.	N	The GSR Project would not include tunneling.
Services/Utilities		
Measure 4.11-1a, Notify Neighbors of Potential Utility Service Disruption: Notify residents and businesses in project area of potential utility service disruption two to four days in advance of construction.	Y	See Impact UT-1. GSR Project construction may result in temporary utility service disruption for residences or businesses. Mitigation Measure M-UT-1e (Advance Notification) requires two- to four-day advanced notice for all disruptions.
Measure 4.11-1b, Locate Utility Lines Prior to Excavation: Locate overhead and underground utility lines prior to excavation work.	Y	See Mitigation Measures M-UT-1a (Confirm Utility Line Information) and M-UT-1b (Safeguard Employees from Potential Accidents Related to Underground Utilities).
Measure 4.11-1c, Confirmation of Utility Line Information: Find the exact location of underground utilities by safe and acceptable means. Confirm information regarding the size, color, and location of existing utilities before construction activities commence.	Y	See Mitigation Measures M-UT-1a (Confirm Utility Line Information) and M-UT-1b (Safeguard Employees from Potential Accidents Related to Underground Utilities).
Measure 4.11-1d, Safeguard Employees from Potential Accidents Related to Underground Utilities: While any excavation is open, protect, support, or remove underground utilities as necessary to safeguard employees.	Y	See Mitigation Measures M-UT-1a (Confirm Utility Line Information) and M-UT-1b (Safeguard Employees from Potential Accidents Related to Underground Utilities).
Measure 4.11-1e, Notify Local Fire Departments: Notify local fire departments any time damage to a gas utility results in a leak or suspected leak, or whenever damage to any utility results in a threat to public safety.	Y	See Mitigation Measure M-UT-1d (Emergency Response Plan).

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.11-1f, Emergency Response Plan: Develop an emergency response plan in the event of a leak or explosion prior to commencing construction activities.	Y	See Mitigation Measure M-UT-1d (Emergency Response Plan).
Measure 4.11-1g, Prompt Reconnection of Utilities: Promptly reconnect any disconnected utility lines.	Y	See Mitigation Measures M-UT-1a (Confirm Utility Line Information) and M-UT-1b (Safeguard Employees from Potential Accidents Related to Underground Utilities).
Measure 4.11-1h, Coordinate Final Construction Plans with Affected Utilities: Coordinate final construction plans and specifications with affected utilities.	Y	See Mitigation Measures M-UT-1a (Confirm Utility Line Information) and M-UT-1b (Safeguard Employees from Potential Accidents Related to Underground Utilities).
Measure 4.11-2, Waste Reduction Measures: Incorporate into contract specifications for each WSIP project the requirement to obtain any necessary waste management permits prior to construction and to comply with conditions of approval attached to project implementation.	N	See Mitigation Measure M-UT-4 (Waste Management Plan).
Recreation		
Measure 4.12-1, Coordination with Golf Course/Recreational Facility Managers: Coordinate with managers of golf courses or other recreational facilities directly affected by pipeline construction to minimize adverse impacts on golfers and other recreational users.	N	The GSR Project Description includes notification of the Jefferson Elementary School District (which includes athletic fields used for recreation) a minimum of nine months prior to construction at school sites. The Project also includes obtaining easements from the Lake Merced Golf Club for placement of a well facility at Site 1. The facility at Site 1 would not be located within the area of play, and construction would not substantially damage this recreational resource.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.12-2, Appropriate Siting of Proposed Facilities: Locate WSIP project facilities on park and recreation properties in consultation with park planning staff to minimize the direct loss of recreation and play space and to minimize inconvenience to park and recreation users.	N	This PEIR mitigation measure was implemented during conceptual design of the GSR Project. Several proposed well facility sites would be located at or near a recreational facility, including construction in athletic fields at local schools and at the Lake Merced Golf Club. As part of Project implementation, construction schedules would be altered to avoid construction during the school year to minimize loss of play space. The Project Description commits the SFPUC to repairing or replacing the existing baseball backstop at Site 3; temporarily removing and then replacing the baseball backstop at Site 4; returning the athletic fields to pre-project conditions; and financially compensating the Lake Merced Golf Club for the loss of a restroom. The site to be located at the Lake Merced Golf Club would not be within the area of play, and construction would not substantially damage this recreational resource. Implementation of mitigation measures to control construction noise and construction dust would reduce the impact on the quality of the recreational experience at the golf club and athletic fields to a less-than-significant level.
Agriculture		
Measure 4.13-1a, Supplemental Noticing and Soil Stockpiling: For the San Joaquin Pipeline projects (San Joaquin System and Rehabilitation of Existing San Joaquin Pipeline), stockpile and replace topsoil in mapped areas of Prime and Unique Farmland and Farmland of Statewide Importance that would be temporarily disturbed by pipeline construction, unless other actions are required under specific agreements with individual landowners.	N	The GSR Project would not be located in the San Joaquin Region.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.13-1b, Avoidance or Soil Stockpiling: Minimize any potential impacts on agricultural lands in the Sunol Valley by avoiding these resources wherever possible. Where this is not possible, stockpile, replace, and hydroseed topsoil to prevent erosion, unless other actions are required as a result of contracts affecting use of the property or under specific agreements with individual landowners.	N	The GSR Project would not be located in the Sunol Valley.
Measure 4.13-2, Siting Facilities to Avoid Prime Farmland: Avoid areas identified as Prime Farmland, Unique Farmland, or Farmland of Statewide Importance. If avoidance is not feasible, adopt a permanent set-aside for an equivalent acreage of similarly valued farmland in the area.	N	No impacts to agricultural resources would occur from GSR Project construction.
Hazards		
Measure 4.14-1a, Site Health and Safety Plan: For all projects where the site assessment indicates the potential to encounter hazardous materials, prepare a site health and safety plan identifying the chemicals present, potential health and safety hazards, monitoring, soil-handling methods, appropriate personnel protective equipment, and emergency response procedures.	Y	See Mitigation Measure M-HZ-2b (Health and Safety Plan) and M-HZ-2c (Hazardous Materials Management Plan). The project-level mitigation measures combines the requirements for a site health and safety plan and materials disposal plan required in PEIR Measures 4.14-1a and 4.14-1b.
Measure 4.14-1b, Materials Disposal Plan: For all projects where the site assessment indicates the potential to encounter hazardous materials in the soil, prepare a materials disposal plan that specifies the disposal method and approved disposal site for the soil.	Y	See Mitigation Measure M-HZ-2b (Health and Safety Plan) and Mitigation Measure M-HZ-2c (Hazardous Materials Management Plan). The project-level mitigation measures combines the requirements for a site health and safety plan and materials disposal plan required in PEIR Measures 4.14-1a and 4.14-1b.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.14-1c, Coordination with Property Owners and Regulatory Agencies: Based on regulatory agency file reviews, assess the potential to encounter unacceptable levels of hazardous materials at known environmental cases, for construction activities to cause groundwater plume migration or interfere with ongoing remediations at known environmental cases, and for increased water levels in reservoirs or lakes to inundate known environmental cases. Modify construction or remediation activities.	Y	The project-level analysis evaluated the potential for encountering contaminated soils and groundwater during GSR Project construction. Mitigation Measure M-HZ-2a (Preconstruction Hazardous Materials Assessment) is included to require a preconstruction hazardous materials assessment within three months of construction to identify new hazardous materials sites or substantial changes in the extent of contamination at known groundwater contamination sites that could affect subsurface conditions at proposed well facility sites. The Project-specific analysis concludes that construction activities would not cause groundwater plume migration or interfere with remediation activities during construction. The Project does not include construction activities that would cause increase water levels at reservoirs or lakes. Operation of the Project may cause increased water levels at Lake Merced, as described in Impact BR-7. This significant impact would be mitigated to less-than-significant levels through implementation of Mitigation Measure M-BR-7 (Lake Level Management for Water Levels).
Measure 4.14-2, Health Risk Screening and Airborne Asbestos Monitoring Plan: For tunneling projects where soil or rock may contain naturally occurring asbestos, conduct a health risk screening assessment to identify acceptable levels of asbestos in tunnel emissions. Prepare an airborne asbestos monitoring plan for approval by the BAAQMD.	N	The GSR Project would not include tunneling and would not disturb a rock unit or soil that contains naturally occurring asbestos. See GSR Section 5.15.1 (Setting) in Section 5.15, Geology and Soils.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.14-5, Hazardous Building Materials Surveys and Abatement: For all WSIP projects involving demolition or renovation of existing facilities, perform a hazardous building materials survey for each structure prior to demolition or renovation activities. If any friable asbestos-containing materials, lead-containing materials, or hazardous components of building materials are identified, implement adequate abatement practices prior to demolition or renovation.	N	The SFPUC would be required to assess and abate hazardous building materials from demolition of the restroom at Site 1 and well with structure at Site 14 in accordance with applicable laws and regulations. Therefore, since the impact was determined to be less than significant, implementation of PEIR Mitigation Measure 4.14-5 is not required.
Energy		
Measure 4.15-2, Incorporation of Energy Efficiency Measures: Consistent with the Energy Action Plan II priorities for reducing energy usage, ensure that energy-efficient equipment is used in all WSIP projects. Prepare a repair and maintenance plan for each facility to minimize power use. Evaluate the potential for use of renewable energy resources.	N	See Impact ME-2. The collective energy demand of the GSR Project well facilities, the Partner Agencies' well facilities, and the SFPUC regional water system would remain at approximately 61 million kW, and the proposed Project would not cause an increase in energy use. Therefore, no mitigation is needed. However, the SFPUC would incorporate all applicable energy efficiency measures into the project design. Projects with building components will attempt to maximize energy efficiency by exceeding Title 24 minimum requirements by at least 20 percent and meet or exceed LEED Silver certification.
Collective Impacts		
Measure 4.16-1a, Construction Coordination at Irvington Portal: If construction schedules of multiple WSIP projects occurring at and near Irvington Portal coincide or overlap, the SFPUC will coordinate with construction contractor(s) and neighbors to minimize disturbance of residents in the adjacent neighborhood to the extent practicable. Such coordination will need to balance the duration of construction with the magnitude of construction-related impacts on the same sensitive receptors.	N	The GSR Project would not be located at the Irvington Portal.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Collective Impacts (cont.)		
Measure 4.16-4a, Bioregional Habitat Restoration Measures: Address the following bioregional effects and implement conservation principles when implementing habitat compensation mitigation required for individual WSIP facility projects: compound impacts on functional units of habitat as WSIP projects simplify vegetation structure and increase "edge" (the boundary between two different habitats); increased habitat impacts due to the spread of weedy, non-native plant species; genetic diversity impacts on small populations; impacts on wildlife movement due to habitat fragmentation; suppression of natural disturbance regimes; and reduced population recovery opportunities from stochastic events.	N	The GSR Project's contribution to cumulative effects on biological resources would be mitigated with project-specific mitigation measures and therefore would not require implementation of bioregional habitat restoration measures.
Measure 4.16-4b, Coordination of Construction Staging and Access: Coordinate construction contractor(s) to minimize surface disturbance when construction schedules for WSIP projects affecting the same areas overlap.	N	The only overlap in construction staging areas would occur at Site 8. At Site 8, the construction area for the Peninsula Pipelines Seismic Upgrade Project would overlap with the construction area for the well facility at Site 8. No significant biological impacts are projected to occur at Site 8, and therefore there is no need for mitigation no coordinate staging and access areas.
Measure 4.16-6a, SFPUC WSIP Projects Construction Coordinator: Identify a qualified construction coordinator to coordinate project-specific traffic control plans; develop a public information campaign to inform the public of construction activities, detour routes, and alternate routes; and work with local and regional agencies to pursue additional traffic mitigation measures and incorporate such measures into the project-specific traffic control plans.	Y	See Mitigation Measure M-C-TR-1 (Coordinate Traffic Control Plan with other SFPUC Construction Projects). The PEIR measure for a SFPUC WSIP project construction coordinator is incorporated into the Project-level measure for cumulative impacts.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Collective Impacts (cont.)		
Measure 4.16-6b, Combined San Joaquin Traffic Control Plan: Develop a San Joaquin Traffic Control Plan that coordinates the project-specific traffic control plans and identifies additional measures (consistent with the standards of San Joaquin County, Stanislaus County, and Caltrans) to minimize the combined impacts of multiple WSIP project construction traffic on I-580, Chrisman Road, and Vernalis Road.		The GSR Project would not be located in San Joaquin County.
Measure 4.16-6c, Combined Sunol Valley Traffic Control Plan: Develop a Sunol Valley Traffic Control Plan that coordinates the project-specific traffic control plans and identifies additional measures (consistent with the standards of Alameda County and Caltrans) to minimize the impacts of construction traffic on Calaveras Road and I-680.	N	The GSR Project would not be located in Sunol Valley.
Measure 4.16-7a, Dust and Exhaust Control Measures for All WSIP Projects: Require implementation of Air Quality Measures 4.9-1a thru 4.9-1d for all WSIP projects to address collective construction-related air quality impacts.	Y	Specified air quality measures are required under project-level Mitigation Measures M-AQ-2a (BAAQMD Basic Construction Measures) and M-AQ-2b (NOx Reduction during Construction of Alternate Sites). The project-level measures are consistent with the PEIR measure.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Collective Impacts (cont.)		
Measure 4.16-7b, Health Risk Screening or Use of Soot Filters for All Projects in the San Joaquin and Sunol Valley Regions: Require Measure 4.9-2a for all WSIP projects in the San Joaquin and Sunol Valley Regions to address collective DPM impacts. When this requirement is applied to the New Irvington Tunnel project, it will be applied to both the Sunol Valley and Fremont tunnel portals, taking into account truck traffic from other WSIP projects in the vicinity of both portals.	N	The GSR Project would not be located in either the San Joaquin or Sunol Valley region.
Measure 4.16-7c, Vacate SFPUC Land Managers' Residences for All Projects in the Sunol Valley Region: Require Measure 4.9-2b for all WSIP projects in the Sunol Valley Region to address collective DPM impacts.	N	The GSR Project would not be located in Sunol Valley.
Measure 4.16-8a, Limiting Hourly Truck Volumes and Restricting Truck Operations on Haul Routes for Multiple WSIP Projects: Apply Measures 4.10-2a and 4.10-2b to total haul and delivery truck volumes attributable to all WSIP projects on any particular haul truck route (including haul routes in the Tesla Portal, Irvington Portal, and Lower Crystal Springs Dam vicinities as well as haul routes in the San Francisco Region) to address collective truck-related noise impacts.	N	See Impact NO-4. The project-level analysis determined that noise levels from truck trips would fall below the daytime speech interference thresholds and within the range of existing baseline noise levels along roadways serving the sites. Therefore, PEIR Mitigation Measure 4.16-8a was determined not to be applicable to the GSR Project.

TABLE D-3
WSIP PEIR Mitigation Measure Consistency

PEIR Mitigation Measure(s)	Applicable to Proposed Project (Y/N)?	Discussion
Measure 4.16-8b, Vacate Land Manager's Residence for All Projects in Sunol Valley Region: To address collective noise impacts, vacate Land Manager's residence adjacent to Alameda East Portal during construction truck operations associated with all WSIP projects in this region if collective daytime truck volumes exceed the 70-dBA speech interference criterion or nighttime truck volumes exceed the 50-dBA sleep interference criterion.	N	The GSR Project would not be located in Sunol Valley.
Cumulative Effects		
Measure 4.17-6, SFPUC WSIP Projects Construction Coordinator – Other Agencies: The SFPUC WSIP construction coordinator designated in accordance with Measure 4.16-6a will also consider the effects of any traffic generated by SFPUC maintenance activities and other SFPUC projects; and coordinate with Caltrans, other county agencies, and local jurisdictions regarding construction of other private and public development projects so as to minimize traffic impacts on local access roads.	Y	See Mitigation Measure M-C-TR-1 (Coordinate Traffic Control Plan with other SFPUC Construction Projects). The project-level measure is consistent with the PEIR measure and requires construction coordination with other agencies and other WSIP projects.
Measure 4.17-8, Coordination of Truck Traffic on Local Streets: The SFPUC WSIP construction coordinator designated in Measure 4.17-6 will also be responsible for coordinating truck traffic generated on these same streets by SFPUC maintenance activities and other SFPUC projects so that SFPUC-related truck noise increases are maintained at or below threshold levels specified in Measures 4.10-2a and 4.10-2b to the extent feasible.	Y	See Mitigation Measure M-C-TR-1 (Coordinate Traffic Control Plan with other SFPUC Construction Projects). The project-level measure is consistent with the PEIR measure and requires construction coordination with other agencies and other WSIP projects, however, the Mitigation Measure is intended to reduce congestion and safety concerns, not reduce significant noise impacts from construction truck traffic

REFERENCES

San Francisco Planning Department. 2010. *Final Environmental Impact Report for the San Francisco Public Utilities Commission's Lower Crystal Springs Dam Improvements Project, San Francisco Planning Department File No. 2005.0161E, State Clearinghouse No. 2007012002*. Certified October 7, 2010.

San Francisco Planning Department. 2011. *Final Environmental Impact Report for the San Francisco Public Utilities Commission Calaveras Dam Replacement Project, San Francisco Planning Department File No. 2005.0161E, State Clearinghouse No. 2005102102*. Certified January 27, 2011.

Appendix E

Air Quality Technical Report

Final

Air Quality Technical Report

Regional Groundwater Storage and Recovery Project

Prepared for:

GHD
2235 Mercury Way, Suite 150
Santa Rosa, CA 95407, USA

Prepared by:

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality
505 Petaluma Boulevard South
Petaluma, CA 94952
(707) 766-7700

Report Date:

July 25, 2012

Project: 08-139

Table of Contents

Appendices

Appendix 1 - GSR Air Quality Scope of Work, dated June 24, 2011 and Revised October 28, 2011

Appendix 2 - Site Maps Showing Construction Area and Sensitive Receptors

Appendix 3 - Detailed Emissions Computations and CalEEMod Modeling Output Files

Appendix 4 - Dispersion Modeling Inputs and Health Risk Calculations

Appendix 5 - Cumulative TAC Data

Appendix 6 - Communications with BAAQMD

Appendix 7 - Site Specific Facility Characteristics

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Introduction

Illingworth & Rodkin, Inc., under subcontract to GHD, has prepared this air quality emissions analysis and health risk assessment that evaluates the impacts associated with the San Francisco Public Utilities Commission's (SFPUC's) Regional Groundwater Storage and Recovery Project (the project), which includes installation and operation of up to 16 new groundwater production well facilities within the South Westside Groundwater Basin, consideration of three alternate sites for the well facilities, and a pump station upgrade. This analysis was prepared following the scope of work submitted to San Francisco Planning Department's Environmental Planning Division (EP), dated October 28, 2011, and included in this report as *Appendix 1*. The scope of work was developed in consideration of the Bay Area Air Quality Management District (BAAQMD) CEQA Air Quality Guidelines[1]. These guidelines include thresholds for construction emissions and community risk.

Based on a writ mandated by the Alameda Superior Court, these thresholds have currently been set aside and the BAAQMD has to cease dissemination of them until the BAAQMD complies with CEQA for the adoption of the thresholds. As a result, the BAAQMD is no longer recommending the 2011 thresholds be used to measure a project's significant air quality impacts. Instead, the BAAQMD suggests that lead agencies use the 1999 CEQA thresholds to make determinations regarding the significance of an individual project's air quality impacts. However, the Planning Department has determined that Appendix D of the 2011 BAAQMD CEQA Air Quality Guidelines, in combination with BAAQMD's Revised Draft Options and Justification Report, provide substantial evidence to support the BAAQMD recommended thresholds and, therefore, has determined they are appropriate for use in CEQA analyses[2].

In accordance with the 2011 BAAQMD CEQA Air Quality Guidelines and thresholds, this air quality technical report addresses the significance of:

- Construction-period emissions; and
- Construction-period health risk, including cumulative risk.

Operational emissions from the Project are considered to be negligible, since there would be no direct emissions expected from the facilities and maintenance or worker travel would be infrequent. Worker maintenance trips would produce very small emissions. Indirect emissions from use of electricity for the pumps would decrease, because existing Partner Agency wells would pump less over the long-term, and new wells would use green electricity from the SFPUC Power Enterprise.

Project Description

The proposed project would increase water supply reliability during dry years or in emergencies, by increasing water storage in the Westside Groundwater Basin during wet and normal years for subsequent recapture during dry years. The proposed Project is located in San Mateo County and is sponsored by the SFPUC in coordination with its partner agencies, which include the cities of Daly City and San Bruno, and the California Water Company (Cal Water) in its South San Francisco service area (collectively referred to as Partner Agencies).

The SFPUC currently supplies surface water to the Partner Agencies from its regional water system. The Partner Agencies supply potable water to their retail customers through a combination of groundwater from the South Westside Groundwater Basin and purchase of SFPUC surface water. The proposed project would provide supplemental SFPUC surface water to the Partner Agencies during normal and wet years. During these

[1] BAAQMD. *CEQA Air Quality Guidelines*. May, 2011.

[2] BAAQMD. *Revised Draft Options and Justification Report California Environmental Quality Act Thresholds of Significance*. October, 2009.

years, the Partner Agencies would reduce their groundwater pumping by a comparable amount to increase the amount of groundwater in storage through natural (in-lieu) recharge. During normal and wet years, the volume of groundwater in the South Westside Groundwater Basin would increase due to natural recharge and reduced groundwater pumping by the Partner Agencies. During dry years, the Partner Agencies and the SFPUC would pump the stored groundwater using 16 new well facilities, as needed to supplement other supplies. This new dry-year water supply would be blended with water from the SFPUC regional water system, and would thereby increase the available water supply to all regional water system customers.

The proposed project consists of the construction and operation of up to 16 new well facilities within the South Westside Groundwater Basin and an upgrade to the existing Westlake Pump Station. The EIR includes the evaluation of three additional well facilities (19 wells in total) in the instance where one of the 16 preferred well facilities cannot be successfully constructed or operated. The calculation of emissions is presented for both the preferred 16 well sites and an "alternate scenario" of 16 well sites that include the three alternate sites.

Each well facility would contain a well pump station, distribution piping, and utility connections. Most well facilities would also have disinfection units designed to eliminate bacteria in the groundwater using chlorine and ammonia. At certain sites, additional treatment (i.e., pH adjustment, fluoridation, and/or iron/manganese removal) has been incorporated into the design of the facility to meet both regulatory and water quality targets in the finished water for all agencies.

Site-specific well facility characteristics for the 19 potential well facility sites are listed in *Appendix 7*. These characteristics include the proposed well facility (i.e., building) type, pump type and pumping capacity, water distribution system connection point and alternate connection point (if any), groundwater disinfection location, and the method that would be used to achieve water quality goals. Water treatment may occur at the well site or at off-site treatment areas. For the purpose of calculating emissions, the connection point is assumed to be the one which would require a longer pipeline for connection, as this would represent the maximum emissions.

Groundwater from Sites 2, 3, and 4 would be conveyed to the Westlake Pump Station for treatment prior to addition to the Daly City distribution system. Sites 5, 6, and 7 include two treatment options: Consolidated Treatment at Site 6 and On-site Treatment. Under the consolidated treatment option, groundwater from Sites 5 and 7 would be conveyed to Site 6 for treatment before addition to the SFPUC regional water system. The consolidated treatment option requires pipelines to convey water from Sites 5 and 7 to Site 6. Under the on-site treatment option, groundwater would be treated at each of the sites, and water treated on-site would be added directly to the SFPUC regional water system. For the purpose of calculating emissions, only the On-site Treatment option is evaluated for criteria air pollutants, because construction of three separate buildings with treatment systems would generate more emissions than the Consolidated Treatment at Site 6 option which only has one building at Site 6. However, both options are evaluated for health risk impacts.

The proposed well facilities have been designed and sited so that wells are close to treatment systems and close to existing distribution systems (the SFPUC regional water system and the local distribution systems of the Partner Agencies), resulting in a more energy efficient system. Of the 16 well facility sites evaluated for the Project, four well facilities would connect to Daly City's distribution system; three to San Bruno's distribution system; two to Cal Water's distribution system; and seven to the SFPUC regional water system.

Well facility types would be either a:

- Well with a fenced enclosure which would include fencing, the wellhead, pump, piping and associated electrical controls; or
- Well with a building which would house the wellhead, pump, piping, treatment system, and associated electrical controls.

Where a building is proposed, the building size would vary between 20 feet x 35 feet to 23 feet by 103 feet. For the purpose of calculating emissions, all buildings were assumed to be the largest building size.

Each site would require underground piping to connect the new well to the local water distribution system or to the SFPUC regional water system, or to connect the well to a neighboring facility for treatment. Underground piping would connect well facilities to the local storm drain system and/or the sanitary sewer system to allow discharge of overboard well water, chloraminated water, or filter backwash. The total pipe length required for all 19 well facility sites, including either of the distribution system connections (whichever one is longer), would be approximately 19,000 feet of 6-inch and 8-inch pipe.

Project Construction Schedule

The SFPUC proposes to construct the project starting in June 2014, with completion targeted for May 2016 (an additional three months is provided in the event of a schedule delay, however construction would occur over 21 months as indicated in Table 1). Construction would occur in clusters of four well facilities, plus an alternate site, grouped together as shown in Table 1. Within each construction cluster, well construction would occur during the first month, followed by approximately three months of construction at the sites without a building or approximately 16 months of construction for sites with a building.

TABLE 1
Facility Construction Clusters and Construction Sequencing

Facility Sites	**Well Drilling**		**Well Facilities**	
	Estimated Construction Start date	**Estimated Construction Finish date**	**Estimated Construction Start date**	**Estimated Construction Finish date**
Construction Cluster A				
Sites 1, 3, 4, 7	June 2014	July 2014	July 2014	October 2015
Construction Cluster B				
Sites 12, 14, 15, 16, 19 (Alternate)	August 2014	September 2014	September 2014	December 2015
Construction Cluster C				
Sites 9, 11, 18 (Alternate)	October 2014	November 2014	November 2014	February 2016
Sites 10, 13	No well drilling needed	No well drilling needed	November 2014	February 2016
Construction Cluster D				
Sites 2, 5, 6, 8, Westlake Pump Station	No well drilling needed	No well drilling needed	June 2014	September 2015
Site 17 (Alternate)	July 2014	August 2014	August 2014	November 2015

Project Construction Methods

Wells

To install a production well on a site with no existing test well, the site would first be cleared of vegetation, if present, which would be temporarily stockpiled on-site. Then an area would be graded (as needed) and covered with gravel base rock, to create a level pad for supporting the drill rig and other equipment. A 30-inch steel conductor casing would be installed to a depth of 50 feet and cemented in place. A minimum 22-inch diameter production borehole would be drilled to a depth of approximately 500 to 750 feet, the approximate depth of the aquifer that is proposed for production. Drilling and other drilling related activities (e.g., equipment and material delivery to support drilling) would extend for about a week both during the day and night. The well casing, consisting of a 12-inch diameter stainless steel well casing and well screen would be installed in the borehole. A 2-inch diameter steel pipe would be welded to the well casing and installed to a depth of approximately 350 to 400 feet. Finally, an impervious seal consisting of sand/cement grout would be placed in the well annular space above the filter pack.

Various well pumping tests would be performed after final well development. These tests would include: (a) pumping for durations of two hours each at different discharge rates ("step-drawdown test"); and (b) continuous pumping for 12 to 48 hours at the final design capacity of the well ("constant-discharge aquifer test").

After construction is complete, well sites would be restored to their general pre-construction conditions, and all disturbed areas would be hydroseeded and receive erosion control measures as necessary.

Well Facilities

Construction of facilities at the well sites may require additional site clearing and grubbing beyond that conducted for the well drilling. Most of the proposed facility sites are located within developed urban areas, many on existing rights-of-way where large SFPUC transmission pipes have previously been installed. Accordingly, large portions of many of the sites have already been disturbed. Site excavation and grading would be minor, with grading to a maximum depth of five feet for the building foundation (if the well facility is intended to have a building) and utilities underneath the building. After the foundation and utilities connections are constructed, the remainder of the building would be constructed and the well pump and other equipment installed, as needed.

Water Distribution and Utility Pipeline Installation

New pipelines would be installed below ground using standard open-trench construction methods. Open-trench construction involves the following steps:

1. vegetation removal and grading or pavement cutting depending on the location,
2. trench excavation and shoring to stabilize the sides of the trench if necessary,
3. pipeline installation,
4. trench backfilling and compacting, and
5. surface restoration.

<u>Project Operation</u>

The SFPUC and Partner Agencies would operate 16 new well facilities with an annual average pumping capacity of 7.2 million gallons per day (equivalent to 8,100 acre-feet per year) to provide a supplemental dry-year water supply. During dry-year conditions, Partner Agencies would also pump from their own existing wells up to annual average rates consistent with the pumping limitations expressed in the project's Operating Agreement. During wet or normal years, weekly or monthly exercising of the production wells for one- to four-hour periods would be required to ensure that the facilities remain operational. Operators may fine-tune the exercise schedule according to the characteristics of individual wells.

The well facilities would be powered by electricity. All well facilities would have provisions for a drive-up portable generator connection, so that in the event of a power failure the well pumps could continue to run in a dry year or be used as a temporary alternate water supply (in a normal or wet year). The portable diesel generators would be trailer-mounted models with built-in sound reduction and spill containment features. SFPUC or the Partner Agencies would utilize existing generators and would not acquire new generators for this project.

Operation and maintenance activities would result in less than one vehicle trip to each site per day during a dry year and less than one vehicle trip per week during a wet or normal year. As a result, vehicle emissions associated with operation of the project would be negligible.

Project Setting

Appendix 2 includes aerial maps that show each facility site (including the planned construction footprint) and sensitive receptors located within 1,000 feet of each facility site. Also shown on those maps are cumulative sources of toxic air contaminants (TACs). These sources include freeways, highways, high volume roadways, and stationary sources listed by BAAQMD. Sensitive receptor locations include residential dwellings, schools, daycare facilities, senior care facilities, and medical facilities, as defined in the BAAQMD CEQA Air Quality Guidelines.

Project Significance Thresholds

Table 2 summarizes the air quality thresholds of significance used in this analysis. These thresholds are based on an evaluation by EP of thresholds identified by BAAQMD in May 2011[3].

TABLE 2
Air Quality Significance Thresholds

Pollutant	**Construction Thresholds**	**Operational Thresholds**	
	Average Daily Emissions (lbs./day)	**Average Daily Emissions (lbs./day)**	**Annual Average Emissions (tons/year)**
Criteria Air Pollutants			
ROG	54	54	10
NO_x	54	54	10
PM_{10}	82	82	15
$PM_{2.5}$	54	54	10
CO	Not Applicable	9.0 ppm (8-hour average) or 20.0 ppm (1-hour average)	
Fugitive Dust	Construction Dust Ordinance or other Best Management Practices	Not Applicable	
Health Risks and Hazards for New Sources			
Excess Cancer Risk	10 per one million	10 per one million	
Chronic or Acute Hazard Index	1.0	1.0	
Incremental annual average $PM_{2.5}$	0.3 µg/m^3	0.3 µg/m^3	

[3] BAAQMD. *California Environmental Quality Act Guidelines*. May, 2011.

TABLE 2
Air Quality Significance Thresholds

Pollutant	**Construction Thresholds**	**Operational Thresholds**	
	Average Daily Emissions (lbs./day)	**Average Daily Emissions (lbs./day)**	**Annual Average Emissions (tons/year)**
Health Risks and Hazards for Sensitive Receptors (Cumulative from all sources within 1,000 foot zone of influence) and Cumulative Thresholds for New Sources			
Excess Cancer Risk	100 per one million		
Chronic Hazard Index	10.0		
Annual Average $PM_{2.5}$	0.8 µg/m^3		

Note: ROG = reactive organic gases, NOx = nitrogen oxides, PM_{10} = course particulate matter or particulates with an aerodynamic diameter of 10 micrometers (µm) or less, and $PM_{2.5}$ = fine particulate matter or particulates with an aerodynamic diameter of 2.5µm or less.

Project Emissions Modeling

On-site construction-period air pollutants were modeled using the latest version of the California Emissions Estimator Model, CalEEMod (Version 2011.1.1). The mobile emissions during construction, which include haul truck trips, vendor or delivery truck trips, and worker trips, were computed using the EMFAC2011 model developed by the California Air Resources Board (CARB). Both models also provide greenhouse gas emissions that were utilized as part of the project environmental impact analysis. The on-site modeling was based on the construction equipment inventories and schedule provided by SFPUC. A production well would be installed at each site, except for the Westlake Pump Station and Sites 2, 5, 6, 8, 10, and 13 where test wells currently exist. Either a well facility building or a fenced enclosure would be constructed at each site. In addition, pipelines would be installed to connect the well facilities to the existing distribution system. Interior upgrades at the Westlake Pump Station were not modeled because there would be very little use of diesel-powered equipment, so health risk impacts would be negligible. Emissions associated with each component of the construction activities were computed as follows:

- Well Drilling/Well Construction anticipated to last 30 working days
- Construction of Well Facility Building anticipated to last 240 working days
- Construction of Fenced Enclosure (for sites that would not have buildings) anticipated to last 40 working days
- Construction of pipeline anticipated to be constructed at a rate of 120 feet per day

For sites with well facility buildings, the largest building construction scenario was assumed and applied to each site on which a building is proposed, because this phase of construction would have the highest emissions. For Sites 5, 6 and 7, a well facility building was assumed at each site, because this configuration would have the highest emissions. Pipeline construction was based on an assumption that 120 feet of pipeline could be constructed in an average work day, because the majority of the pipeline is in soil where minimal obstructions are anticipated.

Model input assumptions are based on the type and quantity of equipment, projected average daily usage (in hours) and size (in terms of horsepower). Where horsepower was unknown, the CalEEMod default value for that type of equipment was assumed. CalEEMod only computes annual emissions in tons per year or maximum daily emissions in pounds per day. Since some of the construction phases would have relatively low emissions, predicting annual emissions was found to be problematic, because CalEEMod only predicts emission in tons with accuracy to one significant decimal point. For $PM_{2.5}$ emissions, which are used for the health risk analysis, this would introduce a large error in the predicted emissions. To avoid this type of error, average daily emissions for an entire construction phase (e.g., Construction of Well Facility Building) were predicted by inputting the usage of each piece of construction equipment with average hours per day based on the entire construction duration. For example, a grader would be operated for approximately 4 hours on one day during the Site Preparation sub-phase of Production Well Installation, but was modeled as operating for 0.1 hours per Phase Day (4 hours divided by 30 days) to account for the average amount of time it would be operated over the course of the entire 30-day phase. As a result, average daily construction period emissions from the off-road equipment operating at each site were computed in terms of pounds per day.

Construction equipment assumptions in CalEEMod were adjusted to account for the CARB overestimation of emissions, because the model is based on older load factor assumptions. CARB adjusted construction fleet emissions by reducing the load factors used in their OFFROAD model by 33 percent. Since CalEEMod is also based on the same OFFROAD model, the load factors in the model for this project were also reduced by 33 percent.

Mobile-source emissions were computed using the CARB EMFAC2011 model that computes emissions from on-road vehicles. The emissions from haul truck tips were assumed to be all heavy heavy-duty trucks. Vendor and delivery truck trips were computed assuming a mix of 50 percent heavy-duty trucks and 50 percent medium-duty trucks. Worker trips were assumed to be 50 percent light-duty automobiles and 50 percent light-duty trucks. Vehicle trips were assumed to be the default trip lengths used in CalEEMod, which are 12.4 miles for worker trips, 7.3 miles for vendor truck trips and 20 miles for heavy-duty and heavy heavy-duty truck trips. Emissions for 10 minutes of idling were applied to each haul truck roundtrip, which would include 5 minutes for each trip.

Table 3 shows criteria air pollutant emissions associated with construction of each site. It is possible that alternate sites (Sites 17, 18 and 19) may need to be constructed. As an “alternate scenario”, it is assumed that Site 1 through 19 plus the Westlake Pump Station modification would be developed, because these sites would represent the construction of all 19 possible sites. This would result in the maximum emissions.

The emissions are reported as total emissions for each site in pounds and average daily emissions are computed for the entire project construction period, assumed to be 420 days. Construction days were calculated based on 20 construction days over 21 months. Average daily emissions are compared against the daily criteria air pollutant emission significance thresholds and found to be below the significance thresholds, both for Sites 1-16 and the alternate scenario. However, NO_x emissions would exceed the significance thresholds under the Alternate Scenario where all 19 sites plus the Westlake Pump Station modification are constructed. Detailed emissions computations and assumptions along with CalEEMod modeling output are contained in *Appendix 3*.

Note that the computed emissions do not include fugitive dust, which is treated separately under the BAAQMD CEQA Air Quality Guidelines. Application of Best Management Practices for minimizing dust emissions that are identified in the BAAQMD CEQA Air Quality Guidelines would minimize those impacts to a less than significant level.

Mitigation of Project Construction NO_x Emissions for Construction of Alternate Sites

If one to three wells at Sites 1-16 are constructed but found to be unusable for any reason, and one to three wells are therefore constructed at alternate sites, the SFPUC shall reduce modeled NO_x emissions by 20% at the alternate sites. To meet this performance standard, the SFPUC shall develop and implement a plan demonstrating that the off-road equipment (i.e., equipment rated at more than 50 horsepower that is owned or leased by the contractor or subcontractors) to be used in constructing the wells and facilities at the alternate sites would achieve a fleet-wide average 20-percent NO_x reduction compared to the most recent CARB fleet average.

Acceptable options for reducing emissions include the use of late model engines (i.e., meeting U.S. EPA Tier 3 standards or later), low emission diesel products, alternative fuels that have lower NO_x emissions, engine retrofit technology, after-treatment products, add-on devices, and/or other options that may become available.

Construction NOx emissions for construction of all sites were recomputed assuming that all on-site off-road construction equipment used in constructing the wells and facilities at the alternate sites would have emissions that are 20 percent lower than the current fleet-wide average assumed in the CalEEMod model. With this mitigation measure, construction of all 19 sites plus the Westlake Pump Station modifications would result in daily NO_x emissions of 53.7 pounds per day on average over the 420-day construction period, which is below the threshold of 54 pounds per day.

TABLE 3
Estimated Criteria Air Pollutant Construction Emissions (in pounds)

Facility Site	ROG	NO_x	PM_{10}	$PM_{2.5}$
Site 1	205	1,511	81	73
Site 2	15	107	7	6
Site 3	57	419	22	20
Site 4	62	434	23	21
Westlake Pump Station	5	26	4	1
Site 5 (On-site Treatment)	176	1,291	77	66
Site 6 (On-site Treatment)	172	1,266	76	65
Site 7 (On-site Treatment)	220	1,593	88	79
Site 8	165	1,228	73	62
Site 9	207	1,522	82	74
Site 10	165	1,229	73	62
Site 11	212	1,549	85	76
Site 12	214	1,564	86	77
Site 13	179	1,308	79	68
Site 14	223	1,616	90	81
Site 15	209	1,534	83	75
Site 16	211	1,540	84	75
Site 17 (Alternate)	204	1,506	81	73
Site 18 (Alternate)	206	1,516	82	74
Site 19 (Alternate)	66	451	25	22
Sites 1-16 and Westlake Pump Station				
Total (pounds)	2,697	19,738	1,113	981
Average Daily Emissions[a] (pounds per day)	6.4	47.0	2.7	2.3

TABLE 3
Estimated Criteria Air Pollutant Construction Emissions (in pounds)

Facility Site	ROG	NO_x	PM_{10}	$PM_{2.5}$
Alternate Scenario (Sites 1 -19 [Alternate] and Westlake Pump Station)				
Total (pounds)	3,174	23,211	1,301	1,150
Average Daily Emissions[a] (pounds per day)	7.6	55.3	3.1	2.7

Notes: [a] Assumes 420 days of construction for entire project based on 20 construction days per month and 21 months.

Health Risk Analysis

The construction activities will require the use of heavy-duty diesel vehicles and equipment, which emit diesel particulate matter (DPM) as $PM_{2.5}$, which is a toxic air contaminant (TAC) that is identified by CARB as causing cancer. In addition, the organic gas components of diesel exhaust can pose non-cancer hazards. In order to address health risk impacts, emissions from construction activities are input to a dispersion model that computes DPM/$PM_{2.5}$ and organic compound concentrations at receptors. The exposures are computed based on receptor type (i.e., residential infant or adult, school child or daycare child) and the corresponding risks are based on the toxicity of the TAC and the sensitivity of the receptor (e.g., infant, child or adult). The corresponding cancer risk and non-cancer hazards are computed and the receptor with the highest impact is considered the maximum exposed individual (MEI).

BAAQMD Regulation 2, Rule 5 sets cancer risk limits for new and modified sources of TACs at the MEI at 10 chances per million. In addition to cancer risk, some TACs pose non-carcinogenic chronic and acute health hazards. Acute and chronic non-cancer health hazards are expressed in terms of a hazard index, or HI, which is a ratio of the TAC concentration to a reference exposure level (REL), a level below which no adverse health effects are expected, even for sensitive individuals.[4] If the HI is 1.0 or greater, which means that the TAC concentration equals or exceeds the REL, then the exposure is considered significant. In addition, particulate matter, primarily associated with construction equipment and mobile sources (vehicular emissions) is strongly associated with mortality, respiratory diseases, and impairment of lung development in children, and other endpoints such as hospitalization for cardiopulmonary disease. The U.S. Environmental Protection Agency (EPA) has proposed a Significant Impact Level (SIL) for $PM_{2.5}$. For developed urban areas, including much of San Francisco, the EPA has proposed a SIL of between 0.3 $\mu g/m^3$ to 0.8 $\mu g/m^3$. The SIL represents the level of incremental $PM_{2.5}$ emissions that represents a significant contribution to regional non-attainment.[5] The lower range of the EPA-recommended SIL of 0.3 $\mu g/m^3$ is an appropriate threshold for determining the significance of a source's $PM_{2.5}$ impact.

Potential health risks and hazards from project construction activities on existing sensitive receptors are assessed within a 1,000-foot zone of influence through (1) prediction of emissions from project activities; (2) dispersion modeling to identify exposure and (3) computing the resulting risks and hazards based on the type of receptor exposed.

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4 Ibid, p. D-35.

5 BAAQMD. *CEQA Air Quality Guidelines*. May, 2011, available online at: http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Updated-CEQA-Guidelines.aspx, p. D-36.

Project Emissions of TACs

Emissions of TACs were based on the project emissions modeling described above using the CalEEMod and EMFAC2011 models. Since all construction equipment was assumed to be diesel powered, all $PM_{2.5}$ emissions computed using CalEEMod were assumed to be DPM. The diesel $PM_{2.5}$ vehicle emissions produced by EMFAC2011 were assumed to represent DPM from on-road mobile sources associated with construction.

For each construction phase, the CalEEMod provided daily emissions of $PM_{2.5}$ exhaust emissions (assumed to be DPM) and emissions of ROG from the off-road construction equipment in pounds per day. These emissions were converted into grams per second per square meter ($g/sec/m^2$) for input into a dispersion model. The construction area was based on the size of the construction footprint for each construction phase (i.e., well construction, building or fenced enclosure construction and pipeline construction). Truck traffic emissions generated by the project were converted into grams per second per cubic meter ($g/sec/m^3$) for on-site truck travel and g/sec for trucks while traveling off-site for input into the dispersion model. Worker traffic was assumed to have a negligible affect on health risk due to the relatively low volume of traffic generated and the small amount of emissions when compared with daily construction equipment and truck activity. Much of the worker travel emissions occur beyond 1,000 feet from the facility sites. So those emissions from worker vehicle trips were not included in the health risk assessment.

Two sets of emissions were computed: (1) emissions based on average daily activity through the course of each construction component used to compute cancer risk and annual $PM_{2.5}$ concentrations and (2) a maximum daily scenario that uses the maximum daily emissions computed by CalEEMod when considering each sub-phase of construction (i.e., site preparation, building construction, or trenching for pipeline work) to compute acute non-cancer health risk. Therefore, the highest hourly concentration modeled using the maximum daily emission scenario was calculated.

For non-cancer health effects of DPM the California Office of Health Hazard Assessment (OEHHA) has established DPM concentration levels for evaluating chronic health effects; however, concentration levels for acute (short-term) health effects have not been identified for DPM as a whole. Thus, in order to evaluate potential acute health effects from exposure to diesel exhaust, the individual chemicals that make up the total organic gas (TOG) portion of diesel exhaust were evaluated for acute health effects. A speciation profile of individual chemicals in the TOG from off-road diesel equipment exhaust provided by the BAQMD was used to identify the compounds for evaluation of acute health effects. It was assumed that the ROG emissions computed using CalEEMod are functionally equivalent to TOG emissions, and, therefore, the ROG emissions from construction activities were used to calculate the emissions and concentrations for the individual chemicals with acute non-cancer health effects. The speciation profiles and the applicable toxicity values, based on acute exposures, are shown in Table 4.

Air Dispersion Modeling

As part of the health risk assessment, the U.S. EPA ISCST3 dispersion model was used to predict concentrations of DPM and ROG at existing residences and other sensitive receptors surrounding the facility sites. The ISCST3 dispersion model is a BAAQMD-recommended model for use in refined modeling analysis of CEQA projects[6]. The model calculates pollutant concentrations at receptors located in areas of flat or complex terrain from a variety of emission source types including point, area, volume and line sources. The model was run using regulatory default dispersion options and urban dispersion coefficients due to the urban nature of the project area.

[6] BAAQMD. *Recommended Methods for Screening and Modeling Local Risks and Hazards*. Version 2.0, May, 2011.

Annual modeled concentrations based on average daily emissions rates were used to compute cancer risk. Modeled worst-hour concentrations were used to compute acute hazards resulting from speciated TAC components of diesel exhaust with acute risks using BAAQMD speciation factors[7].
Emissions from on-site construction equipment were modeled as a series of area sources in the areas associated with construction activities. An emission release height of 6 meters was used for each area source. DPM emissions from truck traffic on-site were included in the on-site area sources and the off-site trucks traveling on the roadways near the facility sites were modeled as line sources (a series of volume sources along a path). Line sources for off-site truck travel were used to simulate the expected travel routes along local roadways within the 1,000-foot zone of influence from the construction sites.

Modeled receptors were placed at sensitive receptors anticipated to have the greatest impacts that are within 1,000 feet of the modeled construction site. For assessing impacts, the receptor with the highest impacts from construction activities within 1,000 feet would be identified as the maximum exposed individual (MEI). All receptors were assumed to be at ground-level with a breathing height of 1.5 meters. Since there is variation in the terrain elevations at some of the facility sites and surrounding areas, terrain elevations were used with the model. Elevations for project emission sources and sensitive receptor locations were obtained from USGS Digital Elevation Model (DEM) data for the project area. Receptor locations and the depiction of the project emission sources are shown in the figures provided in *Appendix 2*.

TABLE 4
Speciation Profile of Off-road Diesel Total Organic Gas Emissions Provided by BAAQMD and Acute Toxicity Values

Chemical	Fraction of TOG[1]	OEHHA Acute Reference Exposure Level (μg/m^3)
acetaldehyde	0.07353	470
acrolein	0.01297 [a]	2.5
benzaldehyde	0.00699	--
benzene	0.02001	1,300
ethanol	0.00009	--
ethylbenzene	0.00305	--
ethylene	0.14377	--
ethylene dibromide (1,2-dibromoethane)	--	--
ethylene dichloride (1,2-dichloroethane)	--	--
ethylene glycol	--	--
ethylene oxide (1,2-epoxyethane)	--	--
ethylene thiourea	--	--
ethylene glycol butyl ether	--	--
ethylene glycol ethyl ether		
ethylene glycol ethyl ether acetate	--	--
ethylene glycol methyl ether	--	--
ethylene glycol methyl ether acetate	--	--
formaldehyde	0.14714	55
isobutane	0.01222	--
isopentane	0.00602	--
methane	0.04084	--

[7] Speciation factors are based on a March 30, 2011 email from Virginia Lau (BAAQMD).

TABLE 4
Speciation Profile of Off-road Diesel Total Organic Gas Emissions Provided by BAAQMD and Acute Toxicity Values

Chemical	Fraction of TOG1	OEHHA Acute Reference Exposure Level (μg/m^3)
methyl ethyl ketone (mek) (2-butanone)	0.01477	13,000
methylcyclopentane	0.00149	--
m-xylene	0.00611	--
n-butane	0.00104	--
n-hexane	0.00157	--
n-pentane	0.00175	--
o-xylene	0.00335	--
propionaldehyde	0.0097	
propylene	0.02597	
propylene glycol monomethyl ether		
propylene oxide		
toluene	0.01473	37,000

[a] Note that speciation factor for acrolein only applies to on-road diesel vehicles

BAAQMD collects and records meteorological data at a number of locations throughout the Bay Area. In the vicinity of the facility sites, there are two BAAQMD meteorological monitoring stations for which the BAAQMD has processed the hourly data for use with the ISCST3 model. Based on the locations of the facility sites, BAAQMD recommended that meteorological data collected at the District's Fort Funston station be used for sites 1 through 7 and data collected at San Francisco International Airport and processed by the District be used for the remaining sites[8]. BAAQMD provided the ISCST3 formatted data for both sites.

Emissions, computed for the project using CalEEMod as described above, were modeled as occurring between 7 am - 7 pm. For each site, these emissions would occur in 2014 and 2015. Annual concentrations were predicted for each year along with the maximum hourly concentration. For most sites, worst day emissions occurred during well installation. Well Facility Building construction had the highest emissions for those sites that did not include well construction.

The health risk associated with 19 facility sites was analyzed to capture potential health risks, even though only 16 facility sites would be constructed. Health risk was estimated by calculating risk at groups of geographically close sites. Some facility sites are separated sufficiently that they would not have additive effects with other sites. However, effects from some facility sites overlap with the effects from other sites ; therefore, those facility sites that had overlapping 1,000-foot zone of influences were grouped and modeled together, with an MEI for each group of modeled sites identified. Nine modeling groups were evaluated as follows, with Group 3 modeled under two different scenarios:

Group 1: Facility Site 1
Group 2: Facility Sites 2, 3 and 4
Group 3: Facility Sites 5, 6 and 7 (On-site Treatment)
Group 3: Facility Sites 5, 6, and 7 (Consolidated Treatment at Site 6)
Group 4: Facility Site 8 and Site 17 (Alternate)
Group 5: Facility Sites 9 and 10 and Site 18 (Alternate)
Group 6: Facility Sites 11 and 12 and Site 19 (Alternate)

[8] Based on email from James Cordova (BAAQMD) to Bill Popenuck (Illingworth & Rodkin, Inc.), dated April 16, 2012.

Group 7: Facility Site 13
Group 8: Facility Sites 14 and 15
Group 9: Facility Site 16
Note: Westlake Pump Station Upgrade was not included in health risk analysis, as noted under project Emissions Modeling above.

Excess Lifetime Cancer Risk and $PM_{2.5}$ Prediction

The dispersion modeling provided the annual $PM_{2.5}$ concentration predicted at each receptor. As discussed previously, $PM_{2.5}$ emissions from the project are conservatively assumed to be all DPM. The annual DPM concentrations are used to compute increased cancer risk caused by the project.

Increased cancer risks at each of the sites were calculated using the modeled annual average concentrations and using the most recent methods recommended by BAAQMD[9] and the California Office of Environmental Health Hazard Assessment (OEHHA)[10]. The factors used to compute cancer risk are highly dependent on modeled concentrations, exposure period or duration, and the type of receptor. The exposure level is determined by the modeled concentration; however, it has to be averaged over a representative exposure period. The averaging period is dependent on many factors, but primarily the type of sensitive receptor that would reside at a site. OEHHA has developed exposure assumptions for typical types of sensitive receptors. These include nearly continuous exposures for residences.

It should be noted that the cancer risk calculations for residential exposures reflect use of BAAQMD's most recent cancer risk calculation method, adopted in January 2010[11]. The cancer risk calculations were based on applying the BAAQMD recommended age sensitivity factors to TAC concentrations. Age sensitivity factors reflect the greater sensitivity of infants and children to cancer causing TACs. This analysis assumed that residential and daycare receptors represented infant exposures and applied a sensitivity factor of 10 to the cancer risk calculations. Where exposures were assumed to be school children, an age sensitivity factor of 3 was applied. An age sensitivity factor of 1 was applied to adult exposures. This analysis, therefore, presents the most conservative cancer risk for various types of exposures.

The cancer risk calculations incorporate breathing rates of 581 liters per kilogram day (L/kg-day) for infants and children and 302 L/kg-day for adults. Since the modeling was conducted assuming emissions occurred 365 days per year, a default OEHHA exposure period of 350 days per year was used. For school and daycare child exposure, they were assumed to be exposed to the construction emissions for 10 hours per day out of the 12 hours of daily construction emissions.

MEIs were identified for each geographic group of sites and are shown on Figures 1 through 10 in *Appendix 2*. The MEI for Group 3 is shown for the On-site Treatment configuration, because it represents a higher health risk than Group 3 with Consolidated Treatment at Site 6. The MEI for the group with the highest risk is the MEI for the project as a whole.

Table 5 summarizes the excess lifetime cancer risk and $PM_{2.5}$ concentrations for each group of sites at the MEIs. Cancer risk computations for each facility site, along with the assumptions used, are presented in *Appendix 4.* The figures contained in *Appendix 2* show model receptors and sources. Results were compared to the excess lifetime cancer risk threshold of 10 per million (evaluated as 10.0 per million) and an annual $PM_{2.5}$ concentration thresholds of 0.3 $\mu g/m^3$.

[9] BAAQMD, *Air Toxics NSR Program Health Risk Screening Analysis (HSRA) Guidelines*. January, 2010.

[10] OEHHA 2003. Air Toxics Hot Spots Program Risk Assessment Guid*elines, The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*. Office of Environmental Health Hazard Assessment. August, 2003.

[11] BAAQMD. *Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines.* January, 2010.

Non-Cancer Hazard Index

Table 5 also includes the predicted chronic or acute hazards at the MEIs for each geographic group of sites, expressed as the hazard index (HI). Potential non-cancer health effects due to chronic exposure to DPM were estimated using the modeled $PM_{2.5}$ concentration and the chronic inhalation REL for DPM of 5 µg/m^3. There is no REL for acute exposures associated with DPM. Therefore, speciated total organic gas components of diesel exhaust that have acute toxicity values assigned were used to evaluate hazards due to acute exposures. For this assessment, ROG emissions were considered to be equivalent to total organic gas emissions from construction activities. Emissions were modeled using CalEEMOD, which provides ROG emissions. Modeled worst-hour concentrations were used to compute acute hazards resulting from speciated TAC components of DPM with acute risks using BAAQMD speciation factors[12]. BAAQMD risk management policy does not recommend including acrolein in health risk assessments due to the lack of reliable emissions data[13]. EP recommends that acrolein be included for truck traffic, but not off-road construction emissions. Since the project would generate very little hourly truck traffic during construction, the effects of acrolein were not evaluated. Table 4 includes the speciation profiles and acute toxicity values for organic DPM compounds.

Discussion of Excess Cancer Risks, Hazard Indices, and $PM_{2.5}$ Concentrations

The excess cancer risk, hazard index for acute or chronic exposures (whichever is highest) and the highest $PM_{2.5}$ concentrations for each of the geographic groups of sites are shown in Table 5. The results shown in Table 5 apply to the MEI for each group. Results that exceed the applicable thresholds are highlighted in Table 5.

As indicated in Table 5, the excess cancer risk at the MEI for each geographic group caused by construction of the project would range from 1.05 to 10.74. The highest value would be 10.74, which exceeds the BAAQMD threshold of 10 in a million, at Group 3 for Sites 5, 6, and 7 for the On-site Treatment option. Because construction of Group 3 with On-site Treatment would have the highest risk, the MEI for Group 3 would also be the MEI for the project as a whole.

The Hazard Index, which evaluates non-cancer health risks, would range from 0.11 to 0.72, which is less than the BAAMQD project impact threshold of 1.00. The annual $PM_{2.5}$ concentrations would range from 0.01 to 0.07 µg/m^{3,} which would be less than the BAAMQD project impact threshold of 0.3 µg/m^3.

TABLE 5
Project and Cumulative Cancer Risks, Non-Cancer Hazard Indices and $PM_{2.5}$ Concentrations

Site Modeling Group	Cumulative TAC Source Analyzed[a]	Lifetime Excess Cancer Risk (per million)	Non-Cancer Acute or Chronic Hazard Index[c]	$PM_{2.5}$ Concentration (µg/m^3)
Project Thresholds		**10**	**1.00**	**0.3**
Cumulative Thresholds		**100**	**10.00**	**0.8**
Group 1: Site 1				
PROJECT RISK		**2.41**	**0.48**	**0.02**
Cumulative	I-280	9.85	0.04	0.15
Cumulative	John Daly Blvd.	1.14	0.02	0.03
Cumulative	G11629	0.91	0.00	0.00

[12] Speciation factors are based on a March 30, 2011 email from Virginia Lau (BAAQMD).

[13] BAAQMD. *BAAQMD Air Toxics NSR Program Health Risk Screening Analysis (HRSA) Guidelines*. January, 2010.

TABLE 5
Project and Cumulative Cancer Risks, Non-Cancer Hazard Indices and $PM_{2.5}$ Concentrations

Site Modeling Group	Cumulative TAC Source Analyzed[a]	Lifetime Excess Cancer Risk (per million)	Non-Cancer Acute or Chronic Hazard Index[c]	$PM_{2.5}$ Concentration ($\mu g/m^3$)
Cumulative	14852	1.18	0.00	0.00
Cumulative	13420	0.42	0.00	0.00
Cumulative	13221	0.67	0.00	0.00
	CUMULATIVE RISK AT GROUP 1 MEI	**16.58**	**0.54**	**0.21**
Group 2: Sites 2, 3 and 4				
PROJECT RISK		**1.51**	**0.72**	**0.02**
Cumulative	S. Park Plaza Drive	3.34	0.02	0.098
Cumulative	87th St.	1.68	0.02	0.059
Cumulative	16794	4.08	0.00	0.00
Cumulative	G10657	0.48	0.00	0.00
Cumulative	12568	5.03	0.00	0.00
Cumulative	12876	2.05	0.00	0.00
	CUMULATIVE RISK AT GROUP 2 MEI	**18.18**	**0.76**	**0.18**
Group 3: Sites 5, 6 and 7 (Consolidated Treatment at Site 6)				
PROJECT RISK		**1.31**	**0.11**	**0.01**
Cumulative	I-280	7.74	0.01	0.13
Cumulative	Junipero Serra Blvd.	1.84	0.02	0.05
Cumulative	San Pedro Rd.	1.04	0.02	0.05
Cumulative	Washington St	0.96	0.02	0.02
Cumulative	G9309	0.29	0.00	0.00
Cumulative	14102	6.32	0.00	0.00
	CUMULATIVE RISK AT GROUP 3 MEI	**19.50**	**0.18**	**0.26**
Group 3: Sites 5, 6 and 7 (On-site Treatment)				
PROJECT RISK		**10.74**	**0.22**	**0.08**
Cumulative	I-280	7.74	0.01	0.13
Cumulative	Junipero Serra Blvd.	1.84	0.02	0.05
Cumulative	San Pedro Rd.	1.04	0.02	0.05

TABLE 5
Project and Cumulative Cancer Risks, Non-Cancer Hazard Indices and $PM_{2.5}$ Concentrations

Site Modeling Group	Cumulative TAC Source Analyzed[a]	Lifetime Excess Cancer Risk (per million)	Non-Cancer Acute or Chronic Hazard Index[c]	$PM_{2.5}$ Concentration ($\mu g/m^3$)
Cumulative	Washington St	0.96	0.02	0.02
Cumulative	G9309	0.29	0.00	0.00
Cumulative	14102	6.32	0.00	0.00
	CUMULATIVE RISK AT GROUP 3 MEI	**28.93**	**0.29**	**0.33**
Group 4: Facility Site 8 and Site 17 (Alternate)				
PROJECT RISK		**1.05**	**0.18**	**0.01**
Cumulative	Mission Rd. (SR 82)	4.28	0.01	0.06
Cumulative	Serramonte Blvd.	2.64	0.02	0.08
Cumulative	1364	0.45	0.02	0.26
Cumulative	G11198	0.14	0.00	0.00
	CUMULATIVE RISK AT GROUP 4 MEI	**8.56**	**0.23**	**0.41**
Group 5: Facility Sites 9 and 10				
PROJECT RISK		**5.87**	**0.33**	**0.05**
Cumulative	El Camino Real (SR 82)	1.73	0.00	0.02
Cumulative	Hickey Blvd	0.61	0.02	0.02
Cumulative	G3305	1.43	0.00	0.00
	CUMULATIVE RISK AT GROUP 5 MEI	**9.64**	**0.35**	**0.07**
Group 5: Sites 9 and 10 and Site 18 (Alternate)				
PROJECT RISK		**9.55**	**0.53**	**0.08**
Cumulative	No sources within 1,000 feet			
	CUMULATIVE RISK AT GROUP 5 MEI	**9.55**	**0.53**	**0.08**
Group 6: Sites 11 and 12 and Site 19 (Alternate)				
PROJECT RISK		**7.88**	**0.46**	**0.07**
Cumulative	El Camino Real (SR 82)	2.28	0.00	0.03
Cumulative	Westborough Blvd.	1.50	0.02	0.05

TABLE 5
Project and Cumulative Cancer Risks, Non-Cancer Hazard Indices and $PM_{2.5}$ Concentrations

Site Modeling Group	Cumulative TAC Source Analyzed[a]	Lifetime Excess Cancer Risk (per million)	Non-Cancer Acute or Chronic Hazard Index[c]	$PM_{2.5}$ Concentration (μg/m^3)
Cumulative	G11428	0.73	0.00	0.00
	CUMULATIVE RISK AT GROUP 6 MEI	**12.39**	**0.48**	**0.15**
Group 7: Site 13				
PROJECT RISK		**1.34**	**0.14**	**0.01**
Cumulative	South Spruce Ave.	5.62	0.02	0.20
Cumulative	G12073	0.17	0.00	0.00
Cumulative	2483	0.19	0.00	14.30
	CUMULATIVE RISK AT GROUP 7 MEI	**7.32**	**0.16**	**14.53**
Group 8: Sites 14 and 15				
PROJECT RISK		**3.37**	**0.54**	**0.03**
Cumulative	Sneath Lane	0.75	0.02	0.02
	CUMULATIVE RISK AT GROUP 8 MEI	**4.12**	**0.56**	**0.05**
Group 9: Site 16				
PROJECT RISK		**7.60**	**0.37**	**0.06**
Cumulative	CalTrain	5.70	0.01	0.03
Cumulative	El Camino Real (SR 82)	1.66	0.00	0.02
Cumulative	19283	2.35	0.00	0.00
Cumulative	19194	2.21	0.00	0.01
Cumulative	G6250	0.02	0.00	0.00
Cumulative	G2970	2.25	0.00	0.00
Cumulative	19561	7.30	0.00	0.02
	CUMULATIVE RISK AT GROUP 9 MEI	**29.09**	**0.38**	**0.14**

Notes:
[a] Stationary sources are identified by their BAAQMD Plant ID.
[b] There are no cumulative sources for the MEI at Group 5.
[c] The acute or chronic hazard index is reported, whichever is higher.

Mitigation of Project Construction Health Risks for Group 3 with On-site Treatment

During the construction of Site 5 (On-site Treatment), the SFPUC shall utilize off-road equipment (more than 50 horsepower) with late model engines meeting U.S. EPA Tier 4 (Interim), or utilize a combination of Tier 2 or Tier 3 engines with add-on devices that consist of level 3 diesel particulate filters.

Construction emissions for Group 3, which includes Site 5 (On-site Treatment), Site 6 (On-site Treatment), and Site 7 (On-site Treatment), were recomputed in CalEEMod assuming that all on-site off-road construction equipment larger than 50 horsepower for construction of the well facility building would have diesel engines that meet the minimum mitigation requirements. This would reduce $PM_{2.5}$ emissions by greater than 50 percent. As a result, excess cancer risks were computed to be less than 5.39 per million. The resulting cancer risks with mitigation would be below the significance thresholds.

Cumulative Health Risk Analysis

Potential health risks and hazards were assessed from TAC sources that are located within 1,000 feet of the MEIs for each geographic group of sites. Note that the MEI refers to the receptor that has the greatest impact with respect to health risks caused only by the project. Cumulative sources were then identified for each group of facility sites and the impact of those sources upon the MEI for each group was evaluated. For those sources that were more than 1,000 feet from the MEI for each group, the contribution to the cumulative impact was considered to be negligible (i.e., the sources beyond the 1,000-feet radius had a negligible contribution to the MEI cancer risk, non-cancer hazards or $PM_{2.5}$ concentrations). For each group of sites, cumulative health risks were predicted at the MEI for that group.

These cumulative health risks are presented in Table 5. The cumulative risk analysis included the aggregate effects of past, present and foreseeable TAC sources within 1,000 feet of the MEI for the group; these sources included the project, highways, local roads (with average daily volume above 10,000 vehicles), and stationary sources identified using BAAQMD's database. Cumulative TAC source data are included in Appendix 5.

Roadways

Busy roadways are a source of TAC emissions that could affect sensitive receptors near the facility site. The BAAQMD provides screening tables that indicate predicted community risk impacts that roadways pose[14]. These tables were used to develop screening levels of cancer risk and $PM_{2.5}$ concentrations. Note that the screening tables published by BAAQMD indicate that non-cancer chronic and acute hazards from traffic would be well below the BAAQMD thresholds. BAAQMD reports the chronic and acute Hazard Index for local roadways as less than 0.02. The traffic level on each roadway was estimated and rounded upward to the traffic volumes analyzed by the BAAQMD screening tables. Traffic volumes were estimated by assuming the peak-hour traffic volumes reported in the traffic section (1st Administrative Draft EIR, Transportation and Circulation Section Table 5.6-3) was about 8 to 10 percent of the average daily traffic volume. The distance between the roadway and the MEI for each geographic group was measured and the screening levels cancer risk and $PM_{2.5}$ levels were identified in the BAAQMD screening tables.

BAAQMD provides a Highway Screening Analysis Google Earth Map tool to identify estimated risk and hazard impacts from highways throughout the Bay Area. Cumulative risk, hazard and $PM_{2.5}$ impacts at various distances from the highway are estimated for different segments of the highways. The tool uses the average annual daily traffic (AADT) count, fleet mix and other modeling parameters specific to that segment of the highway. Impacts from Interstate 280 and State Route 82 were assessed using this tool.

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14 BAAQMD. Roadway Analysis Tables can be accessed from BAAQMD's website at: *http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx*. Note that these tables are used to determine whether additional refined analyses are necessary.

Stationary Sources

The risk, hazard and $PM_{2.5}$ impacts from stationary sources were assessed using the BAAQMD Stationary Source Screening Analysis Google Earth Map tool. This tool was used to identify sources within 1,000 feet of the MEI locations. BAAQMD provided screening risk data for each of the identified sources. BAAQMD also provided distances multipliers to adjust the risk and $PM_{2.5}$ concentrations of gasoline station and diesel engine sources from the screening distance of 50 feet to the actual measured distance. In the case where screening risk data were not available, a source health risk screening assessment (HRSA) was requested from BAAQMD through the Stationary Source Information Request process.

CalTrain Rail Line at Group 9 (Site 16)

Trains using the CalTrain rail line are a source of DPM emissions. The CalTrain rail line near Group 9 was modeled to assess cancer risk, hazards and $PM_{2.5}$ concentrations at the group MEI location affected by Group 9. The rail line within the 1,000 ft buffer area of Site 16 was modeled using ISCST2 with hourly historical meteorological data from San Francisco International Airport.

Annual DPM/$PM_{2.5}$ emissions were computed based on the current schedule that includes 62 CalTrain passenger trains and 4 freight trains. Travel speed was assumed at 30 mph. CalTrain is planning to electrify the line, so DPM emissions may not occur in the future, however no definitive date for implementation has been established. DPM emissions from CalTrain were assumed to occur through the year 2025. For acute impacts, maximum short-term emissions were calculated assuming there would be a maximum of 3 trains (2 Caltrain and 1 freight train) during a one-hour period passing the MEI location.

Based on this modeling, the child exposure cancer risk was 4.5 per million at a DPM/$PM_{2.5}$ concentration of 0.03 $\mu g/m^3$. The chronic DPM HI was 0.005. The maximum 1-hour volatile organic compound concentration was 1.09 $\mu g/m^3$. TAC concentrations with acute health effects were calculated using the U.S. EPA Speciation Profile 4674 for Medium Duty Trucks. The acute total Hazard Index is 0.01 from rail traffic.

Discussion of Cumulative Excess Cancer Risks, Hazard Indices, and $PM_{2.5}$ Concentrations

Table 5 shows the cumulative risk, hazard indices and annual $PM_{2.5}$ concentrations for construction at each group of sites. Results that exceed the applicable thresholds are highlighted in Table 5.

The cumulative excess cancer risk at the MEIs for the groups would range from 4.12 to 29.09. The project MEI would be at Group 3 (Sites 5, 6, 7 with On-site Treatment). The cumulative excess cancer risk to the project MEI would be 28.93 in one million, which is below the cumulative significance threshold of 100 in one million.

The cumulative non-cancer Hazard Index at the MEIs for the groups would range from 0.16 to 0.76. The cumulative Hazard Index for the project MEI would be at Group 2 (Sites 2, 3, and 4) and is predicted to be 0.76, which is below the cumulative significance threshold of 10.0.

The cumulative annual $PM_{2.5}$ concentration at the MEIs for the groups would range from 0.05 $\mu g/m^3$ to 14.53 $\mu g/m^3$. The highest value for the cumulative annual $PM_{2.5}$ concentration occurs at Group 7 (Site 13) and is due primarily to a stationary source in South San Francisco, Bimbo Bakery. Much of this concentration appears to be caused by fugitive emissions of flour from the flour holding tanks, reported only as PM or total particulate matter and assumed to be all $PM_{2.5}$. The cumulative $PM_{2.5}$ concentration from construction at Group 7 would exceed the BAAQMD threshold of 0.8 $\mu g/m^3$, however the project contribution to this cumulative impact is only 0.01 $\mu g/m^3$. The cumulative annual $PM_{2.5}$ concentration for the project MEI at Group 3 is predicted to be 0.33 $\mu g/m^3$, which is below the cumulative significance threshold of 0.8 $\mu g/m^3$.

Health Risk Uncertainties

The resulting health risks reported are based on a series of assumptions related to predicted emissions, concentrations, exposures, and chemical toxicity. The assumptions used in the analysis are generally conservative and meant to provide upper-bound estimates of risk. Emissions from the project are based on the best available estimates of project activity and emissions factors from models recommended by BAAQMD. The uncertainty of the emissions is unknown. Dispersion modeling to predict resulting concentrations was conducted using a model recommended by BAAQMD that used meteorological data recommended by the District's meteorologist. The exposure periods are assumed to be almost continuous for the type of receptors modeled (i.e., the receptors will be present almost continuously during the period that activity occurs). In addition, the most sensitive receptors that could be present were assumed. For example, an infant was assumed to be continuously present at all residential receptors. Infants were considered to be ten times more susceptible to carcinogenic TACs. In general, the methods used in this risk assessment are meant to be conservative, so that the real risks from the source would be lower than the risks predicted in this assessment.

Appendix 1
GSR Air Quality Scope of Work, dated June 24, 2011 and Revised October 28, 2011

ILLINGWORTH & RODKIN, INC.
Acoustics • Air Quality

Memo

To: Kristine Gaspar, *Winzler & Kelly*

Date: June 24, 2011, Revised October 28, 2011

From: James A. Reyff

Subject: Regional Groundwater Storage and Recovery (GSR) Project EIR Air Quality Analysis

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As you are aware, Illingworth & Rodkin, Inc. (I&R) prepared a draft air quality analysis of GSR Project environmental impacts. That air quality analysis was conducted in 2009 and used the URBEMIS2007 model to conservatively analyze air pollutant emissions from construction of the project. Operational emissions were considered to be negligible, since there were no emissions expected from the facilities and maintenance or worker travel would be minor.

Since that analysis was conducted, the Bay Area Air Quality Management District (BAAQMD) adopted new CEQA Air Quality Guidelines. These guidelines include adopted thresholds for construction emissions and community risk. GSR emissions are difficult to compare against thresholds, because construction activities at each well facility site are quite small, but there are 20 potential construction sites. The construction schedule (see attached) indicates that construction of all sites may overlap to some extent.

A new CEQA air quality issue that has come up is community health risk associated with construction activities. In May 2010, BAAQMD made construction screening tables available that indicate the distances from construction activities to where health risk for $PM_{2.5}$ levels would be at less-than-significant levels. These tables are quite conservative and indicate that minimal setbacks would be around 300 feet. District staff admittedly believes these are quite conservative and expect to issue more refined guidance in 2011.

In response to the new BAAQMD CEQA Air Quality Guidelines, the San Francisco Planning Department's Environmental Planning (EP) division has developed new guidance for reviewing environmental documents. Where there are substantial or significant air quality issues, the guidance requires an air quality technical report. As a result, there are several air quality issues that need to be addressed for this project:

1. Significance of construction period emissions as compared to the new BAAQMD CEQA thresholds;
2. Prediction of construction period health risk impacts; and
3. Preparation of an Air Quality Technical Report per EP guidelines.

Below is the proposed scope of work to prepare a Focused Air Quality Technical Report for the GSR Project. This scope addresses the three items listed above.

Project Description

The purpose of the proposed Project is to further the use of the South Westside Groundwater Basin as an underground storage reservoir by storing water in the basin during wet periods for subsequent recapture during dry periods. The San Francisco Public Utilities Commission (SFPUC) proposes to provide surface water to the cities of Daly City and San Bruno, and the California Water Company (Cal Water) in its South San Francisco service area (collectively designated as Partner Agencies) to be used by these agencies in lieu of pumping groundwater during normal and wet rainfall years. As part of the Project, SFPUC would install new groundwater well facilities, which would be operated by SFPUC and the Partner Agencies for pumping groundwater during dry years as part of the regional water supply.

The proposed Project consists of installation and operation of up to 16 new groundwater production well facilities within the South Westside Groundwater Basin. Nineteen well facility sites are currently being evaluated; however, a maximum of 16 well facilities would be developed and operated as part of the Project. In addition, an existing pump station site may be upgraded.

The new project sites are located in San Mateo County overlying the South Westside Groundwater Basin. Four well facilities would connect to Daly City's distribution system; three well facilities would connect to San Bruno's distribution system; three well facilities would connect to Cal Water's distribution system; and nine well facilities would connect to the SFPUC distribution system. Most of the proposed project sites are located within developed urban areas, many on existing rights-of-way where large SFPUC transmission pipes have previously been installed. Accordingly, large portions of many of the sites have already been disturbed.

Each groundwater well facility site would contain a pump or a well facility to house above-ground pumps, and pipeline and utility trenches to connect the site to water mains, sanitary sewer, storm drains, and the electrical grid. In some cases monitoring wells and geotechnical borings may be installed. In addition, the Westlake Pump Station may require upgrades.

The SFPUC proposes to construct the proposed Project starting in February 2013 through approximately November 2015. The well facility sites would be constructed in groups of four and phased during this time period. Not all construction activities include traditional air-emitting activities such as ground disturbance and running of heavy equipment. Following is a list of the activities and estimated duration associated with construction of a single well facility and its associated features.

- Monitoring well (if needed): approximately 3 weeks each.
- Geotechnical boring (as needed): 1 day each.
- Production well: 45 days each.
- Well station building: 14 months total for each building
    - Clearing and grubbing and other site preparation activity: 1 month
    - Foundation and utility connections: 2 months
    - Building and equipment: 9 months
    - Start-up and testing: 2 months

- Well facilities at Sites 2, 3, and 4: These facilities would be constructed only during the summer months (when school is not in session).
- Pipelines: 300 to 600 feet per week (approximately one to two blocks per week).
- 16 months total.

All construction activities would occur during the daytime hours, from 7 AM to 7 PM, Monday through Friday except for construction of wells, which would require nighttime construction during drilling and other drilling-related activities (for seven consecutive days/nights) and a pump test (for one continuous 48-hour period) at each site.

Focused Air Quality Technical Report

The Air Quality Technical Report would focus on construction period impacts and explain why operational impacts are not quantified (the only operational emissions identified are, at maximum, from one maintenance vehicle visit per day and eight supply deliveries per month to a well site with full treatment).

The Focused Air Quality Technical Report for the project will include the following sections:

Project Description

A brief project description would be prepared, focusing on those elements of the GSR Project that relate to air quality. Since the project includes 20 project sites, a reference to the detailed project description would be included to keep the report to a reasonable size. The attached figures will be used in the Report.

Project Setting

Construction activities that would generate emissions of TACs will be described for each kind of project site. Maps showing the construction sites and the surrounding sensitive receptors would be shown. A table listing the distance from the nearest sensitive receptor to the construction area boundary will be included. In addition, other sources of TAC emissions identified using BAAQMD's stationary source screening tool would be identified on these maps.

Impact of Criteria Air Pollutants

Construction period criteria air pollutants would be modeled using the latest version of the CalEEMod . Construction equipment assumptions in the model would be adjusted to account for the California Air Resources Board (CARB) overestimation of emissions. These adjustments would be verified with City staff or CARB. Model input in terms of equipment quantity, daily usage, size, and number of days used at the site will be developed in consultation with SFPUC. Average daily construction period emissions would be computed. Average daily emissions would be compared against the BAAQMD significance thresholds. Mitigation measures to reduce fugitive dust, and if necessary, exhaust emissions would be identified. Emissions of on-site (construction site) diesel exhaust fine particulate matter emissions developed in this task would be used in the health risk assessment tasks described below.

Single-Source Health Risk Construction Analysis

Where sensitive receptors are located within 1,000 feet of a construction site, the potential for health effects in terms of community risk would be addressed. I&R would conduct a health risk assessment that would model emissions from each of the construction project sites (i.e., construction of a well or pump facility, including chemical treatment and filtration). The pipeline construction associated with these sites would be included. Even though pipeline construction is expected to have very small impacts due to the short duration, the pipeline construction within 1,000 feet of the well facility construction sites would be included.

This modeling would be conducted by computing construction period emissions of toxic air contaminants (TACs) and $PM_{2.5}$ and using dispersion models to predict the received concentrations. The health risks associated with the received concentrations would be assessed by applying BAAQMD risk calculation methods that include age-sensitivity factors. Health risk would be predicted per BAAQMD Risk Management policy. Details of this analysis include:

- Construction Emissions would be computed using the CalEEMod model as described above. If construction equipment is known or SFPUC commits to certain construction equipment fleet emissions requirements, then CARB's OFFROAD2007 and EMFAC2007 model would be used. As described above, construction equipment activity levels would be determined using the CalEEMod model, unless specific information is provided by SFPUC. All $PM_{2.5}$ exhaust emissions from on-site off-road and on-road equipment will be considered as diesel particulate matter. The latest off-road equipment load factors recommended by CARB would be applied to the CalEEMod modeling.

- EPA's ISCST3 model would be used to model emissions from the construction activities. The first approach would be to identify appropriate hourly meteorological data that could be used in this task. This would be done by consulting with BAAQMD's meteorologist in consultation with City staff. Otherwise, screening meteorological conditions would be used to model a worst-hour concentration. The worst-hour concentration would be converted to an annual concentration to address cancer, non-cancer chronic health risk impacts and annual $PM_{2.5}$ concentrations. Modeled worst-hour concentrations would be used to compute acute hazards resulting from acrolein and all other speciated TAC components of DPM with acute risks using BAAQMD speciation factors[1]. Annual concentrations would be adjusted from worst-hour concentrations by applying a 0.1 persistence factor. Screening meteorological conditions would be based on the meteorological conditions used by the SCREEN3 model[2]. Receptors would be placed at sensitive receptors anticipated to have the greatest impacts that are within 1,000 feet from the modeled construction site. For assessing impacts, the receptor with the highest impacts from construction activities within 1,000 feet would be identified. This analysis would also take into account the situations where some receptors would be within 1,000 feet of more than one construction site. A draft receptor grid will be provided to EP for review prior to modeling and revised per EP comments.

- Health risks and $PM_{2.5}$ concentrations would be predicted based on BAAQMD guidance for sensitive receptor exposures. We would confirm the exposure assumptions and speciation factors for emissions with the City EP Division and BAAQMD to ensure risks are not under or over predicted. The analysis would incorporate the appropriate breathing rates (for adults and children), hours of operation and the number of days per year that emissions would occur.

<u>Cumulative Health Risks</u>

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[1] Speciation factors would be based on a 3/30/2011 email from Virginia Lau (BAAQMD). The City EP Division and/or BAAQMD would be consulted to identify the acute reference exposure levels.

[2] The SCREEN3 meteorological data is a set of 54 discrete combinations of wind speed, wind direction and atmospheric stability.

Screening tables and screening analysis tools provided by BAAQMD along with the database on stationary sources would be used to identify community risk impacts from other nearby sources. The impact from project construction combined with published impacts from roadways or stationary sources within 1,000 feet of each project site would be compared against the BAAQMD thresholds. At this point, modeling of cumulative sources that are not part of the project is not proposed. It is assumed, at this time, that cumulative impacts from non-project sources would not contribute to a significant cumulative health risk. If cumulative risk would exceed the BAAQMD thresholds, then additional refined modeling, which is not included in this scope of work, may be necessary.

For each site, a table would be developed for the maximally exposed individual (MEI), based on exposure to the project construction sites. This table would report the cancer risk, chronic and acute non-cancer risk and $PM_{2.5}$ concentration associated with the project (including the combination of multiple project sites that are within 1,000 feet). This would be the maximum project impact and compared to the BAAQMD community risk thresholds for a single source (e.g., cancer risk of 10 in one million).

In addition, the table would list the impacts from other sources using BAAQMD screening tables for roadways and BAAQMD's stationary source database. The impacts from roadways would be looked up in the screening tables based on the receptor distance from the roadway. Impacts from stationary sources would be based on a search using BAAQMD's Google Earth Stationary Source tool to initially identify the nearby sources. For each site that has identified stationary sources within 1,000 feet, a request would be made to BAAQMD to provide the screening level risk and $PM_{2.5}$ data that would be used as screening level. BAAQMD distance adjustment factors for any diesel engines would be applied. These data would be entered into the table and combined with the project impacts to assess cumulative risk. The risk from each source would be added and the total would be compared against BAAQMD's community risk thresholds for cumulative sources (e.g., cancer risk of 100 in one million).

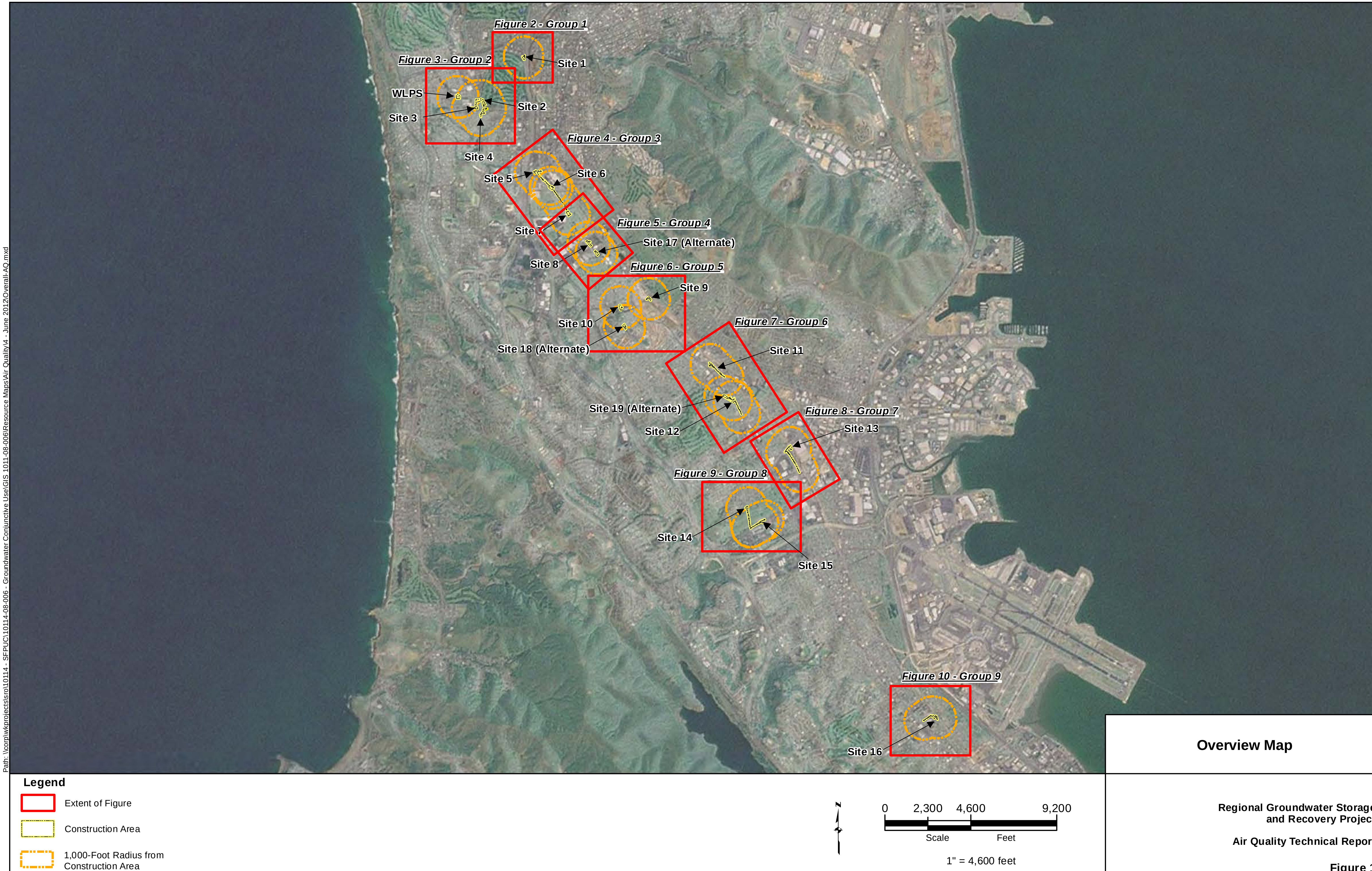
<u>Appendices</u>

The model print outs, speciation tables, emission factors, and this scope of work will be included in the appendices. In addition, correspondence with any agency, such as BAAQMD or CARB, which was used in developing the technical report, will be included.

Attachments: Proposed GSR Construction Schedule

08-139

Appendix 2
Site Maps Showing Construction Area and Sensitive Receptors



Overview Map

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 1

Group 1 - Site 1

Legend

- Well
- Construction Area
- 1,000-Foot Radius from Construction Area

Sources

- Roadways with over 10,000 ADT
- Stationary Sources from BAAQMD

Sensitive Receptor Grid

- Residential
- Daycare Facilities

Maximum Exposed Individual

- Acute Hazard
- Cancer Risk and Chronic Hazard

0 75 150 300
Scale Feet
1" = 300'

N

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 2

Path: \\corp\wk\projects\sro10114 - SFPUC\10114-08-006 - Groundwater Conjunctive Use\GIS 1011-08-006\Resource Maps\Air Quality\4 - June 2012\Site 01-AQ.mxd

Legend

Well

Construction Area

1,000-Foot Radius from Construction Area

Sources

Roadways with over 10,000 ADT

Stationary Sources from BAAQMD

Sensitive Receptor Grid

Residential

Schools

Maximum Exposed Individual

Acute Hazard

Cancer Risk and Chronic Hazard

0 112.5 225 450

Scale Feet

1" = 450'

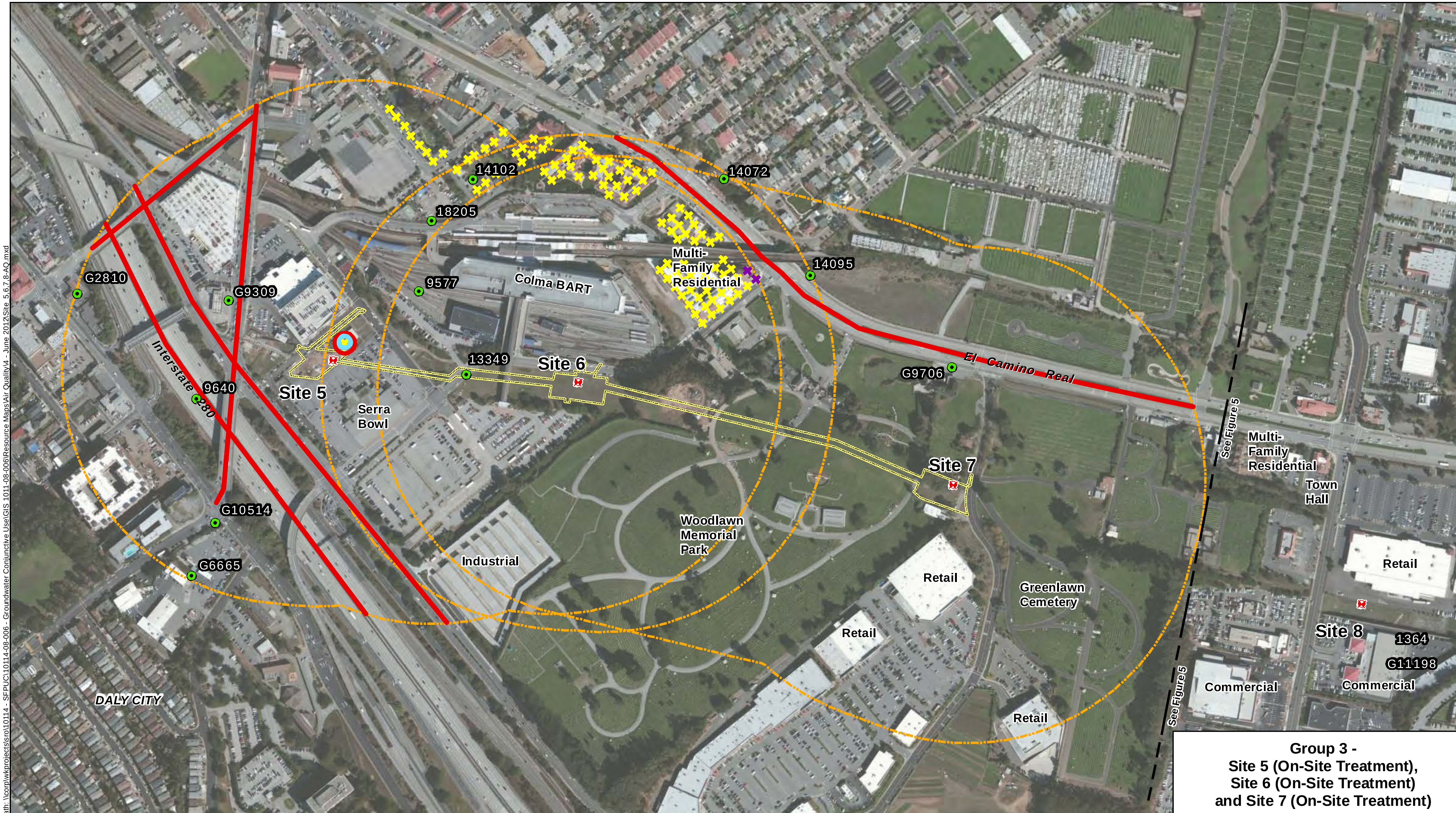
Group 2 - Site 2, Site 3, Site 4, and Westlake Pump Station (WLPS) Upgrades

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 3

Path: \\corp\wkprojects\sro10114 - SFPUC10114-08-006 - Groundwater Conjunctive Use\GIS 10111-08-006\Resource Maps\Air Quality\4 - June 2012\Site 2,3,4-AQ.mxd



Legend

- Well
- Construction Area
- 1,000-Foot Radius from Construction Area

Sources

- Roadways with over 10,000 ADT
- Stationary Sources from BAAQMD

Sensitive Receptor Grid

- Residential
- Daycare Facilities

Maximum Exposed Individual

- Acute Hazard
- Cancer Risk and Chronic Hazard

0 100 200 400
Scale Feet
1" = 400'

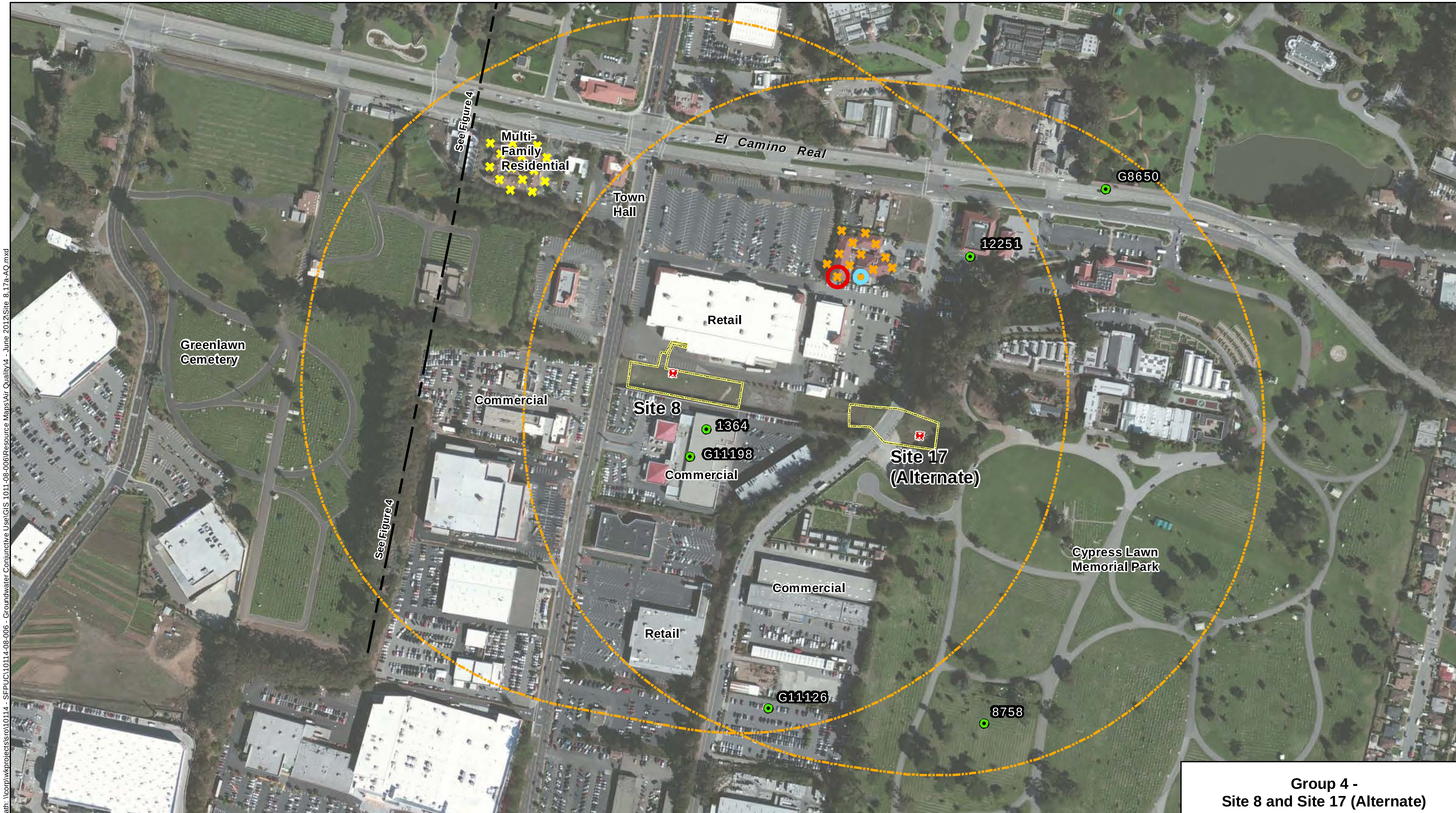
Group 3 - Site 5 (On-Site Treatment), Site 6 (On-Site Treatment) and Site 7 (On-Site Treatment)

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 4

Path: \\corp\wkprojects\sro10114 - SFPUC10114-08-006 - Groundwater Conjunctive Use\GIS 1011-08-006\Resource Maps\Air Quality\4 - June 2012\Site_5,6,7,8-AQ.mxd



Path: \corp\wkprojects\sro\10114 - SFPUC\10114-08-006 - Groundwater Conjunctive Use\GIS 1011-08-006\Resource Maps\Air Quality\4 - June 2012\Site 8_17a-AQ.mxd

Legend

- Well
- Construction Area
- 1,000-Foot Radius from Construction Area

Sources

- Roadways with over 10,000 ADT
- Stationary Sources from BAAQMD

Sensitive Receptor Grid

- Residential
- Senior Facilities

Maximum Exposed Individual

- Acute Hazard
- Cancer Risk and Chronic Hazard

0 70 140 280
Scale Feet
1" = 280'

Group 4 - Site 8 and Site 17 (Alternate)

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 5

Path: \\corp\wkprojects\sro10114\ - SFPUC\10114-08-006 - Groundwater Conjunctive Use\GIS 1011-08-006\Resource Maps\Air Quality\4 - June 2012\Site 09,10,18a-AQ.mxd

Legend

- Well
- Construction Area
- 1,000-Foot Radius from Construction Area

Sources

- Roadways with over 10,000 ADT
- Stationary Sources from BAAQMD

Sensitive Receptor Grid

- Residential
- Schools
- Daycare Facilities

Maximum Exposed Individual

- Acute Hazard
- Cancer Risk and Chronic Hazard

0 105 210 420
Scale Feet
1" = 420'

Group 5 - Site 9, Site 10, and Site 18 (Alternate)

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 6

Group 6 -
Site 11, Site 12, and Site 19 (Alternate)

Legend

- Well
- Construction Area
- 1,000-Foot Radius from Construction Area

Sources

- Roadways with over 10,000 ADT
- Stationary Sources from BAAQMD

Sensitive Receptor Grid

- Hospitals
- Residential
- Daycare Facilities
- Schools

Maximum Exposed Individual

- Acute Hazard
- Cancer Risk and Chronic Hazard

0 100 200 400
Scale Feet
1" = 400'

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 7

Path: \\corp\wkprojects\sro\10114 - SFPUC\10114-08-006 - Groundwater Conjunctive Use\GIS 1011-08-006\Resource Maps\Air Quality\4 - June 2012\Site 11.12.19-AQ.mxd

Path: \\corp\wkprojects\sro\10114 - SFPUC\10114-08-006 - Groundwater Conjunctive Use\GIS 1011-08-006\Resource Maps\Air Quality\4 - June 2012\Site_13-AQ.mxd

Legend

Well

Construction Area

1,000-Foot Radius from Construction Area

Sources

Roadways with over 10,000 ADT

Stationary Sources from BAAQMD

Sensitive Receptor Grid

Residential

Schools

Maximum Exposed Individual

Acute Hazard

Cancer Risk and Chronic Hazard

0 80 160 320

Scale Feet

1" = 320'

Group 7 - Site 13

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 8

Legend

- Well
- Construction Area
- 1,000-Foot Radius from Construction Area

Sources

- Roadways with over 10,000 ADT
- Stationary Sources from BAAQMD

Sensitive Receptor Grid

- Residential

Maximum Exposed Individual

- Acute Hazard
- Cancer Risk and Chronic Hazard

0 100 200 400
Scale Feet
1" = 400'

N

**Group 8 -
Site 14 and Site 15**

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 9

Legend

Well

Construction Area

1,000-Foot Radius from Construction Area

Sources

Roadways with over 10,000 ADT

Caltrain Line

Stationary Sources from BAAQMD

Sensitive Receptor Grid

Hospitals

Residential

Maximum Exposed Individual

Acute Hazard

Cancer Risk and Chronic Hazard

0 75 150 300

Scale Feet

1" = 300'

Group 9 - Site 16

Regional Groundwater Storage and Recovery Project

Air Quality Technical Report

Figure 10

Appendix 3
Detailed Emissions Computations and CalEEMod Modeling Output Files

Regional Groundwater Storage and Recovery Project

Summary of Criteria Air Pollutant Emissions

Construction Schedule: June 2014 to February 2016 = 21 Months of Construction

Site ID	Pipeline Length	Vehicle Trips: Haul Truck	Vendor/ Worker Trips	Estimated Worker Trips (b)	Estimated Vendor Trips (c)	Construction Type: Well	Fence	WF & Treatment	Emissions in total pounds: ROG	NOx	PM_{10}	$PM_{2.5}$	CO_2	Mitigated NOx	Mitigated $PM_{2.5}$
Site 1	295	9	1435	952	482	x		x	205	1511	81	73	275967	1511	73
Site 2[(b)]	440	2	125	81	44		x		15	107	7	6	16685	107	6
Site 3[(b)]	845	10	353	266	87	x	x		57	419	22	20	99645	419	20
Site 4[(b)]	1000	27	358	270	88	x	x		62	434	23	21	102559	434	21
Westlake Pump Station	0	0	440	280	160				5	26	4	1	10585	26	1
Site 5 (assume worst case) [(a)]	2135	7	1370	877	492			x	176	1291	77	66	211294	1291	**30**
Site 6 (assume worst case) [(a)]	1530	4	1346	859	486			x	172	1266	76	65	206707	1266	65
Site 7 (assume worst case) [(a)]	2435	17	1484	990	495	x		x	220	1593	88	79	291094	1593	79
Site 8	450	5	1335	851	484			x	165	1228	73	62	199948	1228	62
Site 9	600	8	1445	960	485	x		x	207	1522	82	74	277961	1522	74
Site 10	455	7	1335	851	484			x	165	1229	73	62	200199	1229	62
Site 11	1315	9	1469	978	491	x		x	212	1549	85	76	282999	1549	76
Site 12	1635	15	1480	986	494	x		x	214	1564	86	77	285856	1564	77
Site 13	2475	14	1403	902	501			x	179	1308	79	68	214884	1308	**32**
Site 14	2895	25	1522	1017	504	x		x	223	1616	90	81	295628	1616	81
Site 15	935	8	1456	968	488	x		x	209	1534	83	75	280271	1534	75
Site 16	1095	8	1462	972	489	x		x	211	1540	84	75	281374	1540	75
Site 17 (Alternate)	140	10	1430	949	481	x		x	204	1506	81	73	275015	**1221**	73
Site 18 (Alternate)	425	10	1438	955	483	x		x	206	1516	82	74	276950	**1230**	74
Site 19 (Alternate)	1640	15	380	286	94	x	x		66	451	25	22	105668	**366**	22
Total (Sites 1 - 16):									2,697	19,738	1,113	981	3,533,657		
Average Daily Emissions (Sites 1 - 16): *assuming 420 construction days*									**6.42**	**46.99**	**2.65**	**2.34**			
Total + Alternative Sites:									3174	23211	1301	1150		22555	
assuming 420 construction days									**7.56**	**55.26**	**3.10**	**2.74**		**53.70**	

(a) Worst-case assumes chemical treatment, longest pipeline and hightest trip generation.

(b) Based on dfference between Worker/Vendor trips and computed vendor trips

(c) Calculated based on Worker/Vendor trips and worker trips.

Regional Groundwater Storage and Recovery Project

GSR Construction Phasing and Equipment List for Air Quality Modeling
Preliminary - Subject to Change
Revised May 31, 2012

Well Drilling/Well Construction

Phase	Working Days[3]	Equipment Type[1]	hp (if known)	Fuel Type	Quantity of Equipment[2]	No. of Days	Hours per Day	Average Hours per Sub-Phase Day	Average Hours per Phase Day
Site Preparation	3	Grader			1	1	4	1.3	0.1
Pilot Hole	2	Mounted Drill Rig			1	2	8	8.0	0.5
		Cement Truck			2	1	1	0.5	0.0
Bore Hole, Drilling	9	Mounted Drill Rig	330	diesel	1	5	24	13.3	4.0
Well Development	6	Mounted Drill Rig	330	diesel	1	6	12	12.0	2.4
		Cement Truck			3	1	1	0.2	0.0
		Air Compressor	300	diesel	1	6	12	12.0	2.4
		Pump Truck			1	1	8	1.3	0.3
Pump Testing, Water Sampling	8	Diesel pump - submersible	100		1	4	12	6.0	1.6
Continuous 48-hour pumping	2	Diesel pump - submersible	100		1	2	24	24.0	1.6
	Total Days								
	30								

	ROG	NOx	PM_{10}	$PM_{2.5}$	CO_2
Max Day					
2014	**5.69**	**46.35**	**1.58**	**1.58**	**9204**
during Well Development					
Average Day					
2014	**1.34**	**9.5**	**0.39**	**0.39**	**2487**
Total per Phase				**30 days**	
	40.20	**285.00**	**11.70**	**11.70**	**74610.00**
Mitigated Average day					
	0.68	**6.57**	**0.10**	**0.10**	**2487**
Total per Phase				**30 days**	
	20.40	**197.10**	**3.00**	**3.00**	**74610.00**

Construction for WF & Treatment Building (5 rooms)

Phase	Working Days[3]	Equipment Type[1]	hp (if known)	Fuel Type	Quantity of Equipment[2]	No. of Days	Hours per Day	Average Hours per Sub-Phase Day	Average Hours per Phase Day
Site Preparation	18	Frontend Loaders			1	14	6	4.67	0.4
		Graders/Roller Compactor			1	4	8	1.78	0.1
		Generator			1	18	1	1.00	0.1
Building Foundation	32	Cement Trucks			14	1	1	0.03	0.0
		Pump Truck			1	1	4	0.13	0.0
		Generator			1	32	1	1.00	0.1
		Forklift			1	32	2	2.00	0.3
Building Construction	180	Forklift			1	180	2	2.00	1.5
		Cement Trucks			9	3	1	0.02	0.0
		Pump Truck			1	3	4	0.07	0.1
		Crane	200		1	45	8	2.00	1.5
		Generator			1	180	1	1.00	0.8
Pipeline (onsite)	8	Loader Backhoe			1	8	8	8.00	0.3
		Roller compactor or wacker			1	8	2	2.00	0.1
Paving	2	Cement Trucks			1	1	1	0.50	0.0
		Rollers			1	1	2	1.00	0.0
		Asphalt Truck			1	1	2	1.00	0.0
~~Well &~~ Pump Install**	NA	Accounted for Under Building Construction							
Landscaping	NA	None							
	Total Days								
	240								

	ROG	NOx	PM_{10}	$PM_{2.5}$	CO_2
Max Day					
2014	**2.47**	**15.77**	**1.07**	**1.07**	**2475**
during Site Preperation					
Average Day					
2014	**0.61**	**4.66**	**0.23**	**0.23**	**678**
2015	**0.57**	**4.21**	**0.2**	**0.2**	**678**
Total per Phase				**240 days**	
	146.40	**1118.40**	**55.20**	**55.20**	**162720.00**
Mitigated Average Day					
2014	**0.34**	**3.22**	**0.08**	**0.08**	**678**
2015	**0.33**	**3.00**	**0.07**	**0.07**	**678**
Total per Phase				**240 days**	
	81.60	**772.80**	**19.20**	**19.20**	**162720.00**

Construction for Fenced Enclosure

Phase	Working Days[3]	Equipment Type[1]	hp (if known)	Fuel Tupe	Quantity of Equipment[2]	No. of Days	Hours per Day	Average Hours per Sub-Phase Day	Average Hours per Phase Day
Site Preparation	5	Skid Steer Loaders			1	1	6	1.20	0.2
		Graders/Roller Compactor			1	1	8	1.60	0.20
		Generator			1	2	1	0.40	0.05
Foundation	10	Cement Trucks			4	1	1	0.10	0.03
		Generator			1	10	1	1.00	0.25
		Forklift			1	10	2	2.00	0.50
Pipeline (onsite)	5	Loader Backhoe			1	5	8	8.00	1.00
		Roller compactor or wacker			1	5	2	2.00	0.25
Paving	4	Cement Trucks			1	1	1	0.25	0.03
		Rollers			1	1	2	0.50	0.05
		Asphalt Truck			1	1	2	0.50	0.05
Pump Install	1	Small Crane	200		1	1	2	2.00	0.05
Mechanical Pump	5	None							
Landscaping	NA	None							
Fencing	5	None							
Electrical	5	None							
	Total Days								
	40								

	ROG	NOx	PM_{10}	$PM_{2.5}$	CO_2
	Max Day				
2014	1.07	7.43	0.44	0.44	823
	during Site Preperation				
	Average Day				
2014	0.24	1.75	0.10	0.10	224
	Total per Phase			40 days	
	9.60	70.00	4.00	4.00	8960.00

Construction of Pipeline (per 120 feet)*

Phase	~~Working Days~~[3]	Equipment Type[1]	hp (if known)	Fuel Type	Quantity of Equipment[2]	No. of Days	Hours per Day	Average Hours per Sub-Phase Day	Average Hours per Phase Day
Vegetation Removal	1	None						0.00	0.0
Trenching	1	Loader Backhoe			1	1	4	4.00	4.00
Pipeline	1	Tractors/Loaders/Backhoes			1	1	2	2.00	2.00
		Generator			1	1	1	1.00	1.00
Backfill	1	Loader Backhow			1	1	2	2.00	2.00
		Small Roller Compactor or wacker			1	1	2	2.00	2.00
Surface Restoration***	1	Cement Trucks			2	1	1	1.00	1.00
		Rollers			1	1	8	8.00	8.00
		Asphalt Truck			1	1	8	8.00	8.00
	Total Days								
	NA								

	ROG	NOx	PM_{10}	$PM_{2.5}$	CO_2
	Max Day (street work)				
2014	2.47	17.73	0.96	0.96	2564.77
	Average Day (no street work)				
2014	0.76	4.26	0.33	0.33	736.74
	Total per Phase			1 days	
	0.76	4.26	0.33	0.33	736.74
	Mitigated Average Day (no street work)				
	0.54	2.64	0.24	0.24	736.74
	Total per Phase			1 days	
	0.54	2.64	0.24	0.24	736.74

1. Revise equipment type, except "On Highway Trucks," as appropriate for this project. Provide hp if known.
2. For "On Highway Trucks" (which includes vendors, haul trucks,& deliveries) the "quantity of equipment" should be reported as round trip truck trips.
3. Working days are counted as 20 days within a calendar month.

* Typically we use an average of 60 - 120 ft/day pipeline construction, depending on conditions. Majority of the pipeline in this project is in soil where we would anticipate minimal obstructions, so we can assume a higher production rate.

** Assume pump, tanks, and other equipment installed during building construction, while fork lift and crane are avaialble. The 40 days includes testing

*** Needed for pipeline work in the street.

Regional Groundwater Storage and Recovery Project
On-Road Vehicle Emissions

Air Pollutant and GHG Emissions using EMFAC2011 for 2014

	Round	**Vehicle Emissions per Construction Period (pounds)**								
Site ID	**Trips**	**ROG**	**NOx**	**PM10**	**PM2.5**	**PM2.5**	**PM2.5**	**CO2**	**CO2**	**CO2**
Site 1					Running	Idle		Running	Idle	
Employee Traffic	952	8.77	12.30	8.48	2.55	0.00	2.55	18539	0	18,539
Vendor/Equipment Trips	482	5.95	66.52	4.36	2.04	0.09	2.13	14175	1308	15,482
Heavy-Heavy Duty Trucks	9	0.32	4.83	0.30	0.17	0.00	0.17	954	23	977
Total	**1444**	**15.05**	**83.65**	**13.14**	**4.8**	**0.1**	**4.85**	**33,667**	**1,331**	**34,998**
Site 2										
Employee Traffic	81	0.75	1.05	0.72	0.22	0.00	0.22	1577	0	1,577
Vendor/Equipment Trips	44	0.54	6.02	0.39	0.18	0.01	0.19	1283	118	1,401
Heavy-Heavy Duty Trucks	2	0.07	1.07	0.07	0.04	0.00	0.04	212	5	217
Total	**127**	**1.36**	**8.14**	**1.18**	**0.4**	**0.0**	**0.45**	**3072**	**124**	**3,195**
Site 3										
Employee Traffic	266		3.44	2.37	0.71	0.00	0.71	5180	0	5,180
Vendor/Equipment Trips	87		12.00	0.79	0.37	0.02	0.38	2557	236	2,793
Heavy-Heavy Duty Trucks	10		5.37	0.34	0.18	0.00	0.19	1060	26	1,086
Total	**363**		**20.81**	**3.49**	**1.3**	**0.0**	**1.28**	**8798**	**262**	**9,059**
Site 4										
Employee Traffic	270	2.49	3.49	2.40	0.72	0.00	0.72	5256	0	5,256
Vendor/Equipment Trips	88	1.09	12.18	0.80	0.37	0.02	0.39	2595	239	2,835
Heavy-Heavy Duty Trucks	27	0.97	14.49	0.91	0.50	0.00	0.50	2862	70	2,931
Total	**385**	**4.54**	**30.16**	**4.11**	**1.6**	**0.0**	**1.62**	**10713**	**309**	**11,022**
Westlake Pump Station										
Employee Traffic	280	2.58	3.62	2.49	0.75	0.00	0.75	5450	0	5,450
Vendor/Equipment Trips	160	1.97	22.06	1.44	0.68	0.03	0.71	4701	434	5,134
Heavy-Heavy Duty Trucks	0	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0
Total	**440**	**4.55**	**25.68**	**3.94**	**1.4**	**0.0**	**1.46**	**10151**	**434**	**10,585**
Site 5 (assume worst case)										
Employee Traffic	877	8.08	11.33	7.81	2.35	0.00	2.35	17077	0	17,077
Vendor/Equipment Trips	492	6.08	67.89	4.45	2.08	0.09	2.18	14467	1335	15,802
Heavy-Heavy Duty Trucks	7	0.25	3.76	0.23	0.13	0.00	0.13	742	18	760
Total	**1377**	**14.41**	**82.98**	**12.49**	**4.6**	**0.1**	**4.66**	**32286**	**1,353**	**33,638**
Site 6 (assume worst case)										
Employee Traffic	859	7.92	11.10	7.65	2.30	0.00	2.30	16724	0	16,724
Vendor/Equipment Trips	486	6.00	67.06	4.39	2.06	0.09	2.15	14290	1318	15,608
Heavy-Heavy Duty Trucks	4	0.14	2.15	0.13	0.07	0.00	0.07	424	10	434
Total	**1350**	**14.06**	**80.31**	**12.18**	**4.4**	**0.1**	**4.53**	**31437**	**1,329**	**32,766**
Site 7 (assume worst case)										
Employee Traffic	990	9.12	12.78	8.81	2.65	0.00	2.65	19262	0	19,262
Vendor/Equipment Trips	495	6.11	68.23	4.47	2.09	0.10	2.19	14538	1341	15,879
Heavy-Heavy Duty Trucks	17	0.61	9.12	0.57	0.31	0.00	0.32	1802	44	1,846
Total	**1501**	**15.83**	**90.13**	**13.85**	**5.1**	**0.1**	**5.16**	**35602**	**1,385**	**36,987**
Site 8										
Employee Traffic	851	7.84	11.00	7.58	2.28	0.00	2.28	16570	0	16,570
Vendor/Equipment Trips	484	5.97	66.70	4.37	2.05	0.09	2.14	14213	1311	15,524
Heavy-Heavy Duty Trucks	5	0.18	2.68	0.17	0.09	0.00	0.09	530	13	543
Total	**1340**	**13.99**	**80.38**	**12.12**	**4.4**	**0.1**	**4.51**	**31313**	**1,324**	**32,637**
Site 9										
Employee Traffic	960	8.84	12.40	8.55	2.57	0.00	2.57	18687	0	18,687
Vendor/Equipment Trips	485	5.99	66.87	4.38	2.05	0.09	2.14	14249	1314	15,564
Heavy-Heavy Duty Trucks	8	0.29	4.29	0.27	0.15	0.00	0.15	848	21	869
Total	**1453**	**15.12**	**83.57**	**13.20**	**4.8**	**0.1**	**4.87**	**33785**	**1,335**	**35,120**

Site ID	Round Trips	ROG	NOx	PM10	PM2.5	PM2.5	PM2.5	CO2	CO2	CO2
		Vehicle Emissions per Construction Period (pounds)								
Site 10										
Employee Traffic	851	7.84	11.00	7.58	2.28	0.00	2.28	16573	0	16,573
Vendor/Equipment Trips	484	5.97	66.71	4.37	2.05	0.09	2.14	14214	1311	15,525
Heavy-Heavy Duty Trucks	7	0.25	3.76	0.23	0.13	0.00	0.13	742	18	760
Total	**1342**	**14.06**	**81.46**	**12.18**	**4.5**	**0.1**	**4.55**	**31529**	**1,329**	**32,858**
Site 11										
Employee Traffic	978	9.01	12.63	8.71	2.62	0.00	2.62	19035	0	19,035
Vendor/Equipment Trips	491	6.06	67.69	4.43	2.08	0.09	2.17	14424	1331	15,755
Heavy-Heavy Duty Trucks	9	0.32	4.83	0.30	0.17	0.00	0.17	954	23	977
Total	**1478**	**15.39**	**85.15**	**13.44**	**4.9**	**0.1**	**4.96**	**34414**	**1,354**	**35,767**
Site 12										
Employee Traffic	986	9.08	12.73	8.78	2.64	0.00	2.64	19191	0	19,191
Vendor/Equipment Trips	494	6.09	68.06	4.46	2.09	0.09	2.18	14503	1338	15,841
Heavy-Heavy Duty Trucks	15	0.54	8.05	0.50	0.28	0.00	0.28	1590	39	1,628
Total	**1495**	**15.71**	**88.85**	**13.74**	**5.0**	**0.1**	**5.11**	**35284**	**1,377**	**36,660**
Site 13										
Employee Traffic	902	8.31	11.65	8.03	2.42	0.00	2.42	17556	0	17,556
Vendor/Equipment Trips	501	6.18	69.03	4.52	2.12	0.10	2.21	14708	1357	16,065
Heavy-Heavy Duty Trucks	14	0.50	7.51	0.47	0.26	0.00	0.26	1484	36	1,520
Total	**1417**	**14.99**	**88.19**	**13.02**	**4.8**	**0.1**	**4.89**	**33748**	**1,393**	**35,141**
Site 14										
Employee Traffic	1017	9.37	13.14	9.06	2.73	0.00	2.73	19804	0	19,804
Vendor/Equipment Trips	504	6.22	69.51	4.55	2.13	0.10	2.23	14811	1366	16,178
Heavy-Heavy Duty Trucks	25	0.89	13.42	0.84	0.46	0.00	0.46	2650	64	2,714
Total	**1547**	**16.49**	**96.07**	**14.45**	**5.3**	**0.1**	**5.42**	**37265**	**1,431**	**38,696**
Site 15										
Employee Traffic	968	8.92	12.51	8.62	2.60	0.00	2.60	18850	0	18,850
Vendor/Equipment Trips	488	6.02	67.26	4.40	2.06	0.09	2.16	14331	1322	15,653
Heavy-Heavy Duty Trucks	8	0.29	4.29	0.27	0.15	0.00	0.15	848	21	869
Total	**1464**	**15.23**	**84.06**	**13.30**	**4.8**	**0.1**	**4.90**	**34030**	**1,343**	**35,372**
Site 16										
Employee Traffic	972	8.96	12.56	8.66	2.61	0.00	2.61	18928	0	18,928
Vendor/Equipment Trips	489	6.04	67.44	4.42	2.07	0.09	2.16	14371	1326	15,696
Heavy-Heavy Duty Trucks	8	0.29	4.29	0.27	0.15	0.00	0.15	848	21	869
Total	**1470**	**15.28**	**84.29**	**13.34**	**4.8**	**0.1**	**4.92**	**34147**	**1,346**	**35,493**
Site 17 (Alternate)										
Employee Traffic	949	8.74	12.25	8.45	2.54	0.00	2.54	18468	0	18,468
Vendor/Equipment Trips	481	5.94	66.36	4.35	2.04	0.09	2.13	14139	1304	15,443
Heavy-Heavy Duty Trucks	10	0.36	5.37	0.34	0.18	0.00	0.19	1060	26	1,086
Total	**1440**	**15.04**	**83.98**	**13.13**	**4.8**	**0.1**	**4.86**	**33667**	**1,330**	**34,997**
Site 18 (Alternate)										
Employee Traffic	955	8.80	12.33	8.50	2.56	0.00	2.56	18588	0	18,588
Vendor/Equipment Trips	483	5.96	66.64	4.36	2.04	0.09	2.14	14199	1310	15,509
Heavy-Heavy Duty Trucks	10	0.36	5.37	0.34	0.18	0.00	0.19	1060	26	1,086
Total	**1448**	**15.12**	**84.34**	**13.20**	**4.8**	**0.1**	**4.88**	**33847**	**1,336**	**35,182**
Site 19 (Alternate)										
Employee Traffic	286	2.63	3.69	2.55	0.77	0.00	0.77	5567	0	5,567
Vendor/Equipment Trips	94	1.16	12.91	0.85	0.40	0.02	0.41	2752	254	3,006
Heavy-Heavy Duty Trucks	15	0.54	8.05	0.50	0.28	0.00	0.28	1590	39	1,628
Total	**395**	**4.33**	**24.66**	**3.90**	**1.4**	**0.0**	**1.46**	**9909**	**293**	**10,202**

Vehicle & Trip Information

Description	Trip Length*	% LDA	%LDT	%MDT	%HDT	%HHDT
Employee Vehicles	**12.4**	50%	50%			
Vendor/Equipment Trips	**7.3**			50%	50%	
Heavy Duty Trucks	**20**				100%	
Heavy-Heavy Duty Trucks	**20**					100%

* Trip length is one way distance in miles

Composite Running Emission Factors, gm/mi

						Entrained Dust	
Description	**ROG**	**NOx**	**PM10**	**PM2.5**	**CO2**	**PM10**	**PM2.5**
Employee Vehicles	0.144	0.213	0.047	0.020	350.06	0.116	0.029
Vendor/Equipment Trips	0.294	3.216	0.158	0.102	906.02	0.116	0.029
Heavy Duty Trucks	0.363	5.768	0.263	0.180	1202.52	0.116	0.029
Heavy-Heavy Duty Trucks	0.418	8.488	0.241	0.170	1646.48	0.116	0.029

Emission factors based on EMFAC2011

Trip Emissions, gm/trip

Description	ROG	NOx	PM10	PM2.5	CO2
Employee Vehicles	0.311	0.289	0.003	0.003	78.09
Vendor/Equipment Trips	0.450	0.635	0.002	0.002	55.31
Heavy Duty Trucks	0.317	0.460	0.001	0.001	8.56
Heavy-Heavy Duty Trucks	0.323	0.397	0.000	0.000	5.29

Emission factors based on EMFAC2011

Idle Emissions, gm/hr-veh

Description	ROG	NOx	PM10	PM2.5	CO2
Employee Vehicles[a]	-	-	-	-	-
Vendor/Equipment Trips[b]	2.489	86.283	0.569	0.524	7382.69
Heavy Duty Trucks[c]	6.357	72.190	0.384	0.3536	7022.55
Heavy-Heavy Duty Trucks[c]	6.357	72.190	0.384	0.354	7022.55

Emision rates from CARB Idling Emission Rates for EMFAC2011-HD Vehicle Categories, Feb. 8, 2012

Idle time per vehicle round trip assumet to be = 10 minutes

[a] Idle emissions from employee vehicles assumed to be negligible

[b] Idle emissions from Vendor/Equipment vehicles assumed to be same as for MHDT vehicle category

[c] Idle emissions from Heavy Duty Trucks and Heavy-Heavy Duty trucks assumed to be same as for HHDT vehicle category

Entrained Roadway Dust (PM10)
gm/mi

Vehicle	PM10	PM2.5
All	0.116	0.029

EPA AP-42 Section 13.2.1

$E = k(sL)^{0.91} \times (W)^{1.02}$ EPA AP-42 Section 13

Where:

k (PM2.5) = 0.25

k (PM10) = 1.00

sL = 0.035 g/m2 for major & colle

W = 2.4 tons

4/8/2012
From Table 3-4

Site ID	Approximate Pipeline Lengths (feet) Proposed Water Connection Pipeline	Alternate Water Connection Pipeline	Sanitary Sewer Pipeline	Storm Drain Pipeline	Total	Total Days
Site 1	125	175	55	65	295	2.5
Site 2[b]	315	None	None	125	440	3.7
Site 3[b]	375	None	None	470	845	7.0
Site 4[b]	670	None	None	330	1000	8.3
Westlake Pump Station	None	None	None	None	0	0.0
Site 5 (Consolidated Treatment at Site 6) [c]	1,120	None	None	370	1490	12.4
Site 6 (Consolidated Treatment at Site 6) [c]	115	525	130	110	765	6.4
Site 7 (Consolidated Treatment at Site 6) [c]	1,780	None	None	170	1950	16.3
Site 5 (On-Site Treatment)	145	165	110	370	645	5.4
Site 6 (On-Site Treatment)	115	525	130	110	765	6.4
Site 7 (On-Site Treatment)	75	145	170	170	485	4.0
Site 8	145	125	85	220	450	3.8
Site 9	245	None	185	170	600	5.0
Site 10	200	100	145	110	455	3.8
Site 11	205	160	965	145	1315	11.0
Site 12	925	90	355	355	1635	13.6
Site 13	1,835	185	495	145	2,475	20.6
Site 14	1,785	None	None	1,110	2895	24.1
Site 15	670	680	100	155	935	7.8
Site 16	40	700	290	105	1095	9.1
Site 17 (Alternate)	105	20	70	75	140	1.2
Site 18 (Alternate)	130	120	140	155	425	3.5
Site 19 (Alternate)[d]	1450	150	None	190	1640	13.7
				Total	22740	

a. Pipelines listed in the table are illustrated on site plans for each site – Figures 3-12 through Figure 3-39.

b. The water connection pipeline for Sites 2, 3, and 4 includes the length of pipeline needed to connect to the existing Daly City pipeline for conveyance to the Westlake Pump Station.

c. Water connection pipelines for Site 5 (Consolidated Treatment at Site 6) and Site 7 (Consolidated Treatment at Site 6) include the pipeline length necessary to deliver water to Site 6 for treatment.

Regional Groundwater Storage and Recovery Project
Vehilce Trips Breakdown

5/31/2012
Taken from Sheet 1, PD Table 3-10, andPD Table 3-11

					Round-trips Worker, Equipment, and Delivery Trips				Vendor Trips (Equipment & Delivery)				Haul Trips (Soil Import/Export)			
	Well Drilling	**Building or Fenced-only**	**Pipeline Length**	**Haul Truck Trips**	**Well**	**Facility**	**Pipeline**	**Total**	**Well**	**Facility**	**Pipeline**	**Total**	**Well**	**Facility**	**Pipeline**	**Total**
Cluster A																
Site 1	Yes	Building	295	9	105	1,320	10	1,435	0	480	2	482	5.0	2.0	2.0	9
Site 3[(b)]	Yes	Fenced-only	845	10	105	220	28	353	0	80	7	87	6.0	4.0	0.0	10
Site 4[(b)]	Yes	Fenced-only	1,000	27	105	220	33	358	0	80	8	88	6.0	5.0	16.0	27
Site 7 (on-site is worse)	Yes	Building	1,780	17	105	1,320	59	1,484	0	480	15	495	6.0	10.0	1.0	17
Subtotal			**3,920**	**63**	**420**	**3,080**	**131**	**3,631**								
Cluster B																
Site 12	Yes	Building	1,635	15	105	1,320	55	1,480	0	480	14	494	5.0	8.0	2.0	15
Site 14	Yes	Building	2,895	25	105	1,320	97	1,522	0	480	24	504	5.0	18.0	2.0	25
Site 15	Yes	Building	935	8	105	1,320	31	1,456	0	480	8	488	5.0	3.0	0.0	8
Site 16 (alternate water connection, which is longer)	Yes	Building	1,095	8	105	1,320	37	1,462	0	480	9	489	4.0	4.0	0.0	8
Site 19 (Alternate)[(d)]	Yes	Fenced-only	1,640	15	105	220	55	380	0	80	14	94	6.0	5.0	4.0	15
Subtotal			**8,200**	**71**	**525**	**5,500**	**273**	**6,298**								
Cluster C																
Site 9	Yes	Building	600	8	105	1,320	20	1,445	0	480	5	485	5.0	3.0	0.0	8
Site 10	No	Building	455	7	-	1,320	15	1,335	0	480	4	484	-	3.0	4.0	7
Site 11	Yes	Building	1,315	9	105	1,320	44	1,469	0	480	11	491	6.0	3.0	0.0	9
Site 13	No	Building	2,475	14	-	1,320	83	1,403	0	480	21	501	-	14.0	0.0	14
Site 18 (Alternate)	Yes	Building	395	10	105	1,320	13	1,438	0	480	3	483	6.0	2.0	2.0	10
Subtotal			**5,240**	**48**	**315**	**6,600**	**175**	**7,090**								
Cluster D																
Site 2[(b)]	No	Fenced-only	440	2	-	110	15	125	0	40	4	44	-	1.0	1.0	2
Site 5 (on-site is worse)	No	Building	1,490	7	-	1,320	50	1,370	0	480	12	492	-	7.0	0.0	7
Site 6	No	Building	765	4	-	1,320	26	1,346	0	480	6	486	-	2.0	2.0	4
Site 8	No	Building	450	5	-	1,320	15	1,335	0	480	4	484	-	2.5	2.5	5
Site 17 (Alternate)	Yes	Building	150	10	105	1,320	5	1,430	0	480	1	481	6.0	2.0	2.0	10
Westlake Pump Station		Pumps and treatment only	-	-	-	440	-	440	0	160	-	160	0.0	0.0	0.0	0
Subtotal			**3,295**	**28**	**105**	**5,830**	**110**	**6,045**								
Total			**20,655**	**210**	**1,365**	**21,010**	**689**	**23,064**								

F & G column is calculated:
(average typical workers + Delivery and Equipment trips from PD Table 3-8)*days per month

Regional Groundwater Storage and Recovery Project

EMFAC2011 - Average Emission Rates
2014 Estimated Annual Emission Rates
San Mateo COUNTY

		Fraction	Total	Fraction	Fraction	ROG		TOG		NOx		PM10		PM2.5		CO2 (Pavley + LCFS)		PM2.5	
	Population (Vehicles)	of Total Vehicles	VMT (Miles/day)	of Total VMT	Diesel VMT of Class	Running* (gms/mile)	Starting (gms/trip)	Running* (gms/mile)	Starting (gms/trip)	Running (gms/mile)	Starting (gms/trip)	Running** (gms/mile)	Starting (gms/trip)	Running** (gms/mile)	Starting (gms/trip)	Running (gms/mile)	Starting (gms/trip)	All Fuels Exh (gms/mile)	Diesel Exhaust (gms/mile)
LDA	343,898	0.594	12,487,933	0.5778	0.00408	0.10856	0.24873	0.12358	0.26590	0.1386	0.19463	0.04686	0.00291	0.01967	0.00265	296.431	66.676	0.001919	0.03488
LDT1	34,964	0.060	1,358,386	0.0628	0.00145	0.28812	0.51092	0.32047	0.54600	0.3757	0.34515	0.04948	0.00518	0.02206	0.00474	352.419	78.181	0.004309	0.07284
LDT2	95,611	0.165	3,813,529	0.1764	0.00049	0.13961	0.32404	0.16051	0.34613	0.2565	0.39596	0.04680	0.00276	0.01962	0.00254	421.942	93.528	0.001874	0.04868
LHD1	15,491	0.027	647,808	0.0300	0.24450	0.41367	0.55407	0.45085	0.59171	1.4979	1.47038	0.07207	0.00153	0.03747	0.00140	850.143	42.628	0.015318	0.05247
LHD2	2,193	0.004	91,310	0.0042	0.49494	0.35807	0.37110	0.39197	0.39661	2.2474	0.96805	0.10041	0.00111	0.05487	0.00100	739.945	29.065	0.025508	0.04821
MCY	13,488	0.023	139,857	0.0065	0.00000	3.29148	2.42327	3.55540	2.60691	1.2899	0.31959	0.00088	0.00270	0.00070	0.00211	149.04149	46.07064	0.000700	0.00070
MDV	63,894	0.110	2,504,597	0.1159	0.00129	0.17007	0.59812	0.20208	0.63877	0.3898	0.63374	0.04697	0.00351	0.01980	0.00323	542.530	120.102	0.002046	0.03151
MH	1,610	0.003	21,240	0.0010	0.15298	0.32416	0.87092	0.37225	0.93327	2.1618	1.05938	0.09653	0.00252	0.05785	0.00214	745.812	34.264	0.033810	0.20342
OBUS	764	0.001	55,083	0.0025	0.66381	0.35810	0.33224	0.40035	0.35531	6.4430	0.69446	0.22055	0.00045	0.14718	0.00039	1192.688	12.715	0.102139	0.15339
SBUS	116	0.000	5,038	0.0002	0.53149	0.94070	1.63654	1.03104	1.74911	7.0771	1.85677	0.48737	0.00405	0.23856	0.00364	1023.027	60.379	0.058997	0.10401
MHDT (T6)	5,781	0.010	327,966	0.0152	0.84516	0.34975	0.31584	0.39314	0.33814	5.0933	0.47505	0.26905	0.00069	0.18296	0.00059	1092.459	9.367	0.130469	0.15401
HHDT (T7)	591	0.001	81,307	0.0038	0.92420	0.41831	0.32252	0.47369	0.34606	8.4884	0.39745	0.24058	0.00047	0.17035	0.00038	1646.479	5.294	0.136975	0.14814
UBUS	508	0.001	80,455	0.0037	0.91903	0.83005	0.49309	0.92853	0.52691	14.8226	0.74147	1.05012	0.00043	0.57908	0.00038	2385.570	12.178	0.244245	0.26538
Total	578,910	1.00	21,614,508	1.00															

* ROG running includes evaporative running loss

** PM10 & PM2.5 running includes tire & brake wear

Average Weekday Emisions Factors

	Fraction	Fraction	Fraction	ROG		TOG		NOx		PM10		PM2.5		CO2		All Fuels	Diesel
Vehicle Class	of Total Vehicles	of Total VMT	Diesel VMT of Class	Running (gms/mile)	Starting (gms/trip)	Running (gms/mile)	Starting (gms/trip)	Running (gms/mile)	Starting (gms/trip)	Running (gms/mile)	Starting (gms/trip)	Running (gms/mile)	Starting (gms/trip)	Running (gms/mile)	Starting (gms/trip)	PM2.5 (gms/mile)	PM2.5 (gms/mile)
LDA	0.594	0.5778	0.00408	0.10856	0.24873	0.12358	0.26590	0.13858	0.19463	0.04686	0.00291	0.01967	0.00265	296.431	66.676	0.00192	0.03488
LDT	0.226	0.2393	0.00074	0.17862	0.37312	0.20252	0.39863	0.28778	0.38262	0.04750	0.00340	0.02026	0.00312	403.682	89.497	0.00251	0.05503
MDT	0.141	0.1501	0.06376	0.22401	0.58293	0.25710	0.62255	0.66340	0.81023	0.05349	0.00304	0.02431	0.00281	609.521	102.067	0.00536	0.03617
HDT*	0.015	0.0227	0.80471	0.36337	0.31717	0.40914	0.33971	5.76778	0.45964	0.26339	0.00065	0.18046	0.00055	1202.521	8.558	0.13176	0.15284

* HDT includes emissions from MHDT and HHDT, but not from any buses

Average Daily Emissions

CalEEMod Version: CalEEMod.2011.1.1

Date: 6/14/2012

GSR - Well Drilling/Well Construction

San Mateo County, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Heavy Industry	0	1000sqft

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**
Climate Zone	5	**Precipitation Freq (Days)**	70	

1.3 User Entered Comments

Project Characteristics -

Land Use - Small Area for Well

Construction Phase - Project-specific schedule using 2/1/2014 as earliest start date and 20-day construction period.

Off-road Equipment - Project-specific equipment & LF adjustment (-33%)

Off-road Equipment - Project-specific equipment list averaged to daily use over 30 construction days
Adjusted load factors by -33%

Trips and VMT - Worker trips computed seperately using EMFAC2011

Construction Off-road Equipment Mitigation -

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	1.34	9.50	6.93	0.02	0.49	0.39	0.89	0.02	0.39	0.41	0.00	2,484.03	0.00	0.12	0.00	2,486.56
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	0.78	6.57	83.78	0.02	0.02	0.10	0.11	0.02	0.10	0.11	0.00	2,484.03	0.00	0.12	0.00	2,486.56
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.1 Mitigation Measures Construction

Use Cleaner Engines for Construction Equipment

Use DPF for Construction Equipment

3.2 Well Drilling/WellConstruction - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.15	9.32	4.88	0.02		0.38	0.38		0.38	0.38		2,103.12		0.10		2,105.24
Total	**1.15**	**9.32**	**4.88**	**0.02**		**0.38**	**0.38**		**0.38**	**0.38**		**2,103.12**		**0.10**		**2,105.24**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.19	0.19	2.05	0.00	0.49	0.01	0.51	0.02	0.01	0.03		380.90		0.02		381.32
Total	**0.19**	**0.19**	**2.05**	**0.00**	**0.49**	**0.01**	**0.51**	**0.02**	**0.01**	**0.03**		**380.90**		**0.02**		**381.32**

3.2 Well Drilling/WellConstruction - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.59	6.38	81.73	0.02		0.08	0.08		0.08	0.08	0.00	2,103.12		0.10		2,105.24
Total	**0.59**	**6.38**	**81.73**	**0.02**		**0.08**	**0.08**		**0.08**	**0.08**	**0.00**	**2,103.12**		**0.10**		**2,105.24**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.19	0.19	2.05	0.00	0.02	0.01	0.03	0.02	0.01	0.03		380.90		0.02		381.32
Total	**0.19**	**0.19**	**2.05**	**0.00**	**0.02**	**0.01**	**0.03**	**0.02**	**0.01**	**0.03**		**380.90**		**0.02**		**381.32**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

Average Daily Emissions

CalEEMod Version: CalEEMod.2011.1.1 Date: 6/14/2012

GSR - Construction WF & Treatment Building Avg Day

San Mateo County, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Light Industry	2	1000sqft

1.2 Other Project Characteristics

Urbanization Urban

Wind Speed (m/s) 2.2

Utility Company Pacific Gas & Electric Company

Climate Zone 5

Precipitation Freq (Days) 70

1.3 User Entered Comments

Project Characteristics -

Land Use -

Construction Phase - Based on project information - total Building Phase

Off-road Equipment - Equipment list and load factor adjustment -33%

Off-road Equipment - Equipment list averaged over entire 240-day period and adjusted load factors down by 33%

Trips and VMT - All trips modeled using EMFAC2011

Construction Off-road Equipment Mitigation -

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	0.61	4.66	2.46	0.01	0.01	0.23	0.24	0.00	0.23	0.23	0.00	677.03	0.00	0.05	0.00	678.17
2015	0.57	4.21	2.41	0.01	0.01	0.20	0.22	0.00	0.20	0.20	0.00	676.80	0.00	0.05	0.00	677.86
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	0.34	3.22	2.75	0.01	0.00	0.08	0.08	0.00	0.08	0.08	0.00	677.03	0.00	0.05	0.00	678.17
2015	0.33	3.00	2.72	0.01	0.00	0.07	0.07	0.00	0.07	0.07	0.00	676.80	0.00	0.05	0.00	677.86
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.1 Mitigation Measures Construction

Use Cleaner Engines for Construction Equipment

Use DPF for Construction Equipment

3.2 WF & Treatment Building - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.60	4.66	2.40	0.01		0.23	0.23		0.23	0.23		665.49		0.05		666.62
Total	**0.60**	**4.66**	**2.40**	**0.01**		**0.23**	**0.23**		**0.23**	**0.23**		**665.49**		**0.05**		**666.62**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.01	0.01	0.06	0.00	0.01	0.00	0.02	0.00	0.00	0.00		11.54		0.00		11.56
Total	**0.01**	**0.01**	**0.06**	**0.00**	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**		**11.54**		**0.00**		**11.56**

3.2 WF & Treatment Building - 2014

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.34	3.22	2.69	0.01		0.08	0.08		0.08	0.08	0.00	665.49		0.05		666.62
Total	**0.34**	**3.22**	**2.69**	**0.01**		**0.08**	**0.08**		**0.08**	**0.08**	**0.00**	**665.49**		**0.05**		**666.62**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.01	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00		11.54		0.00		11.56
Total	**0.01**	**0.01**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**11.54**		**0.00**		**11.56**

3.2 WF & Treatment Building - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.56	4.20	2.36	0.01		0.20	0.20		0.20	0.20		665.49		0.05		666.54
Total	**0.56**	**4.20**	**2.36**	**0.01**		**0.20**	**0.20**		**0.20**	**0.20**		**665.49**		**0.05**		**666.54**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.01	0.01	0.06	0.00	0.01	0.00	0.02	0.00	0.00	0.00		11.31		0.00		11.32
Total	**0.01**	**0.01**	**0.06**	**0.00**	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**		**11.31**		**0.00**		**11.32**

3.2 WF & Treatment Building - 2015

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.32	3.00	2.66	0.01		0.07	0.07		0.07	0.07	0.00	665.49		0.05		666.54
Total	**0.32**	**3.00**	**2.66**	**0.01**		**0.07**	**0.07**		**0.07**	**0.07**	**0.00**	**665.49**		**0.05**		**666.54**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.01	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00		11.31		0.00		11.32
Total	**0.01**	**0.01**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**11.31**		**0.00**		**11.32**

4.0 Mobile Detail

4.1 Mitigation Measures Mobile

GSR - Fenced Enclosure Construction

San Mateo County, Summer

Average Daily Emissions

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Heavy Industry	1	1000sqft

1.2 Other Project Characteristics

Urbanization Urban

Climate Zone 5

Wind Speed (m/s) 2.2

Precipitation Freq (Days) 70

Utility Company

1.3 User Entered Comments

Project Characteristics -

Land Use - Small Area for Fenced Enclosure around Well

Construction Phase - Project-specific schedule using 3/4/2014 as earliest start date and 20-day construction period.

Off-road Equipment - Project-specific equipment & LF adjustment (-33%)

Off-road Equipment - Project-specific equipment list with hours adjusted for entire phase duration of 40 construction days

Adjusted load factors by -33%

Trips and VMT - Worker trips computed seperately using EMFAC2011

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2013	0.24	1.75	0.97	0.00	0.00	0.10	0.10	0.00	0.10	0.10	0.00	222.95	0.00	0.02	0.00	223.39
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2013	0.24	1.75	0.97	0.00	0.00	0.10	0.10	0.00	0.10	0.10	0.00	222.95	0.00	0.02	0.00	223.39
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.0 Construction Detail

3.1 Mitigation Measures Construction

3.2 Fenced Enclosure Construction - 2013

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.24	1.75	0.97	0.00		0.10	0.10		0.10	0.10		222.95		0.02		223.39
Total	**0.24**	**1.75**	**0.97**	**0.00**		**0.10**	**0.10**		**0.10**	**0.10**		**222.95**		**0.02**		**223.39**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.24	1.75	0.97	0.00		0.10	0.10		0.10	0.10	0.00	222.95		0.02		223.39
Total	**0.24**	**1.75**	**0.97**	**0.00**		**0.10**	**0.10**		**0.10**	**0.10**	**0.00**	**222.95**		**0.02**		**223.39**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

GSR - Pipeline Per Day Construction

San Mateo County, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Heavy Industry	1	1000sqft

1.2 Other Project Characteristics

Urbanization	Urban	**Wind Speed (m/s)**	2.2	**Utility Company**
Climate Zone	5	**Precipitation Freq (Days)**	70	

1.3 User Entered Comments

Project Characteristics -

Land Use - Small Area for pipeline

Construction Phase - These are per-day estimates of activity that would construct 120-linear feet of pipeline

Off-road Equipment - Project-specific equipment & LF adjustment (-33%)

Off-road Equipment - Max. Avg Day equipment activity based on one day of pipline construction
Adjusted load factors by -33%

Trips and VMT - Worker trips computed seperately using EMFAC2011

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	0.76	4.26	4.39	0.01	0.34	0.33	0.68	0.01	0.33	0.34	0.00	735.26	0.00	0.07	0.00	736.74
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	0.76	4.26	4.39	0.01	0.01	0.33	0.34	0.01	0.33	0.34	0.00	735.26	0.00	0.07	0.00	736.74
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.0 Construction Detail

3.1 Mitigation Measures Construction

3.2 Pipeline Construction - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.63	4.13	2.95	0.00		0.32	0.32		0.32	0.32		469.78		0.06		470.96
Total	**0.63**	**4.13**	**2.95**	**0.00**		**0.32**	**0.32**		**0.32**	**0.32**		**469.78**		**0.06**		**470.96**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.13	0.13	1.43	0.00	0.34	0.01	0.35	0.01	0.01	0.02		265.48		0.01		265.77
Total	**0.13**	**0.13**	**1.43**	**0.00**	**0.34**	**0.01**	**0.35**	**0.01**	**0.01**	**0.02**		**265.48**		**0.01**		**265.77**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.63	4.13	2.95	0.00		0.32	0.32		0.32	0.32	0.00	469.78		0.06		470.96
Total	**0.63**	**4.13**	**2.95**	**0.00**		**0.32**	**0.32**		**0.32**	**0.32**	**0.00**	**469.78**		**0.06**		**470.96**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.13	0.13	1.43	0.00	0.01	0.01	0.02	0.01	0.01	0.02		265.48		0.01		265.77
Total	**0.13**	**0.13**	**1.43**	**0.00**	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**	**0.02**		**265.48**		**0.01**		**265.77**

Maximum Daily Emissions

CalEEMod Version: CalEEMod.2011.1.1

Date: 6/5/2012

GSR - Well Drilling/Well Construction

San Mateo County, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Heavy Industry	0	1000sqft

1.2 Other Project Characteristics

Urbanization Urban

Climate Zone 5

Wind Speed (m/s) 2.2

Precipitation Freq (Days) 70

Utility Company

1.3 User Entered Comments

Project Characteristics -

Land Use - Small Area for Well

Construction Phase - Project-specific schedule using 2/1/2014 as earliest start date and 20-day construction period.

Off-road Equipment - Project-specific equipment & LF adjustment (-33%)

Off-road Equipment - Project-specific equipment list averaged to daily use over 30 construction days

Adjusted load factors by -33%

Trips and VMT - Worker trips computed seperately using EMFAC2011

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	5.79	46.35	20.62	0.08	0.49	1.58	2.07	0.02	1.58	1.60	0.00	9,193.47	0.00	0.51	0.00	9,204.23
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	5.79	46.35	20.62	0.08	0.02	1.58	1.60	0.02	1.58	1.60	0.00	9,193.47	0.00	0.51	0.00	9,204.23
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.0 Construction Detail

3.1 Mitigation Measures Construction

3.2 Well Drilling/WellConstruction - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	5.60	46.16	18.57	0.08		1.57	1.57		1.57	1.57		8,812.57		0.49		8,822.90
Total	**5.60**	**46.16**	**18.57**	**0.08**		**1.57**	**1.57**		**1.57**	**1.57**		**8,812.57**		**0.49**		**8,822.90**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.19	0.19	2.05	0.00	0.49	0.01	0.51	0.02	0.01	0.03		380.90		0.02		381.32
Total	**0.19**	**0.19**	**2.05**	**0.00**	**0.49**	**0.01**	**0.51**	**0.02**	**0.01**	**0.03**		**380.90**		**0.02**		**381.32**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	5.60	46.16	18.57	0.08		1.57	1.57		1.57	1.57	0.00	8,812.57		0.49		8,822.90
Total	**5.60**	**46.16**	**18.57**	**0.08**		**1.57**	**1.57**		**1.57**	**1.57**	**0.00**	**8,812.57**		**0.49**		**8,822.90**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.19	0.19	2.05	0.00	0.02	0.01	0.03	0.02	0.01	0.03		380.90		0.02		381.32
Total	**0.19**	**0.19**	**2.05**	**0.00**	**0.02**	**0.01**	**0.03**	**0.02**	**0.01**	**0.03**		**380.90**		**0.02**		**381.32**

Maximum Daily Emissions

CalEEMod Version: CalEEMod.2011.1.1

Date: 6/5/2012

GSR - Construction WF & Treatment Building

San Mateo County, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Light Industry	2	1000sqft

1.2 Other Project Characteristics

Urbanization Urban

Climate Zone 5

Wind Speed (m/s) 2.2

Precipitation Freq (Days) 70

Utility Company Pacific Gas & Electric Company

1.3 User Entered Comments

Project Characteristics -

Land Use -

Construction Phase - Based on project information

Off-road Equipment - Equipment list and load factor adjustment -33%

Off-road Equipment - Equipment list and load factor adjustment -33%

Off-road Equipment - Per project information, no demolition planned

Off-road Equipment - Equipment list and load factor adjustment -33%

Off-road Equipment - Equipment list and load factor adjustment -33%

Off-road Equipment - Equipment list and load factor adjustments -33%

Trips and VMT - All trips modeled using EMFAC2011

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	2.47	15.77	13.95	0.03	1.55	1.07	2.62	0.44	1.07	1.51	0.00	2,470.28	0.00	0.23	0.00	2,475.02
2015	1.66	10.21	7.80	0.01	0.22	0.75	0.98	0.01	0.75	0.76	0.00	1,407.44	0.00	0.15	0.00	1,410.59
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	2.47	15.77	13.95	0.03	0.78	1.07	1.85	0.44	1.07	1.51	0.00	2,470.28	0.00	0.23	0.00	2,475.02
2015	1.66	10.21	7.80	0.01	0.01	0.75	0.76	0.01	0.75	0.76	0.00	1,407.44	0.00	0.15	0.00	1,410.59
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.0 Construction Detail

3.1 Mitigation Measures Construction

3.2 Demolition - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00		0.00		0.00		0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.06	0.06	0.62	0.00	0.15	0.00	0.15	0.01	0.00	0.01		115.43		0.01		115.55
Total	**0.06**	**0.06**	**0.62**	**0.00**	**0.15**	**0.00**	**0.15**	**0.01**	**0.00**	**0.01**		**115.43**		**0.01**		**115.55**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e

Category	lb/day									lb/day					
Off-Road	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00		0.00		0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**		**0.00**	**0.00**		**0.00**	**0.00**	**0.00**	**0.00**		**0.00**		**0.00**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.06	0.06	0.62	0.00	0.01	0.00	0.01	0.01	0.00	0.01		115.43		0.01		115.55
Total	**0.06**	**0.06**	**0.62**	**0.00**	**0.01**	**0.00**	**0.01**	**0.01**	**0.00**	**0.01**		**115.43**		**0.01**		**115.55**

3.3 Site Preparation - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					0.03	0.00	0.03	0.00	0.00	0.00						0.00
Off-Road	0.94	6.80	5.03	0.01		0.44	0.44		0.44	0.44		807.67		0.08		809.44
Total	**0.94**	**6.80**	**5.03**	**0.01**	**0.03**	**0.44**	**0.47**	**0.00**	**0.44**	**0.44**		**807.67**		**0.08**		**809.44**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.05	0.05	0.50	0.00	0.12	0.00	0.12	0.00	0.00	0.01		92.34		0.00		92.44
Total	**0.05**	**0.05**	**0.50**	**0.00**	**0.12**	**0.00**	**0.12**	**0.00**	**0.00**	**0.01**		**92.34**		**0.00**		**92.44**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					0.03	0.00	0.03	0.00	0.00	0.00						0.00
Off-Road	0.94	6.80	5.03	0.01		0.44	0.44		0.44	0.44	0.00	807.67		0.08		809.44
Total	**0.94**	**6.80**	**5.03**	**0.01**	**0.03**	**0.44**	**0.47**	**0.00**	**0.44**	**0.44**	**0.00**	**807.67**		**0.08**		**809.44**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.05	0.05	0.50	0.00	0.00	0.00	0.01	0.00	0.00	0.01		92.34		0.00		92.44
Total	**0.05**	**0.05**	**0.50**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**		**92.34**		**0.00**		**92.44**

3.4 Building Foundation - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					0.75	0.00	0.75	0.41	0.00	0.41						0.00
Off-Road	2.17	15.48	10.66	0.02		1.05	1.05		1.05	1.05		1,858.52		0.19		1,862.59
Total	**2.17**	**15.48**	**10.66**	**0.02**	**0.75**	**1.05**	**1.80**	**0.41**	**1.05**	**1.46**		**1,858.52**		**0.19**		**1,862.59**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.30	0.30	3.30	0.01	0.79	0.02	0.82	0.03	0.02	0.05		611.76		0.03		612.43
Total	**0.30**	**0.30**	**3.30**	**0.01**	**0.79**	**0.02**	**0.82**	**0.03**	**0.02**	**0.05**		**611.76**		**0.03**		**612.43**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Fugitive Dust					0.75	0.00	0.75	0.41	0.00	0.41						0.00

Off-Road	2.17	15.48	10.66	0.02		1.05	1.05		1.05	1.05	0.00	1,858.52		0.19		1,862.59
Total	**2.17**	**15.48**	**10.66**	**0.02**	**0.75**	**1.05**	**1.80**	**0.41**	**1.05**	**1.46**	**0.00**	**1,858.52**		**0.19**		**1,862.59**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.30	0.30	3.30	0.01	0.03	0.02	0.05	0.03	0.02	0.05		611.76		0.03		612.43
Total	**0.30**	**0.30**	**3.30**	**0.01**	**0.03**	**0.02**	**0.05**	**0.03**	**0.02**	**0.05**		**611.76**		**0.03**		**612.43**

3.5 Building Construction - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.35	9.59	6.82	0.01		0.64	0.64		0.64	0.64		1,232.98		0.12		1,235.51
Total	**1.35**	**9.59**	**6.82**	**0.01**		**0.64**	**0.64**		**0.64**	**0.64**		**1,232.98**		**0.12**		**1,235.51**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e

Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.01	0.01	0.06	0.00	0.01	0.00	0.02	0.00	0.00	0.00		11.54		0.00		11.56
Total	**0.01**	**0.01**	**0.06**	**0.00**	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**		**11.54**		**0.00**		**11.56**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.35	9.59	6.82	0.01		0.64	0.64		0.64	0.64	0.00	1,232.98		0.12		1,235.51
Total	**1.35**	**9.59**	**6.82**	**0.01**		**0.64**	**0.64**		**0.64**	**0.64**	**0.00**	**1,232.98**		**0.12**		**1,235.51**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.01	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00		11.54		0.00		11.56
Total	**0.01**	**0.01**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**11.54**		**0.00**		**11.56**

3.5 Building Construction - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.24	8.69	6.76	0.01		0.56	0.56		0.56	0.56		1,232.98		0.11		1,235.32
Total	**1.24**	**8.69**	**6.76**	**0.01**		**0.56**	**0.56**		**0.56**	**0.56**		**1,232.98**		**0.11**		**1,235.32**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.01	0.01	0.06	0.00	0.01	0.00	0.02	0.00	0.00	0.00		11.31		0.00		11.32
Total	**0.01**	**0.01**	**0.06**	**0.00**	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**		**11.31**		**0.00**		**11.32**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.24	8.69	6.76	0.01		0.56	0.56		0.56	0.56	0.00	1,232.98		0.11		1,235.32
Total	**1.24**	**8.69**	**6.76**	**0.01**		**0.56**	**0.56**		**0.56**	**0.56**	**0.00**	**1,232.98**		**0.11**		**1,235.32**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.01	0.01	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00		11.31		0.00		11.32
Total	**0.01**	**0.01**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**11.31**		**0.00**		**11.32**

3.6 On-site Pipeline - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.51	3.36	2.77	0.00		0.26	0.26		0.26	0.26		408.87		0.05		409.84
Total	**0.51**	**3.36**	**2.77**	**0.00**		**0.26**	**0.26**		**0.26**	**0.26**		**408.87**		**0.05**		**409.84**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00

Category	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.05	0.05	0.57	0.00	0.15	0.00	0.15	0.01	0.00	0.01		113.09		0.01		113.21
Total	**0.05**	**0.05**	**0.57**	**0.00**	**0.15**	**0.00**	**0.15**	**0.01**	**0.00**	**0.01**		**113.09**		**0.01**		**113.21**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	0.51	3.36	2.77	0.00		0.26	0.26		0.26	0.26	0.00	408.87		0.05		409.84
Total	**0.51**	**3.36**	**2.77**	**0.00**		**0.26**	**0.26**		**0.26**	**0.26**	**0.00**	**408.87**		**0.05**		**409.84**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.05	0.05	0.57	0.00	0.01	0.00	0.01	0.01	0.00	0.01		113.09		0.01		113.21
Total	**0.05**	**0.05**	**0.57**	**0.00**	**0.01**	**0.00**	**0.01**	**0.01**	**0.00**	**0.01**		**113.09**		**0.01**		**113.21**

3.7 Paving - 2015

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.58	10.14	6.94	0.01		0.74	0.74		0.74	0.74		1,237.80		0.14		1,240.77
Paving	0.00					0.00	0.00		0.00	0.00						0.00
Total	**1.58**	**10.14**	**6.94**	**0.01**		**0.74**	**0.74**		**0.74**	**0.74**		**1,237.80**		**0.14**		**1,240.77**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.08	0.08	0.86	0.00	0.22	0.01	0.23	0.01	0.01	0.01		169.64		0.01		169.82
Total	**0.08**	**0.08**	**0.86**	**0.00**	**0.22**	**0.01**	**0.23**	**0.01**	**0.01**	**0.01**		**169.64**		**0.01**		**169.82**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	1.58	10.14	6.94	0.01		0.74	0.74		0.74	0.74	0.00	1,237.80		0.14		1,240.77
Paving	0.00					0.00	0.00		0.00	0.00						0.00
Total	**1.58**	**10.14**	**6.94**	**0.01**		**0.74**	**0.74**		**0.74**	**0.74**	**0.00**	**1,237.80**		**0.14**		**1,240.77**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.08	0.08	0.86	0.00	0.01	0.01	0.01	0.01	0.01	0.01		169.64		0.01		169.82
Total	**0.08**	**0.08**	**0.86**	**0.00**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**		**169.64**		**0.01**		**169.82**

Maximum Daily Emissions

CalEEMod Version: CalEEMod.2011.1.1

Date: 4/19/2012

GSR - Pipeline Per Day Construction

San Mateo County, Summer

1.0 Project Characteristics

1.1 Land Usage

Land Uses	Size	Metric
General Heavy Industry	1	1000sqft

1.2 Other Project Characteristics

Urbanization Urban

Climate Zone 5

Wind Speed (m/s) 2.2

Precipitation Freq (Days) 70

Utility Company

1.3 User Entered Comments

Project Characteristics -

Land Use - Small Area for pipeline

Construction Phase - These are per-day estimates of activity that would construct 120-linear feet of pipeline

Off-road Equipment - Project-specific equipment & LF adjustment (-33%)

Off-road Equipment - Max. Worst Day equipment activity based on one day of pipline construction

Adjusted load factors by -33%

Trips and VMT - Worker trips computed seperately using EMFAC2011

2.0 Emissions Summary

2.1 Overall Construction (Maximum Daily Emission)

Unmitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	2.47	17.73	9.17	0.02	0.00	0.96	0.96	0.00	0.96	0.96	0.00	2,560.15	0.00	0.22	0.00	2,564.77
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

Mitigated Construction

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Year	lb/day										lb/day					
2014	2.47	17.73	9.17	0.02	0.00	0.96	0.96	0.00	0.96	0.96	0.00	2,560.15	0.00	0.22	0.00	2,564.77
Total	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**

3.0 Construction Detail

3.1 Mitigation Measures Construction

3.2 Pipeline Construction - 2014

Unmitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	2.47	17.73	9.17	0.02		0.96	0.96		0.96	0.96		2,560.15		0.22		2,564.77
Total	**2.47**	**17.73**	**9.17**	**0.02**		**0.96**	**0.96**		**0.96**	**0.96**		**2,560.15**		**0.22**		**2,564.77**

Unmitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

Mitigated Construction On-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Off-Road	2.47	17.73	9.17	0.02		0.96	0.96		0.96	0.96	0.00	2,560.15		0.22		2,564.77
Total	**2.47**	**17.73**	**9.17**	**0.02**		**0.96**	**0.96**		**0.96**	**0.96**	**0.00**	**2,560.15**		**0.22**		**2,564.77**

Mitigated Construction Off-Site

	ROG	NOx	CO	SO2	Fugitive PM10	Exhaust PM10	PM10 Total	Fugitive PM2.5	Exhaust PM2.5	PM2.5 Total	Bio- CO2	NBio- CO2	Total CO2	CH4	N2O	CO2e
Category	lb/day										lb/day					
Hauling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Vendor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Worker	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00		0.00		0.00
Total	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**		**0.00**		**0.00**		**0.00**

Appendix 4
Dispersion Modeling Inputs and Health Risk Calculations

SFPUC GSR - Construction Impacts
Maximum DPM Cancer Risk & Hazard Index Calculations From Construction
at Sensitive Receptors

Site	Residential Child Exposure: Location of Maximum (m) UTMx (m)	UTMy (m)	Maximum Concentration (ug/m3) 2014	2015	Cancer Risk (in a million)	Chronic Hazard Index	Residential Adult Exposure: Location of Maximum (m) UTMx (m)	UTMy (m)	Maximum Concentra (ug/m3) 2014	2015	Cancer Risk (in a million)	Chronic Hazard Index
Site 1	***546492.6***	***4172909.3***	***0.01984***	***0.00774***	***2.41***	***0.0040***	***546492.6***	***4172909.3***	***0.01984***	***0.00774***	***0.13***	***0.0040***
Sites 2	545838.6	4172219.9	0.00051	0.00000	0.04	0.0001	545838.6	4172219.9	0.00051	0.00000	0.00	0.0001
Sites 3	545672.3	4172025.2	0.00807	0.00000	0.71	0.0016	545672.3	4172025.2	0.00807	0.00000	0.04	0.0016
Sites 4	545889.6	4171962.2	0.01542	0.00000	1.35	0.0031	545889.6	4171962.2	0.01542	0.00000	0.07	0.0031
Sites 2, 3, and 4	***545887.7***	***4171925.1***	***0.01721***	***0.00000***	***1.51***	***0.0034***	***545887.7***	***4171925.1***	***0.01721***	***0.00000***	***0.08***	***0.0034***
Site 5 - On-Site Treatment	546797.1	4171010.2	0.07866	0.04335	10.68	0.0157	546797.1	4171010.2	0.07866	0.04335	0.56	0.0157
Site 6 - On-Site Treatment	547188.0	4170823.7	0.00921	0.00471	1.22	0.0018	547188.0	4170823.7	0.00921	0.00471	0.06	0.0018
Site 7 - On-Site Treatment	547280.7	4170734.4	0.00055	0.00022	0.07	0.0001	547280.7	4170734.4	0.00055	0.00022	0.00	0.0001
Sites 5, 6,and 7 - On-Site Treatment	***546797.1***	***4171010.2***	***0.07911***	***0.04356***	***10.74***	***0.0158***	***546797.1***	***4171010.2***	***0.07911***	***0.04356***	***0.56***	***0.0158***
Sites 5- Consolidated Treatment	546797.1	4171010.2	0.01428	0.00000	1.25	0.0029	546797.1	4171010.2	0.01428	0.00000	0.06	0.0029
Sites 6- Consolidated Treatment	547188.0	4170823.7	0.00928	0.00507	1.26	0.0019	547188.0	4170823.7	0.00928	0.00507	0.07	0.0019
Sites 7- Consolidated Treatment	547188.5	4170733.4	0.00119	0.00000	0.10	0.0002	547188.5	4170733.4	0.00119	0.00000	0.01	0.0002
Sites 5, 6, and 7 - Consolidated Treatme	***546797.1***	***4171010.2***	***0.01471***	***0.00020***	***1.31***	***0.0029***	***546797.1***	***4171010.2***	***0.01471***	***0.00020***	***0.07***	***0.0029***
Site 8	547821.3	4169865.4	0.00514	0.00266	0.68	0.0010	547821.3	4169865.4	0.00514	0.00266	0.04	0.0010
Site 17 (Alternate)	547866.6	4169840.3	0.00329	0.00136	0.41	0.0007	547866.6	4169840.3	0.00329	0.00136	0.02	0.0007
Sites 8 & 17 (Alternate)	***547821.3***	***4169865.4***	***0.00808***	***0.00388***	***1.05***	***0.0016***	***547821.3***	***4169865.4***	***0.00808***	***0.00388***	***0.05***	***0.0016***
Site 9	548717.3	4168997.6	0.04847	0.01860	5.87	0.0097	548717.3	4168997.6	0.04847	0.01860	0.31	0.0097
Site 10	548129.0	4168779.0	0.01271	0.00662	1.69	0.0025	548129.0	4168779.0	0.01271	0.00662	0.09	0.0025
Site 18 (Alternate)	548240.8	4168525.7	0.07916	0.02810	9.39	0.0158	548240.8	4168525.7	0.07916	0.02810	0.49	0.0158
Sites 9, 10 & 18 (Alternate)	***548240.8***	***4168525.7***	***0.08036***	***0.02867***	***9.55***	***0.0161***	***548240.8***	***4168525.7***	***0.08036***	***0.02867***	***0.50***	***0.0161***
Site 11	549597.5	4167859.8	0.00982	0.00393	1.20	0.0020	549597.5	4167859.8	0.00982	0.00393	0.06	0.0020
Site 12	550052.8	4167342.1	0.05927	0.02449	7.33	0.0119	550052.8	4167342.1	0.05927	0.02449	0.38	0.0119
Site 19	549913.2	4167413.3	0.02302	0.00000	2.02	0.0046	549913.2	4167413.3	0.02302	0.00000	0.10	0.0046
Sites 11, 12 & 19 (Alternate)	***550052.8***	***4167342.1***	***0.06545***	***0.02460***	***7.88***	***0.0131***	***550052.8***	***4167342.1***	***0.06545***	***0.02460***	***0.41***	***0.0131***
Site 13	***550947.2***	***4166668.7***	***0.01101***	***0.00432***	***1.34***	***0.0022***	***550947.2***	***4166668.7***	***0.01101***	***0.00432***	***0.07***	***0.0022***
Site14	550305.3	4165663.4	0.02693	0.01006	3.24	0.0054	550305.3	4165663.4	0.02693	0.01006	0.17	0.0054
Site 15	550384.1	4165224.3	0.00576	0.00093	0.59	0.0012	550384.1	4165224.3	0.00576	0.00093	0.03	0.0012
Sites 14 & 15	***550305.3***	***4165663.4***	***0.02813***	***0.0104***	***3.37***	***0.0056***	***550305.3***	***4165663.4***	***0.02813***	***0.0104***	***0.18***	***0.0056***
Site 16	***553511.1***	***4162274.6***	***0.06411***	***0.02275***	***7.60***	***0.0128***	***553511.1***	***4162274.6***	***0.06411***	***0.02275***	***0.40***	***0.0128***

Site	School Child Exposure: Location of Maximum (m) UTMx (m)	UTMy (m)	Maximum Concentration (ug/m3) 2014	2015	Cancer Risk (in a million)	Chronic Hazard Index	Day Care Child Exposure: Location of Maximum (m) UTMx (m)	UTMy (m)	Maximum Concentration (ug/m3) 2014	2015	Cancer Risk (in a million)	Chronic Hazard Index
Site 1	-	-	-	-	-	-	***546785.6***	***4172896.3***	***0.00444***	***0.00176***	***0.45***	***0.0009***
Sites 2	545840.1	4172114.0	0.00377	0.00000	0.08	0.0008	-	-	-	-	-	-
Sites 3	545765.9	4172051.9	0.05397	0.00000	1.18	0.0108	-	-	-	-	-	-
Sites 4	545889.6	4171962.2	0.05877	0.00000	1.29	0.0118	-	-	-	-	-	-
Sites 2, 3, and 4	***545889.6***	***4171962.2***	***0.06168***	***0.00000***	***1.35***	***0.0123***	-	-	-	-	-	-
Site 5 - On-Site Treatment	-	-	-	-	-	-	547278.8	4170750.6	0.00053	0.00028	0.06	0.0001
Site 6 - On-Site Treatment	-	-	-	-	-	-	547278.8	4170750.6	0.00327	0.00167	0.36	0.0007
Site 7 - On-Site Treatment	-	-	-	-	-	-	547280.7	4170734.4	0.00055	0.00022	0.06	0.0001
Sites 5, 6,and 7 - On-Site Treatment	-	-	-	-	-	-	***547278.8***	***4170750.6***	***0.00430***	***0.00215***	***0.47***	***0.0009***
Sites 5- Consolidated Treatment	-	-	-	-	-	-	547278.8	4170750.6	0.00037	0.00000	0.03	0.0001
Sites 6- Consolidated Treatment	-	-	-	-	-	-	547278.8	4170750.6	0.00328	0.00180	0.37	0.0007
Sites 7- Consolidated Treatment	-	-	-	-	-	-	547280.7	4170734.4	0.00089	0.00000	0.06	0.0002
Sites 5, 6, and 7 - Consolidated Treatme	-	-	-	-	-	-	***547278.8***	***4170750.6***	***0.00447***	***0.00180***	***0.46***	***0.0009***
Site 8	-	-	-	-	-	-	-	-	-	-	-	-
Site 17 (Alternate)	-	-	-	-	-	-	-	-	-	-	-	-
Sites 8 & 17 (Alternate)	-	-	-	-	-	-	-	-	-	-	-	-
Site 9	548509.4	4168634.5	0.00108	0.00042	0.03	0.0002	548348.4	4168416.7	0.00040	0.00015	0.04	0.0001
Site 10	548496.6	4168632.5	0.00179	0.00091	0.06	0.0004	548348.4	4168416.7	0.00036	0.00019	0.04	0.0001
Site 18 (Alternate)	548407.3	4168526.2	0.01023	0.00426	0.32	0.0020	548348.4	4168416.7	0.00607	0.00231	0.61	0.0012
Sites 9, 10 & 18 (Alternate)	***548407.3***	***4168526.2***	***0.01157***	***0.00488***	***0.36***	***0.0023***	***548348.4***	***4168416.7***	***0.00682***	***0.00265***	***0.69***	***0.0014***
Site 11	550464.3	4167276.2	0.00033	0.00013	0.01	0.0001	549957.7	4167477.6	0.00048	0.00018	0.05	0.0001
Site 12	550464.3	4167276.2	0.00205	0.00072	0.06	0.0004	549957.0	4167460.9	0.00594	0.00184	0.57	0.0012
Site 19	550464.3	4167276.2	0.00048	0.00000	0.01	0.0001	549957.0	4167460.9	0.01401	0.00000	1.02	0.0028
Sites 11, 12 & 19 (Alternate)	***550464.3***	***4167276.2***	***0.00286***	***0.00084***	***0.08***	***0.0006***	***549957.0***	***4167460.9***	***0.02038***	***0.00200***	***1.63***	***0.0041***
Site 13	***550812.5***	***4166835.3***	***0.00134***	***0.00054***	***0.04***	***0.0003***	-	-	-	-	-	-
Site14	-	-	-	-	-	-	-	-	-	-	-	-
Site 15	-	-	-	-	-	-	-	-	-	-	-	-
Sites 14 & 15	-	-	-	-	-	-	-	-	-	-	-	-
Site 16	-	-	-	-	-	-	-	-	-	-	-	-

Cancer Risk Calculation Method

Cancer Risk (per million) = CPF x Inhalation Dose x 1.0E6

Where: CPF = Cancer potency factor (mg/kg-day)$^{-1}$

Inhalation Dose = C_{air} x DBR x A x EF x ED x 10^{-6} / AT

Where: C_{air} = concentration in air ($\mu g/m^3$)
DBR = daily breathing rate (L/kg body weight-day)
A = Inhalation absorption factor
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time period over which exposure is averaged.
10^{-6} = Conversion factor

Exposure Parameter	Units	Exposure Type: Residential Child	Residential Adult	School Child	Day Care Child
Breathing Rate (DBR)	(L/kg-day)	581	302	581	581
Exposure period					
Daily	(hours/day)	24	24	10	10
Annual (EF)	(days/year)	350	350	180	245
Exposure Duration (ED)	(years)	2	2	2	2
Exposure Period	(years)	70	70	70	70
Averaging Time (AT)	(days)	25,550	25,550	25,550	25,550
Age Adjustment Factor (ASF)	-	10	1	3	10

Site Construction Activities

Daily (hours/day) = 12
Weekly (days/week) = 5
Annual (days/year) = varies by site

Modeling Time Periods

Days used in Model (days/year) = 365
Hours used in Model (hours/day) = 12 (7am - 7 pm)

DPM Health Risk Factors

DPM Cancer Potency Factor (mg/kg-day)-1 = 1.10E+00
DPM Reference Exposure Level (ug/m^3) = 5

GSR - Construction Impacts
Summary of Maximum Acute Health Hazard Index (HI) at Sensitive Receptors
from Construction Equipment Diesel Exhaust at each Project Site Location

	Acute Hazard Index MEI Location		Total Hazard Index
Site	**UTM- X (m)**	**UTM-Y (m)**	
Site 1	***546492.6***	***4172909.3***	***0.48***
Site 2	545902.4	4172053.9	0.12
Site 3	545720.0	4172035.7	0.56
Site 4	545889.6	4171962.2	0.58
Sites 2, 3, and 4	***545903.7***	***4171924.5***	***0.72***
Site 5 - On-Site Treatment	546797.1	4171010.2	0.22
Site 6 - On-Site Treatment	547188.7	4170748.5	0.10
Site 7 - On-Site Treatment	547219.4	4170734.0	0.22
Sites 5, 6, and 7 - On-Site Treatment	***546797.1***	***4171010.2***	***0.22***
Sites 5- Consolidated Treatment	546797.1	4171010.2	0.11
Sites 6- Consolidated Treatment	547188.7	4170748.5	0.10
Sites 7- Consolidated Treatment	547219.4	4170734.0	0.03
Sites 5, 6, and 7 - Consolidated Treatment at 6	***546797.1***	***4171010.2***	***0.11***
Site 8	547821.3	4169865.4	0.05
Site 17 (Alternate)	547837.8	4169850.8	0.10
Sites 8 & 17 (Alternate)	***547837.8***	***4169850.8***	***0.18***
Site 9	548635.6	4169049.6	0.33
Site 10	548167.8	4168971.0	0.13
Site 18 (Alternate)	548240.8	4168525.7	0.40
Sites 9, 10 & 18 (Alternate)	***548620.7***	***4169049.6***	***0.53***
Site 11	549597.5	4167859.8	0.13
Site 12	550052.8	4167342.1	0.32
Site 19	549940.8	4167476.8	0.38
Sites 11, 12 & 19 (Alternate)	***550073.6***	***4167327.8***	***0.46***
Site 13	***550947.2***	***4166668.7***	***0.14***
Site14	550305.3	4165663.4	0.32
Site 15	550538.9	4165182.4	0.05
Sites 14 & 15	***550313.4***	***4165695.5***	***0.54***
Site 16	***553497.0***	***4162273.9***	***0.37***

Acute Health Effects Hazard Index (HI) by Chemical and Total HI for all Chemicals at Maximum Exposed Individual (MEI) Location for Each Project Site

Chemical	Fraction of TOG	Acute REL (ug/m3)	Site 1 Chemical Concentration (ug/m^3)	Site 1 Hazard Index	Site 2 Chemical Concentration (ug/m^3)	Site 2 Hazard Index	Site 3 Chemical Concentration (ug/m^3)	Site 3 Hazard Index	Site 4 Chemical Concentration (ug/m^3)	Site 4 Hazard Index	Site 2, 3, and 4 (all souces at same time) Chemical Concentration (ug/m^3)	Site 2, 3, and 4 (all souces at same time) Hazard Index
Acetaldehyde	0.07353	470	12.471	0.027	3.000	0.006	14.566	0.031	14.846	0.032	18.566	0.040
Benzene	0.02001	1,300	3.394	0.003	0.816	0.001	3.964	0.003	4.040	0.003	5.053	0.004
Formaldehyde	0.14714	55	24.955	0.454	6.003	0.109	29.148	0.530	29.708	0.540	37.153	0.676
Methyl Ethyl Ketone (2-butanone)	0.01477	13,000	2.505	0.0002	0.603	0.0000	2.926	0.0002	2.982	0.0002	3.729	0.0003
Toluene	0.01473	37,000	2.498	0.0001	0.601	0.0000	2.918	0.0001	2.974	0.0001	3.719	0.0001
Total Hazard Index				**0.48**		**0.12**		**0.56**		**0.58**		**0.72**

Acute Health Effects Hazard Index (HI) by Chemical and Tota

Chemical	Fraction of TOG	Acute REL (ug/m3)	Site 5 (Onsite Treatment) Chemical Concentration (ug/m^3)	Site 5 Hazard Index	Site 6 (Onsite Treatment) Chemical Concentration (ug/m^3)	Site 6 Hazard Index	Site 7 (Onsite Treatment) Chemical Concentration (ug/m^3)	Site 7 Hazard Index	Site 5, 6, and 7 (Onsite Treatment) (all souces at same time) Chemical Concentration (ug/m^3)	Site 5, 6, and 7 Hazard Index
Acetaldehyde	0.07353	470	5.625	0.012	2.551	0.005	0.890	0.002	5.552	0.012
Benzene	0.02001	1,300	1.531	0.001	0.694	0.001	0.242	0.000	1.511	0.001
Formaldehyde	0.14714	55	11.256	0.205	5.106	0.093	1.780	0.032	11.109	0.202
Methyl Ethyl Ketone (2-butanone)	0.01477	13,000	1.130	0.0001	0.513	0.0000	0.179	0.0000	1.115	0.0001
Toluene	0.01473	37,000	1.127	0.0000	0.511	0.0000	0.178	0.0000	1.112	0.0000
Total Hazard Index				**0.22**		**0.10**		**0.03**		**0.22**

Acute Health Effects Hazard Index (HI) by Chemical and Tota

Chemical	Fraction of TOG	Acute REL (ug/m3)	Site 5 (Treatment at Site 6) Chemical Concentration (ug/m^3)	Site 5 Hazard Index	Site 6 (Treatment at Site 6) Chemical Concentration (ug/m^3)	Site 6 Hazard Index	Site 7 (Treatment at Site 6) Chemical Concentration (ug/m^3)	Site 7 Hazard Index	Site 5, 6, and 7 (Treatment at Site 6) (all souces at same time) Chemical Concentration (ug/m^3)	Site 5, 6, and 7 Hazard Index
Acetaldehyde	0.07353	470	2.735	0.006	2.551	0.005	0.890	0.002	2.735	0.006
Benzene	0.02001	1,300	0.744	0.001	0.694	0.001	0.242	0.000	0.744	0.001
Formaldehyde	0.14714	55	5.474	0.100	5.106	0.093	1.780	0.032	5.474	0.100
Methyl Ethyl Ketone (2-butanone)	0.01477	13,000	0.549	0.0000	0.513	0.0000	0.179	0.0000	0.549	0.0000
Toluene	0.01473	37,000	0.548	0.0000	0.511	0.0000	0.178	0.0000	0.548	0.0000
Total Hazard Index				**0.11**		**0.10**		**0.03**		**0.11**

Acute Health Effects Hazard Index (HI) by Chemical and Tota

Chemical	Fraction of TOG	Acute REL (ug/m3)	Site 8 Chemical Concentration (ug/m^3)	Site 8 Hazard Index	Site 17 Chemical Concentration (ug/m^3)	Site 17 Hazard Index	Site 8 and 17 (Alternate) (all souces at same time) Chemical Concentration (ug/m^3)	Site 8 and 17 (Alternate) (all souces at same time) Hazard Index
Acetaldehyde	0.07353	470	1.412	0.003	2.625	0.006	4.581	0.010
Benzene	0.02001	1,300	0.384	0.000	0.714	0.001	1.247	0.001
Formaldehyde	0.14714	55	2.825	0.051	5.253	0.096	9.167	0.167
Methyl Ethyl Ketone (2-butanone)	0.01477	13,000	0.284	0.0000	0.527	0.0000	0.920	0.0001
Toluene	0.01473	37,000	0.283	0.0000	0.526	0.0000	0.918	0.0000
		Total Hazard Index		**0.05**		**0.10**		**0.18**

Acute Health Effects Hazard Index (HI) by Chemical and Tota

Chemical	Fraction of TOG	Acute REL (ug/m3)	Site 9 Chemical Concentration (ug/m^3)	Site 9 Hazard Index	Site 10 Chemical Concentration (ug/m^3)	Site 10 Hazard Index	Site 18 Chemical Concentration (ug/m^3)	Site 18 Hazard Index	Site 9, 10 and 18 (Alternate) (all souces at same time) Chemical Concentration (ug/m^3)	Site 9, 10 and 18 (Alternate) (all souces at same time) Hazard Index
Acetaldehyde	0.07353	470	8.581	0.018	3.301	0.007	10.434	0.022	13.625	0.029
Benzene	0.02001	1,300	2.335	0.002	0.898	0.001	2.839	0.002	3.708	0.003
Formaldehyde	0.14714	55	17.171	0.312	6.607	0.120	20.879	0.380	27.265	0.496
Methyl Ethyl Ketone (2-butanone)	0.01477	13,000	1.724	0.0001	0.663	0.0001	2.096	0.0002	2.737	0.0002
Toluene	0.01473	37,000	1.719	0.0000	0.661	0.0000	2.090	0.0001	2.729	0.0001
Total Hazard Index				**0.33**		**0.13**		**0.40**		**0.53**

Acute Health Effects Hazard Index (HI) by Chemical and Tota

Chemical	Fraction of TOG	Acute REL (ug/m3)	Site 11 Chemical Concentration (ug/m^3)	Site 11 Hazard Index	Site 12 Chemical Concentration (ug/m^3)	Site 12 Hazard Index	Site 19 (Alternate) (all souces at same time) Chemical Concentration (ug/m^3)	Site 19 (Alternate) Hazard Index	Site 11, 12 and 19 (Alternate) (all souces at same time) Chemical Concentration (ug/m^3)	Site 11, 12 and 19 (Alternate) Hazard Index
Acetaldehyde	0.07353	470	3.280	0.007	8.154	0.017	9.831	0.021	11.765	0.025
Benzene	0.02001	1,300	0.893	0.001	2.219	0.002	2.675	0.002	3.202	0.002
Formaldehyde	0.14714	55	6.564	0.119	16.318	0.297	19.673	0.358	23.542	0.428
Methyl Ethyl Ketone (2-butanone)	0.01477	13,000	0.659	0.0001	1.638	0.0001	1.975	0.0002	2.363	0.0002
Toluene	0.01473	37,000	0.657	0.0000	1.634	0.0000	1.969	0.0001	2.357	0.0001
Total Hazard Index				**0.13**		**0.32**		**0.38**		**0.46**

Acute Health Effects Hazard Index (HI) by Chemical and Tota

Chemical	Fraction of TOG	Acute REL (ug/m3)	Site 13 Chemical Concentration (ug/m^3)	Site 13 Hazard Index	Site 14 Chemical oncentratio (ug/m^3)	Site 14 Hazard Index	Site 15 Chemical oncentratio (ug/m^3)	Site 15 Hazard Index	Site 14 and 15 (all souces at same time) Chemical Concentration (ug/m^3)	Site 14 and 15 Hazard Index	Site 16 Chemical Concentration (ug/m^3)	Site 16 Hazard Index
Acetaldehyde	0.07353	470	3.677	0.008	8.382	0.018	1.404	0.003	13.875	0.030	9.522	0.020
Benzene	0.02001	1,300	1.001	0.001	2.281	0.002	0.382	0.000	3.776	0.003	2.591	0.002
Formaldehyde	0.14714	55	7.357	0.134	16.774	0.305	2.810	0.051	27.765	0.505	19.055	0.346
Methyl Ethyl Ketone (2-butanone)	0.01477	13,000	0.739	0.0001	1.684	0.0001	0.282	0.0000	2.787	0.0002	1.913	0.0001
Toluene	0.01473	37,000	0.737	0.0000	1.679	0.0000	0.281	0.0000	2.780	0.0001	1.908	0.0001
Total Hazard Index				**0.14**		**0.32**		**0.05**		**0.54**		**0.37**

Appendix 5
Cumulative TAC Data

Maximum Modeled 1-Hour ROG Concentrations at Each Project Site Location

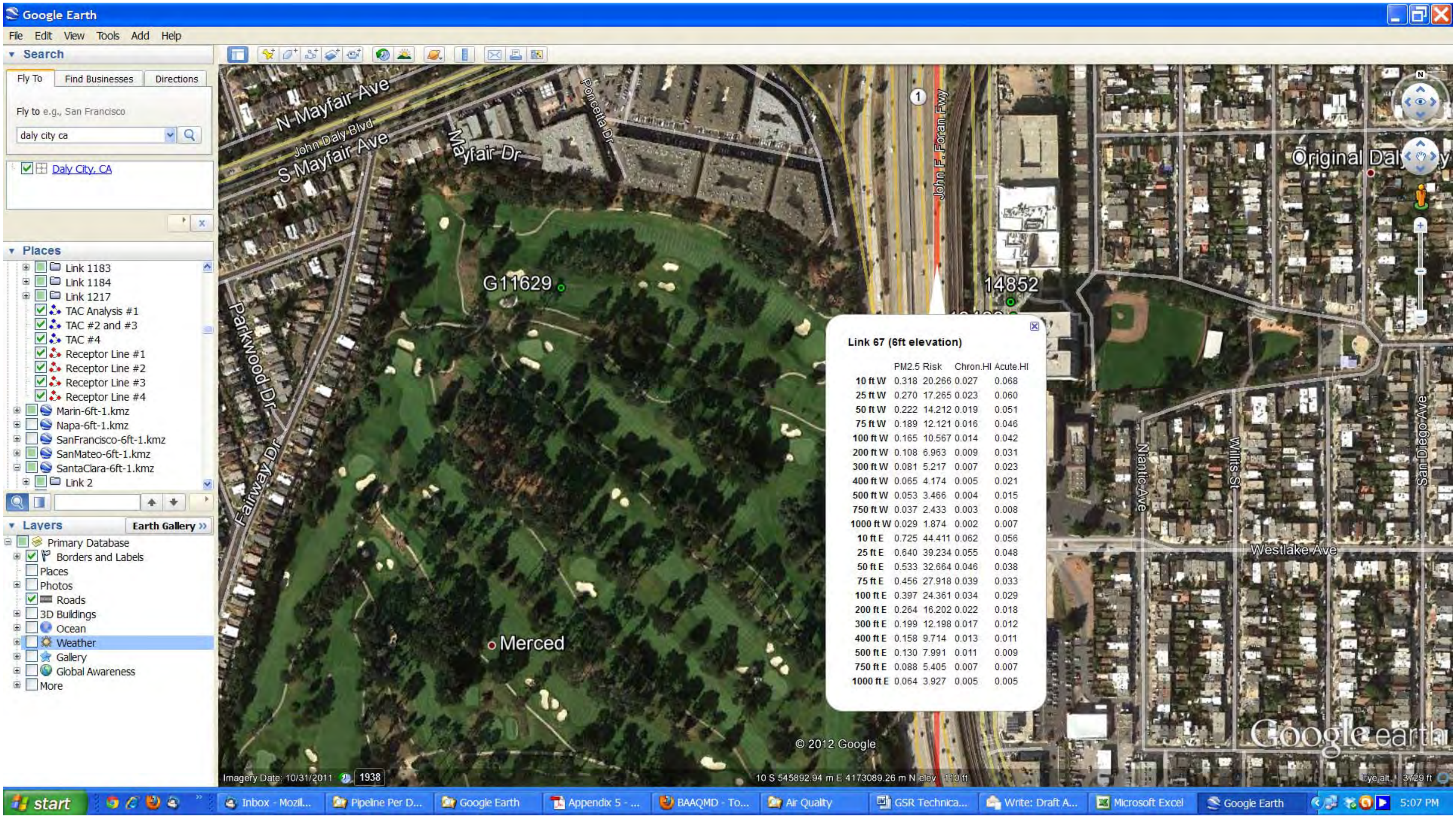
Site	UTM x (m)	UTM y (m)	Maximum ROG Concentration (ug/m3)	Max Conc From	
1	546492.59	4172909.31	109.1	Treatment Facility	
1	546492.59	4172909.31	169.6	Well	
2	545902.4	4172053.87	40.8	Fence Construction	
3	545719.97	4172035.68	198.1	Well	in field adjacent to well construction site
4	545889.63	4171962.19	201.9	Well	in field adjacent to well construction site
2, 3, and 4	545903.72	4171924.54	252.5	from all sources at all sites at the same time	
5 (Onsite Treatment)	546797.12	4171010.2	76.5	Treatment Facility	
6 (Onsite Treatment)	547188.71	4170748.51	34.7	Treatment Facility	
7 (Onsite Treatment)	547219.39	4170733.95	12.1	Well	
5, 6, 7 (Onsite Treatment)	546797.12	4171010.2	75.5	from all sources at all sites at the same time	
5 (Treatment at 6)	546797.12	4171010.2	37.2	Fence Construction	
6 (Treatment at 6)	547188.71	4170748.51	34.7	Treatment Facility	
7 (Treatment at 6)	547219.39	4170733.95	12.1	Well	
5, 6, and 7 (Treatment at 6)	546797.12	4171010.2	37.2	from all sources at all sites at the same time	
8	547821.3	4169865.44	19.2	Treatment Facility	
17 (Alternate)	547837.83	4169850.81	35.7	Well	
8 and 17 (Alternate)	547837.83	4169850.81	62.3	from all sources at all sites at the same time	
9	548635.55	4169049.56	116.7	Well	
10	548167.79	4168970.99	44.9	Treatment Facility	
18 (Alternate)	548240.75	4168525.69	141.9	Well	
9, 10, and 18 (Alternate)	548620.74	4169049.56	185.3	from all sources at all sites at the same time	
11	549597.51	4167859.77	44.61	Well	
12	550052.75	4167342.12	110.9	Well	
19 (Alternate)	549940.83	4167476.79	133.7	Well	
11, 12, and 19 (Alternate)	550073.61	4167327.84	160.0	from all sources at all sites at the same time	
13	550947.2	4166668.67	50.0	Treatment Facility	
14	550305.3	4165663.44	114.0	Well	
15	550538.85	4165182.35	19.1	Well	
14 and 15	550313.39	4165695.45	188.7	from all sources at all sites at the same time	
16	553496.99	4162273.85	129.5	Well	

Regional Groundwater Storage and Recovery Project

Cumulative TAC Impacts

MEI Source	Distance (feet)	Cancer Risk (per million)	Hazard HI	$PM_{2.5}$ $\mu g/m^3$	Source
Site 1					
I-280	120	9.85	0.04	0.15	BAAQMD Google Earth Highway Screening Analysis Tool
John Daly Blvd (estimated 35,000 ADT)	900	1.14	0.02	0.03	BAAQMD Roadway Screening Analysis Tables (east-west road, 40,000 ADT)
G11629	900	0.91	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
14852	700	1.18	0.00	0.00	BAAQMD Stationary Source data with diesel engine multiplier
13420	700	0.42	0.00	0.00	BAAQMD Stationary Source data with diesel engine multiplier
13221	1000	0.67	0.00	0.00	BAAQMD Stationary Source data with diesel engine multiplier
		14.17	0.06	0.19	
Site 2, 3, 4					
S.Park Plaza Drive (estimated <10,000 ADT)	50	3.34	0.02	0.098	BAAQMD Roadway Screening Analysis Tables (north-south road, 10,000 ADT)
87th St. (unknown ADT)	360	1.68	0.02	0.059	BAAQMD Roadway Screening Analysis Tables (east-west road, 20,000 ADT)
16794	730	4.08	0.00	0.00	BAAQMD Stationary Source data with diesel engine multiplier
G10657	900	0.48	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
12568	590	5.03	0.00	0.00	BAAQMD Stationary Source data with diesel engine multiplier
12876	1000	2.05	0.00	0.00	BAAQMD Stationary Source data with diesel engine multiplier
		16.67	0.04	0.16	
Site 5,6,7					
I-280	560	7.74	0.01	0.13	BAAQMD Google Earth Highway Screening Analysis Tool
Junipero Serra Blvd (estimated 20,000 ADT)	350	1.84	0.02	0.05	BAAQMD Roadway Screening Analysis Tables (north-south road, 20,000 ADT)
San Pedro Rd (estimated 20,000 ADT)	500	1.04	0.02	0.05	BAAQMD Roadway Screening Analysis Tables (north-south road, 20,000 ADT)
Washington St (estimated 15,000 ADT)	500	0.96	0.02	0.02	BAAQMD Roadway Screening Analysis Tables (east-west road, 20,000 ADT)
G9309	580	0.29	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
14102	660	6.32	0.00	0.00	BAAQMD Stationary Source data with diesel engine multiplier
		18.19	0.07	0.25	
Sites 8 and 17 (alternate)					
Mission Rd (SR 82)	100	4.28	0.01	0.06	BAAQMD Google Earth Highway Screening Analysis Tool
Serramonte Blvd (estimated 20,000 ADT)	>200	2.64	0.02	0.08	BAAQMD Roadway Screening Analysis Tables (north-south road, 20,000 ADT)
1364	900	0.45	0.02	0.26	BAAQMD Stationary Source data with diesel engine multiplier
G11198	950	0.14	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
		7.51	0.05	0.40	
Sites 9, 10, 18 (alternate)	MEI at Site 18, no cumulative sources within 1,000 feet				
Site 9 and 10					
El Camino Real (SR 82)	>500	1.73	0.00	0.02	BAAQMD Google Earth Highway Screening Analysis Tool
Hickey Blvd (estimated 25,000 ADT)	1000	0.61	0.02	0.02	BAAQMD Roadway Screening Analysis Tables (east-west road, 30,000 ADT)
G3305	870	1.43	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
		3.77	0.02	0.04	
Site 11, 12 and 19 (alternate)					
El Camino Real (SR 82)	300	2.28	0.00	0.03	
Westborough Blvd (estimated 30,000 ADT)	500	1.50	0.02	0.05	BAAQMD Roadway Screening Analysis Tables (east-west road, 40,000 ADT)
G11428	600	0.73	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
		4.51	0.02	0.08	
Site 13					

South SpruceAve (estimated 30,000 ADT)	70	5.62	0.02	0.20	BAAQMD Roadway Screening Analysis Tables (north-south road, 30,000 ADT)
G12073	700	0.17	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
2483	400	0.19	0.00	14.00	Bimbos Bakery
		5.98	0.02	14.20	
Site 14 and 15					
Sneath Lane (estimated 20,000 ADT)	700	0.75	0.02	0.02	BAAQMD Roadway Screening Analysis Tables (east-west road, 20,000 ADT)
Site 16					
CalTrain	150	5.70	0.01	0.03	Dispersion Modeling of CalTrain
19283	130	2.35	0.00	0.00	BAAQMD Stationary Source data with diesel engine multiplier
19194	500	2.21	0.00	0.01	BAAQMD HRSA obtained from Public Records Request
G6250	500	0.02	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
G2970	950	2.25	0.00	0.00	BAAQMD Stationary Source data with gasoline station multiplier
19561	700	7.30	0.00	0.02	BAAQMD HRSA obtained from Public Records Request
		19.82	0.02	0.06	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TAC Analysis #1
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TAC #4
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SantaClara-6ft-1.kmz
Link 2
Layers
Earth Gallery
Primary Database
Borders and Labels
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Global Awareness
More
N-Mayfair Ave
John Daly Blvd
S Mayfair Ave
Mayfair Dr
Poncetta Dr
John F. Foran Fwy
Original Daly City
G11629
14852
Parkwood Dr
Fairway Dr
Merced
Niantic Ave
Willits St
San Diego Ave
Westlake Ave
Link 67 (6ft elevation)
PM2.5 Risk Chron.HI Acute.HI
10 ft W 0.318 20.266 0.027 0.068
25 ft W 0.270 17.265 0.023 0.060
50 ft W 0.222 14.212 0.019 0.051
75 ft W 0.189 12.121 0.016 0.046
100 ft W 0.165 10.567 0.014 0.042
200 ft W 0.108 6.963 0.009 0.031
300 ft W 0.081 5.217 0.007 0.023
400 ft W 0.065 4.174 0.005 0.021
500 ft W 0.053 3.466 0.004 0.015
750 ft W 0.037 2.433 0.003 0.008
1000 ft W 0.029 1.874 0.002 0.007
10 ft E 0.725 44.411 0.062 0.056
25 ft E 0.640 39.234 0.055 0.048
50 ft E 0.533 32.664 0.046 0.038
75 ft E 0.456 27.918 0.039 0.033
100 ft E 0.397 24.361 0.034 0.029
200 ft E 0.264 16.202 0.022 0.018
300 ft E 0.199 12.198 0.017 0.012
400 ft E 0.158 9.714 0.013 0.011
500 ft E 0.130 7.991 0.011 0.009
750 ft E 0.088 5.405 0.007 0.007
1000 ft E 0.064 3.927 0.005 0.005
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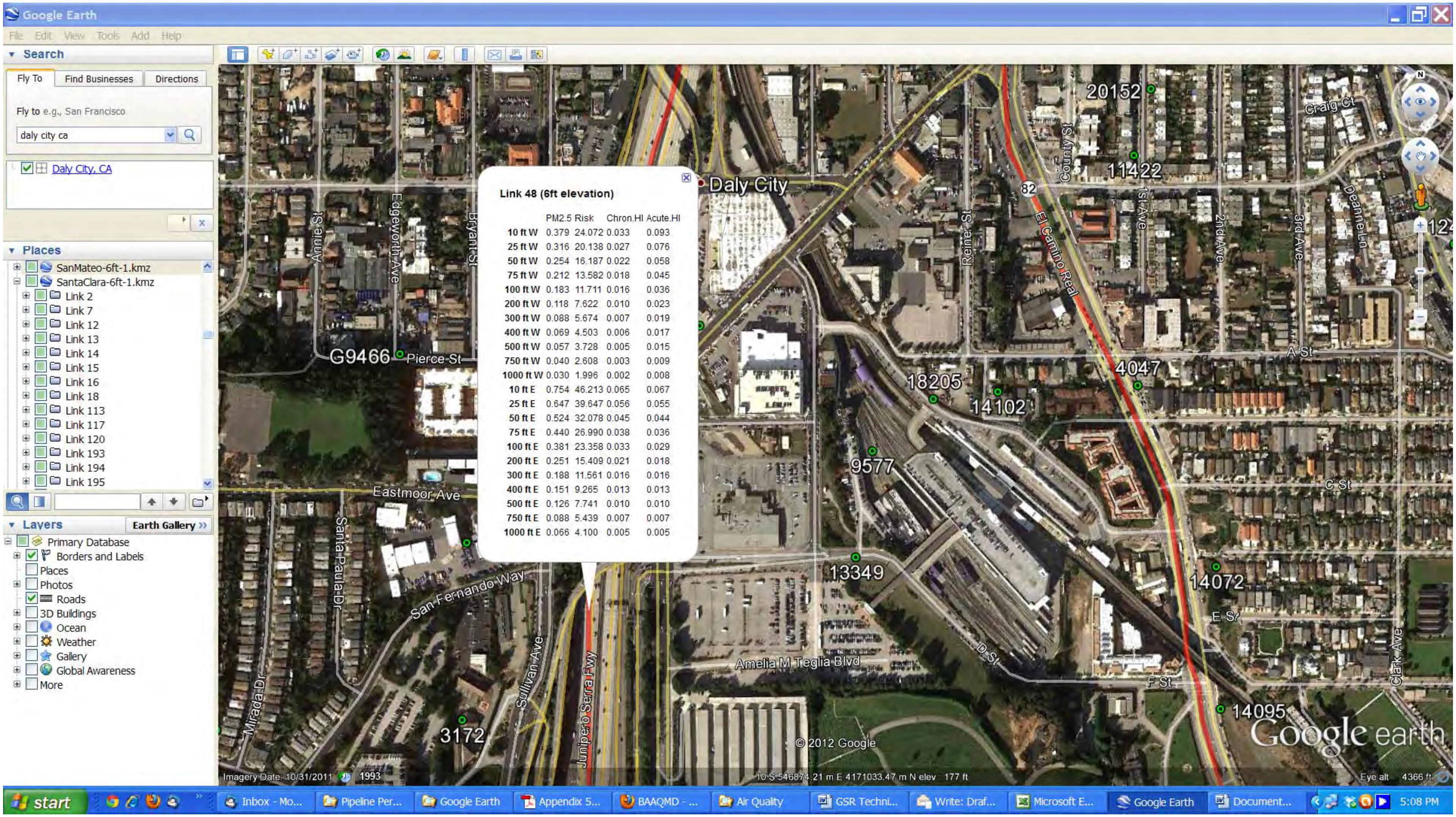
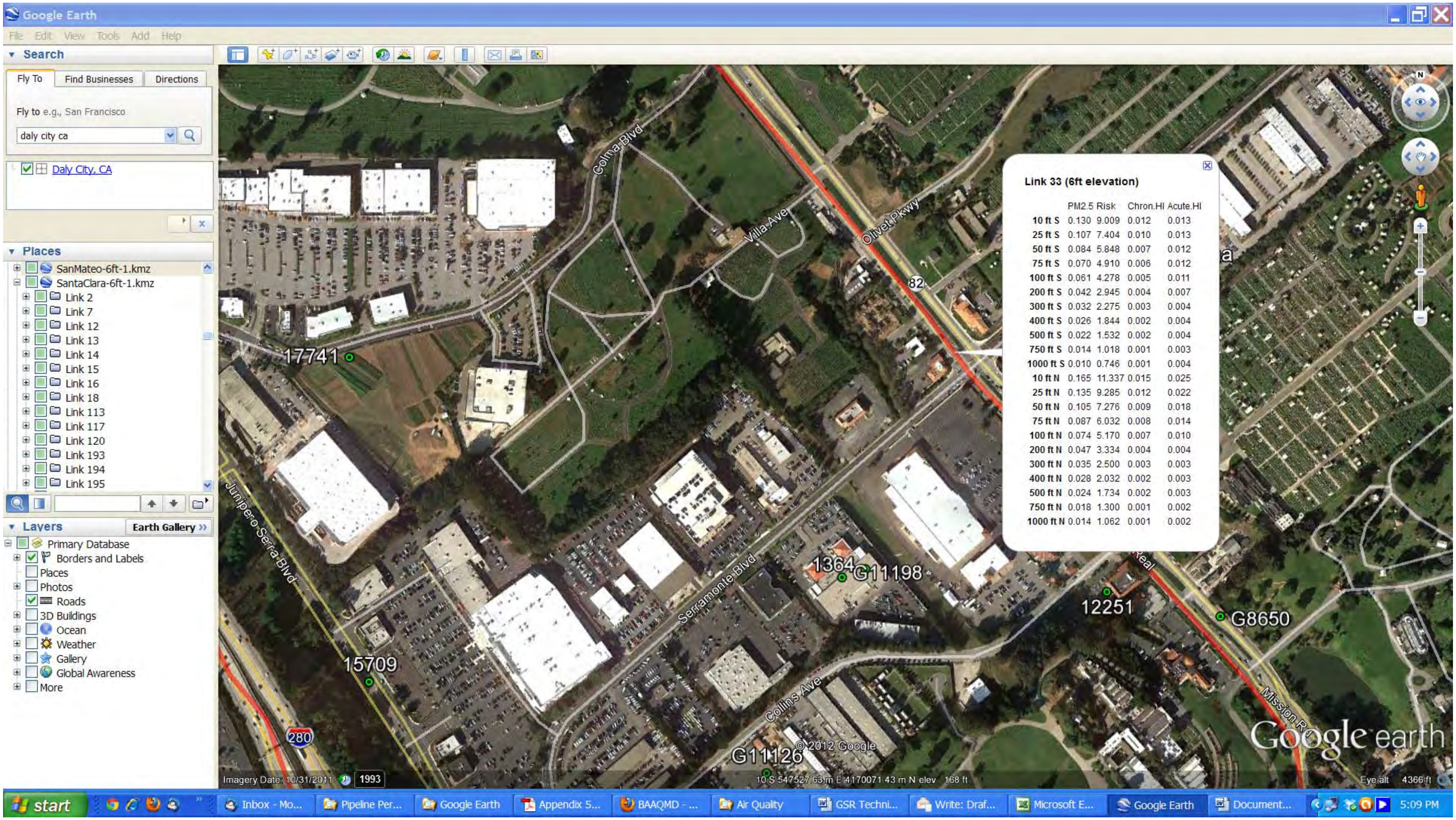


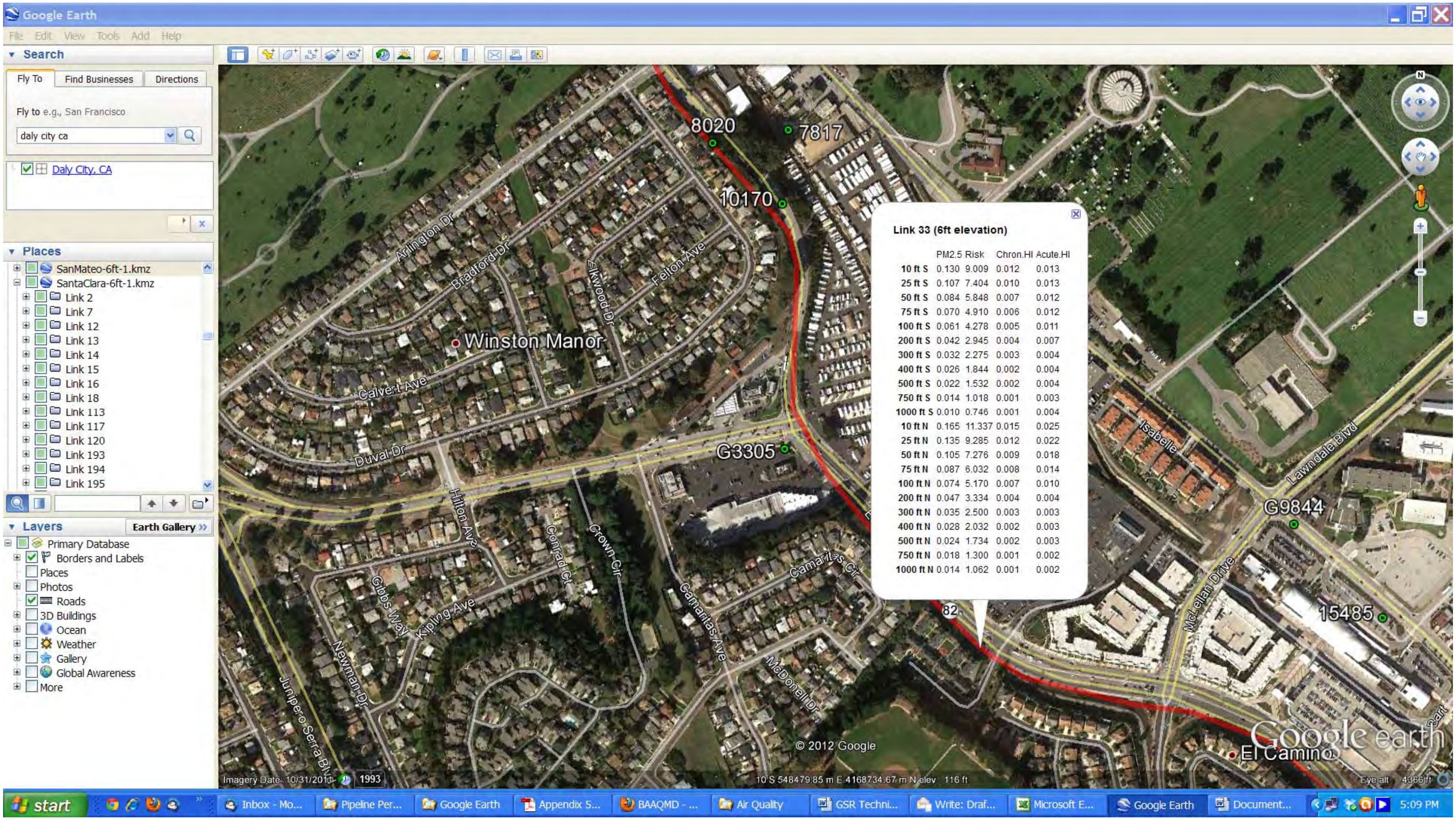
Link 48 (6ft elevation)

	PM2.5	Risk	Chron.HI	Acute.HI
10 ft W	0.379	24.072	0.033	0.093
25 ft W	0.316	20.138	0.027	0.076
50 ft W	0.254	16.187	0.022	0.058
75 ft W	0.212	13.582	0.018	0.045
100 ft W	0.183	11.711	0.016	0.036
200 ft W	0.118	7.622	0.010	0.023
300 ft W	0.088	5.674	0.007	0.019
400 ft W	0.069	4.503	0.006	0.017
500 ft W	0.057	3.728	0.005	0.015
750 ft W	0.040	2.608	0.003	0.009
1000 ft W	0.030	1.996	0.002	0.008
10 ft E	0.754	46.213	0.065	0.067
25 ft E	0.647	39.647	0.056	0.055
50 ft E	0.524	32.078	0.045	0.044
75 ft E	0.440	26.990	0.038	0.036
100 ft E	0.381	23.358	0.033	0.029
200 ft E	0.251	15.409	0.021	0.018
300 ft E	0.188	11.561	0.016	0.016
400 ft E	0.151	9.265	0.013	0.013
500 ft E	0.126	7.741	0.010	0.010
750 ft E	0.088	5.439	0.007	0.007
1000 ft E	0.066	4.100	0.005	0.005



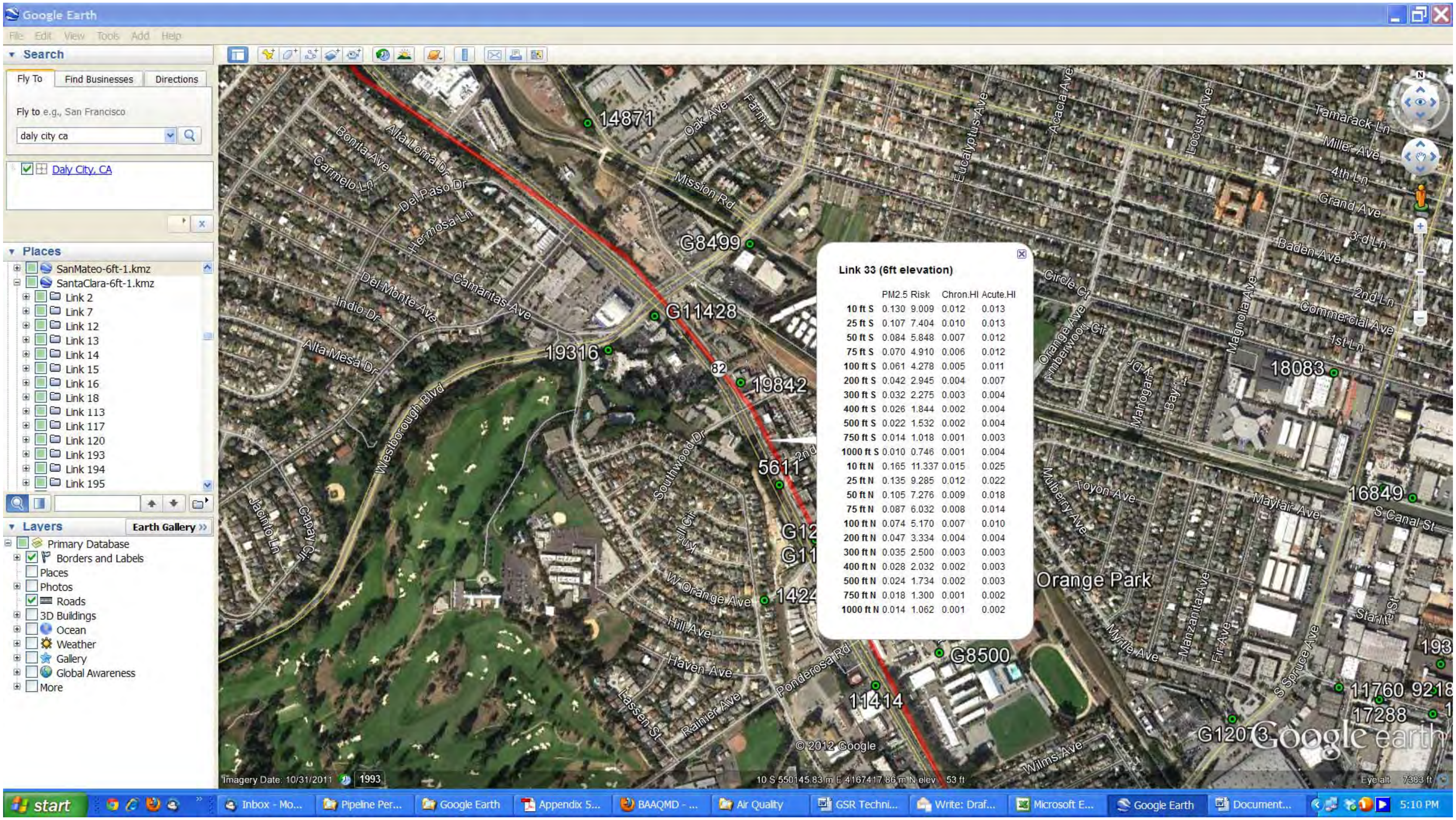
Link 33 (6ft elevation)

	PM2.5	Risk	Chron.HI	Acute.HI
10 ft S	0.130	9.009	0.012	0.013
25 ft S	0.107	7.404	0.010	0.013
50 ft S	0.084	5.848	0.007	0.012
75 ft S	0.070	4.910	0.006	0.012
100 ft S	0.061	4.278	0.005	0.011
200 ft S	0.042	2.945	0.004	0.007
300 ft S	0.032	2.275	0.003	0.004
400 ft S	0.026	1.844	0.002	0.004
500 ft S	0.022	1.532	0.002	0.004
750 ft S	0.014	1.018	0.001	0.003
1000 ft S	0.010	0.746	0.001	0.004
10 ft N	0.165	11.337	0.015	0.025
25 ft N	0.135	9.285	0.012	0.022
50 ft N	0.105	7.276	0.009	0.018
75 ft N	0.087	6.032	0.008	0.014
100 ft N	0.074	5.170	0.007	0.010
200 ft N	0.047	3.334	0.004	0.004
300 ft N	0.035	2.500	0.003	0.003
400 ft N	0.028	2.032	0.002	0.003
500 ft N	0.024	1.734	0.002	0.003
750 ft N	0.018	1.300	0.001	0.002
1000 ft N	0.014	1.062	0.001	0.002



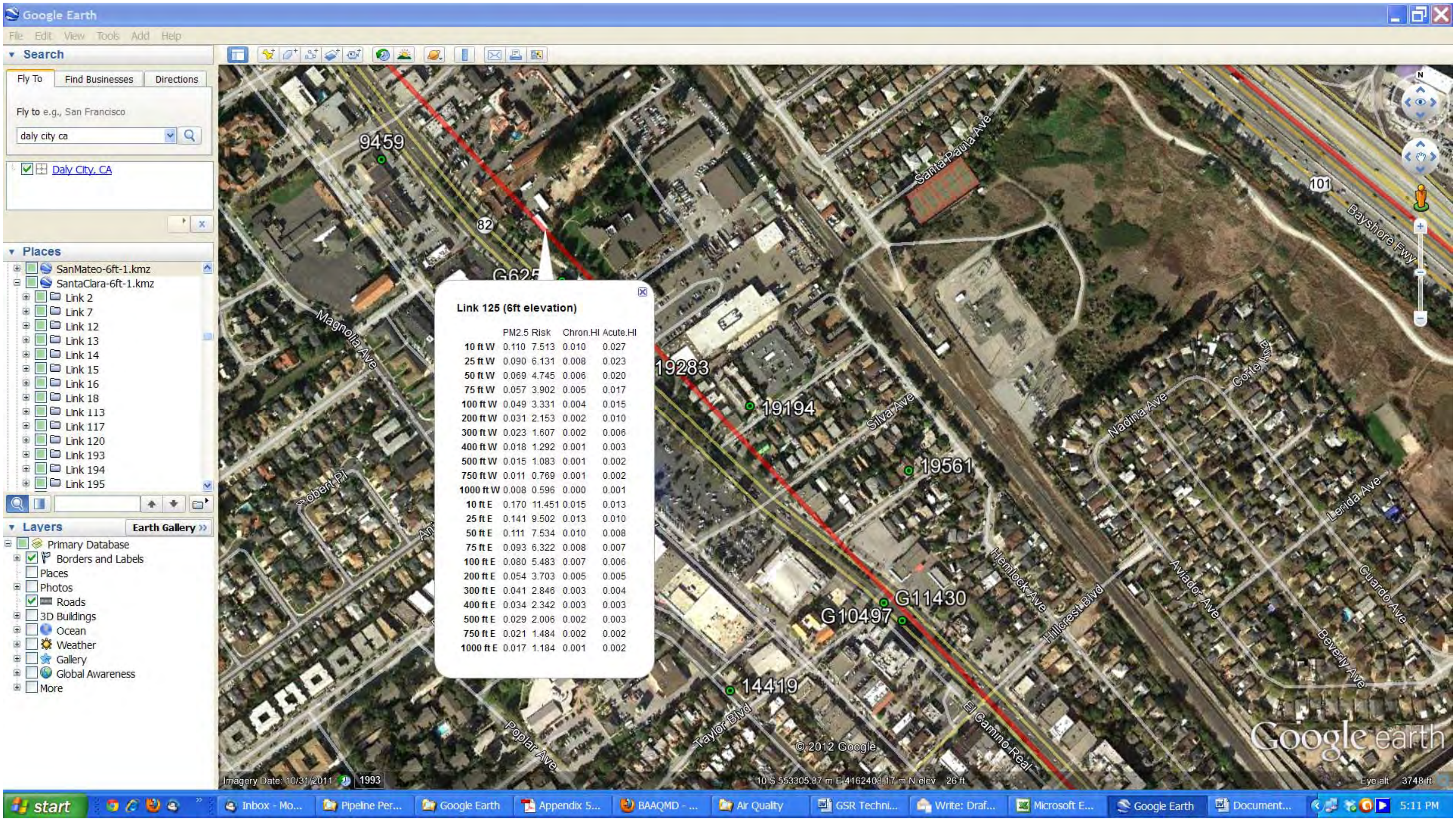
Link 33 (6ft elevation)

	PM2.5	Risk	Chron.HI	Acute.HI
10 ft S	0.130	9.009	0.012	0.013
25 ft S	0.107	7.404	0.010	0.013
50 ft S	0.084	5.848	0.007	0.012
75 ft S	0.070	4.910	0.006	0.012
100 ft S	0.061	4.278	0.005	0.011
200 ft S	0.042	2.945	0.004	0.007
300 ft S	0.032	2.275	0.003	0.004
400 ft S	0.026	1.844	0.002	0.004
500 ft S	0.022	1.532	0.002	0.004
750 ft S	0.014	1.018	0.001	0.003
1000 ft S	0.010	0.746	0.001	0.004
10 ft N	0.165	11.337	0.015	0.025
25 ft N	0.135	9.285	0.012	0.022
50 ft N	0.105	7.276	0.009	0.018
75 ft N	0.087	6.032	0.008	0.014
100 ft N	0.074	5.170	0.007	0.010
200 ft N	0.047	3.334	0.004	0.004
300 ft N	0.035	2.500	0.003	0.003
400 ft N	0.028	2.032	0.002	0.003
500 ft N	0.024	1.734	0.002	0.003
750 ft N	0.018	1.300	0.001	0.002
1000 ft N	0.014	1.062	0.001	0.002



Link 33 (6ft elevation)

	PM2.5	Risk	Chron.HI	Acute.HI
10 ft S	0.130	9.009	0.012	0.013
25 ft S	0.107	7.404	0.010	0.013
50 ft S	0.084	5.848	0.007	0.012
75 ft S	0.070	4.910	0.006	0.012
100 ft S	0.061	4.278	0.005	0.011
200 ft S	0.042	2.945	0.004	0.007
300 ft S	0.032	2.275	0.003	0.004
400 ft S	0.026	1.844	0.002	0.004
500 ft S	0.022	1.532	0.002	0.004
750 ft S	0.014	1.018	0.001	0.003
1000 ft S	0.010	0.746	0.001	0.004
10 ft N	0.165	11.337	0.015	0.025
25 ft N	0.135	9.285	0.012	0.022
50 ft N	0.105	7.276	0.009	0.018
75 ft N	0.087	6.032	0.008	0.014
100 ft N	0.074	5.170	0.007	0.010
200 ft N	0.047	3.334	0.004	0.004
300 ft N	0.035	2.500	0.003	0.003
400 ft N	0.028	2.032	0.002	0.003
500 ft N	0.024	1.734	0.002	0.003
750 ft N	0.018	1.300	0.001	0.002
1000 ft N	0.014	1.062	0.001	0.002



Link 125 (6ft elevation)

	PM2.5	Risk	Chron.HI	Acute.HI
10 ft W	0.110	7.513	0.010	0.027
25 ft W	0.090	6.131	0.008	0.023
50 ft W	0.069	4.745	0.006	0.020
75 ft W	0.057	3.902	0.005	0.017
100 ft W	0.049	3.331	0.004	0.015
200 ft W	0.031	2.153	0.002	0.010
300 ft W	0.023	1.607	0.002	0.006
400 ft W	0.018	1.292	0.001	0.003
500 ft W	0.015	1.083	0.001	0.002
750 ft W	0.011	0.769	0.001	0.002
1000 ft W	0.008	0.596	0.000	0.001
10 ft E	0.170	11.451	0.015	0.013
25 ft E	0.141	9.502	0.013	0.010
50 ft E	0.111	7.534	0.010	0.008
75 ft E	0.093	6.322	0.008	0.007
100 ft E	0.080	5.483	0.007	0.006
200 ft E	0.054	3.703	0.005	0.005
300 ft E	0.041	2.846	0.003	0.004
400 ft E	0.034	2.342	0.003	0.003
500 ft E	0.029	2.006	0.002	0.003
750 ft E	0.021	1.484	0.002	0.002
1000 ft E	0.017	1.184	0.001	0.002

San Mateo County
PM2.5 Concentrations and Cancer Risks Generated from Surface Streets

How to use the screening tables:

- Distance is from the edge of the nearest travel lane of a street to the facility or development
- When two or more streets are within the influence area, sum the contribution from each street

$PM_{2.5}$ CONCENTRATIONS (UG/M^3)

NORTH-SOUTH DIRECTIONAL ROADWAY

Annual Average Daily Traffic	Distance East or West of Surface Street - PM2.5 Concentration (ug/m^3)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	0.117	0.098	0.068	0.029	0.014	0.012	0.000
20,000	0.147	0.137	0.117	0.078	0.022	0.018	0.014
30,000	0.215	0.205	0.186	0.127	0.047	0.027	0.018
40,000	0.264	0.254	0.245	0.166	0.059	0.047	0.031
50,000	0.372	0.362	0.323	0.215	0.078	0.056	0.040
60,000	0.499	0.489	0.411	0.269	0.098	0.069	0.047
70,000	0.626	0.616	0.499	0.323	0.117	0.083	0.055
80,000	0.716	0.704	0.570	0.369	0.134	0.095	0.063
90,000	0.805	0.792	0.641	0.415	0.151	0.107	0.070
100,000	0.894	0.880	0.713	0.461	0.168	0.119	0.078

EAST-WEST DIRECTIONAL ROADWAY

Annual Average Daily Traffic	Distance North or South of Surface Street - PM2.5 Concentration (ug/m^3)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	0.098	0.088	0.064	0.020	0.014	0.012	0.000
20,000	0.186	0.166	0.117	0.059	0.022	0.018	0.010
30,000	0.205	0.176	0.147	0.088	0.034	0.023	0.017
40,000	0.323	0.313	0.235	0.108	0.047	0.032	0.023
50,000	0.558	0.489	0.382	0.176	0.063	0.042	0.032
60,000	0.597	0.523	0.421	0.201	0.072	0.049	0.038
70,000	0.636	0.558	0.460	0.225	0.081	0.057	0.043
80,000	0.727	0.637	0.525	0.257	0.093	0.065	0.049
90,000	0.818	0.717	0.591	0.289	0.104	0.073	0.055
100,000	0.908	0.797	0.657	0.321	0.116	0.081	0.061

LIFETIME CANCER RISK

NORTH-SOUTH DIRECTIONAL ROADWAY

Annual Average Daily Traffic	Distance East or West of Surface Street - Cancer Risk (per million)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	3.79	3.34	2.46	1.05	0.57	0.44	0.32
20,000	4.33	4.24	3.70	2.64	1.04	0.78	0.55
30,000	6.03	5.93	5.31	3.72	1.50	1.09	0.74
40,000	7.61	7.52	7.00	5.12	2.02	1.50	1.06
50,000	10.80	10.70	9.29	6.45	2.38	1.85	1.32
60,000	14.30	14.20	11.73	7.66	2.96	2.20	1.58
70,000	17.80	17.71	14.17	8.87	3.53	2.56	1.85
80,000	20.35	20.24	16.20	10.14	4.04	2.93	2.11
90,000	22.89	22.77	18.22	11.40	4.54	3.29	2.38
100,000	25.43	25.29	20.25	12.67	5.05	3.66	2.64

EAST-WEST DIRECTIONAL ROADWAY

Annual Average Daily Traffic	Distance North or South of Surface Street - Cancer Risk (per million)						
	10 feet	50 feet	100 feet	200 feet	500 feet	700 feet	1,000 feet
1,000	No analysis required						
5,000							
10,000	2.75	2.48	1.86	0.96	0.53	0.42	0.33
20,000	4.91	4.78	3.79	1.68	0.96	0.75	0.56
30,000	4.97	4.88	4.25	2.57	1.14	0.87	0.61
40,000	9.04	8.94	6.81	3.18	1.50	1.14	0.83
50,000	16.19	13.91	10.64	5.13	1.94	1.41	1.06
60,000	17.09	14.92	11.96	6.09	2.29	1.67	1.23
70,000	17.98	15.94	13.28	7.06	2.64	1.93	1.41
80,000	20.55	18.22	15.17	8.07	3.02	2.21	1.61
90,000	23.12	20.49	17.07	9.07	3.40	2.49	1.81
100,000	25.69	22.77	18.97	10.08	3.78	2.76	2.01

- Screening tables based on meteorological data collected from San Mateo Sewage Treatment Plant in 2005.
- The maximum acute and chronic hazard index for the distances and AADT shown in the table will be less than 0.02.
- Cancer risk were estimated based on exposure from 2014 through 2084. PM2.5 concentrations were based on emissions in 2014.

Bay Area Air Quality Management District

Risk & Hazard Stationary Source Inquiry Form

This form is required when users request stationary source data from BAAQMD. This form is to be used with the BAAQMD's Google Earth stationary source screening tables.

For guidance on conducting a risk & hazard screening, including for roadways & freeways, refer to the District's Risk & Hazard Analysis flow chart.

Also see the District's Recommended Methods for Screening and Modeling Local Risks and Hazards document.

Table A: Requestor Contact Information	
Contact Name:	James A. Reyff
Affiliation:	Illingworth & Rodkin, Inc.
Phone:	707-766-7700
Email:	jreyff@illingworthrodkin.com
Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

For Air District assistance, the following steps must be completed:

Complete all the contact and project information requested in Table A. Incomplete forms will not be processed. Please include a project site map.

Download and install the free program Google Earth, http://www.google.com/earth/download/ge/, and then download the county specific Google Earth stationary source application files from the District's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. The small points on the map represent stationary sources permitted by the District (Map A on right). These permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc. Click on a point to view the source's Information Table, including the name, location, and preliminary estimated cancer risk, hazard index, and PM2.5 concentration.

Find the project site in Google Earth by inputting the site's address in the Google Earth search box.

Using the Google Earth ruler function, measure the distance in feet between the project's fenceline and the stationary source's fenceline for all the sources that are within 1,000 feet of the project's fenceline. Verify that the location of the source on the map matches with the source's address in the Information Table, by using the Google Earth address search box to confirm that the source is within 1,000 feet of the project. Please report any mapping errors to the District (District contact information in Step 9).

If the stationary source is within 1,000 feet of the project's fenceline and the stationary source's information table does not list the cancer risk, hazard index, and PM2.5 concentration, and instead says to "Contact District Staff", list the stationary source information in Table B Section 1 below.

Note that a small percentage of the stationary sources have Health Risk Screening Assessment (HRSA) data INSTEAD of screening level data. These sources will be noted by an asterisk next to the Plant Name (Map B on right). If HRSA values are presented, these values have already been modeled and cannot be adjusted further.

Email this completed form to District staff (Step 9). District staff will provide the most recent risk, hazard, and PM2.5 data that are available for the source(s). If this information or data are not available, source emissions data will be provided. Staff will respond to inquiries within three weeks.

Note that a public records request received for the same stationary source information will cancel the processing of your SSIF request.

Submit forms, maps, and questions to Alison Kirk at 415-749-5169, or akirk@baaqmd.gov.

Map A: Snapshot of Google Earth with Plant 20248 Information Table Selected

Table B: Stationary Sources within 1,000 feet of Receptor that say "Contact District Staff"

Table B Section 1: Requestor fills out these columns based on Google Earth data				Table B Section 2: BAAQMD returns form with additional information in these columns as needed																			
Distance from Receptor (feet)	Plant # or Gas Dispensary #	Facility Name	Street Address	Screening Level Cancer Risk (1)	Screening Level Hazard Index (1)	Screening Level PM2.5 (1)	Adjusted Screening Risk	Adjusted Screening Hazard	Adjusted Screening PM2.5	Type	Permit #s (2)	Source #s (2)	Fuel Code (3)	Type of Source(s) (4)	HRSA Ap # (5)	HRSA Date (6)	HRSA Engineer (7)	HRSA Cancer Risk in a million	Age Sensitivity Factor (8)	HRSA Adjusted Cancer Risk	HRSA Chronic Health (9)	HRSA PM2.5 Risk	Status/Comments
900	G11629	Mayfair 76	101 So Mayfair Avenue Daly City	50.814	0.084	na	**0.91**	**0.00**	**0.00**	Gas Station												0	
1000	13221	DB Real Estate Pacific Plaza Partners LP	2001 Juniperro Serra Blvd Daly City	16.68	0.006	0.004	**0.67**	**0.00**	**0.00**	Generator												0	
700	13420	Digidesign	2001 Juniperro Serra Blvd Daly City	5.27	0.002	0.001	**0.42**	**0.00**	**0.00**	Generator												0	
700	14852	Genesys Telecommunications Laboratories	JUNIPERO SERRA BLVD, SUITE 700 Daly City	14.7	0.005	0.026	**1.18**	**0.00**	**0.00**	Generator												0	
																						0	
																						0	
																						0	
																						0	
																						0	
																						0	
																						0	
																						0	
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																						0	

Footnotes:

1. These Cancer Risk, Hazard Index, and PM2.5 columns represent the rows in the Google Earth Plant Information Table that say "Contact District Staff" (Map A above). BAAQMD will return this form to you with this screening level information entered in thes
2. Each plant may have multiple permits and sources.
3. Fuel codes: 98 = diesel, 189 = Natural Gas.
4. Permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc.
5. If a Health Risk Screening Assessment (HRSA) was completed for the source, the application number will be listed here.
6. The date that the HRSA was completed.
7. Engineer who completed the HRSA. For District purposes only.
8. All HRSA completed before 1/5/2010 need to be multiplied by an age sensitivity factor of 1.7.
9. The HRSA "Chronic Health" number represents the Hazard Index.
10. Further information about common sources:
    a. Sources that only include diesel internal combustion engines can be adjusted using the BAAQMD's Diesel Multiplier worksheet.
    b. The risk from natural gas boilers used for space heating when <25 MM BTU/hr would have an estimated cancer risk of one in a million or less, and a chronic hazard index of 0.003 or less. To be conservative, requestor should assume the cancer risk is 1 i
    c. BAAQMD Reg 11 Rule 16 required that all co-residential (sharing a wall, floor, ceiling or is in the same building as a residential unit) dry cleaners cease use of perc on July 1, 2010. Therefore, there is no cancer risk, hazard or PM2.5 concentrations from co-residential dry cleaning businesses in the BAAQMD.
    d. Non co-residential dry cleaners must phase out use of perc by Jan. 1, 2023. Therefore, the risk from these dry cleaners does not need to be factored in over a 70-year period, but instead should reflect the number of years perc use will continue after t
    e. Gas stations can be adjusted using BAAQMD's Gas Station Distance Mulitplier worksheet.
    f. Unless otherwise noted, exempt sources are considered insignificant. See BAAQMD Reg 2 Rule 1 for a list of exempt sources.
    g. This spray booth is considered to be insignificant.

Date last updated:
3/12/12

Bay Area Air Quality Management District

Risk & Hazard Stationary Source Inquiry Form

This form is required when users request stationary source data from BAAQMD. This form is to be used with the BAAQMD's Google Earth stationary source screening tables.

For guidance on conducting a risk & hazard screening, including for roadways & freeways, refer to the District's Risk & Hazard Analysis flow chart.

Also see the District's Recommended Methods for Screening and Modeling Local Risks and Hazards document.

Table A: Requestor Contact Information	
Contact Name:	James A. Reyff
Affiliation:	Illingworth & Rodkin, Inc.
Phone:	707-766-7700
Email:	jreyff@illingworthrodkin.com
Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

For Air District assistance, the following steps must be completed:

Complete all the contact and project information requested in Table A. Incomplete forms will not be processed. Please include a project site map.

Download and install the free program Google Earth, http://www.google.com/earth/download/ge/, and then download the county specific Google Earth stationary source application files from the District's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. The small points on the map represent stationary sources permitted by the District (Map A on right). These permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc. Click on a point to view the source's Information Table, including the name, location, and preliminary estimated cancer risk, hazard index, and PM2.5 concentration.

Find the project site in Google Earth by inputting the site's address in the Google Earth search box.

Using the Google Earth ruler function, measure the distance in feet between the project's fenceline and the stationary source's fenceline for all the sources that are within 1,000 feet of the project's fenceline. Verify that the location of the source on the map matches with the source's address in the Information Table, by using the Google Earth address search box to confirm that the source is within 1,000 feet of the project. Please report any mapping errors to the District (District contact information in Step 9).

If the stationary source is within 1,000 feet of the project's fenceline and the stationary source's information table does not list the cancer risk, hazard index, and PM2.5 concentration, and instead says to "Contact District Staff", list the stationary source information in Table B Section 1 below.

Note that a small percentage of the stationary sources have Health Risk Screening Assessment (HRSA) data INSTEAD of screening level data. These sources will be noted by an asterisk next to the Plant Name (Map B on right). If HRSA values are presented, these values have already been modeled and cannot be adjusted further.

Email this completed form to District staff (Step 9). District staff will provide the most recent risk, hazard, and PM2.5 data that are available for the source(s). If this information or data are not available, source emissions data will be provided. Staff will respond to inquiries within three weeks.

Note that a public records request received for the same stationary source information will cancel the processing of your SSIF request.

Submit forms, maps, and questions to Alison Kirk at 415-749-5169, or akirk@baaqmd.gov.

Map A: Snapshot of Google Earth with Plant 20248 Information Table Selected

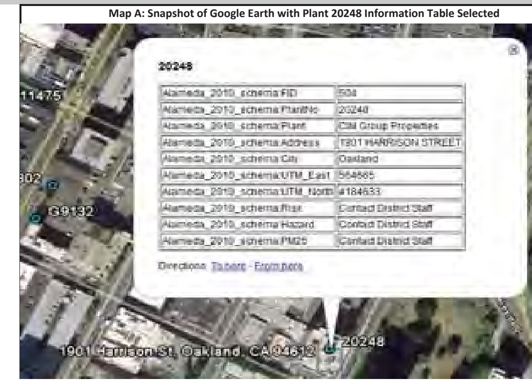

Table B: Stationary Sources within 1,000 feet of Receptor that say "Contact District Staff"

Table B Section 1: Requestor fills out these columns based on Google Earth data (first four columns); Table B Section 2: BAAQMD returns form with additional information in these columns as needed (remaining columns)

Distance from Receptor (feet)	Plant # or Gas Dispensary #	Facility Name	Street Address	Screening Level Cancer Risk (1)	Screening Level Hazard Index (1)	Screening Level PM2.5 (1)	Adjusted Screening Risk	Adjusted Screening Hazard	Adjusted Screening PM2.5	Type
Site 2										
730	16794	The Home Depot (Store# 1092	303 E LAKE MERCED BLVD Daly City	50.99	0.018	0.012	**4.08**	**0.00**	**0.00**	Generator
900	G10657	Arco Facility #00465 - MICHAEL J MONTE	151 Southgate Avenue Daly City	26.878	0.044	na	**0.48**	**0.00**	**0.00**	Gasoline Station
590	12568	Calclean Inc	151 SOUTHGATE AVENUE Daly City	5.03	0.002	0.00	**5.03**	**0.00**	**0.00**	Cleaners (no Adjustment)
1000	12876	City of Daly City	295 CORONADO AVENUE Daly City	51.32	0.018	0.012	**2.05**	**0.00**	**0.00**	Generator
Site 3										
590	12568	Calclean Inc	151 SOUTHGATE AVENUE Daly City	5.03	0.002	0.00	**5.03**	**0.00**	**0.00**	Cleaners (no Adjustment)

Distance from Receptor (feet)	Permit #s (2)	Source #s (2)	Fuel Code (3)	Type of Source(s) (4)	HRSA Ap # (5)	HRSA Date (6)	HRSA Engineer (7)	HRSA Cancer Risk in a million	Age Sensitivity Factor (8)	HRSA Adjusted Cancer Risk	HRSA Chronic Health (9)	HRSA PM2.5 Risk	Status/Comments
Site 2													
730												0	
900												0	
590												0	
1000												0	
Site 3												0	
590												0	
												0	
												0	
												0	
												0	
												0	
												0	
												0	
												0	
												0	
												0	
												0	
												0	

Footnotes:

1. These Cancer Risk, Hazard Index, and PM2.5 columns represent the rows in the Google Earth Plant Information Table that say "Contact District Staff" (Map A above). BAAQMD will return this form to you with this screening level information entered in thes
2. Each plant may have multiple permits and sources.
3. Fuel codes: 98 = diesel, 189 = Natural Gas.
4. Permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc.
5. If a Health Risk Screening Assessment (HRSA) was completed for the source, the application number will be listed here.
6. The date that the HRSA was completed.
7. Engineer who completed the HRSA. For District purposes only.
8. All HRSA completed before 1/5/2010 need to be multiplied by an age sensitivity factor of 1.7.
9. The HRSA "Chronic Health" number represents the Hazard Index.
10. Further information about common sources:
    a. Sources that only include diesel internal combustion engines can be adjusted using the BAAQMD's Diesel Multiplier worksheet.
    b. The risk from natural gas boilers used for space heating when <25 MM BTU/hr would have an estimated cancer risk of one in a million or less, and a chronic hazard index of 0.003 or less. To be conservative, requestor should assume the cancer risk is 1 i
    c. BAAQMD Reg 11 Rule 16 required that all co-residential (sharing a wall, floor, ceiling or is in the same building as a residential unit) dry cleaners cease use of perc on July 1, 2010. Therefore, there is no cancer risk, hazard or PM2.5 concentrations from co-residential dry cleaning businesses in the BAAQMD.
    d. Non co-residential dry cleaners must phase out use of perc by Jan. 1, 2023. Therefore, the risk from these dry cleaners does not need to be factored in over a 70-year period, but instead should reflect the number of years perc use will continue after t
    e. Gas stations can be adjusted using BAAQMD's Gas Station Distance Mulitplier worksheet.
    f. Unless otherwise noted, exempt sources are considered insignificant. See BAAQMD Reg 2 Rule 1 for a list of exempt sources.
    g. This spray booth is considered to be insignificant.

Date last updated:
3/12/12

Bay Area Air Quality Management District
Risk & Hazard Stationary Source Inquiry Form
This form is required when users request stationary source data from BAAQMD. This form is to be used with the BAAQMD's Google Earth stationary source screening tables.

For guidance on conducting a risk & hazard screening, including for roadways & freeways, refer to the District's Risk & Hazard Analysis flow chart

Also see the District's Recommended Methods for Screening and Modeling Local Risks and Hazards document.

Table A: Requestor Contact Information	
Contact Name:	James A. Reyff
Affiliation:	Illingworth & Rodkin, Inc.
Phone:	707-766-7700
Email:	jreyff@illingworthrodkin.com
Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

For Air District assistance, the following steps must be completed:
Complete all the contact and project information requested in Table A. Incomplete forms will not be processed. Please include a project site map.
Download and install the free program Google Earth, http://www.google.com/earth/download/ge/, and then download the county specific Google Earth stationary source application files from the District's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx.
The small points on the map represent stationary sources permitted by the District (Map A on right). These permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc. Click on a point to view the source's Information Table, including the name, location, and preliminary estimated cancer risk, hazard index, and PM2.5 concentration.
Find the project site in Google Earth by inputting the site's address in the Google Earth search box.
Using the Google Earth ruler function, measure the distance in feet between the project's fenceline and the stationary source's fenceline for all the sources that are within 1,000 feet of the project's fenceline. Verify that the location of the source on the map matches with the source's address in the Information Table, by using the Google Earth address search box to confirm that the source is within 1,000 feet of the project. Please report any mapping errors to the District (District contact information in Step 9).
If the stationary source is within 1,000 feet of the project's fenceline and the stationary source's information table does not list the cancer risk, hazard index, and PM2.5 concentration, and instead says to "Contact District Staff", list the stationary source information in Table B Section 1 below.
Note that a small percentage of the stationary sources have Health Risk Screening Assessment (HRSA) data INSTEAD of screening level data. These sources will be noted by an asterisk next to the Plant Name (Map B on right). If HRSA values are presented, these values have already been modeled and cannot be adjusted further.
Email this completed form to District staff (Step 9). District staff will provide the most recent risk, hazard, and PM2.5 data that are available for the source(s). If this information or data are not available, source emissions data will be provided. Staff will respond to inquiries within three weeks.
Note that a public records request received for the same stationary source information will cancel the processing of your SSIF request.
Submit forms, maps, and questions to Alison Kirk at 415-749-5169, or akirk@baaqmd.gov.

Map A: Snapshot of Google Earth with Plant 20248 Information Table Selected

Table B: Stationary Sources within 1,000 feet of Receptor that say "Contact District Staff"

Table B Section 1: Requestor fills out these columns based on Google Earth data				Table B Section 2: BAAQMD returns form with additional information in these columns as needed																			
Distance from Receptor (feet)	Plant # or Gas Dispensary #	Facility Name	Street Address	Screening Level Cancer Risk (1)	Screening Level Hazard Index (1)	Screening Level PM2.5 (1)	Adjusted Screening Risk	Adjusted Screening Hazard	Adjusted Screening PM2.5	Type	Permit #s (2)	Source #s (2)	Fuel Code (3)	Type of Source(s) (4)	HRSA Ap # (5)	HRSA Date (6)	HRSA Engineer (7)	HRSA Cancer Risk in a million	Age Sensitivity Factor (8)	HRSA Adjusted Cancer Risk	HRSA Chronic Health (9)	HRSA PM2.5 Risk	Status/Comments
Site 5																							
>1,000	G2810	ARCO Facility #02090 - COPOWER INC	295 Washington Street Daly City	24.391	0.032	na																0	
580	G9309	R K Chan #2611202	3001 Junipero Serra Daly City	8.009	0.01	na	0.29	0.00	0.00	Gasoline Station												0	
>>1,000	9640	AT&T	359 Washington St Colma	0.27	0.012	0.012																0	
>1,000	G10514	Sullivan Valero	1690 Sullivan Avenue Daly City	13.931	0.023	na																0	
~200	9577	D'Garcis Auto Body	254 SAN PEDRO ROAD Daly City	0.00	0.009	0.00																0	
600	18205	Collision Specialists Auto Center(CST Co	250 SAN PEDRO ROAD Daly City	0.00	0.00	0.00																	
660	14102	City of Daly City	280 A STREET Daly City	79.01	0.028	0.018	6.32	0.00	0.00	Generator													
>1000	G6665	Pacific Gas and Electric Company	450 Eastmoor Avenue Daly City	0.098	0.00	na																0	
>1000	18205	Collision Specialists Auto Center(CST Co	250 SAN PEDRO ROAD Daly City	0.00	0.00	0.00																0	
>1000	9577	D'Garcis Auto Body	254 SAN PEDRO ROAD Daly City	0.00	0.009	0.00																0	
>1000	13349	S F Bay Area Rapid Transit District	255 D STREET Colma	0.00	0.00	0.015																0	
>1000	14072	S F Bay Area Rapid Transit District	365 D STREET Colma	20.46	0.007	0.005																0	
>1000	14095	North San Mateo County Sanitation Distri	300 F STREET Daly City	33.77	0.012	0.008																0	
>1000	G9706	Woodlawn Memorial Park	1000 El Camino Colma	0.05	0.00	na																0	
																						0	
																						0	

Footnotes:
1. These Cancer Risk, Hazard Index, and PM2.5 columns represent the rows in the Google Earth Plant Information Table that say "Contact District Staff" (Map A above). BAAQMD will return this form to you with this screening level information entered in thes
2. Each plant may have multiple permits and sources.
3. Fuel codes: 98 = diesel, 189 = Natural Gas.
4. Permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc.
5. If a Health Risk Screening Assessment (HRSA) was completed for the source, the application number will be listed here.
6. The date that the HRSA was completed.
7. Engineer who completed the HRSA. For District purposes only.
8. All HRSA completed before 1/5/2010 need to be multiplied by an age sensitivity factor of 1.7.
9. The HRSA "Chronic Health" number represents the Hazard Index.
10. Further information about common sources:
   a. Sources that only include diesel internal combustion engines can be adjusted using the BAAQMD's Diesel Multiplier worksheet.
   b. The risk from natural gas boilers used for space heating when <25 MM BTU/hr would have an estimated cancer risk of one in a million or less, and a chronic hazard index of 0.003 or less. To be conservative, requestor should assume the cancer risk is 1 i
   c. BAAQMD Reg 11 Rule 16 required that all co-residential (sharing a wall, floor, ceiling or is in the same building as a residential unit) dry cleaners cease use of perc on July 1, 2010. Therefore, there is no cancer risk, hazard or PM2.5 concentrations from co-residential dry cleaning businesses in the BAAQMD.
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Date last updated:
3/12/12

Bay Area Air Quality Management District

Risk & Hazard Stationary Source Inquiry Form

This form is required when users request stationary source data from BAAQMD. This form is to be used with the BAAQMD's Google Earth stationary source screening tables.

For guidance on conducting a risk & hazard screening, including for roadways & freeways, refer to the District's Risk & Hazard Analysis flow chart.

Also see the District's Recommended Methods for Screening and Modeling Local Risks and Hazards document.

Table A: Requestor Contact Information	
Contact Name:	James A. Reyff
Affiliation:	Illingworth & Rodkin, Inc.
Phone:	707-766-7700
Email:	jreyff@illingworthrodkin.com
Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

For Air District assistance, the following steps must be completed:
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Download and install the free program Google Earth, http://www.google.com/earth/download/ge/, and then download the county specific Google Earth stationary source application files from the District's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. The small points on the map represent stationary sources permitted by the District (Map A on right). These permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc. Click on a point to view the source's Information Table, including the name, location, and preliminary estimated cancer risk, hazard index, and PM2.5 concentration.
Find the project site in Google Earth by inputting the site's address in the Google Earth search box.
Using the Google Earth ruler function, measure the distance in feet between the project's fenceline and the stationary source's fenceline for all the sources that are within 1,000 feet of the project's fenceline. Verify that the location of the source on the map matches with the source's address in the Information Table, by using the Google Earth address search box to confirm that the source is within 1,000 feet of the project. Please report any mapping errors to the District (District contact information in Step 9).
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Note that a small percentage of the stationary sources have Health Risk Screening Assessment (HRSA) data INSTEAD of screening level data. These sources will be noted by an asterisk next to the Plant Name (Map B on right). If HRSA values are presented, these values have already been modeled and cannot be adjusted further.
Email this completed form to District staff (Step 9). District staff will provide the most recent risk, hazard, and PM2.5 data that are available for the source(s). If this information or data are not available, source emissions data will be provided. Staff will respond to inquiries within three weeks.
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Submit forms, maps, and questions to Alison Kirk at 415-749-5169, or akirk@baaqmd.gov.

Map A: Snapshot of Google Earth with Plant 20248 Information Table Selected

Table B: Stationary Sources within 1,000 feet of Receptor that say "Contact District Staff"

Table B Section 1: Requestor fills out these columns based on Google Earth data				Table B Section 2: BAAQMD returns form with additional information in these columns as needed																			
Distance from Receptor (feet)	Plant # or Gas Dispensary #	Facility Name	Street Address	Screening Level Cancer Risk (1)	Screening Level Hazard Index (1)	Screening Level PM2.5 (1)	Adjusted Screening Risk	Adjusted Screening Hazard	Adjusted Screening PM2.5	Type	Permit #s (2)	Source #s (2)	Fuel Code (3)	Type of Source(s) (4)	HRSA Ap # (5)	HRSA Date (6)	HRSA Engineer (7)	HRSA Cancer Risk in a million	Age Sensitivity Factor (8)	HRSA Adjusted Cancer Risk	HRSA Chronic Health (9)	HRSA PM2.5 Risk	Status/Comments
900	1364	Cypress Amloc Land Co , Inc	1 SAND HILL ROAD	9.08	0.349	5.13	**0.45**	**0.02**	**0.26**	Generator												0	
950	G11198	Lexus of Serramonte - Attn: Ray Chin	700 Serramonte Blvd Colma	8.722	0.012	na	**0.14**	**0.00**		Gasoline Station												0	
	G11126	Christy Vault Company, Inc	1000 Collins Ave Colma	108.802	0.144	na																0	
	8758	Serramonte Ford Body Shop	500 COLLINS AVE Colma	0.00	0.00	0.018																0	
	12251	G & M Auto Body	245 COLLINS AVE Colma	0.04	0.00	0.00																0	
	G8650	Home of Peace Cemetery	1299 El Camino Real Colma	0.222	0.00	na																0	
																						0	
																						0	
																						0	
																						0	
																						0	
																						0	
																						0	
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8. All HRSA completed before 1/5/2010 need to be multiplied by an age sensitivity factor of 1.7.
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10. Further information about common sources:
   a. Sources that only include diesel internal combustion engines can be adjusted using the BAAQMD's Diesel Multiplier worksheet.
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   e. Gas stations can be adjusted using BAAQMD's Gas Station Distance Mulitplier worksheet.
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3/12/12

Bay Area Air Quality Management District

Risk & Hazard Stationary Source Inquiry Form

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Also see the District's Recommended Methods for Screening and Modeling Local Risks and Hazards document.

Table A: Requestor Contact Information	
Contact Name:	James A. Reyff
Affiliation:	Illingworth & Rodkin, Inc.
Phone:	707-766-7700
Email:	jreyff@illingworthrodkin.com
Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

For Air District assistance, the following steps must be completed:
Complete all the contact and project information requested in Table A. Incomplete forms will not be processed. Please include a project site map.
Download and install the free program Google Earth, http://www.google.com/earth/download/ge/, and then download the county specific Google Earth stationary source application files from the District's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx. The small points on the map represent stationary sources permitted by the District (Map A on right). These permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc. Click on a point to view the source's Information Table, including the name, location, and preliminary estimated cancer risk, hazard index, and PM2.5 concentration.
Find the project site in Google Earth by inputting the site's address in the Google Earth search box.
Using the Google Earth ruler function, measure the distance in feet between the project's fenceline and the stationary source's fenceline for all the sources that are within 1,000 feet of the project's fenceline. Verify that the location of the source on the map matches with the source's address in the Information Table, by using the Google Earth address search box to confirm that the source is within 1,000 feet of the project. Please report any mapping errors to the District (District contact information in Step 9).
If the stationary source is within 1,000 feet of the project's fenceline and the stationary source's information table does not list the cancer risk, hazard index, and PM2.5 concentration, and instead says to "Contact District Staff", list the stationary source information in Table B Section 1 below.
Note that a small percentage of the stationary sources have Health Risk Screening Assessment (HRSA) data INSTEAD of screening level data. These sources will be noted by an asterisk next to the Plant Name (Map B on right). If HRSA values are presented, these values have already been modeled and cannot be adjusted further.
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Map A: Snapshot of Google Earth with Plant 20248 Information Table Selected

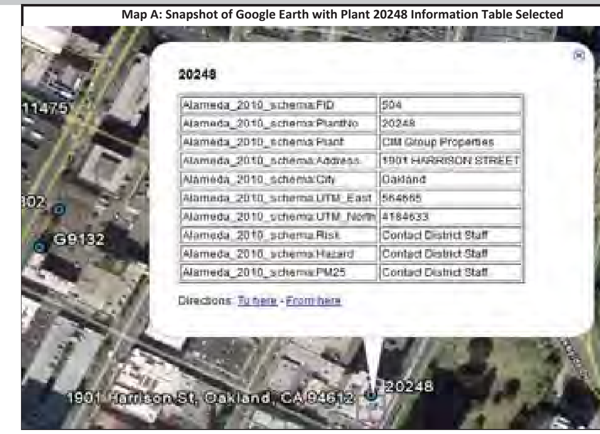

Table B: Stationary Sources within 1,000 feet of Receptor that say "Contact District Staff"

Table B Section 1: Requestor fills out these columns based on Google Earth data				Table B Section 2: BAAQMD returns form with additional information in these columns as needed																		
Distance from Receptor (feet)	Plant # or Gas Dispensary #	Facility Name	Street Address	Screening Level Cancer Risk (1)	Screening Level Hazard Index (1)	Screening Level PM2.5 (1)	Adjusted Screening Risk	Adjusted Screening Hazard	Adjusted Screening PM2.5	Type	Permit #s (2)	Source #s (2)	Fuel Code (3)	Type of Source(s) (4)	HRSA Ap # (5)	HRSA Date (6)	HRSA Engineer (7)	HRSA Cancer Risk in a million	Age Sensitivity Factor (8)	HRSA Adjusted Cancer Risk	HRSA Chronic Health (9)	HRSA PM2.5 Risk	Status/Comments
870	G3305	Xtra Oil Company	110 Hickey Boulevard Soutgh San Francisco	71.457	0.118	na	1.43	0.00		Gasoline Station												0	
20	11016	Image Auto Body	1687 MISSION ROAD South San Francisco	0.00	0.00	0.00																0	
																						0	
																						0	
																						0	
																						0	
																						0	
																						0	
																						0	
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2. Each plant may have multiple permits and sources.
3. Fuel codes: 98 = diesel, 189 = Natural Gas.
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10. Further information about common sources:
  a. Sources that only include diesel internal combustion engines can be adjusted using the BAAQMD's Diesel Multiplier worksheet.
  b. The risk from natural gas boilers used for space heating when <25 MM BTU/hr would have an estimated cancer risk of one in a million or less, and a chronic hazard index of 0.003 or less. To be conservative, requestor should assume the cancer risk is 1 i
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  e. Gas stations can be adjusted using BAAQMD's Gas Station Distance Mulitplier worksheet.
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Date last updated:
3/12/12

Bay Area Air Quality Management District
Risk & Hazard Stationary Source Inquiry Form

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Table A: Requestor Contact Information	
Contact Name:	James A. Reyff
Affiliation:	Illingworth & Rodkin, Inc.
Phone:	707-766-7700
Email:	jreyff@illingworthrodkin.com
Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

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>1000	G11573	Grand Avenue Olympic	1086 Grand Avenue South San Francisco	na	na	na																0	
>1000	14871	County of San Mateo	1040 OLD MISSION ROAD South San Fransico	18.06	0.006	0.004																0	
>1000	G8499	California Water Service Company	80 Chestnut Avenue South San Francisco	na	na	na																0	
600	G11428	Westborough Chevron	1 Westborough Boulevard South San Fransico	22.056	0.037	na	**0.73**	**0.00**		Gasoline Station												0	
500	19316	Access Properties LLC	91 WESTBOROUGH BOULEVARD South San Francisco	na	na	na																0	
>1000	19842	Chestnut Cleaners	26 CHESTNUT AVENUE South San Francisco	7.49	0.02	0.00																0	
	5611	Daland Body Shop	890 EL CAMINO REAL South San Francisco	0.00	0.00	0.00																0	
>1000	G11391	Camino Petroleum	698 El Camino Real South San Francisco	14.285	0.019	na																0	
>1000	G12394	Orange Avenue Shell	710 El Camino Real South San Francisco	9.902	0.013	na																0	
>1000	14240	SFPUC Water Supply and Treatment Divisio	609 W ORANGE AVENUE South San Francisco	58.80	0.021	0.104																0	
>1000	11414	Holiday Cleaners	675 EL CAMINO REAL South San Francisco	11.20	0.03	0.00																0	
																						0	
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																						0	
																						0	
																						0	
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Phone:	707-766-7700
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Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

For Air District assistance, the following steps must be completed:

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Find the project site in Google Earth by inputting the site's address in the Google Earth search box.

Using the Google Earth ruler function, measure the distance in feet between the project's fenceline and the stationary source's fenceline for all the sources that are within 1,000 feet of the project's fenceline. Verify that the location of the source on the map matches with the source's address in the Information Table, by using the Google Earth address search box to confirm that the source is within 1,000 feet of the project. Please report any mapping errors to the District (District contact information in Step 9).

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Submit forms, maps, and questions to Alison Kirk at 415-749-5169, or akirk@baaqmd.gov .

Map A: Snapshot of Google Earth with Plant 20248 Information Table Selected

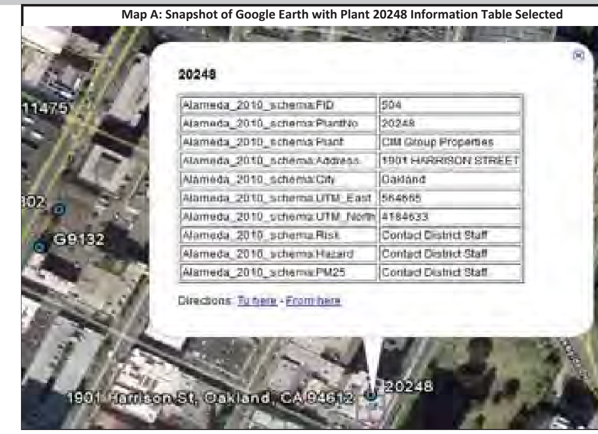

Table B: Stationary Sources within 1,000 feet of Receptor that say "Contact District Staff"

Table B Section 1: Requestor fills out these columns based on Google Earth data				Table B Section 2: BAAQMD returns form with additional information in these columns as needed																			
Distance from Receptor (feet)	Plant # or Gas Dispensary #	Facility Name	Street Address	Screening Level Cancer Risk (1)	Screening Level Hazard Index (1)	Screening Level PM2.5 (1)	Adjusted Screening Risk	Adjusted Screening Hazard	Adjusted Screening PM2.5	Type	Permit #s (2)	Source #s (2)	Fuel Code (3)	Type of Source(s) (4)	HRSA Ap # (5)	HRSA Date (6)	HRSA Engineer (7)	HRSA Cancer Risk in a million	Age Sensitivity Factor (8)	HRSA Adjusted Cancer Risk	HRSA Chronic Health (9)	HRSA PM2.5 Risk	Status/Comments
700	G12073	Spruce Street Car Wash	246 So Spruce Avenue South San Francisco	6.193	0.010	na	0.167211	0.00027		Gasoline Station												0	
400	2483	Bimbo Bakeries USA	264 SO SPRUCE AVENUE South San Francisco	0.19	0.001	14.300																0	
																						0	
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Footnotes:

1. These Cancer Risk, Hazard Index, and PM2.5 columns represent the rows in the Google Earth Plant Information Table that say "Contact District Staff" (Map A above). BAAQMD will return this form to you with this screening level information entered in thes
2. Each plant may have multiple permits and sources.
3. Fuel codes: 98 = diesel, 189 = Natural Gas.
4. Permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc.
5. If a Health Risk Screening Assessment (HRSA) was completed for the source, the application number will be listed here.
6. The date that the HRSA was completed.
7. Engineer who completed the HRSA. For District purposes only.
8. All HRSA completed before 1/5/2010 need to be multiplied by an age sensitivity factor of 1.7.
9. The HRSA "Chronic Health" number represents the Hazard Index.
10. Further information about common sources:
    a. Sources that only include diesel internal combustion engines can be adjusted using the BAAQMD's Diesel Multiplier worksheet.
    b. The risk from natural gas boilers used for space heating when <25 MM BTU/hr would have an estimated cancer risk of one in a million or less, and a chronic hazard index of 0.003 or less. To be conservative, requestor should assume the cancer risk is 1 i
    c. BAAQMD Reg 11 Rule 16 required that all co-residential (sharing a wall, floor, ceiling or is in the same building as a residential unit) dry cleaners cease use of perc on July 1, 2010. Therefore, there is no cancer risk, hazard or PM2.5 concentrations from co-residential dry cleaning businesses in the BAAQMD.
    d. Non co-residential dry cleaners must phase out use of perc by Jan. 1, 2023. Therefore, the risk from these dry cleaners does not need to be factored in over a 70-year period, but instead should reflect the number of years perc use will continue after t
    e. Gas stations can be adjusted using BAAQMD's Gas Station Distance Mulitplier worksheet.
    f. Unless otherwise noted, exempt sources are considered insignificant. See BAAQMD Reg 2 Rule 1 for a list of exempt sources.
    g. This spray booth is considered to be insignificant.

Date last updated:
3/12/12

Bay Area Air Quality Management District

Risk & Hazard Stationary Source Inquiry Form

This form is required when users request stationary source data from BAAQMD. This form is to be used with the BAAQMD's Google Earth stationary source screening tables.

For guidance on conducting a risk & hazard screening, including for roadways & freeways, refer to the District's Risk & Hazard Analysis flow chart.

Also see the District's Recommended Methods for Screening and Modeling Local Risks and Hazards document.

Table A: Requestor Contact Information	
Contact Name:	James A. Reyff
Affiliation:	Illingworth & Rodkin, Inc.
Phone:	707-766-7700
Email:	jreyff@illingworthrodkin.com
Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

For Air District assistance, the following steps must be completed:

Complete all the contact and project information requested in Table A. Incomplete forms will not be processed. Please include a project site map.

Download and install the free program Google Earth, http://www.google.com/earth/download/ge/, and then download the county specific Google Earth stationary source application files from the District's website, http://www.baaqmd.gov/Divisions/Planning-and-Research/CEQA-GUIDELINES/Tools-and-Methodology.aspx.

The small points on the map represent stationary sources permitted by the District (Map A on right). These permitted sources include diesel back-up generators, gas stations, dry cleaners, boilers, printers, auto spray booths, etc. Click on a point to view the source's Information Table, including the name, location, and preliminary estimated cancer risk, hazard index, and PM2.5 concentration.

Find the project site in Google Earth by inputting the site's address in the Google Earth search box.

Using the Google Earth ruler function, measure the distance in feet between the project's fenceline and the stationary source's fenceline for all the sources that are within 1,000 feet of the project's fenceline. Verify that the location of the source on the map matches with the source's address in the Information Table, by using the Google Earth address search box to confirm that the source is within 1,000 feet of the project. Please report any mapping errors to the District (District contact information in Step 9).

If the stationary source is within 1,000 feet of the project's fenceline and the stationary source's information table does not list the cancer risk, hazard index, and PM2.5 concentration, and instead says to "Contact District Staff", list the stationary source information in Table B Section 1 below.

Note that a small percentage of the stationary sources have Health Risk Screening Assessment (HRSA) data INSTEAD of screening level data. These sources will be noted by an asterisk next to the Plant Name (Map B on right). If HRSA values are presented, these values have already been modeled and cannot be adjusted further.

Email this completed form to District staff (Step 9). District staff will provide the most recent risk, hazard, and PM2.5 data that are available for the source(s). If this information or data are not available, source emissions data will be provided. Staff will respond to inquiries within three weeks.

Note that a public records request received for the same stationary source information will cancel the processing of your SSIF request.

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Map A: Snapshot of Google Earth with Plant 20248 Information Table Selected

Table B: Stationary Sources within 1,000 feet of Receptor that say "Contact District Staff"

Table B Section 1: Requestor fills out these columns based on Google Earth data				Table B Section 2: BAAQMD returns form with additional information in these columns as needed														
Distance from Receptor (feet)	**Plant # or Gas Dispensary #**	**Facility Name**	**Street Address**	**Screening Level Cancer Risk (1)**	**Screening Level Hazard Index (1)**	**Screening Level PM2.5 (1)**	**Permit #s (2)**	**Source #s (2)**	**Fuel Code (3)**	**Type of Source(s) (4)**	**HRSA Ap # (5)**	**HRSA Date (6)**	**HRSA Engineer (7)**	**HRSA Cancer Risk in a million**	**Age Sensitivity Factor (8)**	**HRSA Adjusted Cancer Risk**	**HRSA Chronic Health (9)**	**HRSA PM2.5 Risk**	**Status/Comments**
	19262	DaVita	1178 CHERRY AVENUE San Bruno	4.02	0.001	0.001												0	
																		0	
																		0	
																		0	
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																		0	

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10. Further information about common sources:
    a. Sources that only include diesel internal combustion engines can be adjusted using the BAAQMD's Diesel Multiplier worksheet.
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    e. Gas stations can be adjusted using BAAQMD's Gas Station Distance Mulitplier worksheet.
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Date last updated:
3/12/12

Bay Area Air Quality Management District

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Date of Request	4/9/2012
Project Name:	Regional Groundwater Storage and
Address:	various
City:	
County:	
Type (residential, commercial, mixed use, industrial, etc.):	Public Works - Pump Stations
Project size (# of units, or building square feet):	<3,000 sf
Comments:	

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500	G6250	San Francisco Water Department	1000 El Camino Real Millbrae	0.361	0.001	na	0.02	0.00		Gasoline Station												0	
950	G2970	Olympic	1009 El Camino Real Millbrae	83.15	0.138	na	**2.25**	**0.00**		Gasoline Station												0	
130	19283	Orchard Supply Hardware	900 EL CAMINO REAL Millbrae	4.05	0.001	0.001	**2.35**	**0.00**	**0.00**	Generator												0	
	4998	Holiday Cleaners of America	1050 BROADWAY Millbrae	0.00	0.00	0.00																0	
500	19194	San Francisco Public Utilities Commissio	1000 EL CAMINO REAL Millbrae	No data	No data	No data																0	
700	19561	Verizon Wireless (SFO West)	1009A HEMLOCK DRIVE Millbrae	No data	No data	No data																0	
																						0	
																						0	
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    e. Gas stations can be adjusted using BAAQMD's Gas Station Distance Mulitplier worksheet.
    f. Unless otherwise noted, exempt sources are considered insignificant. See BAAQMD Reg 2 Rule 1 for a list of exempt sources.
    g. This spray booth is considered to be insignificant.

Date last updated:
3/12/12

Cancer Risk and Chronic Hazard Index Distance Adjustment Multiplier for Diesel IC Engines			
Meters	Feet		Multiplier
25	83		0.85
30	99		0.73
35	116		0.64
40	132		0.58
50	165		0.5
60	198		0.41
70	231		0.31
80	264		0.28
90	297		0.25
100	330		0.22
110	363		0.18
120	396		0.16
130	429		0.15
140	462		0.14
150	495		0.12
160	528		0.1
180	594		0.09
200	661		0.08
220	727		0.07
240	793		0.06
260	859		0.05
280	925		0.04

Cancer Risk and Chronic Hazard Index Distance Adjustment Multiplier for Gasoline Dispensing Facilities						
Meters	Feet	Multiplier		Meters	Feet	Multiplier
20	66	1		140	459	0.052
25	82	0.728		145	476	0.049
30	98	0.559		150	492	0.046
35	115	0.445		155	509	0.044
40	131	0.365		160	525	0.042
45	148	0.305		165	541	0.04
50	164	0.26		170	558	0.038
55	180	0.225		175	574	0.036
60	197	0.197		180	591	0.034
65	213	0.174		185	607	0.033
70	230	0.155		190	623	0.031
75	246	0.139		195	640	0.03
80	262	0.126		200	656	0.029
85	279	0.114		205	673	0.028
90	295	0.104		210	689	0.027
95	312	0.096		220	722	0.025
100	328	0.088		230	755	0.023
110	361	0.076		250	820	0.02
120	394	0.066		270	886	0.018
130	427	0.058		290	951	0.016

Table B: Stationary Sources within 1,000 feet of Receptor that say "Contact District Staff"

Table B Section 1: Requestor fills out these columns based on Google Earth data				Table B Section 2: BAAQMD returns form with additional information in these columns as needed															
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Site 13																			
700	G12073	Spruce Street Car Wash	246 So Spruce Avenue South San Francisco	6.193	0.010	na												0	
400	2483	Bimbo Bakeries USA	264 SO SPRUCE AVENUE South San Francisco	0.19	0.001	14.300		various baking things										0	use screening level or see emissions data on next spreadsheet in workbook
Site 16																		0	
500	19194	San Francisco Public Utilities Commissio	1000 EL CAMINO REAL Millbrae	No data	No data	No data				1 Diesel engine	18529	8/11/2008	ICS	1.3	1.7	2.21	7.8 E-4	0.0069279	use HRSA values
700	19561	Verizon Wireless (SFO West)	1009A HEMLOCK DRIVE Millbrae	No data	No data	No data				1 Diesel engine generator	20184	4/15/2009	JAC	5.6	1.7	7.3	3.4 E-03	0.022884013	use HRSA values
																		0	
																		0	
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    g. This spray booth is considered to be insignificant.

Date last updated:
3/12/12

Bimbo Bakeries USA (P# 2483)

S# SOURCE NAME
MATERIAL SOURCE CODE
THROUGHPUT DATE POLLUTANT CODE LBS/DAY

---

1 Peterson 100 Foot Tunnel Oven
C6250189
Benzene 41 7.01E-06
Formaldehyde 124 8.24E-05
Toluene 293 3.74E-06
Organics (part not spec el 990 6.29E-03
Particulates (portion of t 1990 6.59E-02
Nitrous Oxide (N2O) 2030 5.08E-03
Nitrogen Oxides (part not 2990 3.08E+00
Sulfur Dioxide (SO2) 3990 1.25E-02
Carbon Monoxide (CO) pollu 4990 7.69E-01
Carbon Dioxide, non-biogen 6960 2.69E+03
Methane (CH4) 6970 6.26E-03
G1025109
Organics (part not spec el 990 2.54E-03
Carbon Dioxide, non-biogen 6960 1.21E-01
3 Baking Oven
C6250189
0 0.00E+00
G1025319
0 0.00E+00
4 Johnston Steam Boiler
C1240189
Benzene 41 6.52E-06
Formaldehyde 124 2.33E-04
Toluene 293 1.06E-05
Organics (part not spec el 990 9.07E-03
Particulates (portion of t 1990 9.32E-03
Nitrous Oxide (N2O) 2030 7.18E-04
Nitrogen Oxides (part not 2990 1.09E-01
Sulfur Dioxide (SO2) 3990 1.77E-03
Carbon Monoxide (CO) pollu 4990 1.09E-01
Carbon Dioxide, non-biogen 6960 3.80E+02
Methane (CH4) 6970 5.90E-03
5 Floor Silo Holding Tanks #4
G1999109
Particulates (portion of t 1990 3.72E+00
6 Floor Silo Holding Tanks #3
G1999109
Particulates (portion of t 1990 3.74E+00
7 Floor Silo Holding Tanks #2

G1999350

Particulates (portion of t 1990 9.34E-02

8 Flour Silo Holding Tanks #1

G1999350

Particulates (portion of t 1990 9.34E-02

9 APV Baker Tray Oven

C1650189

Benzene 41 1.23E-05

Formaldehyde 124 1.44E-04

Toluene 293 6.54E-06

Organics (part not spec el 990 1.10E-02

Particulates (portion of t 1990 1.15E-01

Nitrous Oxide (N2O) 2030 8.89E-03

Nitrogen Oxides (part not 2990 5.39E+00

Sulfur Dioxide (SO2) 3990 2.19E-02

Carbon Monoxide (CO) pollu 4990 1.35E+00

Carbon Dioxide, non-biogen 6960 4.71E+03

Methane (CH4) 6970 1.10E-02

-6 Catalytic Oxidation System

C8360189

Benzene 41 6.16E-05

Formaldehyde 124 7.24E-04

Toluene 293 3.28E-05

Organics (part not spec el 990 5.52E-02

Particulates (portion of t 1990 2.90E-02

Nitrous Oxide (N2O) 2030 2.23E-03

Nitrogen Oxides (part not 2990 1.35E+00

Sulfur Dioxide (SO2) 3990 5.49E-03

Carbon Monoxide (CO) pollu 4990 3.38E-01

Carbon Dioxide, non-biogen 6960 1.18E+03

Methane (CH4) 6970 1.83E-02

PLANT TOTAL:

lbs/day Pollutant

8.74E-05 Benzene (41)

8.97E+03 Carbon Dioxide, non-biogenic CO2 (6960)

2.56E+00 Carbon Monoxide (CO) pollutant (4990)

1.18E-03 Formaldehyde (124)

4.15E-02 Methane (CH4) (6970)

9.93E+00 Nitrogen Oxides (part not spec elsewhere) (2990)

1.69E-02 Nitrous Oxide (N2O) (2030)

8.41E-02 Organics (part not spec elsewhere) -- including Methane (990)

7.86E+00 Particulates (portion of total not spec elsewhere) (1990)

4.16E-02 Sulfur Dioxide (SO2) (3990)

5.37E-05 Toluene (293)

GSR - Site 16 MEI Location
Cumulative Analysis
ISCST3 Railroad DPM Risk Modeling Parameters and Maximum Cancer Risk at MEI

Receptor Information

Number of Receptors	3
Receptor Height =	1.5 m
Receptor distances =	NA

Meteorological Conditions

San Francisco Airport Hourly Met Data	1991 - 1995
Land Use Classification	Urban
Wind speed =	variable
Wind direction =	variable

Cancer Risk Calculation Method

Inhalation Dose = C_{air} x DBR x A x EF x ED x 10^{-6} / AT

Where: C_{air} = concentration in air ($\mu g/m^3$)
DBR = daily breathing rate (L/kg body weight-day)
A = Inhalation absorption factor
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
AT = Averaging time period over which exposure is averaged.
10^{-6} = Conversion factor

Inhalation Dose Factors

	Value[1]							
Exposure Type	**DBR (L/kg BW-day)**	**A (-)**	**Exposure (hr/day)**	**Exposure (days/week)**	**Exposure (week/year)**	**EF (days/yr)**	**ED (Years)**	**AT (days)**
Residential (70-Year)	302	1	24	7	50	350	70	25,550

[1] Default values recommended by OEHHA& Bay Area Air Quality Management District

Cancer Risk (per million) = Inhalation Dose x CRAF x CPF x 10^6
= URF x Cair

Where: CPF = Cancer potency factor $(mg/kg\text{-}day)^{-1}$
URF =Unit risk factor (cancer risk per $\mu g/m^3$)

Unit Risk Factors (unadjusted for age sensitivity) for DPM

Exposure Type	**CPF $(mg/kg\text{-}day)^{-1}$**	***DPM***
Residential (70-Yr Exposure)	1.10E+00	318.5

MEI Cancer Risk Calculations

Meteorological Data Year	**Maximum Annual DPM Concentration ($\mu g/m^3$)** 2014-2025		**2025***
1991 - 1995	0.0259		0.0000
Cancer Risk[a]	8.24		0.00
Sensitivity Weighting Factors	0.696		0.993
Contribution to Total Cancer Risk	5.74		0.0
70-yr Cumulative Risk [b]	***5.7***		

Notes:
* DPM concentration expected to be negligible due to train electrification
Receptor Heights = 1.5 m
Maximum DPM & PM2.5 concentrations occur at the residences closest to the rail line
a Cancer risk (per million) calculated assuming a 70-year exposure to concentration for year of analysis.
b Cumulative cancer risk (per million) calculated assuming variable exposure over a 70-year period due to decreased concentrations over time.

Exposure Period Sensitivity Weighting Factors for Modeling Periods

Calendar Year	Exposure Year	Age Sensitivity Factors 10	3	1	Sensitivity Weighting Factor	Emissions Period Weighting Factor
2014	1	1.0	0.0	0.0	0.143	
2015	2	1.0			0.143	
2016	3	0.25	0.75		0.068	
2017	4		1.0		0.043	
2018	5		1.0		0.043	
2019	6		1.0		0.043	
2020	7		1.0		0.043	
2021	8		1.0		0.043	
2022	9		1.0		0.043	
2023	10		1.0		0.043	
2024	11		1.0		0.043	**0.696**
2025	12		1.0		0.043	
2026	13		1.0		0.043	
2027	14		1.0		0.043	
2028	15		1.0		0.043	
2029	16		1.0		0.043	
2030	17		0.25	0.75	0.021	
2031	18			1.0	0.014	
2032	19			1.0	0.014	
2033	20			1.0	0.014	
2034	21			1.0	0.014	
2035	22			1.0	0.014	
2036	23			1.0	0.014	
2037	24			1.0	0.014	
2038	25			1.0	0.014	
2039	26			1.0	0.014	
2040	27			1.0	0.014	
2041	28			1.0	0.014	
2042	29			1.0	0.014	
2043	30			1.0	0.014	
2044	31			1.0	0.014	
2045	32			1.0	0.014	
2046	33			1.0	0.014	
2047	34			1.0	0.014	
2048	35			1.0	0.014	
2049	36			1.0	0.014	
2050	37			1.0	0.014	
2051	38			1.0	0.014	
2052	39			1.0	0.014	
2053	40			1.0	0.014	
2054	41			1.0	0.014	
2055	42			1.0	0.014	
2056	43			1.0	0.014	
2057	44			1.0	0.014	
2058	45			1.0	0.014	

2059	46	1.0	0.014		
2060	47	1.0	0.014		
2061	48	1.0	0.014		
2062	49	1.0	0.014		
2063	50	1.0	0.014		
2064	51	1.0	0.014		
2065	52	1.0	0.014		
2066	53	1.0	0.014		
2067	54	1.0	0.014		
2068	55	1.0	0.014		
2069	56	1.0	0.014		
2070	57	1.0	0.014		
2071	58	1.0	0.014		
2072	59	1.0	0.014		
2073	60	1.0	0.014		
2074	61	1.0	0.014		
2075	62	1.0	0.014		
2076	63	1.0	0.014		
2077	64	1.0	0.014		
2078	65	1.0	0.014		
2079	66	1.0	0.014		
2080	67	1.0	0.014		
2081	68	1.0	0.014		
2082	69	1.0	0.014		
2083	70	1.0	0.014	**0.993**	2025 - 2084
Total			1.689	1.689	

Acute Health Effects from Rail Line Emissions at Site 16 MEI Location

			Site 16 MEI	
Chemical	Fraction of VOC	Acute REL (ug/m3)	Chemical Concentration (ug/m^3)	Hazard Index
Acetaldehyde	0.15942	470	0.174	0.0004
Acrolein	0.01297	2.5	0.014	0.0057
Benzene	0.01045	1,300	0.011	0.0000
Formaldehyde	0.08505	55	0.093	0.0017
Methyl Ethyl Ketone (2-butanone)	0.02860	13,000	0.031	0.0000
Toluene	0.01579	37,000	0.017	0.0000
Xylenes	0.012052	2,200	0.013	0.0000
Total Hazard Index				**0.008**

Note: Speciation fractions from USEPA Speciation Profile 4674 for Medium Duty Trucks

Max 1-hr ROG Conc. (ug/m^3) = 1.09

Appendix 6
Communications with BAAQMD

Subject: FW: Fwd: Public Records Request Number. 2012-06-0072
From: Alison Kirk <AKirk@baaqmd.gov>
Date: 6/20/2012 10:23 AM
To: "jreyff@illingworthrodkin.com" <jreyff@illingworthrodkin.com>

Hello,

Attached please find your completed SSIF request. Please let me know if you have any questions. I'm in until Friday and then out for 2 weeks.

Alison Kirk
415-749-5169

From: Andrea Gordon
Sent: Thursday, June 14, 2012 3:24 PM
To: Alison Kirk
Cc: jreyff@illingworthrodkin.com
Subject: FW: Fwd: Public Records Request Number. 2012-06-0072

Alison,

Here's a SSIF received today from James Reyff, please process as necessary.

Thank you.

Andrea

From: jreyff@illingworthrodkin.com [mailto:jreyff@illingworthrodkin.com]
Sent: Thursday, June 14, 2012 12:19 PM
To: Andrea Gordon
Subject: Fwd: Fwd: Public Records Request Number. 2012-06-0072

Hi Andrea,
Please disregard the previous SSIF form request (sent yesterday) and use this one. I found two other sources that there were no data included in the database, but it appears there are electronic copies of the HRSAs. This should do it.

Thanks.

James A. Reyff
Illingworth Rodkin, Inc.
505 Petaluma Blvd South
Petaluma CA 94952
707-766-7700x24

-------- Original Message --------
Subject: Fwd: Public Records Request Number. 2012-06-0072
Date: Wed, 13 Jun 2012 17:35:07 -0700
From:jreyff@illingworthrodkin.com <jreyff@illingworthrodkin.com>

To: Andrea Gordon <AGordon@baaqmd.gov>

Hi Andrea,
I went through the database of BAAQMD screening stationary sources and found this source to be a potential problem for our project because of the super high PM2.5 concentration = 14 ug/m**3.

Attached is a SSIF form with the source and I am hoping you might find more information. Also, I did a public records request for the site, as you can see from the link below.

Thanks.

James A. Reyff
Illingworth Rodkin, Inc.
505 Petaluma Blvd South
Petaluma CA 94952
707-766-7700x24

-------- Original Message --------
Subject: Public Records Request Number. 2012-06-0072
Date: 13 Jun 2012 20:27:03 -0400
From: publicrecords@baaqmd.gov
To: jreyff@illingworthrodkin.com

Dear James Reyff:

We have received your public records request of 6/13/2012 5:27:02 PM PST. We have assigned 2012-06-0072 as your Request Number in order to track your request. You requested the following:

Facility Information
Facility ID: 2483
Facility Name: Bimbo Bakeries USA
Facility Street: 264 SO SPRUCE AVENUE
Facility City: South San Francisco
Facility State: CA
Period Covered: 2009-2012

Print Outs Requested

- Permit Application

Other Requests: Permit evaluation and Permit We are trying to determine the PM2.5 emissions from the facility

Within 10 days we will determine whether you have requested disclosable records. If we need more time to make that determination, we will let you know within 10 days. If your request is unclear we will also contact you within the 10 days.

If you have requested disclosable records, and your request is simple, we may respond within 10 days by providingyou with the records requested or with our finding tht we have no records. If you have requested disclosable records and your request is more complicated, we will notify you promptly of our determination and provide your with our estimate of when the records will be made available.

If you have requested records that are exempt from disclosure, we will explain why the records are being withheld.

You can follow our progress in responding to your request by using the PRA Login webpage.

Username: jreyff@illingworthrodkin.com
Password: b491e68f

Sincerely,
Rochelle Henderson Reed
Public Records Section
BAAQMD

Attachments:

GSR Site 13&16 SSIF Request.xls	630 KB

From: James Cordova [mailto:JCordova@baaqmd.gov]
Sent: Monday, April 23, 2012 12:35 PM
To: Bill Popenuck
Subject: RE:

Hi Bill,

I am finally back in the office after a week off.

Based on the locations of your sites, I would use Ft. Funston for Sites 1 – 7. For sites 8 through 16, I would use KSFO data. I have ISC formatted data for KSFO for the years 1991 through 1995. Just submit a Public Records Request for these data and I will send them to you.

I hope all is going well for you.

Jim

From: Bill Popenuck [mailto:popenuck@starband.net]
Sent: Monday, April 16, 2012 5:44 PM
To: James Cordova
Cc: James Reyff
Subject:

Hi Jim,

I'm working on a CEQA analysis for construction of a series of groundwater pumping facilities that will be constructed in Daly City, Colma, South San Francisco, San Bruno, Millbrae, and unincorporated San Mateo County. I'm evaluating 19 sites (16 proposed sites and 3 alternate sites) in these areas. The locations of these sites are shown in the attached figure, and the approximate UTM coordinates (NAD83) are listed below:

	UTM NAD83	
Site No.	UTM - East	UTM - North
1	546500.00 m E	4172900.00 m N
2	545859.00 m E	4172158.00 m N
3	545742.00 m E	4172027.00 m N
4	545847.00 m E	4171936.00 m N
5	546760.00 m E	4171020.00 m N
6	546986.00 m E	4170786.00 m N
7	547298.00 m E	4170351.00 m N
8	547644.00 m E	4169883.00 m N
8a	547790.00 m E	4169717.00 m N
9	548652.00 m E	4169020.00 m N
10	548188.00 m E	4168872.00 m N
10a	548253.00 m E	4168550.00 m N
11	549682.00 m E	4167979.00 m N
12	550095.00 m E	4167377.00 m N
12a	549948.00 m E	4167438.00 m N
13	551032.00 m E	4166632.00 m N
14	550353.00 m E	4165656.00 m N
15	550579.00 m E	4165422.00 m N
16	553509.00 m E	4162308.00 m N

I will be evaluating potential health risks associated with facility construction at each site. Construction of each site is expected to take a little more than one year. I will be modeling toxic air contaminant (TAC) emissions during construction of each site in order to evaluate cancer and non-cancer health risks to nearby sensitive receptors. Currently, I plan on using the ISCST3 model for the dispersion modeling. However, use of the AERMOD model is also possible depending on available meteorological data for use with this model.

Based on the District's Meteorological Data web page, meteorological data in the project region for use with the ISCST3 model is available for the San Francisco Sewage Treatment Plant (STP), Fort Funston, and the San Mateo STP. In reviewing the District's County Surface Street Screening Tables for computing cancer risk and PM2.5 from traffic for San Francisco and San Mateo County roadways, meteorological data from the San Francisco STP was used in developing the screening table values for San Francisco County roads and meteorological data from the San Mateo STP was used for the screening table values for San Mateo roads.

Given that many of the project sites, in particular Sites 1 - 10a, are closer to Fort Funston than the San Francisco STP, use of the Fort Funston meteorological data appears more appropriate for use in modeling these sites. For the remaining sites, Sites 11 - 16, the San Mateo STP meteorological data would appear to be the most appropriate to use for modeling given the available data.

What meteorological data would the District recommend for use in modeling the project sites? Also, are other meteorological data available from the District (e.g., San Francisco Airport) for use with the ISCST3 model or the AERMOD model that would be more appropriate than the data discussed above.

Thanks,
Bill Popenuck
(707) 488-3935

-------- Original Message --------

Subject: RE: Questions on TACs
Date: Wed, 30 Mar 2011 15:43:30 -0700
From: Virginia Lau <VLau@baaqmd.gov>
To: Sigalle Michael <smichael@baaqmd.gov>, "jreyff@illingworthrodkin.com" <jreyff@illingworthrodkin.com>

Hi Jeff - we do not recommend doing an acute hazard estimation from construction activities. You would need to evaluate TAC emissions from construction activities for cancer and chronic hazard - the speciation table that was used in our construction calculator is attached. When noted with Uk, it is unknown the speciation factor and was not included in the calculation.

TAC Name	Speciation Factor
DPM	NA
PM2.5	NA
acetaldehyde	0.07353
acrolein	0.01297
benzaldehyde	0.00699
benzene	0.02001
ethanol	0.00009
ethylbenzene	0.00305
ethylene	0.14377
ethylene dibromide (1,2-dibromoethane)	Uk
ethylene dichloride (1,2-dichloroethane)	Uk
ethylene glycol	Uk
ethylene oxide (1,2-epoxyethane)	Uk
ethylene thiourea	Uk
ethylene glycol butyl ether	Uk
ethylene glycol ethyl ether	Uk
ethylene glycol ethyl ether acetate	Uk
ethylene glycol methyl ether	Uk
ethylene glycol methyl ether acetate	Uk
formaldehyde	0.14714
isobutane	0.01222
isopentane	0.00602
methane	0.04084
methyl ethyl ketone (mek) (2-butanone)	0.01477
methylcyclopentane	0.00149
m-xylene	0.00611
n-butane	0.00104
n-hexane	0.00157
n-pentane	0.00175
o-xylene	0.00335
propionaldehyde	0.0097
propylene	0.02597
propylene glycol monomethyl ether	uk
propylene oxide	uk
toluene	0.01473

Virginia Lau
Bay Area Air Quality Management District
939 Ellis Street

San Francisco, CA 94109
Phone: (415) 749-4696
Fax: (415) 749-4741
E-mail: vlau@baaqmd.gov

-----Original Message-----
From: Sigalle Michael
Sent: Wednesday, March 30, 2011 12:22 PM
To: jreyff@illingworthrodkin.com
Cc: Virginia Lau
Subject: RE: Questions on TACs

HI James,
We do not yet have screening tables for railroads, but will let you know once they are available. I cc'ed Virginia Lau on this email, she should be able to help you with your acrolein question.
~sigalle

Sigalle Michael
Senior Environmental Planner
smichael@baaqmd.gov | 415-749-4683

-----Original Message-----
From: jreyff@illingworthrodkin.com [mailto:jreyff@illingworthrodkin.com]
Sent: Wednesday, March 30, 2011 11:58 AM
To: Sigalle Michael
Subject: Questions on TACs

Hi Sigalle,
Hope you are getting a chance to enjoy some of this long awaited spring weather. Sorry to bug you with a few questions:

I'm checking in to see if the District has developed any guidance on train impacts. I believe there was some mention of this a while ago.
We have some clients who are wondering if this is an issue for them to develop near tracks. We have modeled some train activity south of San Jose, but have found that train assumptions are difficult to determine (i.e., number of locomotives, types, age, power setting, and speed).
The impacts look pretty substantial. In addition, we are not sure what CalTrain status is for electrifying the line.

Also, the issue of addressing acute exposures associated with acrolein from construction has come up. The District's Jan 2010 Health Risk Analysis Guidelines do not address acrolein, because of the lack of reliable emissions data. The questions is - should we be looking at acolein for construction and if so, what speciation factors should we use for EMFAC diesel emissions?

I appreciate any guidance you can provide.

--
James A. Reyff
Illingworth& Rodkin, Inc.
505 Petaluma Blvd. South
Petaluma, CA 94952
ph 707.766.7700x24
fx 707.766.7790

Appendix 7
Site Specific Facility Characteristics

TABLE 3-3
Site-Specific Facility Characteristics

Site ID	Site Name	Facility Type[(a)]	Pump Type/ Capacity (gpm)[(b)]	Proposed Connection Point	Alternate Connection Point	Proposed On-Site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site 1	Lake Merced Golf Club	Well plus chemical treatment, 4 rooms	Aboveground Vertical Turbine/ 300-600	SFPUC	Daly City	Disinfection, pH adjustment, (if needed), fluoridation	At site	Treatment not required.
Site 2	Park Plaza Meter	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	Daly City	None	Treatment not required	Westlake Pump Station	Treatment not required.
Site 3	Ben Franklin Intermediate School	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	Daly City	None	Treatment not required	Westlake Pump Station	Treatment not required.
Site 4	Garden Village Elementary School	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	Daly City	None	Treatment not required	Westlake Pump Station	Treatment not required.
Westlake Pump Station	Westlake Pump Station	Pump station and treatment upgrade	Up to 3 new booster pumps	Daly City	None	Disinfection, fluoridation	At site	Treatment not required.
Site 5 (Consolidated Treatment at Site 6)	Right-of-Way at Serra Bowl	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	SFPUC	None	Treatment not required	At Site 6	Treatment at Site 6
Site 6 (Consolidated Treatment at Site 6)	Right-of-Way at Colma BART	Well plus chemical treatment and filtration, 5 rooms	Aboveground Vertical Turbine/ 300-600	SFPUC	Cal Water	Disinfection, pH adjustment fluoridation, iron/manganese removal	At Site 6	Treatment

TABLE 3-3
Site-Specific Facility Characteristics

Site ID	Site Name	Facility Type[(a)]	Pump Type/ Capacity (gpm)[(b)]	Proposed Connection Point	Alternate Connection Point	Proposed On-Site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site 7 (Consolidated Treatment at Site 6)	Right-of-Way at Colma Boulevard	Well with fenced enclosure	Submersible Vertical Turbine/ 300-600	SFPUC	None	Treatment not required	At Site 6	Treatment at Site 6
Site 5 (On-Site Treatment)	Right-of-Way at Serra Bowl	Well plus chemical treatment, 5 rooms	Aboveground Vertical Turbine/ 300-600	SFPUC	Daly City	Disinfection, pH adjustment, fluoridation, iron/manganese removal	At site	Treatment not required.
Site 6 (On-Site Treatment)	Right-of-Way at Colma BART	Well plus chemical treatment, 5 rooms	Aboveground Vertical Turbine/ 300-600	SFPUC	Cal Water	Disinfection, pH adjustment, fluoridation, iron/manganese removal	At site	Treatment not required.
Site 7 (On-Site Treatment)	Right-of-Way at Colma Boulevard	Well plus chemical treatment, 5 rooms	Aboveground Vertical Turbine/ 300-600	SFPUC	Cal Water	Disinfection, pH adjustment, fluoridation, iron/manganese removal	At site	Treatment not required.
Site 8	Right-of-Way at Serramonte Boulevard	Well plus chemical treatment and filtration, 5 rooms	Aboveground Vertical Turbine 300-600	Cal Water	SFPUC	Disinfection, pH adjustment (if needed[d]), fluoridation, iron/manganese removal	At site	Treatment

TABLE 3-3
Site-Specific Facility Characteristics

Site ID	Site Name	Facility Type[(a)]	Pump Type/ Capacity (gpm)[(b)]	Proposed Connection Point	Alternate Connection Point	Proposed On-Site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site 9	Treasure Island Trailer Court	Well plus chemical treatment and filtration, 5 rooms	Aboveground Vertical Turbine/ 200-500	SFPUC	None	Disinfection, pH adjustment fluoridation, iron/manganese removal	At site	Treatment
Site 10	Right-of-Way at Hickey Boulevard	Well plus chemical treatment and filtration, 5 rooms	Aboveground Vertical Turbine/ 200-500	Daly City	SFPUC	Disinfection, pH adjustment (if needed[d]), fluoridation, iron/manganese removal	At site	Treatment
Site 11	South San Francisco Main Area	Well plus chemical treatment and filtration, 5 rooms	Aboveground Vertical Turbine/ 200-500	Cal Water	SFPUC	Disinfection, pH adjustment (if needed[d]) fluoridation, iron/manganese removal	At site	Treatment
Site 12	Garden Chapel Funeral Home	Well plus chemical treatment, 3 rooms	Aboveground Vertical Turbine/ 200-500	SFPUC	Other SFPUC	Disinfection, pH adjustment	At site	Blending[(c)c]
Site 13	South San Francisco Linear Park	Well plus chemical treatment and filtration, 5 rooms	Aboveground Vertical Turbine/ 200-500	San Bruno	Cal Water	Disinfection, fluoridation, iron/manganese removal	At site	Treatment

TABLE 3-3
Site-Specific Facility Characteristics

Site ID	Site Name	Facility Type[(a)]	Pump Type/ Capacity (gpm)[(b)]	Proposed Connection Point	Alternate Connection Point	Proposed On-Site Water Treatment	Disinfection Location	Method for Achieving Water Quality Goals for Iron/Manganese
Site14	Golden Gate National Cemetery	Well with building enclosure	Submersible Vertical Turbine/ 300-600	San Bruno	SFPUC	Treatment not required	At Site 15	Treatment at Site 15
Site 15	Golden Gate National Cemetery	Well plus chemical treatment and filtration, 5 rooms	Aboveground Vertical Turbine/ 300-600	San Bruno	SFPUC	Disinfection, pH adjustment (if needed), fluoridation, iron/manganese removal	At site	Treatment
Site 16	Millbrae Corporation Yard	Well plus chemical treatment, 4 rooms	Aboveground Vertical Turbine/ 100-200	SFPUC	Other SFPUC	Disinfection, pH adjustment, fluoridation	At site	Treatment not required.
Site 17 (Alternate)	Standard Plumbing Supply	Well plus chemical treatment, 3 rooms	Aboveground Vertical Turbine/ 300-600	Cal Water	SFPUC	Disinfection, pH adjustment (if needed[d]) fluoridation	At site	Treatment not required.
Site 18 (Alternate)	Alta Loma Drive	Well plus chemical treatment, 3 rooms	Aboveground Vertical Turbine/ 200-500	SFPUC	Cal Water	Disinfection, pH adjustment (if needed) fluoridation	At site	Treatment not required.
Site 19 (Alternate)	Garden Chapel Funeral Home	Well with fenced enclosure	Submersible Vertical Turbine/ 200-500	SFPUC	Other SFPUC	Treatment not required	At Site 12	Blending[(c)]

a) Well station types are described in the text below and shown on the site plans
b) gpm is gallons per minute
c) Blending is mixing groundwater with other potable supply water
d pH adjustment only needed if alternate connection point is used

Appendix F

Special-status Species Tables

APPENDIX F - SPECIAL-STATUS SPECIES TABLES

The following tables were presented in the biological analysis prepared for the Regional Groundwater Storage and Recovery Project. (Ward 2012). A table of the Special-status Plant and Wildlife Species reported or with potential to occur near Lake Merced is also included. The tables contain federal, State and California Native Plant Society special-status plant and wildlife species recorded for the San Francisco North, San Francisco South, Montara Mountain, and San Mateo U.S. Geological Survey (USGS) 7.5 minute quadrangles. An explanation of all rarity status codes is provided.

Wood Biological Consulting

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Alliaceae - Onion Family				
Allium peninsulare var. *franciscanum* Franciscan onion	Federal: none State: none CNPS: 1B.2 Other: DFG: SP	Occurs in cismontane woodland, valley and foothill grassland. Substrate: clay, often serpentinite. Recorded from San Mateo, Santa Clara, Sonoma.	May-Jun Perennial Herb (bulbiferous)	None: no suitable habitat present.
Apiaceae - Carrot Family				
Sanicula maritima adobe sanicle	Federal: none State: SR CNPS: 1B.1 Other: DFG: Special Plant	Occurs in chaparral, coastal prairie, meadows, valley and foothill grassland Substrate: serpentine, Habitats Note: clay. Recorded from Alameda, Monterey, San Francisco, San Luis Obispo.	Feb-May Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Asteraceae - Sunflower Family				
Centromadia parryi ssp. *congdonii* Congdon's tarplant	Federal: none State: none CNPS: 1B.2 Other: DFG: SP	Occurs in valley and foothill grassland. Substrate: alkaline. Recorded from Alameda, Contra Costa, Monterey, San Luis Obispo, Santa Clara, Santa Cruz, Solano.	May-Nov Annual Herb	None: no suitable habitat present.
Centromadia parryi ssp. *parryi* pappose tarplant	Federal: none State: none CNPS: 1B.2 Other:	Occurs in coastal prairie, meadows, seeps, coastal salt marsh, valley and foothill grassland. Moisture: vernally mesic,Substrate: often alkaline, Recorded from Butte, Colusa, Glenn, Lake, Napa, San Mateo, Solano, Sonoma.	May-Nov Annual Herb	None: no suitable habitat present.

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Cirsium andrewsii Franciscan thistle	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in broadleafed upland forest, coastal bluff scrub, coastal prairie, coastal scrub, mixed evergreen forest, northern coastal scrub Substrate: serpentine. Recorded from Contra Costa, Marin, San Francisco, San Mateo, Sonoma.	Mar-Jul Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Cirsium fontinale var. *fontinale* fountain thistle	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in chaparral, valley and foothill grassland Substrate: serpentine. Recorded from San Mateo.	Jun-Oct Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Cirsium occidentale var. *compactum* compact cobwebby thistle	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in chaparral, coastal dunes, coastal prairie, coastal sage scrub, coastal scrub, coastal strand, northern coastal scrub. Recorded from Monterey, San Francisco, San Luis Obispo.	Apr-Jun Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Eriophyllum latilobum San Mateo woolly sunflower	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in cismontane woodland, foothill woodland Substrate: often on serpentine, roadcuts. Recorded from San Mateo.	May-Jun Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Grindelia hirsutula var. *maritima* San Francisco gumplant	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal bluff scrub, coastal sage scrub, coastal scrub, northern coastal scrub, valley and foothill grassland Substrate: serpentine, Habitats Note: sandy. Recorded from Marin, Monterey, San Francisco, San Luis Obispo, San Mateo, Santa Cruz.	Aug-Sep Perennial Herb	None: marginally suitable habitat present. Would have been detectable during present survey.

Mar 24, 2011

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Helianthella castanea Diablo helianthella	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in broadleafed upland forest, chaparral, cismontane woodland, coastal scrub, foothill woodland, northern coastal scrub, riparian woodland, valley and foothill grassland. Recorded from Alameda, Contra Costa, Marin, San Francisco, San Mateo.	Apr-Jun Perennial Herb	None: marginally suitable habitat present. Would have been detectable during present survey.
Hemizonia congesta ssp. *congesta* pale yellow hayfield tarweed	Federal: none State: none CNPS: 1B.2 Other:	Occurs in northern coastal scrub, valley and foothill grassland. Recorded from Mendocino, Marin, San Francisco, San Mateo, Sonoma.	Apr-Nov Annual Herb	None: marginally suitable habitat present. Would have been detectable during present survey.
Hesperevax sparsiflora var. *brevifolia* short-leaved evax	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal bluff scrub, coastal dunes, coastal strand, northern coastal scrub. Recorded from Humboldt, Marin, Mendocino, San Francisco, Santa Cruz, Sonoma.Also recorded from Oregon.	Mar-Jun Annual Herb	None: marginally suitable habitat present. Would have been detectable during present survey.
Layia carnosa beach layia	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in coastal dunes, coastal scrub, coastal strand. Recorded from Humboldt, Marin, Monterey, San Francisco, Santa Barbara.	Mar-Jul Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Lessingia arachnoidea Crystal Springs lessingia	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in cismontane woodland, coastal scrub, foothill woodland, northern coastal scrub, valley and foothill grassland. Substrate: serpentinite. Recorded from San Mateo, Sonoma.	Jul-Oct Annual Herb	None: no suitable habitat present.

Mar 24, 2011

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Lessingia germanorum San Francisco lessingia	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in coastal scrub, northern coastal scrub. Habitats Note: on remnant dunes. Recorded from San Francisco, San Mateo.	Jun-Nov Annual Herb	None: no suitable habitat present.
Lessingia hololeuca woolly-headed lessingia	Federal: none State: none CNPS: 3 Other: DFG: Special Plant	Occurs in broadleafed upland forest, coastal scrub, lower montane coniferous forest, northern coastal scrub, valley and foothill grassland, yellow pine forest. Substrate: serpentinite, clay. Recorded from Alameda, Marin, Monterey, Napa, San Mateo, Santa Clara, Solano, Sonoma, Yolo.	Jun-Oct Annual Herb	None: no suitable habitat present.
Microseris paludosa marsh microseris	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in cismontane woodland, closed-cone coniferous forest, coastal scrub, valley and foothill grassland. Recorded from Marin, Mendocino, Monterey, San Benito, San Francisco, San Luis Obispo, San Mateo, Santa Cruz, Sonoma.	Apr-Jul Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Monolopia gracilens woodland woollythreads	Federal: none State: none CNPS: 1B.2 Other:	Occurs in chaparral, broadleafed upland forest, cismontane woodland, North Coast coniferous forest, valley and foothill grassland. Substrate: serpentinite in grasslands, Habitats Note: forest openings. Recorded from Contra Costa, Monterey, San Luis Obispo, San Mateo, Santa Clara, Santa Cruz.	Mar-Jul Annual Herb	None: no suitable habitat present.
Pentachaeta bellidiflora white-rayed pentachaeta	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in valley and foothill grassland. Substrate: serpentinite. Recorded from Marin, San Mateo, Santa Cruz.	Mar-May Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.

Wood Biological Consulting

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Stebbinsoseris decipiens Santa Cruz microseris	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in broadleafed upland forest, chaparral, closed-cone coniferous forest, closed-cone pine forest, coastal prairie, coastal scrub, mixed evergreen forest, northern coastal scrub, valley and foothill grassland. Substrate: serpentinite. Recorded from Marin, Monterey, Santa Cruz.	Apr-May Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Boraginaceae - Borage Family				
Amsinckia lunaris bent-flowered fiddleneck	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in cismontane woodland, coastal bluff scrub, foothill woodland, valley and foothill grassland. Recorded from Alameda, Colusa, Contra Costa, Lake, Marin, Napa, San Benito, San Mateo, Santa Clara, Santa Cruz, Yolo.	Mar-Jun Annual Herb	None: marginally suitable habitat present. Would have been detectable during present survey.
Plagiobothrys chorisianus var. *chorisianus* Choris's popcorn-flower	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in chaparral, coastal prairie, coastal scrub, northern coastal scrub Moisture: moist. Recorded from Alameda, San Francisco, San Mateo, Santa Cruz.	Mar-Jun Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Plagiobothrys diffusus San Francisco popcorn-flower	Federal: none State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in coastal prairie, valley and foothill grassland. Recorded from Alameda, San Francisco, Santa Cruz.	Mar-Jun Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.

Mar 24, 2011

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Plagiobothrys glaber hairless popcorn-flower	Federal: none State: none CNPS: 1A * Other: DFG: Special Plant	Occurs in coastal salt marsh, meadows. Substrate: alkaline. Recorded from Alameda, Marin, Merced, San Benito, Santa Clara.	Mar-May Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Caryophyllaceae - Pink Family				
Arenaria paludicola marsh sandwort	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in bogs and fens, freshwater marsh, marshes and swamps. Recorded from Los Angeles, Mendocino, San Bernardino, San Francisco, San Luis Obispo, Santa Cruz.Also recorded from Washington.	May-Aug Perennial Herb (stoloniferous)	None: no suitable habitat present.
Silene verecunda ssp. *verecunda* San Francisco campion	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in chaparral, coastal bluff scrub, coastal prairie, coastal scrub, northern coastal scrub, valley and foothill grassland. Recorded from San Francisco, San Mateo, Santa Cruz.	Mar-Aug Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Cyperaceae - Sedge Family				
Carex comosa bristly sedge	Federal: none State: none CNPS: 2.1 Other: DFG: Special Plant	Occurs in coastal prairie, freshwater marsh, marshes and swamps, valley and foothill grassland. Recorded from Contra Costa, Lake, Mendocino, San Bernardino, San Francisco, San Joaquin, Santa Cruz, Shasta, Sonoma.Also recorded from Idaho, Oregon, Washington.	May-Sep Perennial Herb (rhizomatous)	None: no suitable habitat present.

Mar 24, 2011

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Equisetaceae - Horsetail Family				
Equisetum palustre marsh horsetail	Federal: none State: none CNPS: 3 Other: DFG: Special Plant	Occurs in freshwater marsh, marshes and swamps. Recorded from Lake, Napa, San Francisco, San Mateo.Also recorded from Idaho, Oregon, Washington.	Unknown Perennial Herb (rhizomatous)	None: no suitable habitat present. Would have been detectable during present survey.
Ericaceae - Heath Family				
Arctostaphylos andersonii Anderson's manzanita	Federal: none State: none CNPS: 1B.2 Other: DFG: SP	Occurs in broadleafed upland forest, chaparral, mixed evergreen forest, North Coast coniferous forest, redwood forest. Recorded from San Mateo, Santa Clara, Santa Cruz.	Nov-Apr Shrub (evergreen)	None: no suitable habitat present. Would have been detectable during present survey.
Arctostaphylos franciscana Franciscan manzanita	Federal: none State: none CNPS: 1B.1 Other: DFG: SP	Occurs in coastal scrub, northern coastal scrub Substrate: serpentine. Recorded from San Francisco.	Feb-Apr Shrub (evergreen)	None: no suitable habitat present. Would have been detectable during present survey.
Arctostaphylos imbricata San Bruno Mountain manzanita	Federal: none State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in chaparral, coastal scrub. Recorded from San Mateo.	Feb-May Shrub (evergreen)	None: no suitable habitat present. Would have been detectable during present survey.

Mar 24, 2011

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Arctostaphylos montana ssp. *ravenii* Presidio manzanita	Federal: FE State: SE CNPS: 1B.1 Other: DFG: SP	Occurs in chaparral, coastal prairie, coastal scrub, northern coastal scrub Substrate: serpentine. Recorded from San Francisco.	Feb-Mar Shrub (evergreen)	None: no suitable habitat present. Would have been detectable during present survey.
Arctostaphylos montaraensis Montara manzanita	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in chaparral, coastal scrub, northern coastal scrub. Recorded from San Mateo.	Jan-Mar Shrub (evergreen)	None: no suitable habitat present. Would have been detectable during present survey.
Arctostaphylos pacifica Pacific manzanita	Federal: none State: SE CNPS: 1B.2 Other:	Occurs in chaparral, coastal scrub. Recorded from San Mateo. Additional distribution: known only from San Bruno Mt.	Feb-Apr Evergreen Shrub	None: no suitable habitat present. Would have been detectable during present survey.
Arctostaphylos regismontana Kings Mountain manzanita	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in broadleafed upland forest, chaparral, mixed evergreen forest, North Coast coniferous forest. Substrate: granitic sedimentary sandstone. Recorded from San Mateo, Santa Clara, Santa Cruz.	Jan-Apr Shrub (evergreen)	None: no suitable habitat present. Would have been detectable during present survey.

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Fabaceae - Legume Family				
Astragalus nuttallii var. *nuttallii* Nuttall's milk-vetch	Federal: none State: none CNPS: 4.2 Other: DFG: SP	Occurs in coastal bluff scrub, coastal dunes. Recorded from Alameda, Monterey, San Francisco, San Luis Obispo, San Mateo, Santa Barbara.	Jan-Nov Perennial Herb	None: no suitable habitat present.
Astragalus pycnostachyus var. *pycnostachyus* coastal marsh milk-vetch	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal dunes, marshes and swamps. Moisture: mesic, Habitats Note: coastal salt marshes, streamsides. Recorded from Humboldt, Marin, San Mateo.	Apr-Oct Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Astragalus tener var. *tener* alkali milk-vetch	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in alkali sink, playas, valley and foothill grassland, vernal pools. Substrate: adobe clay, alkaline. Recorded from Alameda, Contra Costa, Merced, Monterey, Napa, San Benito, San Francisco, San Joaquin, Santa Clara, Solano, Sonoma, Stanislaus, Yolo.	Mar-Jun Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Lupinus arboreus var. *eximius* San Mateo tree lupine	Federal: none State: none CNPS: 3.2 Other:	Occurs in chaparral, coastal scrub. Recorded from San Mateo, Sonoma (?).	Apr-Jul Evergreen Shrub	None: marginally suitable habitat present. Would have been detectable during present survey.
Trifolium hydrophilum saline clover	Federal: none State: none CNPS: 1B.2 Other: DFG: SP	Occurs in marshes and swamps, valley and foothill grassland, vernal pools. Moisture: mesic,Substrate: alkaline, Recorded from Alameda, Colusa, Monterey, Napa, San Benito, San Luis Obispo, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma.	Apr-Jun Annual Herb	None: no suitable habitat present.

Mar 24, 2011

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Geraniaceae - Geranium Family				
California macrophylla round-leaved filaree	Federal: none State: none CNPS: 1B.1 Other: DFG: SP	Occurs in cismontane woodland, foothill woodland, valley and foothill grassland. Substrate: clay. Recorded from Alameda, Butte, Colusa, Contra Costa, Fresno, Glenn, Kern, Kings, Lake, Lassen, Los Angeles, Merced, Monterey, Napa, Riverside, San Benito, San Diego, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Solano, Sonoma, Stanislaus, Tehama, Ventura, Yolo.Santa Cruz Island.Also recorded from Baja California, Oregon, Utah.	Mar-May Annual Herb	None: no suitable habitat present.
Iridaceae - Iris Family				
Iris longipetala long-petaled iris	Federal: none State: none CNPS: 4.2 Other:	Occurs in coastal prairie, mixed evergreen forest. Moisture: mesic. Recorded from Alameda, Contra Costa, Humboldt, Marin, Mendocino, Monterey, San Francisco, San Mateo, Santa Clara, Santa Cruz, Sonoma.	Mar-May Perennial Herb (rhizomatous)	None: no suitable habitat present. Would have been detectable during present survey.
Lamiaceae - Mint Family				
Acanthomintha duttonii San Mateo thorn-mint	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in valley and foothill grassland, chaparral. Substrate: serpentinite. Recorded from San Mateo.	Apr-Jun Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Monardella villosa ssp. *globosa* robust monardella	Federal: none State: none CNPS: 1B.2 Other: DFG: SP	Occurs in broadleafed upland forest, chaparral, cismontane woodland, coastal scrub, foothill woodland, valley and foothill grassland. Recorded from Alameda, Contra Costa, Humboldt, Lake, Marin, Mendocino, Napa, San Mateo, Santa Clara, Santa Cruz, Sonoma.	Jun-Jul Perennial Herb (rhizomatous)	None: no suitable habitat present.

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Liliaceae - Lily Family				
Calochortus umbellatus Oakland star-tulip	Federal: none State: none CNPS: 4.2 Other: DFG: SP	Occurs in broadleafed upland forest, chaparral, cismontane woodland, lower montane coniferous forest, mixed evergreen forest, valley and foothill grassland, yellow pine forest. Substrate: often serpentinite. Recorded from Alameda, Contra Costa, Marin, San Mateo, Santa Clara, Santa Cruz, Stanislaus.	Mar-May Perennial Herb (bulbiferous)	None: no suitable habitat present.
Fritillaria biflora var. *ineziana* Hillsborough chocolate lily	Federal: none State: none CNPS: 1B.1 Other: DFG: Special Plant	Occurs in cismontane woodland, foothill woodland, valley and foothill grassland Substrate: serpentine. Recorded from San Mateo.	Mar-Apr Perennial Herb (bulbiferous)	None: no suitable habitat present. Would have been detectable during present survey.
Fritillaria lanceolata var. *tristulis* Marin checker lily	Federal: none State: none CNPS: 1B.1 Other: DFG: Special Plant	Occurs in coastal bluff scrub, coastal prairie, coastal scrub. Recorded from Marin. Not recorded from San Mateo County..	Feb-Apr Perennial Herb (bulbiferous)	None: no suitable habitat present. Would have been detectable during present survey.
Fritillaria liliacea fragrant fritillary	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in cismontane woodland, coastal prairie, coastal scrub, northern coastal scrub, valley and foothill grassland. Substrate: often serpentinite. Recorded from Alameda, Contra Costa, Marin, Monterey, San Benito, San Francisco, San Mateo, Santa Clara, Solano, Sonoma.	Feb-Apr Perennial Herb (bulbiferous)	None: marginally suitable habitat present. Would have been detectable during present survey.
Lilium maritimum coast lily	Federal: none State: none CNPS: 1B.1 Other: DFG: Special Plant	Occurs in broadleafed upland forest, closed-cone coniferous forest, closed-cone pine forest, coastal prairie, coastal scrub, marshes and swamps, mixed evergreen forest, North Coast coniferous forest, northern coastal scrub. Recorded from Marin, Mendocino, San Francisco, San Mateo, Sonoma.	May-Jul Perennial Herb (bulbiferous)	None: no suitable habitat present.

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Linaceae - Flax Family				
Hesperolinon congestum Marin western flax	Federal: FT State: ST CNPS: 1B.1 Other: DFG: Special Plant	Occurs in chaparral, valley and foothill grassland. Substrate: serpentinite. Recorded from Marin, San Francisco, San Mateo.	Apr-Jul Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Malvaceae - Mallow Family				
Malacothamnus aboriginum Indian Valley bush mallow	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in chaparral, cismontane woodland, foothill woodland Habitats Note: rocky. Recorded from Fresno, Monterey, San Benito.	Apr-Oct Shrub (deciduous)	None: no suitable habitat present. Would have been detectable during present survey.
Malacothamnus arcuatus arcuate bush mallow	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in chaparral. Recorded from San Mateo, Santa Clara, Santa Cruz.	Apr-Sep Shrub (evergreen)	None: no suitable habitat present. Would have been detectable during present survey.
Malacothamnus davidsonii Davidson's bush mallow	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in chaparral, cismontane woodland, coastal sage scrub, coastal scrub, northern coastal scrub, riparian woodland. Recorded from Los Angeles, Monterey, San Luis Obispo, San Mateo, Santa Clara.	Jun-Jan Shrub (deciduous)	None: no suitable habitat present. Would have been detectable during present survey.

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

Wood Biological Consulting

FAMILY / *Scientific Name* / Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time / Life Form	Potential for Occurrence on Site
Malacothamnus hallii Hall's bush mallow	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in chaparral, coastal scrub. Recorded from Alameda, Contra Costa, Mendocino, Merced, , Santa Clara, Stanislaus.	May-Sep Shrub (evergreen)	None: no suitable habitat present. Would have been detectable during present survey.
Onagraceae - Evening Primrose Family				
Clarkia franciscana Presidio clarkia	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in coastal scrub, northern coastal scrub, valley and foothill grassland Substrate: serpentine. Recorded from Alameda, San Francisco.	May-Jul Annual Herb	None: no suitable habitat present.
Plantaginaceae - Plantain Family				
Collinsia corymbosa round-headed Chinese houses	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal dunes, coastal strand. Recorded from Humboldt, Marin, Mendocino, San Francisco, Sonoma.	Apr-Jun Annual Herb	None: marginally suitable habitat present. Would have been detectable during present survey.
Collinsia multicolor San Francisco collinsia	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in closed-cone coniferous forest, closed-cone pine forest, coastal scrub, northern coastal scrub. Substrate: sometimes serpentinite. Recorded from Monterey, San Francisco, San Mateo, Santa Clara, Santa Cruz.	Mar-May Annual Herb	None: marginally suitable habitat present. Would have been detectable during present survey.

Mar 24, 2011

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Poaceae - Grass Family				
Elymus californicus California bottle-brush grass	Federal: none State: none CNPS: 4.3 Other: DFG: SP	Occurs in broadleafed upland forest, cismontane woodland, closed-cone pine forest, Douglas-fir forest, foothill woodland, mixed evergreen forest, North Coast coniferous forest, redwood forest, riparian woodland. Recorded from Marin, Monterey, San Mateo, Santa Cruz, Sonoma.	May-Nov Perennial Herb	None: no suitable habitat present.
Polemoniaceae - Phlox Family				
Gilia capitata ssp. *chamissonis* blue coast gilia	Federal: none State: none CNPS: 1B.1 Other: DFG: SP	Occurs in coastal dunes, coastal scrub. Recorded from Marin, San Francisco, Sonoma.	Apr-Jul Annual Herb	None: no suitable habitat present.
Gilia millefoliata dark-eyed gilia	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal dunes, coastal strand. Recorded from Del Norte, Humboldt, Marin, Mendocino, San Francisco, Sonoma.Also recorded from Oregon.	Apr-Jul Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Leptosiphon croceus coast yellow linanthus	Federal: none State: none CNPS: 1B.1 Other: DFG: Special Plant	Occurs in coastal bluff scrub, coastal prairie. Recorded from Marin, Monterey, San Mateo. Additional distribution: presumed extirpated in Marin County.	Apr-May Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Leptosiphon rosaceus rose leptosiphon	Federal: none State: none CNPS: 1B.1 Other: DFG: Special Plant	Occurs in coastal bluff scrub. Recorded from Marin, San Francisco, San Mateo, Sonoma. Additional distribution: presumed extirpated from San Francisco and Sonoma.	Apr-Jul Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.

Mar 24, 2011

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Polemonium carneum Oregon polemonium	Federal: none State: none CNPS: 2.2 Other:	Occurs in coastal prairie, northern coastal scrub, lower montane coniferous forest. Recorded from Alameda, Del Norte, Humboldt, Marin, San Francisco, San Mateo, Siskiyou, Sonoma.	Apr-Sep Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Polygonaceae - Buckwheat Family				
Chorizanthe cuspidata var. *cuspidata* San Francisco Bay spineflower	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal bluff scrub, coastal dunes, coastal prairie, coastal scrub, coastal strand, northern coastal scrub. Substrate: sandy. Recorded from Alameda, Marin, San Francisco, San Mateo, Santa Clara, Sonoma.	Apr-Aug Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Chorizanthe robusta var. *robusta* robust spineflower	Federal: FE State: none CNPS: 1B.1 Other: DFG: Special Plant	Occurs in cismontane woodland, coastal dunes, coastal scrub, coastal strand, foothill woodland, northern coastal scrub. Substrate: sandy, gravelly. Recorded from Alameda, Monterey, San Mateo, Santa Clara, Santa Cruz.	Apr-Sep Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Pottiaceae				
Triquetrella californica coastal triquetrella	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal bluff scrub, coastal scrub. Recorded from Contra Costa, Mendocino, San Diego, San Francisco counties.Also recorded from Oregon.	n/a Moss	None: no suitable habitat present.

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

Wood Biological Consulting

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Rosaceae - Rose Family				
Horkelia cuneata ssp. *sericea* Kellogg's horkelia	Federal: none State: none CNPS: 1B.1 Other: DFG: Special Plant	Occurs in closed-cone coniferous forest, closed-cone pine forest, coastal sage scrub, coastal scrub, northern coastal scrub. Recorded from Alameda, Marin, Monterey, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Santa Cruz.	Apr-Sep Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Horkelia marinensis Point Reyes horkelia	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal dunes, coastal prairie, coastal scrub, coastal strand, northern coastal scrub. Recorded from Marin, Mendocino, San Mateo, Santa Cruz.	May-Sep Perennial Herb	None: no suitable habitat present.
Potentilla hickmanii Hickman's cinquefoil	Federal: FE State: SE CNPS: 1B.1 Other: DFG: Special Plant	Occurs in closed-cone coniferous forest, closed-cone pine forest, coastal bluff scrub, freshwater marsh, marshes and swamps, meadows, northern coastal scrub. Recorded from Monterey, San Mateo, Sonoma.	Apr-Aug Perennial Herb	None: no suitable habitat present. Would have been detectable during present survey.
Scrophulariaceae - Figwort Family				
Cordylanthus maritimus ssp. *palustris* Point Reyes bird's-beak	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal salt marsh, marshes and swamps. Habitats Note: coastal salt marsh. Recorded from Alameda, Humboldt, Marin, San Mateo, Santa Clara, Sonoma. Also recorded from Oregon.	Jun-Oct Annual Herb, Hemiparasitic	None: no suitable habitat present.

Special-status Plants Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

Mar 24, 2011

FAMILY *Scientific Name* Common Name	Status	Habitat Affinities and Reported Distribution	Blooming Time Life Form	Potential for Occurrence on Site
Triphysaria floribunda San Francisco owl's-clover	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in coastal prairie, coastal scrub, valley and foothill grassland Substrate: serpentine. Recorded from Marin, San Francisco, San Mateo.	Apr-Jun Annual Herb	None: no suitable habitat present. Would have been detectable during present survey.
Thymelaeaceae - Mezereum Family				
Dirca occidentalis western leatherwood	Federal: none State: none CNPS: 1B.2 Other: DFG: Special Plant	Occurs in broadleafed upland forest, chaparral, cismontane woodland, closed-cone coniferous forest, closed-cone pine forest, foothill woodland, mixed evergreen forest, north coast coniferous forest, riparian forest, riparian woodland. Moisture: moist. Recorded from Alameda, Contra Costa, Marin, San Mateo, Santa Clara, Sonoma.	Jan-Apr Shrub (deciduous)	None: no suitable habitat present. Would have been detectable during present survey.

Wood Biological Consulting

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Gastropoda - Snails And Slugs			
Vespericola marinensis Marin hesperian	Federal none State none Other DFG: Special Animal	Occurs in moist spots in coastal brush and chaparral. Recorded from beneath cow-parsnip, in springs and seeps, in leaf mold along streams, in alder woods and mixed evergreen forests. Recorded from Marin County. Additional distribution: Point Reyes Peninsula and surrounding region. Type locality: Point Reyes, Bear Valley Trail, Marin County.	None: no suitable habitat present.
Arachnida - Arachnids			
Banksula incredula incredible harvestman	Federal none State none Other DFG: Special Animal	Collected on Franciscan sandstone talus slope at 1100 ft. Recorded from San Mateo County. Additional distribution: San Bruno Mt.	None: no suitable habitat present.
Calicina minor Edgewood blind harvestman	Federal none State none Other DFG: Special Animal	Found on the underside of moist serpentine rocks near permanent springs. Recorded from San Mateo, Santa Clara counties.	None: no suitable habitat present.
Malacostraca			
Caecidotea tomalensis Tomales isopod	Federal none State none Other DFG: Special Animal	Inhabits localized fresh-water ponds or streams with still or near-still water in several bay area counties. Recorded from Marin, San Francisco, San Mateo, Sonoma counties.	None: no suitable habitat present.
Insecta - Insects			
Callophrys mossii bayensis San Bruno elfin butterfly	Federal FE State none Other DFG: Special Animal	Inhabits coastal, mountainous areas with grassy ground cover. Colonies are located on steep, north-facing slopes within the fog belt. Larval host plant is Sedum spathulifolium. Recorded from San Mateo County. Additional distribution: primary populations are located in the vicinity of San Bruno Mountain.	None: no suitable habitat present.

Wood Biological Consulting

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

SORTED BY CLASS

Scientific Name / Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Cicindela hirticollis gravida sandy beach tiger beetle	Federal none State none Other DFG: Special Animal	Inhabits clean, dry, light-colored sand in the upper tidal zone. Subterranean larvae prefer moist sand not affected by wave action. Occurs in areas adjacent to non-brackish water. Recorded from Los Angeles, San Diego, Santa Barbara, Ventura counties. Additional distribution: occurs along the coast of California from San Francisco Bay to northern Mexico.	None: no suitable habitat present.
Danaus plexippus monarch butterfly	Federal none State none Other DFG: Special Animal (wintering)	Listing refers to wintering sites only. Roosts located in wind-protected tree groves (eucalyptus, Monterey pine, Monterey cypress), with nectar and water sources nearby. Recorded from Alameda, Contra Costa, Inyo, Kern, Los Angeles, Marin, Mendocino, Monterey, Orange, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Santa Cruz, Solano, Sonoma, Ventura counties. Additional distribution: winter roost sites extend along the coast from northern Mendocino to Baja California, Mexico.	Possible: suitable winter roosting habitat present. See text for discussion.
Dufourea stagei Stage's doufourine bee	Federal none State none Other DFG: Special Animal	Ground nesting bee known from a single collection made in 1962. Recorded from San Mateo County. Additional distribution: Recorded from San Bruno Mt..	None: no suitable habitat present.
Euphydryas editha bayensis bay checkerspot butterfly	Federal FT State none Other DFG: Special Animal	Inhabits native grasslands on outcrops of serpentine soil. The primary host plant is Plantago erecta. Secondary host plants include Orthocarpus densiflorus and O. purpurscens. Recorded from Alameda, San Francisco, San Mateo, Santa Clara counties. Additional distribution: occurs in the vicinity of the San Francisco Bay.	None: no suitable habitat present.
Hydrochara rickseckeri Ricksecker's water scavenger beetle	Federal none State none Other DFG: Special Animal	Inhabits slow moving freshwater ponds, streams, marshes and lakes. Recorded from Alameda, Contra Costa, Marin, San Mateo, Solano, Sonoma counties. Additional distribution: known from the San Francisco Bay area.	None: no suitable habitat present.

Mar 24, 2011

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Hydroporus leechi Leech's skyline diving beetle	Federal none State none Other DFG: Special Animal	Little information is available about the species' life history, habitat requirements and distribution. Initially known from a single location near Pacifica, San Mateo County; recent study has found species to be more widespread. Inhabits freshwater ponds. Recorded from San Mateo County.	None: no suitable habitat present.
Ischnura gemina San Francisco forktail damselfly	Federal none State none Other	Inhabits marshes, ponds and ditches with emergent and/or floating vegetation. Recorded from Marin, San Francisco, San Mateo counties.	None: no suitable habitat present.
Lichnanthe ursina bumblebee scarab beetle	Federal none State none Other DFG: Special Animal	Inhabits coastal sand dunes. Usually flies close to sand surface near the crest of the dunes. Recorded from Marin, San Francisco, San Mateo, Sonoma counties.	None: no suitable habitat present.
Plebejus icarioides missionensis mission blue butterfly	Federal FE State none Other DFG: SA	Inhabits grasslands. Three larval host plants: Lupinus albifrons, L. variicolor, and L. formosus, of which L. albifrons is favored. Primary nectar plants for adults are Eriogonum latifolium, Chrysopsis villosa, Brodiaea pulchella and Brodiaea laxa Recorded from Marin, San Francisco, San Mateo counties. Additional distribution: restricted to the San Francisco Peninsula and Marin headlands.	None: no suitable habitat present.
Speyeria callippe callippe callippe silverspot butterfly	Federal FE State none Other DFG: Special Animal	Inhabits northern coastal scrub. Hostplant is Viola pedunculata. Most adults found on east-facing slopes. Males congregate on hilltops in search of females. Recorded from Alameda, San Mateo, Solano, Sonoma counties.	None: no suitable habitat present.
Speyeria zerene myrtleae Myrtles silverspot	Federal FE State none Other DFG: Special Animal	Restricted to the foggy, coastal dunes and hills Larval foodplant thought to be Viola adunca. Recorded from Marin, San Mateo, Sonoma counties. Additional distribution: Point Reyes Peninsula. Extirpated from coastal San Mateo County.	None: no suitable habitat present.

Mar 24, 2011

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Trachusa gummifera no common name-a leaf cutting bee	Federal none State none Other DFG: Special Animal	Known from two collections made in 1957 and 1962. No specific habitat information is available. Leafcutting bees use cut leaves to construct nests in cavities (mostly in rotting wood). They create multiple cells in the nest, each with a single larva and pollen stored for the larvae to eat. Leafcutting bees are important pollinators of wildflowers, fruits, vegetables and other crops. Recorded from Marin, San Francisco, San Mateo counties.	None: no suitable habitat present.
Actinopterygii - Ray-finned Fishes			
Mylopharodon conocephalus hardhead	Federal none State none Other DFG: SSC FS: S	Inhabits deep pools with sand-gravel-boulder bottoms and slow-moving water. Not found where exotic centrarchids predominate. Freshwater. Occurs in low to mid-elevation streams in the Sacramento-San Joaquin drainage. Recorded from Fresno, Merced, Modoc, Shasta counties.	None: no suitable habitat present.
Oncorhynchus mykiss irideus steelhead - central Calif. coast ESU	Federal FT State none Other DFG: Special Animal	Occurs from the Russian River south to Soquel Creek and to, but not including the Pajarro River. Also occurs in the San Francisco and San Pablo basins. Recorded from Alameda, Marin, Napa, San Mateo, Santa Cruz, Sonoma counties.	None: no suitable habitat present.
Amphibia - Amphibians			
Rana draytonii California red-legged frog	Federal FT State none Other DFG: CSC	Inhabits lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. Requires 11-20 weeks of permanent water for larval development. Must have access to estivation habitat. Recorded from Alameda, Amador, Butte, Calaveras, Contra Costa, El Dorado, Fresno, Glenn, Lake, Los Angeles, Marin, Mariposa, Mendocino, Merced, Monterey, Napa, Nevada, Placer, Plumas, Riverside, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Solano, Sonoma, Stanislaus, Tehama, Tuolumne, Ventura, Yuba counties.	None: no suitable habitat present.

Mar 24, 2011

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

SORTED BY CLASS

Scientific Name / Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Reptilia - Reptiles			
Actinemys marmorata western pond turtle	Federal none State none Other DFG: CSC	A thoroughly aquatic turtle inhabiting ponds, marshes, rivers, streams and irrigation ditches with aquatic vegetation. Needs basking sites and sandy banks or grassy open fields in upland areas for egg-laying. Recorded from Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Kern, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Monterey, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yolo, Yuba counties.	None: no suitable habitat present.
Thamnophis sirtalis tetrataenia San Francisco gartersnake	Federal FE State SE Other DFG: Fully protected	Occurs in the vicinity of freshwater marshes, ponds and slow moving streams. Prefers dense cover and water depths of at least one foot. Upland areas near water are also very important. Recorded from San Mateo, Santa Cruz counties.	None: no suitable habitat present.
Aves - Birds			
Athene cunicularia burrowing owl	Federal none State none Other BLM: Sensitive DFG: CSC (burrow sites) FWS: BCC; MBTA	Inhabits open, dry annual or perennial grasslands, deserts and scrublands characterized by low-growing vegetation. Nests underground in mammal burrows, especially those of California ground squirrel. Recorded from Alameda, Butte, Colusa, Contra Costa, Fresno, Glenn, Imperial, Inyo, Kern, Kings, Lassen, Los Angeles, Madera, Marin, Merced, Monterey, Napa, Orange, Placer, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tulare, Ventura, Yolo counties.	None: no suitable habitat present.

Mar 24, 2011

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Baeolophus inornatus oak titmouse	Federal none State none Other Audubon: Watch List (Yellow) DFG: Special Animal (nesting) USBC: Watch List	The oak titmouse is a common resident in a variety of habitats, but is primarily associated with oaks. Occurs in montane hardwood-conifer, montane hardwood, blue, valley, and coastal oak woodlands, and montane and valley foothill riparian habitats. Range encircles San Joaquin Valley, extending east from the coast through Kern Co. onto the western slope of the Sierra Nevada north to Shasta Co. General distribution:Occurs in cismontane California, from the Mexican border to Humboldt County.	Possible: marginally suitable nesting habitat present. See text for discussion.
Charadrius alexandrinus nivosus western snowy plover	Federal FT State none Other Audubon: Watch List (full species) DFG: CSC (nesting, coastal population) FWS: BCC (full species) FWS: MBTA USBC: Watch List (full species)	Inhabits sandy beaches, salt pond levees and shores of large alkali lakes. Requires sandy, gravelly or friable soils for nesting. Federal listing applies only to the Pacific coastal population. Recorded from Alameda, Del Norte, Humboldt, Inyo, Kern, Kings, Los Angeles, Marin, Mendocino, Modoc, Monterey, Napa, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Siskiyou, Sonoma, Ventura, Yolo counties.	None: no suitable habitat present.
Elanus leucurus white-tailed kite	Federal none State none Other DFG: fully protected FWS: MNBMC, MBTA	Inhabits rolling foothills andvalley margins with scattered oaks and river bottomlands or marshes next to deciduous woodlands. Utilizes open grasslands, meadows, or marshes for foraging close to isolated, dense-topped trees for nesting and perching. Recorded from Alameda, Colusa, Contra Costa, Del Norte, Marin, Napa, Placer, Riverside, Sacramento, San Diego, San Luis Obispo, San Mateo, Santa Clara, Solano, Sonoma, Tehama, Ventura, Yolo counties.	Possible: suitable nesting and foraging habitat present. See text for discussion.

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

Wood Biological Consulting

SORTED BY CLASS

Scientific Name / Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Falco columbarius merlin	Federal none State none Other DFG: SA FWS: MBTA	Winters on the seacoast, in tidal estuaries, open woodlands, savannahs, edges of grasslands and deserts, farms and ranches. Clumps of trees or windbreaks are required for roosting in open country. DFG listing covers non-breeding wintering individuals only.	None: no suitable habitat present.
Falco peregrinus anatum American peregrine falcon	Federal Delisted State Delisted Other CDF: S DFG: FP FS: S FWS: BCC, MBTA	Nests near wetlands, lakes, rivers, or other water bodies, on cliffs, banks, dunes, mounds, and human-made structures. Nests consist of a scrape on a depression or ledge in an open site. DFG listing covers nesting individuals only. Recorded from Alameda, Humboldt, Napa, Shasta, Siskiyou, Tehama counties.	None: no suitable habitat present.
Geothlypis trichas sinuosa saltmarsh common yellowthroat	Federal none State none Other DFG: CSC FWS: BCC	Inhabits freshwater and salt marshes. Requires thick, continuous cover down to water surface for foraging. Nests in tall grasses, tule patches and willows. Resident of the San Francisco Bay region. Recorded from Alameda, Marin, Napa, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma counties.	None: no suitable habitat present.
Lanius ludovicianus loggerhead shrike	Federal none State none Other DFG: CSC (nesting) FWS: BCC; MBTA	A common resident and winter visitor in lowlands and foothills throughout California. Prefers open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches. Highest density occurs in open-canopied valley foothill hardwood, valley foothill hardwood-conifer, valley foothill riparian, pinyon-juniper, juniper, desert riparian, and Joshua tree habitats. Recorded from Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, Lassen, Los Angeles, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Napa, Nevada, Orange, Placer, Plumas, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Clara, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, Ventura, Yolo, Yuba counties.	Possible: marginally suitable nesting habitat present. See text for discussion.

Mar 24, 2011

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Laterallus jamaicensis coturniculus California black rail	Federal none State ST Other Audubon: Watch list (full species) DFG: Fully protected FWS: MBTA FWS: MNBMC (full species) USBC: Watch list (full species)	Mainly inhabits salt-marshes bordering larger bays. Occurs in tidal salt marsh densely vegetated with pickleweed. Also found in freshwater and brackish marshes, near sea level. Recorded from Alameda, Butte, Contra Costa, Imperial, Los Angeles, Marin, Napa, Nevada, Orange, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Cruz, Solano, Sonoma, Yuba counties.	None: no suitable habitat present.
Melospiza melodia pusillula Alameda song sparrow	Federal none State none Other DFG: CSC FWS: BCC; MBTA	Inhabits pickleweed marshes. Nests low in Grindelia bushes (high enough to escape high tides) and in pickleweed. Resident of salt marshes bordering the southern arm of San Francisco Bay.	None: no suitable habitat present.
Melospiza melodia samuelis San Pablo song sparrow	Federal none State none Other DFG: CSC FWS: BCC; MBTA	Inhabits tidal sloughs in pickleweed marshes. Nests in Grindelia bushes bordering slough channels. Resident of salt marshes along the north side of San Francisco and San Pablo bays. Recorded from Solano County.	None: no suitable habitat present.
Phalacrocorax auritus double-crested cormorant	Federal none State none Other DFG: CSC (rookery site) FWS: MBTA	Nests colonially on coastal cliffs, offshore islands, and along lake margins in the interior of the state. Nests along coast on sequestered islets, usually on ground with sloping surface, or in tall trees along lake margins. Recorded from Alameda, Contra Costa, Del Norte, Humboldt, Lake, Lassen, Mariposa, Monterey, Sacramento, San Diego, San Francisco, Santa Barbara, Sonoma, Ventura counties.	None: no suitable habitat present.

Wood Biological Consulting

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Phalacrocorax auritus double-crested cormorant	Federal none State none Other DFG: SA FWS: MBTA	Nests colonially on coastal cliffs, offshore islands, and along lake margins in the interior of the state. Nests along coast on sequestered islets, usually on ground with sloping surface, or in tall trees along lake margins. DFG listing covers rookeries only. Recorded from Alameda, Contra Costa, Del Norte, Humboldt, Lake, Lassen, Mariposa, Monterey, Sacramento, San Diego, San Francisco, Santa Barbara, Sonoma, Ventura counties.	None: no suitable habitat present.
Rallus longirostris obsoletus California clapper rail	Federal FE State SE Other DFG: Fully protected FWS: MBTA USBC: Watch list (full species)	Inhabits salt-water and brackish marshes traversed by tidal sloughs in the vicinity of San Francisco Bay. Associated with abundant growths of pickleweed, but feeds away from cover on invertebrates from mud-bottomed sloughs. Recorded from Alameda, Contra Costa, Humboldt, Marin, Monterey, Napa, San Luis Obispo, San Mateo, Santa Clara, Solano, Sonoma counties.	None: no suitable habitat present.
Riparia riparia bank swallow	Federal none State ST Other DFG: Special Animal (nesting) FWS: MBTA	Nests colonially, primarily in riparian and other lowland habitats west of the desert. Requires vertical banks/cliffs with fine-textured/sandy soils near streams, rivers, lakes, ocean to dig nesting hole. Recorded from Alameda, Butte, Colusa, Del Norte, El Dorado, Fresno, Glenn, Humboldt, Inyo, Lassen, Modoc, Mono, Monterey, Plumas, Sacramento, San Benito, San Diego, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Shasta, Siskiyou, Sonoma, Sutter, Tehama, Ventura, Yolo counties.	None: no suitable habitat present.

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Selasphorus sasin Allen's hummingbird	Federal none State none Other Audubon: Watch List (Yellow) DFG: Special Animal (nesting) FWS: MBTA USBC: Watch List	Breeds most commonly in coastal scrub, valley foothill hardwood, and valley foothill riparian habitats, but also are common in closed-cone pine-cypress, urban, and redwood habitats. Occurs in a variety of woodland and scrub habitats as a migrant.	Possible: suitable nesting and foraging habitat present. See text for discussion.
Toxostoma redivivum California thrasher	Federal none State none Other Audubon: Watch List (Yellow) DFG: Special Animal FWS: MBTA USBC: Watch List	A common resident of foothills and lowlands in cismontane California. Occupies moderate to dense chaparral habitats and, less commonly, extensive thickets in young or open valley foothill riparian habitat. In southern California, occurs in montane chaparral up to 1500-2000 m (5000-6600 ft). Avoids dense tree canopy. General distribution:Occurs from the Mexican border north to Shasta, Trinity, and southern Humboldt counties., and into the Shasta Valley of Siskiyou County.	Possible: marginally suitable nesting habitat present. See text for discussion.
Mammalia - Mammals			
Antrozous pallidus pallid bat	Federal none State none Other BLM: Sensitive DFG: CSC FS: Sensitive WBWG: High priority	Inhabits deserts, grasslands, shrublands, woodlands and forests. Most commonly found in open, dry habitats with rocky areas for roosting. Roosts must provide protection from high temperatures. Species is very sensitive to disturbances to roosting sites. Recorded from Calaveras, Imperial, Inyo, Kern, Lake, Marin, Mariposa, Mono, Napa, Orange, Riverside, San Bernardino, San Diego, San Joaquin, San Luis Obispo, Santa Barbara, Siskiyou, Sonoma, Tuolumne counties. Also from Arizona, Nevada, New Mexico, Oregon, Washington.	Possible: marginally suitable roosting habitat present. See text for discussion.

Mar 24, 2011

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Corynorhinus townsendii Townsend's big-eared bat	Federal none State none Other BLM: S DFG: SSC FS: S WBWG: H	Most abundant in mesic habitats. Found in all but subalpine and alpine habitats, and may be found at any season throughout its range. Once considered common, Townsend's big-eared bat now is considered uncommon in California.	Not expected: no suitable habitat present.
Dipodomys venustus venustus Santa Cruz kangaroo rat	Federal none State none Other DFG: Special Animal	Inhabits silverleaf manzanita mixed chaparral in the Zayante Hills ecosystem of the Santa Cruz mountains. Needs soft, well-drained sand. Recorded from San Mateo, Santa Clara, Santa Cruz counties.	None: no suitable habitat present.
Lasiurus blossevillii western red bat	Federal none State none Other DFG: CSC FS: Sensitive WBWG: High priority	The red bat is locally common in some areas of California, occurring from Shasta Co. to the Mexican border, west of the Sierra Nevada/Cascade crest and deserts. The winter range includes western lowlands and coastal regions south of San Francisco Bay. There is migration between summer and winter ranges, and migrants may be found outside the normal range. Roosting habitat includes forests and woodlands from sea level up through mixed conifer forests. Feeds over a wide variety of habitats including grasslands, shrublands, open woodlands and forests, and croplands. Not found in desert areas. During warm months, sexes occupy different portions of the range (Williams and Findley 1979).	Possible: suitable roosting and foraging habitat present. See text for discussion.
Lasiurus cinereus hoary bat	Federal none State none Other DFG: Special Animal	The hoary bat is the most widespread North American bat. May be found at any location in California, although distribution patchy in southeastern deserts. This common, solitary species winters along the coast and in southern California, breeding inland and north of the winter range. During migration, may be found at locations far from the normal range, such as the Channel Islands (Brown 1980) and the Farallon Islands (Tenaza 1966). Habitats suitable for bearing young include all woodlands and forests with medium to large-size trees and dense foliage.	Possible: suitable roosting and foraging habitat present. See text for discussion.

Mar 24, 2011

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Wood Biological Consulting

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Myotis thysanodes fringed myotis	Federal none State none Other BLM: Sensitive DFG: Special Animal WBWG: High priority	Occurs in a wide variety of habitats. Optimal habitats include pinyon-juniper, valley foothill hardwood and hardwood-conifer woodlands. Forms maternity colonies and roosts in caves, mines, buildings and crevices. General distribution:occurs throughout California.	None: no suitable habitat present.
Neotoma fuscipes annectens San Francisco dusky-footed woodrat	Federal none State none Other DFG: CSC	Inhabits forested areas with a moderate canopy and a moderate to dense understory. Also occurs chaparral habitats. Constructs nests of shredded grass, leaves and other materials. Population may be limited by availability of nest-building materials. Recorded from Alameda, Contra Costa, San Francisco, San Mateo, Santa Clara counties.	None: no suitable habitat present.
Nyctinomops macrotis big free-tailed bat	Federal none State none Other DFG: CSC WBWG: med.-high priority	Prefers rugged, rocky terrain. Found to 2500 m (8000 ft). Feeds principally on large moths but also takes a variety of other flying insects. Roosts in buildings, caves, and occasionally in holes in trees. Also roosts in crevices in high cliffs or rock outcrops. Recorded from Alameda, Contra Costa, San Diego counties. Additional distribution: rare in California, as fall and winter vagrants. Probably does not breed in California. Alameda and Contra Costa records are suspect. Also from Arizona, New Mexico, Texas.	Not expected: marginally suitable roosting habitat present.
Reithrodontomys raviventris salt-marsh harvest mouse	Federal FE State SE Other DFG: Fully protected	Pickleweed (Salicornia) is the primary habitat. Builds loosely organized nests and does not burrow into the ground. Requires higher areas to escape flooding. Restricted to saline emergent wetlands. Recorded from Contra Costa, Marin, Napa, San Mateo, Santa Clara, Solano, Sonoma counties. Additional distribution: San Francisco Bay and its tributaries.	None: no suitable habitat present.
Scapanus latimanus insularis Angel Island mole	Federal none State none Other DFG: Special Animal	Needs friable soils for burrowing. Recorded from Marin County. Angel Island.	None: no suitable habitat present.

Wood Biological Consulting

Special-status Animals Evaluated for the Regional Groundwater Storage and Recovery Project

Mar 24, 2011

SORTED BY CLASS

Scientific Name Common Name	Status	Habitat Affinities and Reported Distribution	Potential for Occurrence on Site
Taxidea taxus American badger	Federal none State none Other DFG: CSC	Most abundant in dry, open stages of most shrub, forest, and herbaceous habitats. Needs sufficient food, friable soils and open, uncultivated ground. Preys on burrowing rodents. Excavates its own burrows. General distribution: recorded from every California county except Del Norte.	None: no suitable habitat present.
Zapus trinotatus orarius Point Reyes jumping mouse	Federal none State none Other DFG: CSC	Inhabits bunch grass marshes in areas protected from continuous inundation. Eats mainly grass seeds with some insects and fruit taken. Builds grassy nests on ground under vegetation, burrows in winter. Recorded from Marin County. Additional distribution: Point Reyes.	None: no suitable habitat present.

EXPLANATION OF RARITY STATUS CODES

ENDANGERED SPECIES ACT (ESA) LISTING CODES

FE = federally listed as Endangered
FT = federally listed as Threatened
FPE = federally proposed for listing as Endangered
FPT = federally proposed for listing as Threatened
FPD = federally proposed for delisting
FC = federal candidate; former Category 1 candidates
FSC = federal species of concern; receives no legal protection. Use of the term does not necessarily mean that a species will eventually be proposed for listing.

CALIFORNIA ENDANGERED SPECIES ACT (CESA) LISTING CODES

S E = State-listed as Endangered
ST = State-listed as Threatened
SR = State-listed as Rare
SCE = State candidate for listing as Endangered
SCT = State candidate for listing as Threatened

CALIFORNIA NATIVE PLANT SOCIETY DESIGNATIONS (CNPS)

List 1: Plants of highest priority
List 1A: Plants presumed extinct in California
List 1B: Plants rare and endangered in California and elsewhere
List 2: Plants rare and endangered in California but more common elsewhere
List 3: Plants about which additional data are needed
List 4: Plants of limited distribution

CNPS Threat Code Extensions (replaces the RED code)

.1 - Seriously endangered in California

.2 – Fairly endangered in California

.3 – Not very endangered in California

OTHER CODES

AFS: American Fisheries Society categories of risk for marine, estuarine and diadromous fish stocks.

Audubon: Watch List: Bird species facing population declines and/or threats such as loss of breeding and wintering grounds, or species with limited geographic ranges.

BLM: Sensitive: Bureau of Land Management. Includes species under review by FWS or NMFS, species whose numbers are declining so rapidly that federal listing may become necessary, species with small and widely dispersed populations, or species inhabiting refugia or other unique habitats.

CDF: Sensitive: California Department of Forestry and Fire Protection. Includes species that warrant special protection during timber operations.

DFG: CSC: California species of Special Concern.

DFG: Special Animal: Species included by the Department of Fish and Game in their special species lists.

DFG: WL (Watch List): taxa that were previously SSCs but no longer merit CSC status or which do not meet CSC criteria but for which there is concern and a need for additional information to clarify status.

DFG: Fully Protected: Species protected under Sections 3511 (birds), 4700 (mammals), 5050 (reptiles and amphibians), and 5515 (fish) of the California Fish and Game Code.

FS: Sensitive: USDA Forest Service. Species identified by a regional forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density, or in habitat capability that would reduce a species' existing distribution.

FWS: BCC: Birds of Conservation Concern: migratory and non-migratory bird species (beyond listed species) that represent the FWS's highest conservation priorities.

FWS: BEPA: Bald Eagle Protection Act

FWS: MBTA: International Migratory Bird Treat Act

FWS: MNBMC: US Fish and Wildlife Service: Migratory Nongame Birds of Management Concern. Species considered to be of concern in the U.S. due to documented or apparent population declines, small or restricted populations, or dependence on restricted or vulnerable habitats.

NMFS: SC: National Marine Fisheries Service: Species of Concern.

USMC Watch List: US Bird Conservation Watch List.

WBWG: Priority: The Western Bat Working Group. Species imperiled or at high, medium, or low risk of imperilment based on available information on distribution, status, ecology, and known threats.

SPECIAL-STATUS PLANT SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR LAKE MERCED

Common Name *Scientific Name*	**Listing Status USFWS/ CDFW/CNPS**	**Habitat**	**Potential to Occur**[(a)]	**Flowering Period**
SPECIES LISTED OR PROPOSED FOR LISTING				
Plants				
San Bruno Mountain manzanita *Arctostaphylos imbricada*	–/CE/1B.1	Chaparral and coastal scrub, usually on sandstone outcrops.	**Low potential.** No suitable habitat present.	February–May
Presidio manzanita *Arctostaphylos montana* ssp. *Ravenii*	FE/CE/1B.1	Open, rocky, serpentine slopes in chaparral, coastal scrub, and coastal prairie.	**Low potential.** No suitable habitat present.	February–April
Pacific manzanita *Arctostaphylos pacifica*	–/CE/1B.1	Coastal scrub and chaparral.	**Low potential.** No suitable habitat present.	February–April
Marsh sandwort *Arenaria paludicola*	FE/CE/1B.1	Freshwater or brackish marshes and swamps.	**Low potential.** Potentially suitable habitat present at Lake Merced, but species not observed there (May and Associates 2009; Nomad Ecology 2011; San Francisco Planning Department 2011); species presumed extirpated in San Francisco.	May–August
Robust spineflower *Chorizanthe robusta var. robusta*	FE/–/1B.1	Sandy or gravelly coastal dunes, coastal scrub, cismontane woodland and maritime chaparral.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not observed there (San Francisco Planning Department 2011; May and Associates 2009; Nomad Ecology2011); species presumed extirpated in San Francisco.	April–September
Presidio clarkia *Clarkia franciscana*	FE/CE/1B.1	Serpentine outcrops in coastal scrub, and valley and foothill grassland.	**Low potential.** No suitable habitat present.	May–July
Marin western flax *Hesperolinon congestum*	FT/CT/1B.1	Chaparral and grassland, usually on serpentine barrens	**Low potential.** No suitable habitat present.	April–July
Beach layia *Layia carnosa*	FE/CE/1B.1	Sparsely vegetated, semi-stabilized coastal dunes and scrub.	**Low potential.** No suitable habitat present; presumed extirpated in San Francisco.	March–July
San Francisco lessingia *Lessingia germanorum*	FE/CE/1B.1	Open, sandy, coastal dunes and scrub.	**Low potential.** No suitable habitat present.	July–November
White-rayed pentachaeta *Pentachaeta bellidiflora*	FE/CE/1B.1	Open, dry, rocky slopes and grassy areas, usually on serpentine.	**Low potential.** No suitable habitat present.	March–May
San Francisco popcorn-flower *Plagiobothrys diffusus*	–/CE/1B.1	Coastal prairie, and valley and foothill grasslands.	**Low potential.** No suitable habitat present.	March–June

SPECIAL-STATUS PLANT SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR LAKE MERCED

Common Name *Scientific Name*	Listing Status USFWS/ CDFW/CNPS	Habitat	Potential to Occur[(a)]	Flowering Period
FEDERAL SPECIES OF CONCERN OR STATE SPECIES OF SPECIAL CONCERN				
Bent-flowered fiddleneck *Amsinckia lunaris*	–/–/1B.2	Coastal bluff scrub, cismontane woodland, and valley and foothill grassland.	**Low potential.** No suitable habitat present.	March–June
Franciscan manzanita *Arctostaphylos franciscana*	–/–/1B.1	Open, rocky, serpentine outcrops in chaparral.	**Low potential.** No suitable habitat present. This species was believed to be extinct in the wild (although still extant through cultivation), but was rediscovered in Presidio National Park in late 2009.	February–April
Montara manzanita Arctostaphylos montaraensis	–/–/1B.2	Slopes and ridges in chaparral and coastal scrub.	**Low potential.** No suitable habitat present.	January–March
Alkali milk-vetch *Astragualus tener* var. *tener*	–/–/1B.2	Alkali flats, flooded grassland, playas and vernal pools.	**Low potential.** No suitable habitat present; species presumed extirpated in San Francisco.	March–June
Bristly sedge *Carex comosa*	–/–/2.1	Lake margins, marshes, swamps, coastal prairie, and valley and foothill grasslands.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not observed there (San Francisco Planning Department 2011; May and Associates 2009; Nomad Ecology 2011)	May–September
Pappose tarplant *Centromadia parryi* ssp. *parryi*	–/–/1B.2	Chaparral, coastal prairie, meadows, seeps, coastal salt marshes and swamps, and vernally mesic, often alkaline, valley and foothill grasslands.	**Low potential.** No suitable habitat present.	May–November
San Francisco spineflower *Chorizanthe cuspidata* var. *cuspidata*	–/–/1B.2	Coastal bluff scrub, dunes, prairie, and coastal scrub; sandy soils on terraces and slopes.	**High potential.** Species is known to occur at Lake Merced (May & Associates 2009; Nomad Ecology 2011).	April–August
Franciscan thistle *Cirsium andrewsii*	–/–/1B.2	Coastal bluff scrub, coastal prairie, coastal mesic scrub, and broadleaf upland forest; sometimes on serpentine.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not observed there (San Francisco Planning Department 2011; May and Associates 2009; Nomad Ecology 2011)	March–July
Compact cobwebby thistle *Cirsium occidentale* var. *compactum*	–/–/1B.2	On dunes or clay in chaparral, coastal dunes, coastal prairie, coastal scrub, and grasslands.	**Low potential.** Suitable habitat present at Lake Merced but species not documented to occur there (May & Associates 2009; Nomad Ecology 2011).	April–June

SPECIAL-STATUS PLANT SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR LAKE MERCED

Common Name *Scientific Name*	**Listing Status USFWS/ CDFW/CNPS**	**Habitat**	**Potential to Occur**[(a)]	**Flowering Period**
Round-headed Chinese-houses *Collinsia corymbosa*	–/–/1B.2	Coastal dunes and coastal prairie.	**Low potential.** No suitable habitat present; species has not been seen in San Francisco for more than 100 years.	April–June
San Francisco collinsia *Collinsia multicolor*	–/–/1B.2	On humus-covered soil derived from mudstone in closed-cone coniferous forest and coastal scrub.	**Low potential.** Potentially suitable habitat present in coastal scrub at Lake Merced but species not documented to occur there (May & Associates 2009; Nomad Ecology 2011).	March–May
Pont Reyes bird's-beak *Cordylanthus maritimus* ssp. *palustris*	–/–/1B.2	Coastal salt marshes and swamps.	**Low potential.** No suitable habitat present.	June–October
Fragrant fritillaria *Fritillaria liliacea*	–/–/1B.2	On clay, often serpentine derived soils in coastal scrub, grassland, and coastal prairie.	**Low potential.** No suitable habitat present.	February–April
Blue coast gilia *Gilia capitata* ssp. *chamissonis*	–/–/1B.1	Coastal scrub and coastal dunes.	**High potential.** Species is known to occur in dune scrub habitat at Lake Merced (May & Associates 2009; Nomad Ecology 2011).	April–July
Dark-eyed gilia *Gilia millefoliata*	–/–/1B.2	Coastal dunes.	**Low potential.** No suitable habitat present; species potentially extirpated in San Francisco.	April–July
San Francisco gumplant *Grindelia hirsutula* var. *maritima*	–/–/1B.2	On sandy or serpentine slopes of sea bluffs in coastal scrub, or valley and foothill grasslands.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not documented to occur there (San Francisco Planning Department 2011; May and Associates 2009; Nomad Ecology 2011).	June–September
Diablo helianthella *Helianthella castanea*	–/–/1B.2	On rocky soils in broadleaf upland forest, cismontane woodland, coastal scrub, riparian woodland, and valley and foothill grassland.	**Low potential.** No suitable habitat present.	March–June
Seaside tarplant *Hemizonia congesta* ssp. *congesta*	–/–/1B.2	Grassy valleys and hills, often on fallow fields in coastal scrub.	**Low potential.** No suitable habitat present.	April–November
Short-leaved evax *Hesperevax sparsiflora* var. *brevifolia*	–/–/1B.2	Sandy bluffs and flats in coastal scrub and coastal dunes.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not observed there (May and Associates 2009; Nomad Ecology 2011; San Francisco Planning Department 2011).	March–June

SPECIAL-STATUS PLANT SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR LAKE MERCED

Common Name *Scientific Name*	**Listing Status USFWS/ CDFW/CNPS**	**Habitat**	**Potential to Occur[a]**	**Flowering Period**
Kellogg's horkelia *Horkelia cuneata* ssp.*sericea*	–/–/1B.1	Openings in old dunes coastal and sandhill in closed-cone coniferous forest, coastal scrub, and chaparral.	**Low potential.** No suitable habitat present.	April–September
Rose leptosiphon *Leptosiphon rosaceus*	–/–/1B.1	Coastal bluff scrub.	**Low potential.** No suitable habitat present.	April–July
Arcuate bush mallow *Malacothamnus arcuatus*	–/–/1B.2	Gravelly alluvium in chaparral and cismontane woodland.	**Low potential.** No suitable habitat present.	April–September
Marsh microseris *Microserus paludosa*	–/–/1B.2	Closed-cone coniferous forest, cismontane woodland, coastal scrub, and valley and foothill grassland.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not observed there (May and Associates 2009; Nomad Ecology 2011; San Francisco Planning Department 2011).	April–June (July)
Choris's popcorn-flower *Plagiobothrys chorisianus* var. *chorisianus*	–/–/1B.2	Mesic sites in chaparral, coastal scrub, and coastal prairie.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not observed there (May and Associates 2009; Nomad Ecology 2011; San Francisco Planning Department 2011).	March–June
Hairless popcorn-flower *Plagiobothrys glaber*	–/–/1A	Coastal salt marshes and alkaline meadows.	**Low potential.** No suitable habitat present.	March–May
Oregon polemonium *Polemonium carneum*	–/–/1B.1	Coastal prairie, coastal scrub, lower montane coniferous forest.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not observed there (May and Associates 2009; Nomad Ecology 2011; San Francisco Planning Department 2011).	April–September
Adobe sanicle *Sanicula maritima*	–/Rare/1B.1	Moist clay or ultramafic soil in chaparral, coastal prairie, meadows, seeps, and valley and foothill grassland.	**Low potential.** No suitable habitat present.	February–March
San Francisco campion *Silene verecunda* ssp. *verecunda*	–/–/1B.2	Mudstone, shale, or serpentine substrates in coastal scrub, coastal prairie, chaparral and valley and foothill grassland.	**Low potential.** No suitable habitat present.	March–August
Santa Cruz microseris *Stebbinsoseris decipiens*	–/–/1B.2	On sandstone, shale or serpentine derived seaward facing slopes in broadleaf upland forest, closed-cone coniferous forest, chaparral, coastal prairie, and coastal scrub.	**Low potential.** No suitable habitat present.	April–May

SPECIAL-STATUS PLANT SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR LAKE MERCED

Common Name *Scientific Name*	**Listing Status USFWS/ CDFW/CNPS**	**Habitat**	**Potential to Occur**[(a)]	**Flowering Period**
San Francisco owl's-clover *Triphysaria floribunda*	–/–/1B.2	Coastal prairie, and valley and foothill grasslands; occasionally on serpentine.	**Low potential.** No suitable habitat present.	April–June
Coastal triquetrella *Triquetrella californica*	–/–/1B.2	On soil in coastal bluff and coastal scrub.	**Low potential.** Potentially suitable habitat present at Lake Merced but species not observed there (May and Associates 2009; Nomad Ecology 2011; San Francisco Planning Department 2011).	N/A

Sources: May and Associates 2009; Nomad Ecology 2011; San Francisco Planning Department 2011; CDFG 2011; CNPS 2011; USFWS 2011 (San Francisco North and San Francisco South quadrangles)

Notes:

(a) High Potential = Species is expected to occur and habitat meets special requirements.
Moderate Potential = Habitat is only marginally suitable or is suitable but not within species geographic range.
Low Potential = Habitat does not meet species requirements as currently understood in the scientific community. Project site is outside species geographic range.

Federal Categories (USFWS)

FE = Listed as endangered by the federal government

FT = Listed as threatened by the federal government

FPE = Proposed for listing as endangered

FPT = Proposed for listing as threatened

FC = Candidate for federal listing

FSC = Former federal species of concern. Species designated as such in this EIR were listed by the Sacramento USFWS office until 2006, when they stopped maintaining their list. These species are still considered to be at-risk species by other federal and State agencies, as well as various organizations with recognized expertise such as the Audubon Society.

State Categories (CDFW)

CE = Listed as endangered by the State of California

CT = Listed as threatened by the State of California

CR = Listed as rare by the State of California

CNPS

Rare Plant Rank 1A = Plants presumed extinct in California.

Rare Plant Rank 1B = Plants rare, threatened, or endangered in California and elsewhere.

Rare Plant Rank 2 = Plants rare, threatened, or endangered in California, but more common elsewhere.

Rare Plant Rank 3 = Plants about which more information is needed.

Rare Plant Rank 4 = Plants of limited distribution.

SPECIAL-STATUS ANIMAL SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR THE GROUNDWATER SUPPLY PROJECT

Common Name *Scientific Name*	Listing Status USFWS/CDFW	Habitat	Potential to Occur[a]
SPECIES LISTED OR PROPOSED FOR LISTING			
Invertebrates			
San Bruno elfin butterfly *Callophrys mossii bayensis*	FE/–	Coastal scrub on rocky outcrops with broadleaf stonecrop (*Sedum spathulifolium*)	**Low potential.** No suitable habitat present.
Bay checkerspot butterfly *Euphydryas editha bayensis*	FT/–	Serpentine grasslands.	**Low potential.** No suitable habitat present.
Mission blue butterfly *Plebejus icarioides missionensis*	FE/–	Grassland with *Lupinus albifrons, L. formosa*, and *L. varicolor.*	**Low potential.** No suitable habitat present.
Callippe silverspot butterfly *Speyeria callippe callippe*	FE/–	Found in native grasslands with *Viola pedunculata* as larval food plant.	**Low potential.** No suitable habitat present.
Amphibians			
California red-legged frog *Rana draytonii*	FT/CSC	Freshwater ponds and slow streams with emergent vegetation for egg attachment.	**Low potential.** Historically present at Lake Merced (SFRPD 2006) but currently presumed extirpated from this area (Jones and Stokes 2007; San Francisco Planning Department 2011).
Reptiles			
San Francisco garter snake *Thamnophis sirtalis tetrataenia*	FE/CE	Freshwater ponds and slow streams with emergent vegetation.	**Low potential.** Potentially suitable habitat present at Lake Merced, but species not documented at this area.
Birds			
Western snowy plover *Charadrius alexandrinus nivosus*	FT/CSC	Nests and forages on sandy beaches on marine and estuarine shores; requires sandy, gravely, or friable soils for nesting.	**Low potential.** No suitable habitat present.
California black rail *Laterallus jamaicensis coturniculus*	–/CT	Tidally influenced, heavily vegetated, high-elevation marshlands.	**Low potential.** No suitable habitat present.
California brown pelican *Pelecanus occidentalis californicus*	Delisted/3511	Nests on coastal islands of small to moderate size that affords protection from predators.	**Low potential.** No suitable habitat present.
California clapper rail *Rallus longirostris obsoletus*	FE/CE	Salt marsh wetlands along the San Francisco Bay.	**Low potential.** No suitable habitat present.
Bank swallow *Riparia riparia*	–/CT	Colony nester on sandy cliffs near water, marshes, lakes, streams, the ocean. Forages in fields.	**Low potential.** No suitable nesting habitat present, although this species nests nearby and occasionally forages at Lake Merced.

SPECIAL-STATUS ANIMAL SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR THE GROUNDWATER SUPPLY PROJECT

Common Name ***Scientific Name***	**Listing Status USFWS/CDFW**	**Habitat**	**Potential to Occur[(a)]**
California least tern *Sterna antillarum browni*	FE/CE	Colonial breeder on bare or sparsely vegetated flat substrates including sand beaches, alkali flats, landfills, or paved areas.	**Low potential.** No suitable habitat present.
Mammals			
Salt marsh harvest mouse *Reithrodontomys raviventris*	FE/CE	Salt marshes along the San Francisco Bay.	**Low potential.** No suitable habitat present.
FEDERAL SPECIES OF CONCERN OR STATE SPECIES OF SPECIAL CONCERN			
Invertebrates			
Incredible harvestman *Banksula incredula*	–/*	Franciscan sandstone talus slope.	**Low potential.** No suitable habitat present.
Tomales isopod *Caecidotea tomalensis*	FSC/*	Shallow freshwater ponds or streams with still or very slow water. Known only to occur in several Bay Area counties.	**Low potential.**Species was collected in 1971 (one individual) and 1984 (three individuals) from Lake Merced but not more recently (SFRPD 2006).
Sandy beach tiger beetle *Cicindela hirticollis gravida*	FSC/*	Sandy areas around water; larva live in burrows in sand along sea beaches, creeks, seepages, and lake shores.	**Low potential.** Potentially suitable habitat present at Lake Merced, but species not documented to occur there; known population of this species in the project area has been extirpated.
Monarch butterfly *Danaus plexippus*	–/*	Eucalyptus groves (winter sites).	**Moderate potential.**
Stage's dufourine bee *Dufourea stagei*	–/*	Ground-nesting bee in coastal scrub habitat.	**Low potential.** Potentially suitable habitat present at Lake Merced; known species range is south of the project area.
Leech's skyline diving beetle *Hydroporus leechi*	FSC/–	Found in freshwater ponds, shallow water of streams marshes and lakes.	**Low potential.** Potentially suitable habitat at Lake Merced, but there are no known populations of this species in project vicinity.
Bumblebee scarab beetle *Lichnanthe ursina*	FSC/–	Inhabits coastal sand dunes.	**Low potential.** Suitable habitat is not present within the project area; CNDDB records indicate historical presence of this species along Ocean Beach.
A leaf-cutter bee *Trachusa gummifera*	–/*	Unknown	**Low potential.** Known from two historical collections in Marin and San Francisco Counties; no records of this species in the project area.
Marin hesperian *Vespericola marinensis*	–/–	Moist areas in coastal brushfield and chaparral vegetation, in Marin County.	**Low potential.** Known species range is north of the proposed project area.
Reptiles			
Western pond turtle *Actinemys marmorata*	–/CSC	Freshwater ponds and slow streams edged with sandy soils for laying eggs.	**High potential.** Species is known to occur at Lake Merced (SFRPD 2006; San Francisco Planning Department 2011).

SPECIAL-STATUS ANIMAL SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR THE GROUNDWATER SUPPLY PROJECT

Common Name *Scientific Name*	**Listing Status USFWS/CDFW**	**Habitat**	**Potential to Occur**[(a)]
Birds			
Cooper's hawk *Accipiter cooperi*	--/3503.5	Typically nests in riparian growths of deciduous trees and live oak woodlands. Becoming more common as an urban breeder.	**Moderate potential.** Large trees in the project area, including eucalyptus and Monterey cypress, could support nests for this species.
Great horned owl *Bubo virginianus*	--/3503.5	Often uses abandoned nests of corvids or squirrels; nests in large oaks, conifers, eucalyptus.	**Moderate potential.** Large trees in the project area, including eucalyptus and Monterey cypress, could support nests for this species.
Red-tailed hawk *Buteo jamaicensis*	--/3503.5	Almost any open habitat, including grassland and urbanized areas.	**Moderate potential.** Large trees in the project area, including eucalyptus and Monterey cypress, could support nests for this species.
Red-shouldered hawk *Buteo lineatus*	--/3503.5	Forages along edges of marshes and grasslands; nests in mature trees in a variety of habitats.	**Moderate potential.** Large trees in the project area, including eucalyptus and Monterey cypress, could support nests for this species.
American kestrel *Falco sparverius*	--/3503.5	Frequents generally open grasslands, pastures, and fields; primarily a cavity nester.	**Moderate potential.** Large trees in the project area, including eucalyptus and Monterey cypress, could support nests for this species.
Salt-marsh common yellowthroat *Geothlypis trichas sinuosa*	FSC/CSC	Inhabits tidal salt and brackish marshes in winter, but breeds in freshwater brackish marshes and riparian woodlands during spring to early summer.	**High potential.** This species is known to breed in the freshwater marshes at Lake Merced.
Alameda song sparrow *Melospiza melodia pusillula*	–/CSC	Salt marshes of eastern and south San Francisco Bay.	**Low potential.** No suitable habitat is present for this species in the project area.
San Pablo song sparrow *Melospiza melodia samuelis*	–/CSC	Salt marshes of eastern and north San Francisco Bay.	**Low potential.** No suitable habitat is present for this species in the project area.
Double-crested cormorant *Phalacrocorax auritus*	–/–	Nests along coast on isolated islands or in trees along lake margins.	**High potential.** There is a colony of double-crested cormorants at Lake Merced (SF Field Ornithologists, 2003).
Mammals			
Pallid bat *Antrozous pallidus*	–/CSC	Roosts in caves, old buildings, and under bark. Forages in open lowland areas, and forms large maternity colonies in the spring.	**Low potential.** Potential roosting habitat is available in buildings and large-diameter trees in Lake Merced, but this species was not detected during recent surveys in San Francisco parks (Krauel 2009). Not expected to breed here but may be present on a transient basis.
Townsend's big-eared bat *Corynorhinus townsendii*	FSC/CSC	Roosts in caves, buildings, bridges, rock crevices, and hollow trees.	**Low potential.** While roosting habitat is available in buildings in Lake Merced, the species was not detected during recent surveys in San Francisco parks (Krauel 2009).

SPECIAL-STATUS ANIMAL SPECIES REPORTED OR WITH POTENTIAL TO OCCUR NEAR THE GROUNDWATER SUPPLY PROJECT

Common Name ***Scientific Name***	**Listing Status** **USFWS/CDFW**	**Habitat**	**Potential to Occur[(a)]**
Western red bat *Lasiurus blossevillii*	–/CSC	Roosts in tree/shrub foliage, particularly in riparian areas.	**Moderate potential.** Roosting habitat is available in tree/shrub foliage at Lake Merced. In recent surveys, this species was one of the most commonly encountered bat species in San Francisco (Krauel 2009) and was found in parks containing water bodies.
Hoary bat *Lasiurus cinereus*	–/*	Roosts in tree/shrub foliage.	**Low potential.** Potential roosting habitat is available in large-diameter trees at Lake Merced, but this species was not detected during recent surveys in San Francisco parks (Krauel 2009). May be present on a transient basis.
Yuma myotis *Myotis yumanensis*	--/*	Open forests and woodlands with sources of water over which to feed.	**Moderate potential.** Roosting habitat is available in tree/shrub foliage at Lake Merced. In recent surveys, this species was one of the most commonly encountered bat species in San Francisco (Krauel 2009), especially in parks with water bodies such as lakes.
American badger *Taxidea taxus*	–/CSC	Open grasslands with loose, friable soils.	**Low potential.** Suitable habitat for this species is no longer present in the project vicinity.
Point Reyes jumping mouse *Zapus trinotatus orarius*	–/CSC	Upland areas of bunch grass marshes in Point Reyes.	**Low potential.** Project area is south of the known range for this species.

Sources: CDFG 2011; USFWS 2011 (San Francisco North and San Francisco South quadrangles); Krauel 2009; SFRPD 2006; SF Field Ornithologists 2003; Nomad Ecology 2011; Jones and Stokes 2007; SF Planning Dept. 2011

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CE = Listed as endangered by the State of California

CT = Listed as threatened by the State of California

CSC = California species of special concern

* = California special animal

3511 = A Fully Protected Species

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Appendix G

Geotechnical Reports

APPENDIX G

GEOTECHNICAL REPORTS

REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT

April 2013

INTRODUCTION

This Appendix includes the three geotechnical reports that were prepared for the Regional Groundwater Storage and Recovery (GSR) Project. Due to the length of the appendices for the geotechnical reports, the appendices are not included.

The reports provided in this Appendix include the following:

- *Geotechnical Report – South Westside Groundwater Basin Conjunctive Use Project, April 2009.* This report includes Section 6.3, Densification Improvements, which provides optional construction methodologies for densification of soils. The GSR Project Description does not include use of these optional methodologies and relies instead on appropriate structural design of all structures.

- *Final Geotechnical Report – CUP Well Locations CUP-11A, CUP-23, CUP-36-1, CUP-44-1, and CUP-M-1, South Westside Basin Groundwater Storage and Recovery Project, December 2009*

- *Geotechnical Report – CUP-3A and CUP-7 sites, Regional Groundwater Storage and Recovery Project, November 2011 (Revised January 2012)*

These geotechnical reports utilize a different numbering system for well sites than the EIR. The table below provides the EIR site numbers for each of the site numbers used in the geotechnical reports.

EIR Site Name	Geotechnical Report Site Name
1	3A
2	6
3	5
4	7
5	10A
6	11A
7	18
8	19
9	23
10	22A
11	31
12	36-1
13	41-4
14	44-2
15	44-1
16	M-1
17 (Alternate)	20A
18 (Alternate	22
19 (Alternate)	36-2

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GEOTECHNICAL REPORT – SOUTH WESTSIDE GROUNDWATER BASIN CONJUNCTIVE USE PROJECT, APRIL 2009

GEOTECHNICAL CONSULTANTS, INC.
Geotechnical Engineering • Geology • Hydrogeology

GEOTECHNICAL REPORT
SOUTH WESTSIDE GROUNDWATER BASIN
CONJUNCTIVE USE PROJECT
SAN MATEO COUNTY, CA

April 2009

Prepared for:

Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Owner:

San Francisco Public Utilities Commission

SF08034

500 Sansome Street, Suite 402 • San Francisco, CA 94111 • (415) 981-9950

TABLE OF CONTENTS

Page

TABLES

FIGURES

PLATES

APPENDIX A – SUPPORTING GEOTECHNICAL DATA

INTRODUCTION

This geotechnical report presents the findings, conclusions, and recommendations of our geotechnical study performed for proposed buildings to facilitate groundwater well stations, and chemical treatment and filtration facilities at five designated sites located in the northern part of San Mateo County, California (Figure 1 – Site Location Map). The proposed wells are part of the South Westside Groundwater Basin Conjunctive Use Project (SWGBCUP), a project being developed through the coordination of the San Francisco Public Utilities Commission (SFPUC) and three partner agencies (California Water Service Company [Cal Water], the City of Daly City and the City of San Bruno). This geotechnical report is being prepared for Kennedy/Jenks Consultants as part of their design services contract with the SFPUC.

We anticipate that the proposed station buildings will typically be constructed with concrete masonry units (CMU), although the material selection will depend on the surrounding structures. The building footprint area for proposed station buildings that house a monitoring well only is approximately 640 square feet. The footprint area for a proposed station building expands to approximately 916 square feet when the building includes chemical treatment facilities in addition to the well. A proposed station building measuring approximately 1,742 square feet is anticipated when the building houses a monitoring well and the facilities for chemical treatment and filtration. Geotechnical recommendations for additional improvements such as new pipeline connections and upgrades, which may require additional geotechnical borings, were not part of our scope of work.

WORK PERFORMED

In accordance with our scope of work as documented in the Subcontract Agreement (Amendment No. 3) with Kennedy/Jenks Consultants, Incorporated (KJ) dated November 17, 2008 and subsequent conversations with personnel from KJ, we have completed the scope of work described below:

1. **Exploratory Drilling.** We explored subsurface conditions by means of drilling one hollow-stem auger boring at each of the five sites designated as CUP-10A, -18, -19, -22A and -41-4. To maintain consistency with the site numbering, our borings have been accordingly labeled as GB-10A, -18, -19, -22A and -41-4 for the subject sites. Boring number, date of drilling, surface elevation and depth are presented for each boring and summarized in Table 1 – Summary of Geotechnical Borings. The surface elevations of the borings were evaluated from topographic maps which were prepared by Chaudhary & Associates from their field surveys in March and September of 2008. The surface elevations presented in this report are approximate. All elevations on Table 1, and referred to throughout this report (unless otherwise noted), are with respect to 1988 North American Vertical Datum (NAVD 88).

FIGURE 1
SITE LOCATION MAP

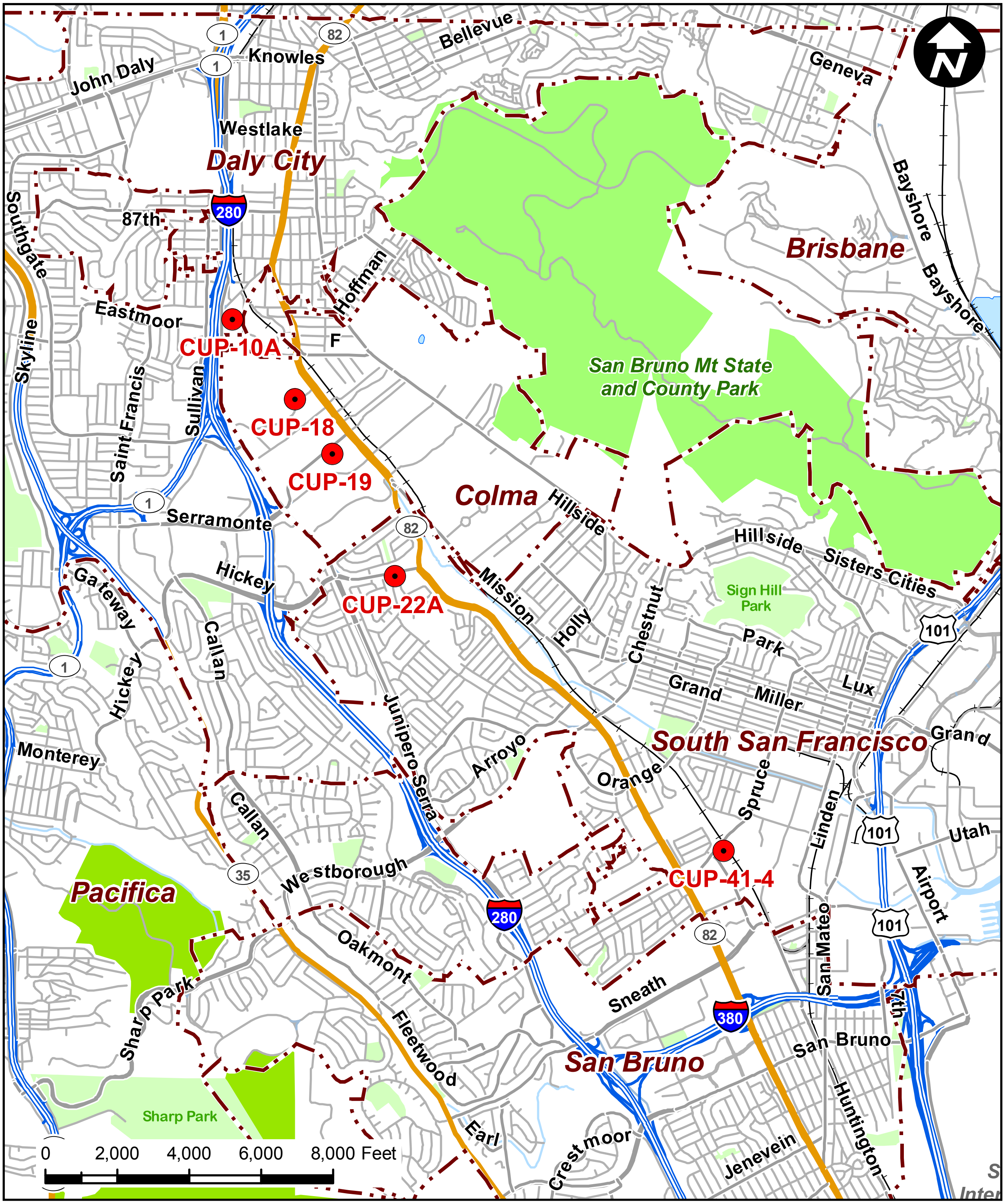


TABLE 1 – SUMMARY OF GEOTECHNICAL BORINGS

Boring	Date Drilled	Approximate Surface Elevation (feet, NAVD 88)	Depth (feet)
GB-10A	12/15/2008	+ 193	30
GB-18	12/15/2008	+ 173	30
GB-19	12/15/2008	+ 112	30.5
GB-22A	12/16/2008	+ 100	30.5
GB-41-4	12/16/2008	(1)	30.5

1. Surface elevation relative to NAVD 88 datum is not available. A preliminary topographic map showing a field survey by Chaudhary & Associates on March 14, 2008 indicates a temporary benchmark was used as a reference.

We visually classified the soil during drilling. We recovered split-spoon (Standard Penetration Test) samples and relatively undisturbed 2 ½ inch diameter sleeve samples using a split-barrel sampler. Selected samples were transferred to a laboratory for testing. The boring locations are shown on Plates 1 through 5 – Boring Location Maps. Boring logs are presented in Appendix A – Supporting Geotechnical Data.

2. **Laboratory Testing.** We performed moisture, density, grain size analysis, Atterberg limits, direct shear and corrosion tests on selected soil samples to measure pertinent index and engineering properties. The laboratory test results are presented on the figures in Appendix A, and on the boring logs on Plates A-1.1 through -1.5.

3. **Engineering Analysis.** We analyzed subsurface conditions and laboratory test results, and reviewed regional and local geology and seismicity. Additionally, we analyzed the following geotechnical parameters:

    - Seismic hazards evaluation including strong ground shaking, liquefaction, seismic and dynamic settlements, and seismically-induced landslides;
    - Seismic design parameters in accordance with the 2006 International Building Code;
    - Bearing capacity (allowable and ultimate) and modulus of subgrade reaction (vertical soil springs) for shallow footings and grade beams, and mat foundations; and
    - Lateral earth pressures (active, passive, at-rest, and seismic increment) and base friction coefficients for restrained and unrestrained walls and/or buried footings.

4. **Report.** We prepared this report presenting our geotechnical findings, conclusions, and recommendations for the proposed improvements at the five subject sites for the SWGBCUP.

FINDINGS

SITE CONDITIONS

The five subject sites are located within the north portion of the South Westside Groundwater Basin in San Mateo County, California. The ground surface along an alignment which roughly transects the five sites, and parallels El Camino Real, generally descends in a northwest-to-southeast direction from elevations of approximately 200 feet to 20 feet above mean sea level for a distance of approximately 4 miles.

The northernmost site CUP-10A is located to the southeast of the intersection between Junipero Serra Boulevard and B Street in Daly City. As indicated on the general layout of the proposed improvements on Plate 1 – Boring Location Map for CUP-10A, the site is located on a relatively flat, abandoned, asphalt paved parking lot. The site is surrounded by parking lots to the south and west, residential/commercial property to the east, and sidewalk abutting B Street to the north. Existing underground water main pipelines (Baden Merced, San Andreas Nos. 2 and 3, Sunset Supply) and proposed connection main and pump-to-waste pipelines are also shown on Plate 1.

Approximately ½ mile to the southeast from CUP-10A, CUP-18 is located to the southwest of the intersection between Colma Boulevard and El Camino Real in the Town of Colma. As indicated on the general layout of the proposed improvements on Plate 2 – Boring Location Map for CUP-18, the site is located on grassy terrain which descends on a mildly sloping (7:1 horizontal to vertical side slope ratio) terrain in a northwest-to-southeast direction. The site is surrounded by a paved turnout for Colma Boulevard to the south, a small maintenance/operations facility building to the west, moderately wooded area to the east, and the Woodlawn Cemetery to the north. Existing underground water main pipelines (Baden Merced, and San Andreas Nos. 2 and 3) and proposed connection main and pump-to-waste pipelines are also shown on Plate 2.

A further 1/3 mile to the southeast from CUP-18, CUP-19 is located to the southwest of the intersection between El Camino Real and Serramonte Boulevard in the Town of Colma. The general layout of the proposed improvements on Plate 3 – Boring Location Map for CUP-19 shows a relatively flat, recently re-graded site which is surrounded to the east by a parking lot for the Kohl's department store, to the west by a concrete retaining wall which retains an automobile dealer parking lot to higher grade, to the north and south by relatively flat, re-graded grounds, and further to the north by Serramonte Boulevard. Existing underground water main pipelines (Baden Merced, and San Andreas Nos. 2 and 3) and proposed connection main and pump-to-waste pipelines are also shown on Plate 3.

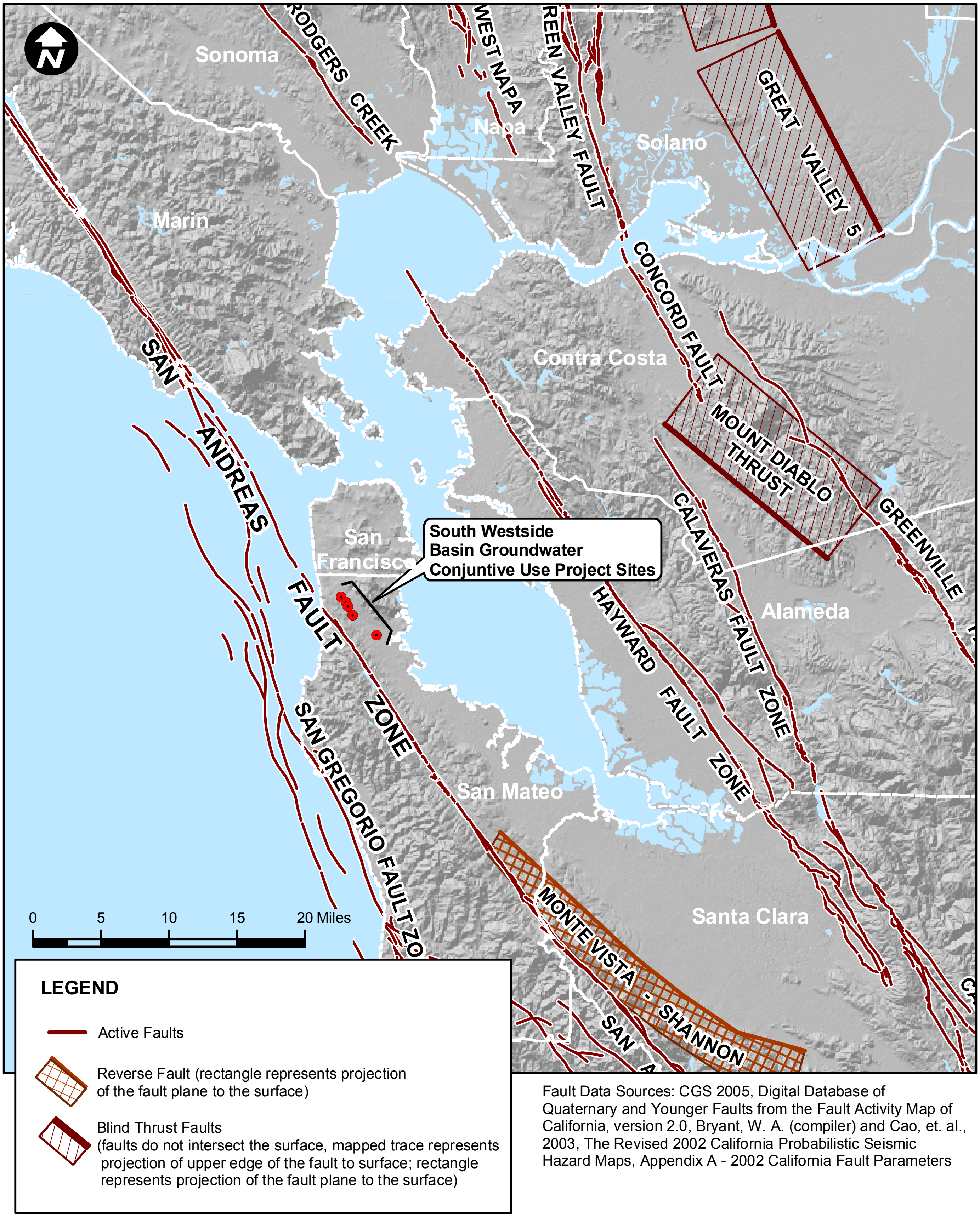
Approximately ¾ mile to the southeast from CUP-19, CUP-22A is located to the southwest of the intersection between Camaritas Avenue and Hickey Boulevard in the City of South San Francisco. The general layout of the proposed improvements on Plate 4 – Boring Location Map for CUP-22A shows a relatively flat, recently re-graded site which is surrounded to the north and east by sidewalks abutting Hickey Boulevard and Camaritas Avenue, to the south and west by relatively flat, recently re-graded grounds, and further to the west by a landscaped slope which ascends to a residential development. Existing underground water main pipelines (Baden Merced, and San Andreas Nos. 2 and 3) and proposed connection main and pump-to-waste pipelines are also shown on Plate 4.

The southernmost site of CUP-41-4 is located approximately 2¼ miles to the southeast from CUP-22A, and is situated to the northeast from the intersection between Huntington Avenue and South Spruce Avenue in South San Francisco. As shown on Plate 5 - Boring Location Map for CUP-41-4, this site is located on relatively flat terrain which is covered with landscaping mulch, lawn and scattered timber logs. The areas surrounding the site are also relatively flat. The site is surrounded to the east by a paved walkway trail which is underlain by the Bay Area Rapid Transit (BART) subway tunnel, to the south by a parking lot for a commercial building, to the west by a two-story commercial office building and its parking lot, and to the north by the sidewalk abutting South Spruce Avenue. Existing underground water main pipelines (Baden Merced, and San Andreas Nos. 2 and 3) and proposed connection main and pump-to-waste pipelines are also shown on Plate 5.

SEISMICITY

The San Francisco Bay Area contains several active faults that could cause strong ground shaking at the project site. Figure 2 – Regional Fault Map shows faults in the vicinity of the subject sites. The San Andreas (1906 Rupture Event and Peninsula Segment) are the nearest active faults and are located within 1.6 miles of the CUP-10A, -18, -19 and -22A sites, and within 2.1 miles of the CUP-41-4 site. The San Andreas is the primary component in a complex system of right-lateral, strike-slip faults; including the San Andreas, San Gregorio-Seal Cove, Hayward, and Calaveras faults; collectively known as the San Andreas fault system. The San Andreas, San Gregorio-Seal Cove, Hayward, and Calaveras faults have produced measurable historic ground motion and movement. The San Andreas fault is capable of producing an earthquake of an estimated maximum magnitude of 7.9. This segment is estimated to have recurrence intervals on the order of 200 years. A summary of nearby faults is presented in Table 2 – Active and Potentially Active Faults.

FIGURE 2
REGIONAL ACTIVE FAULT MAP



Fault Data Sources: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler) and Cao, et. al., 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps, Appendix A - 2002 California Fault Parameters

TABLE 2 – ACTIVE AND POTENTIALLY ACTIVE FAULTS

Fault (Segment or Event)	Distance to Fault (miles)					Estimated Maximum Earthquake Magnitude [1]	Historic Earthquakes [2]	
	CUP-10A	CUP-18	CUP-19	CUP-22A	CUP-41-4		Year	Magnitude
San Andreas							1838	6.8
(1906 rupture)	1.6 [3]	1.6 [3]	1.6 [3]	1.6 [3]	2.1 [3]	7.9 [3]	1898	6.2
(Peninsula)	1.6	1.6	1.6	1.6	2.1	7.2	1906	8.1
(North)	11.2	11.8	19.5	12.9	15.0	7.7	1989	7.1
San Gregorio-Seal Cove							N/A	N/A
(North)	5.5	5.7	5.8	5.8	7.0	7.2		
Hayward							1868	6.8
(North)	17.1	17.1	17.1	17.2	16.5	6.5		
(South)	18.8	18.6	18.5	18.3	17.0	6.7		
Monte Vista-Shannon	20.9	20.4	20.0	19.3	17.1	6.7	N.A.	N.A.
Calaveras							1861	5.3
(North)	26.7	26.6	26.5	26.5	25.5	6.8	1955	5.5
(South)	40.9	40.4	40.1	39.5	37.4	6.2	1979	5.9
							1984	6.1
							2007	5.4

(1) Maximum Moment Magnitude based on California Geological Survey (CGS) fault parameters as updated in 2002 (Cao, et al., 2003), or as suggested by the SFPUC's General Seismic Requirements (SFPUC, 2006).
(2) Historic earthquakes shown may have occurred in other segments of the noted fault.
(3) The 1906 rupture event assumes rupture along the North Coast, Peninsula and Santa Cruz Mountains segments to San Juan Bautista. Maximum magnitude is based on the average 5 m displacement during the 1906 event (WGCEP, 2003; Petersen, et al., 1996).

GEOLOGY

The San Francisco Bay Area is located within the Coast Ranges Geomorphic Province. Past episodes of tectonism have folded and faulted the bedrock, creating the regional topography of the northwest trending ridges and valleys characteristic of the Coast Ranges Geomorphic Province. The San Francisco Bay and vicinity occupy a structurally controlled basin within the province. Late Pleistocene and Holocene sediments (less than 1 million years old) were deposited in the basin as it subsided.

The subject sites at CUP-10A and -18 are located in areas mapped as Colma Formation (Brabb, et al., 1988). Other sedimentary deposits mapped in close proximity to these sites include natural levee deposits, alluvial fan deposits, stream terrace deposits, and Merced Formation. The CUP-19, -22A and -41-4 sites are located in areas mapped as natural levee deposits and Colma Formation. Other sedimentary deposits mapped in close proximity to these sites include historic artificial fill, alluvial fan and stream terrace deposits, and Merced Formation. The geology in the project vicinity is shown on Figure 3 – Regional Geologic Map. Based on a regional geologic study as compiled as a regional geologic cross section of the Westside Basin – Lake Merced (SFPUC, 2008), the Franciscan Complex bedrock is anticipated to be on the order of 600 to 700 feet below ground surface at the subject sites. Geologic maps (Brabb, et al., 1988) describe the identified geologic units as follows:

- **af:** Artificial fill – loose to very well consolidated gravel, sand, silt, clay, rock fragments, organic matter, and man-made debris in various combinations and thicknesses which may exceed 30 m; some compacted and quite firm, but fill made before 1965 is nearly everywhere not compacted and consists of simply dumped materials.

- **Qhl:** Natural levee deposits (Holocene) – loose, moderately to well-sorted sandy or clayey silt grading to sandy or silty clay; porous and permeable and provide conduits for transport of groundwater. Levee deposits border stream channels, usually both banks, and slope away to flatter floodplains and basins. Abandoned levee systems, no longer bordering stream channels, may be present.

- **Qof:** Older alluvial fan and stream terrace deposits (Pleistocene) – poorly consolidated and poorly indurated well- to poorly-sorted sand and gravel with varying thickness probably less than 30 m.

- **Qc:** Colma Formation (Pleistocene) – yellowish-gray, gray, yellowish-orange and red-brown, friable to loose, fine- to medium-grained arkosic sand with subordinate gravel, silt and clay; total thickness is typically unknown, but may up to 60 m.

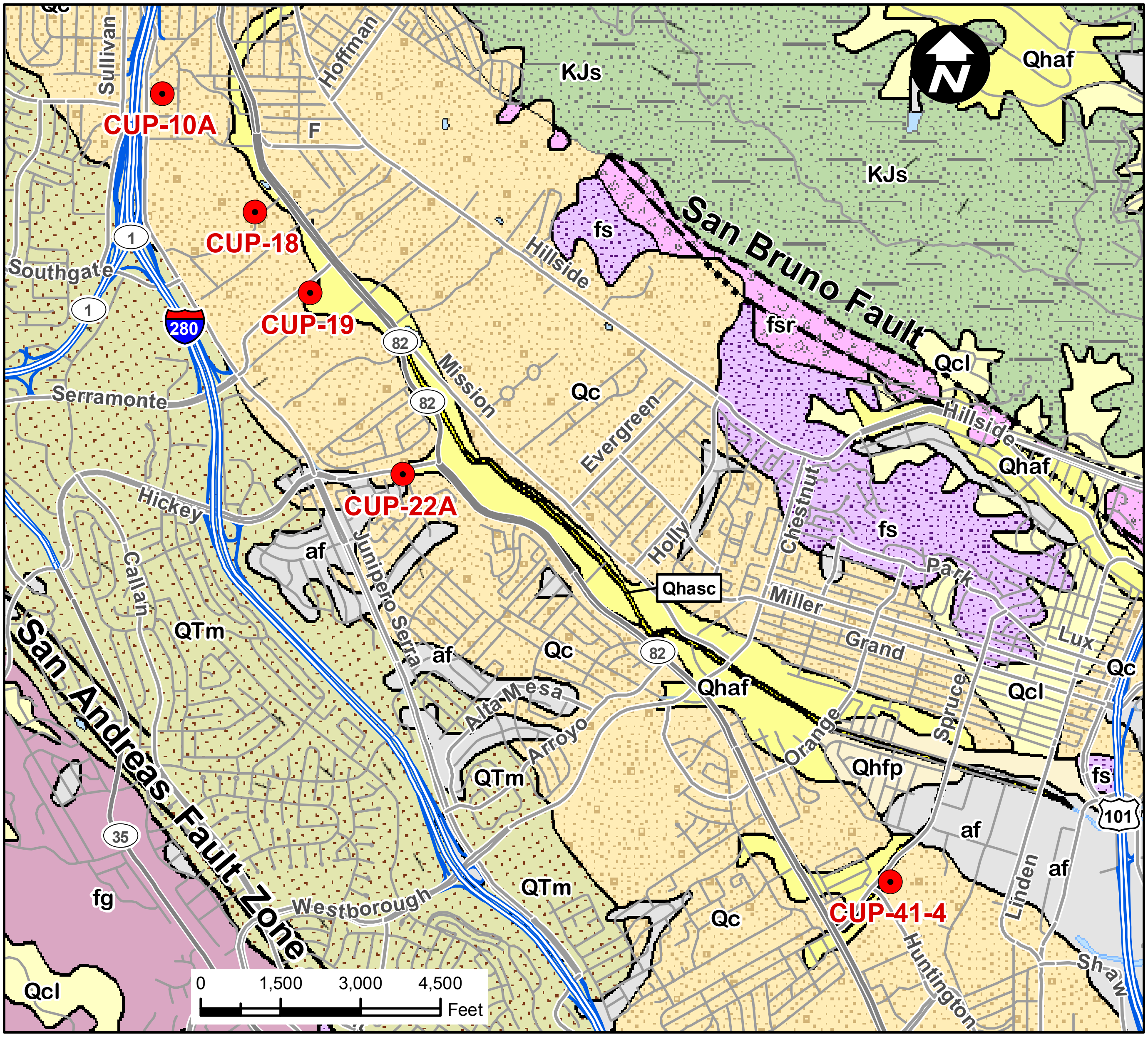
- **QTm:** Merced Formation (lower Pleistocene and upper Pliocene) – medium gray to yellowish gray, yellowish orange, medium- to very fine-grained, poorly indurated to friable sandstone, siltstone, and claystone, with some conglomerate lenses and a few friable beds of white volcanic ash; sandstone is typically silty, clayey, or conglomeratic; fossiliferous conglomerate is well cemented.

- **Qsr:** Slope debris and ravine fill - angular rock fragments in sand, silt, and clay matrix; generally light yellow to reddish brown. Maximum thickness approximately 80 feet.

- **Qd:** Dune sand - clean well-sorted fine to medium sand; yellowish brown to light gray.

- **KJf:** Franciscan Complex – mostly graywacke and shale (fs), and partly unnamed sandstone (KJs); fs consists of greenish gray to buff, fine- to coarse-grained sandstone, with interbedded siltstone and shale; KJs consists of dark gray to yellowish brown graywacke interbedded with shale in approximately equal amounts and resembling fs but the bedding in KJs is better developed.

FIGURE 3
REGIONAL GEOLOGIC MAP



Source: Brabb et. al., 1998, USGS OFR 98-137.

LEGEND

Geologic Units

- af — Artificial Fill
- Qhasc — Artificial Stream Channels
- Qhfp — Floodplain Deposits
- Qhaf — Alluvial Fan and Fluvial Deposits
- Qcl — Colluvium
- Qc — Colma Formation
- QTm — Merced Formation
- KJs — Unnamed Sandstone of San Bruno Mtn.
- fs — Franciscan Sandstone
- fg — Franciscan Greenstone
- fsr — Franciscan Melange

CUP-22A — Conjuntive Use Project (CUP) Sites

Structual Features

- geologic contact
- fault, approx. located
- fault, certain
- fault, concealed

EARTH MATERIALS

The exploratory borings for this investigation at the CUP-10A and -18 sites encountered artificial fill which was underlain by soils of Colma Formation (Qc). An intermediate stratum of natural levee deposits (Qhl) was encountered between the artificial fill and underlying soils of Colma Formation at the CUP-19 and -41-4 sites. At the CUP-22A site, artificial fill was underlain by soils of natural levee deposits to the total depth of exploration.

Artificial Fill. Artificial fill was encountered to depths of approximately 4 to 5 feet in borings GB-10A, -19 and -22A, and approximately 2 feet in borings GB-18 and -41-4. The fill was mainly comprised of light yellowish brown, damp to moist, loose to medium dense, silty fine sand. The origin of this fill at the subject sites of CUP-10A and -18 was likely a result of grading and reuse of on-site, near surface materials of Colma Formation (Qc). The fill at the CUP-19, -22A and -41-4 sites was likely to have originated from on-site, near surface soils of natural levee deposits (Qhl). At the CUP-10A site, the artificial fill was overlain by an asphalt concrete pavement. A surface layer of landscape bark was encountered above the artificial fill at the CUP-41-4 site.

Natural Levee Deposits. At the CUP-19, -22A and -41-4 sites, artificial fill was immediately underlain by soils of the natural levee deposits (Qhl). The thicknesses of the natural levee deposits encountered at the CUP-19 and -41-4 sites are 22, and 15 feet, respectively. The natural levee deposits were underlain by soils of the Colma Formation (Qc). The thickness of the natural levee deposits at the CUP-22A site exceeds 26.5 feet as the bottom contact of the natural levee deposits was not encountered within the total depth of exploration in boring GB-22A. The upper 6 to 8 feet of the soils in the natural levee deposits at the three subject sites consisted of light yellowish to olive brown, damp to moist, loose to medium dense, poorly graded fine sand to silty fine sand. The remaining lower portion of the soils in the natural levee deposits consisted of moist, medium dense to very dense, silty fine sand to sandy silt, and damp to moist, medium stiff to very stiff, sandy clay to clayey sand with some silt. Measured total unit weight ranged from 111 to 131 pounds per cubic feet (pcf), with a moisture content that ranged from 5 to 16 percent.

Colma Formation. Soils of the Colma Formation (Qc) were encountered at the CUP-10A, -18, -19 and -41-4 sites. At the CUP-10A and -18 sites, the soils of Colma Formation were encountered at relatively shallow depths of 5 and 2 feet, respectively, directly underlying the artificial fill. The Colma Formation soils at these two sites consisted of damp to moist, medium dense to very dense, poorly graded fine sand to silty fine sand. At GB-19 and -41-4 sites, the Colma Formation soils, which were encountered at deeper depths of 27 and 17 feet, respectively, were overlain by the natural levee deposits. The Colma Formation soils at these two sites consist of light yellowish to orange brown, moist to wet, dense to very dense, poorly graded fine sand with silt, silty fine sand, and sandy silt. Colma Formation soils at the four sites extended to the total depth of exploration (approximately 30 feet). Measured total unit weight for the Colma Formation soils at the four subject sites ranged from 113 to 129 pcf, with a moisture content ranging from 7 to 17 percent.

GROUNDWATER

Groundwater was not encountered during drilling of our exploratory borings GB-10A, -18, -19 and -22A to the total depths ranging from 30 to 30.5 feet. At GB-41-4, groundwater was encountered during drilling on December 16, 2008 at a depth of 27 feet. A summary of our observed groundwater levels is presented in Table 3 – Observed Groundwater Levels. Seasonal variations are expected to cause fluctuations in groundwater levels.

TABLE 3 – OBSERVED GROUNDWATER LEVELS

Boring	Date of Observation	Depth to Groundwater (feet)
GB-10A	12/15/2008	NE
GB-18	12/15/2008	NE
GB-19	12/15/2008	NE
GB-22A	12/16/2008	NE
GB-41-4	12/16/2008	27

NE = Not encountered.

CONCLUSIONS AND RECOMMENDATIONS

1.0 GENERAL

The following sections provide our conclusions and recommendations for evaluation and design of proposed station buildings at the five subject well sites of CUP-10A, -18, -19, -22A and -41-4. According to the Conceptual Engineering Report (MWH, 2008), station buildings at well sites CUP-10A, -18, -19 and -22A house a well and chemical treatment facilities. The station building at well site CUP-41-4 houses a well and filtration facilities. Based on our findings from our geotechnical field investigation, the CUP-10A and -18 sites are underlain by artificial fill and Colma Formation. Artificial fill at the CUP-22A site is underlain by natural levee deposits. At the CUP-19 and -41-4 sites, an intermediate stratum of natural levee deposits is interbedded between artificial fill and Colma Formation.

We consider the proposed improvements to be geotechnically feasible, provided that our geotechnical recommendations are incorporated into design and construction documents.

2.0 SEISMIC DESIGN CONSIDERATIONS

2.1 **General.** The main seismic hazards at the site are expected to be strong ground shaking and dynamic settlement within isolated zones of loose fill and natural levee deposits. Our seismic design considerations, including fault rupture, ground shaking, liquefaction and dynamic settlement, inundation by tsunamis, seismically-induced landslides, and seismic design with respect to the 2006 International Building Code (which the 2007 California Building Code has adopted) are provided in the following sections.

2.2 **Fault Rupture.** No active or potentially active faults are known to cross the subject sites. Consequently, the hazard posed by ground rupture due to fault offset is considered to be negligible.

2.3 **Ground Shaking**. Strong ground shaking will occur at the site as a result of a moderate to large earthquake occurring on one of the active regional faults. The San Andreas fault is closest to the subject sites (1.6 miles for CUP-10A, -18, -19 and -22A sites; and 2.1 miles for CUP-41-4 site), and therefore has the greatest capability of causing strong ground motions.

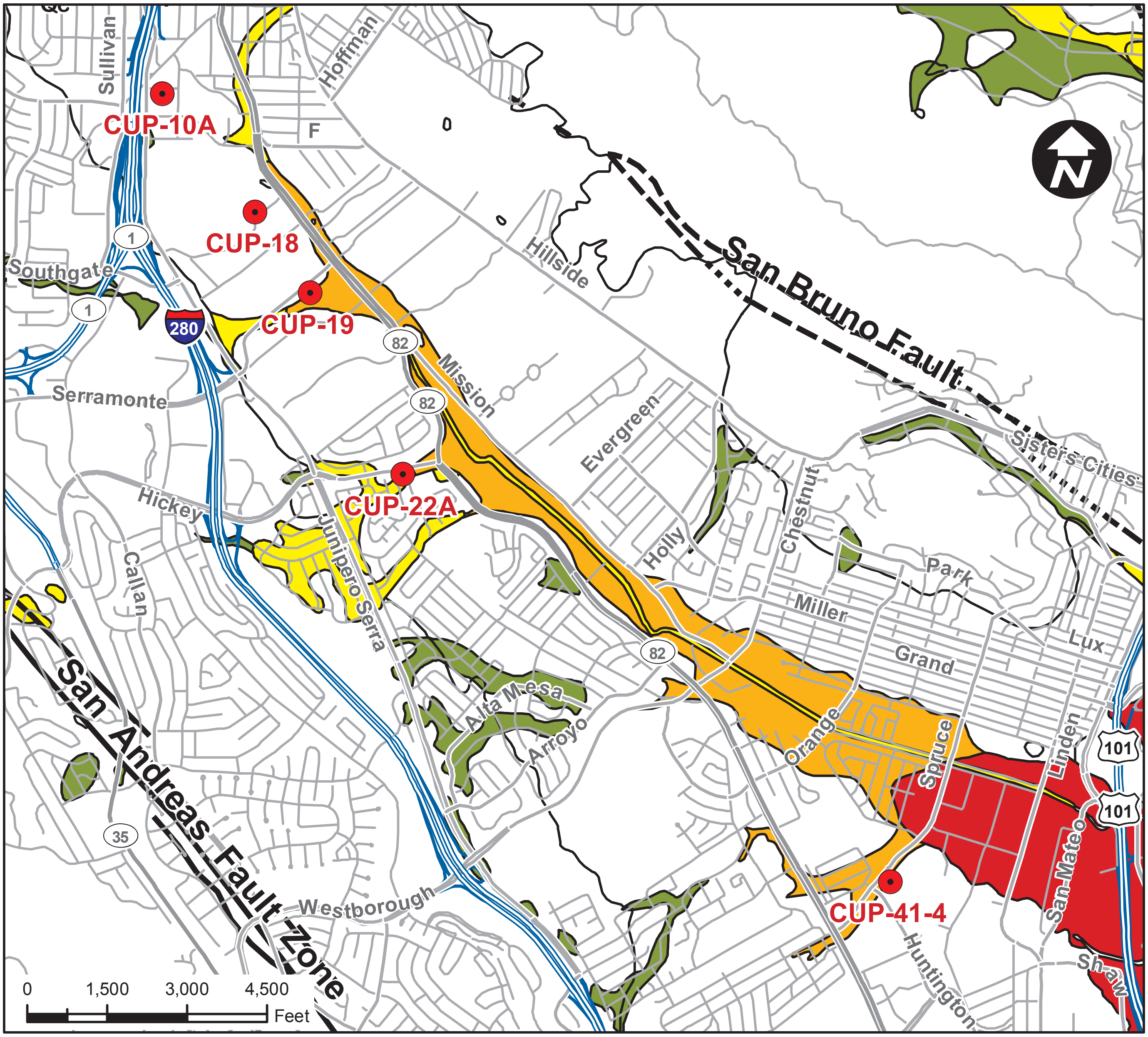
The California Geological Survey (CGS, formerly known as California Division of Mines and Geology) and United States Geological Survey (USGS) completed probabilistic seismic hazard maps in 1996 (Petersen et al., 1996), and subsequently updated fault parameters and revised the maps in 2002 (Cao, et al., 2003). USGS provides a web-based program to evaluate the USGS Probabilistic Uniform Hazard Response Spectra (http://earthquake.usgs.gov/research/hazmaps/design). Based on this data, the PGA at the site is estimated to be 0.71g for an earthquake having a 10 percent probability of exceedance in 50 years.

2.4 **Liquefaction and Dynamic Settlement.** Liquefaction is a phenomenon wherein a temporary, partial loss of shear strength occurs in a soil due to increases in pore pressure that result from cyclic loading during earthquakes. Saturated, loose to medium dense sands and silty sands are most susceptible to liquefaction. Consequences of liquefaction can include ground settlements, foundation failure, sand boils, and lateral spreading. Dynamic settlement is the densification of saturated and unsaturated soils during strong ground shaking. All soil types are prone to dynamic settlement, though loose, sand and silty sand are most susceptible.

The liquefaction susceptibility, as mapped by Witter et al. (2006), is illustrated on Figure 4 – Liquefaction Susceptibility Map. As can be seen from the figure, well sites at CUP-10A and -18 lie within a zone mapped as having a very low liquefaction susceptibility. The mapped liquefaction susceptibility at sites CUP-10 and -41-4 are moderate, and site CUP-22A lies within a zone mapped between moderate and high liquefaction susceptibility. Because of the regional focus of the liquefaction susceptibility mapping, the data only generally correlates with areas of known liquefaction hazard. The site-specific data from the borings is considered to be more indicative of liquefaction and dynamic settlement hazard. The following paragraphs further describe this hazard based on our subsurface investigation and laboratory testing program.

Due to the absence of groundwater within the 30 feet of total exploration depth for each exploratory boring at the CUP-10A, -18, -19 and -22A sites, and the generally dense nature of the Colma Formation (including the clayey nature of the natural levee deposits at the CUP-22A site) below this depth, liquefaction is not considered to be a significant consideration. Despite the observation of groundwater at a depth of 27 feet at the CUP-41-4 site, liquefaction is also not considered to be a significant consideration because of the dense nature of the Colma Formation encountered at this site. Pore pressure generation and liquefaction may occur in isolated pockets of looser material within the Colma Formation and natural levee deposits. The amount of surface settlement resulting from liquefaction is considered to be negligible at the five subject sites.

FIGURE 4
LIQUEFACTION SUSCEPTIBILITY MAP



Source: Witter, R.C., et. al.., 2006, Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California: U.S. Geological Survey Open-File Report 06-1037

LEGEND

CUP-22A — Conjuntive Use Project (CUP) Sites

Liquefaction Susceptibility

- Very Low
- Low
- Moderate
- High
- Very High

The amount of dynamic settlement for each site has been evaluated based on an anticipated earthquake event having a 10 percent probability of exceedance in 50 years. Dynamic settlement resulting from strong ground shaking at CUP-10A is estimated at 2 inches due to the loose nature of the artificial fill. At CUP-18, dynamic settlement is estimated at ¼ inch, and is not considered to be significant due to the presence of relatively dense Colma Formation beneath a relatively thin stratum of artificial fill. Dynamic settlement at CUP-19 is estimated at 2 inches, mostly due to a relatively loose layer of poorly graded sand near the upper stratum of natural levee deposits. As a result of a relatively loose layer of silty fine sand within the natural levee deposits, dynamic settlement is estimated at ½ inch for CUP-22A. Dynamic settlement resulting at CUP-41-4 is estimated at 4 inches, and is considered relatively significant due to a loose layer of silty fine sand that spans the upper 6 feet of the natural levee deposits. The hazard posed by dynamic settlement is therefore considered to be low at CUP-18 and -22A, and moderately high at CUP-10A, CUP-19 and -41-4.

2.5 **Inundation by Tsunamis.** Tsunamis are long period waves usually caused by underwater seismic disturbances, volcanic eruptions, or submerged landslides. The disturbance can occur thousands of miles from the San Francisco area, and generate a tsunami wave that affects the site. As tsunami waves approach the coast, they may increase in height to tens of feet.

Flooding due to tsunami is unlikely to occur at CUP-10A, -18, -19 and -22A due to their relatively high ground elevations and distance from the open Northern California coastline. Although CUP-41-4 is located on relatively low lying terrain estimated on the order 25 to 30 feet above Mean Sea Level (MSL), the potential of flooding during a tsunami is unlikely because of the distance to San Francisco Bay.

2.6 **Seismically-Induced Landslides.** Based on the flat topography surrounding the sites of CUP-10A, -22A and -41-4, seismically-induced landslide hazards do not exist at these sites. An elevated automobile dealership parking lot to the west of CUP-19 is not likely to pose seismically-induce landslide hazards because of an existing concrete retaining structure and 30 to 40 feet of setback distance between the retaining wall and proposed station building. At CUP-18 which is located at the foot of a mildly sloping terrain (on the order of 7:1 horizontal to vertical side slope ratio), seismically-induced landslide hazards are considered not likely because of the dense nature of the subsurface soils and absence of shallow groundwater.

2.7 **Seismic Design Parameters.** The proposed improvements may be designed in accordance with the International Building Code Static Force Procedure (ICC, 2006) using the seismic parameters as presented in Table 4 – 2006 International Building Code (IBC) Seismic Design Parameters in developing the site seismic response:

TABLE 4 – 2006 INTERNATIONAL BUILDING CODE SEISMIC DESIGN PARAMETERS

	Site CUP-10A	Site CUP-18	Site CUP-19	Site CUP-22A	Site CUP-41-4
Site Class	C	C	D	D	C
S_s [(1)] at 0.2-second	2.17	2.16	2.16	2.17	2.07
S_1 [(1)] at 1-second	1.22	1.21	1.21	1.22	1.13
Site Coefficient F_a	1.0	1.0	1.0	1.0	1.0
Site Coefficient F_v	1.3	1.3	1.5	1.5	1.3

[(1)] Maximum Considered Earthquake (MCE) Spectral Response Acceleration (in g).

3.0 GROUNDWATER

With the exception of exploratory boring GB-41-4, groundwater was not encountered in the remaining four 30-foot deep exploratory borings. At GB-41-4, groundwater was encountered during drilling at a depth of 27 feet below ground surface. The observation of groundwater at GB-41-4 is consistent with the 1½-mile proximity of the site from the San Francisco Bayshore coastline to the east, and the relatively flat, low lying topography (ground elevations on the order of 25 to 30 feet above mean sea level). It should be noted that groundwater levels are influenced by seasonal variations in precipitation, local irrigation, groundwater pumping and other factors, and are therefore, subject to variation. To account for seasonal variations, we recommend conservative design groundwater levels for structural design purposes as presented in Table 5 – Recommended Design Groundwater Levels. The actual depth to groundwater is expected to be considerably deeper.

Groundwater related design issues such as hydrostatic pressures on shoring elements (if implemented), excavation dewatering, and hydrostatic uplift pressures on the proposed buildings are not anticipated for excavations less than 20 feet below the ground surface at the relatively flat sites of CUP-10A, -19, -22A and -41-4. Due to a sloping terrain at CUP-18, the aforementioned groundwater related issues are not anticipated for excavations less than 15 feet below the ground surface. For excavations exceeding the mentioned depths, the contractor should anticipate groundwater inflow and the need for dewatering.

TABLE 5 – RECOMMENDED DESIGN GROUNDWATER LEVELS

Site Location	Recommended Design Groundwater Depth (feet)
CUP-10A	20
CUP-18	15
CUP-19	20
CUP-22A	20
GB-41-4	20

4.0 EARTHWORK

4.1 General. Given the earth materials on the project sites encountered during our exploration, the contractor should be able to carry out planned excavations using conventional heavy equipment.

Evaluation of the presence, or absence, and treatment of hazardous materials was not part of this study. If hazardous materials are encountered during excavation, proper handling and treatment during construction will depend on the contaminant type, concentration, and volatility of the contaminated materials.

General geotechnical considerations for site preparation, excavations, temporary shoring and bracing, engineered fill material, engineered fill placement and compaction, pipe bedding, and utility trench backfill are presented in the following sections.

4.2 Site Preparation. Site preparation will consist of demolition, excavation and removal of on-site materials such as pavement, concrete, abandoned utilities, and miscellaneous debris in preparation for the foundation excavations. Any creation of holes from the removal of such materials should be backfilled with engineered fill. Recommendations for engineered fill are provided in Sections 4.5 and 4.6. Also as part of site preparation, the location of active underground utilities should be determined and, if affected by construction activities, should be relocated or protected.

4.3 Excavations. We anticipate that excavations for the planned building improvements to extend up to only a few feet below existing ground elevation. Since CUP-18 is located near the foot of mildly sloping terrain, greater excavation may be necessary at this site.

Shallow excavations for the well station buildings will allow for unshored excavations with adequately sloped sidewalls. Vertically shored walls or braced excavations are anticipated where space constraints may not allow for open, sloped excavations. At a minimum, excavations should be constructed in accordance with the current California Occupational Safety and Health Administration (OSHA) regulations (Title 8, California Code of Regulations) pertaining to excavations. Temporary cut slopes are expected to be stable for configurations described in Title 8 for Type C soils and where unsupported should be cut back no steeper than 1 ½ horizontal to 1 vertical. All excavations should be closely monitored during construction to detect any evidence of instability.

Care should be taken when excavating near existing utilities and pipelines. Excavations can undermine support of adjacent existing pipelines and other subsurface structures. We recommend that some form of vertical shoring system be considered for excavated sidewalls that are adjacent to existing pipelines or other known buried adjacent structures.

As indicated in Section 2.4, loose fill soils at CUP-10A and -19 sites, and loose soils in the upper portion of natural levee deposits at CUP-19 and -41-4, may settle excessively during a seismic event, and may require mitigation if the estimated settlements exceed tolerable levels. Some of the near surface loose soils at the five subject sites will likely be removed during excavation for the proposed improvements. If any footings are founded above loose soils, overexcavation of loose soils and replacement with engineered fill may be required. For loose natural levee deposits encountered at depths of 8 to 12 feet at CUP-19, and 2 to 6 feet at CUP-41-4, removal of materials via conventional grading involving earth removal and replacement may not be practical; instead, remediation of loose materials at intermediate depths can be performed using densification improvement methods, as discussed in Section 6.3.

4.4 Temporary Shoring and Bracing. The type and design of the shoring will depend on the depth of excavation and excavation-bracing sequence. The shoring and bracing design and installation should be the responsibility of the construction contractor. As a general guideline, construction procedures, excavations, and design and construction of any temporary shoring should comply with the current OSHA Title 8 regulations pertaining to excavations. The shoring and bracing should accommodate surcharge loads that may be imposed by adjacent structures, traffic, or construction activities.

Possible shoring schemes include soldier pile and lagging and steel sheeting, both of which may include internal bracing struts to limit lateral deflections. Such braced and shored excavations will be subjected to lateral earth pressures. Recommended active, at-rest, and passive lateral earth pressures are provided in Section 5.

Horizontal and vertical movements of the ground are possible in the vicinity of the excavations. These movements can generally be reduced to acceptable levels by use of a properly designed and constructed shoring system. Measures should be taken to prevent the loss of sand through the gaps in the shoring or lagging.

4.5 Engineered Fill Material. Material for engineered fill should be inorganic, well graded, free of rocks or clods greater than 4 inches in greatest dimension or any other deleterious materials, and have a low potential for expansion. The material should have a liquid limit less than 35, a plasticity index less than 15 and no more than 25 percent passing the No. 200 sieve. Existing on-site soil may be re-used as engineered fill provided it meets the above criteria.

4.6 **Engineered Fill Placement and Compaction.** Engineered fill should be placed in layers no greater than 8 inches in uncompacted thickness, conditioned with water or allowed to dry to achieve a moisture content near optimum, then mechanically compacted to at least 90 percent relative compaction based on ASTM D1557. All engineered fill placed to support footings and the upper 6 inches of engineered fill supporting slabs-on-grade should be mechanically compacted to at least 95 percent relative compaction as determined by ASTM D1557. All compaction should be performed using mechanical compaction means; flooding or jetting should not be used as a means to achieve compaction. The ASTM D1557 laboratory compaction tests should be performed at the time of construction to provide a proper basis for compaction control.

4.7 **Pipe Bedding for Small Diameter Pipes.** Pipe bedding should consist of well-graded sand or a sand-gravel mixture. Maximum gravel size should be ½ inch and the bedding material should have less than 12 percent passing the No. 200 sieve. Uniformly graded material such as pea gravel should not be used as pipe bedding material. Pipe bedding should have a minimum thickness of 6 inches beneath the pipe and 6 inches above the pipe. If soft or otherwise unsuitable soils are exposed in the bottom of the trench excavation, the necessity of over-excavation should be evaluated by the project geotechnical engineer. All pipe bedding should be placed to achieve uniform contact with the pipe and a minimum relative compaction of 90 percent per ASTM D1557.

4.8 **Utility Trench / Pipe Backfill.** Utility and pipe trenches may be backfilled above the pipe zone with excavated on-site soils, provided they meet the gradation requirements of engineered fill. The backfill material should be placed in layers no greater than 8 inches in uncompacted thickness, moisture conditioned or allowed to dry to achieve a moisture content near optimum, then mechanically compacted to at least 90 percent relative compaction based on ASTM D1557. The upper 2 feet should be compacted to at least 95 percent relative compaction in areas where structural or traffic loads are anticipated.

5.0 LATERAL EARTH PRESSURES

5.1 **Active Earth Pressure.** Active earth pressures are imposed by the soil on walls that are unrestrained so that the top of the wall is free to translate or rotate at least 0.004H, where H is the height of the wall. The active earth pressure may be calculated using a design equivalent fluid pressure (EFP) for each of the subject sites as indicated in Table 6.1 – Active Earth Pressures.

TABLE 6.1 – ACTIVE EARTH PRESSURES

Site Location	CUP-10A	CUP-18	CUP-19	CUP-22A	CUP-41-4
Active EFP [(1)] (pcf)	30	30	35	35	35

1. EFP assumes that excavations do not extend below the groundwater table.

5.2 **At-Rest Earth Pressure.** At-rest pressures should be used for design of walls that are restrained such that the deflections required to develop active earth pressures cannot occur or are undesirable. The at-rest earth pressures may be calculated using a design EFP for each of the subject sites as indicated in Table 6.2 – At-Rest Earth Pressures.

TABLE 6.2 – AT-REST EARTH PRESSURES

Site Location	CUP-10A	CUP-18	CUP-19	CUP-22A	CUP-41-4
At-Rest EFP [(1)] (pcf)	50	50	55	55	55

1. EFP assumes that excavations do not extend below the groundwater table.

5.3 **Seismic Earth Pressure.** In addition to the active and at-rest pressures, retaining walls should be designed to consider additional earth pressures due to earthquake loading. The increment in earth pressure due to seismic loading, for both restrained and unrestrained below-grade walls, may be calculated using an inverted triangular distribution with the pressure at the top of the wall equal to a design earth pressure (EP) of 30H, wherein H is the height of the wall in feet, and diminishes to zero at the base of the wall, as indicated in Table 6.3 – Seismic Earth Pressures.

TABLE 6.3 – SEISMIC EARTH PRESSURES

Site Location	CUP-10A	CUP-18	CUP-19	CUP-22A	CUP-41-4
Seismic EP [(1)] at Top of Wall (psf)	30 H [(2)]	30 H [(2)]	30 H [(2)]	30 H [(2)]	30 H [(2)]

1. EFP assumes that excavations do not extend below the groundwater table.
2. H is the height of the wall in feet, and diminishes to zero at the base of the wall.

5.4 **Passive Earth Pressure.** Lateral loads on structures can be resisted by passive pressures that develop against the sides of below-grade structures such as walls or footings. The passive pressure depends on the lateral displacement of the wall or footing. In accordance with FEMA 356 (FEMA, 2000), the ultimate passive pressure is mobilized at a displacement of approximately 6 percent of the wall height. The ultimate passive earth pressure may be calculated using a design EFP that corresponds to the ultimate EFP as long as the structure can be mobilized to such level of displacement and still does not exceed the allowable displacement of the structure. Oftentimes, the displacement to achieve ultimate passive earth pressures exceeds the allowable displacement of the structure. Consequently, a design EFP needs to be reduced when the allowable displacement of the structure is less than 6 percent of the wall height. For displacements of approximately 0.8 and 3 percent of the wall height, the design EFP may be reduced to 50 and 85 percent of the ultimate EFP. Passive pressures computed using these design EFPs may be combined with the base friction mobilized at the concrete-soil interface to resist lateral loading (see Section 5.5). The passive earth pressures may be computed using the following design EFPs as indicated in Table 6.4 – Passive Earth Pressures:

TABLE 6.4 – PASSIVE EARTH PRESSURES

Site Location	CUP-10A	CUP-18	CUP-19	CUP-22A	CUP-41-4
Passive Ultimate EFP [(1)] at 6% Wall Height Displacement (pcf)	390	390	425	425	360
Passive EFP [(1)] at 3% Wall Height Displacement (pcf)	330	330	360	360	305
Passive EFP [(1)] at 0.8% Wall Height Displacement (pcf)	195	195	215	215	180

1. EFP assumes that excavations do not extend below the groundwater table.

5.5 **Base Friction.** A coefficient of friction of 0.4 may be used for estimating the resistance due to base friction. The coefficient should be multiplied by the dead load only. The passive earth pressure and base friction mobilized at the concrete-subgrade interface may be combined to resist lateral loading.

6.0 FOUNDATIONS

6.1 **Subgrade Preparation.** Subgrades to new shallow foundations for the proposed structures should be prepared to provide a flat, relatively dry, and firm working surface. If any unsuitable materials, such as, soft clays or silts, soils containing organic material, debris or other deleterious materials are encountered at subgrade, they should be over-excavated and restored to grade with engineered fill in accordance with Sections 4.5 and 4.6. The fill soils encountered in our exploratory borings were suitable for support of the proposed improvements provided the upper 12 inches are scarified, moisture conditioned, and recompacted. We recommend that the upper 12 inches of subgrade be scarified, moisture conditioned to near optimum moisture content, and compacted in accordance with Sections 4.5 and 4.6. The subgrade should be free of loose debris and ponded water prior to placing reinforcing steel and concrete.

6.2 **Shallow Foundation Alternatives.** A shallow foundation system is suitable for support of the proposed improvements at the subject sites. Alternatives for shallow foundation systems include grade beams / shallow footings, mat foundations, and post-tensioned foundations.

Grade Beams / Shallow Footings: Based on the findings from our subsurface evaluation and laboratory testing, the ultimate bearing capacity of soils below new footings within the footprint of proposed buildings varies according the geotechnical characteristics of soils encountered at each subject site. We recommend an ultimate bearing capacity of 10,000 pounds per square foot (psf) for soils below new footings at the CUP-10A, -18 and -19 sites, 11,000 psf for CUP-22A, and 7,600 psf for CUP-41-4. Settlement of footings to attain these ultimate bearing capacities are expected to be on the order of about 2 inches, and could be significantly more as the ultimate bearing capacity is exceeded. To limit foundation settlements to less than ½ inch for dead and live loads and less than 1 inch for total loads including wind and seismic, the allowable bearing capacities provided in Table 7 – Allowable Bearing Capacities of Grade Beams and Shallow Footings may be used.

TABLE 7 – ALLOWABLE BEARING CAPACITIES OF GRADE BEAMS AND SHALLOW FOOTINGS

Sites	Load Combination	Allowable Bearing Capacity
CUP-10A CUP-18 CUP-19	Dead Load Dead + Live Load Dead + Live + Wind or Seismic Loads	3,300 psf 3,800 psf 5,000 psf
CUP-22A	Dead Load Dead + Live Load Dead + Live + Wind or Seismic Loads	3,600 psf 4,100 psf 5,400 psf
CUP-41-4	Dead Load Dead + Live Load Dead + Live + Wind or Seismic Loads	2,500 psf 3,000 psf 3,800 psf

Allowable bearing capacities recommended herein are applicable to newly constructed footings with widths of at least 18 inches and footing embedment of at least 24 inches below lowest adjacent grade.

A static modulus of subgrade reaction of 60 pounds per cubic inch (pci) may be used in order to develop soil springs below the foundation elements. For the lateral resistance of grade beams and footings, the geotechnical design parameters provided in the Lateral Earth Pressures section may be used.

As discussed in Section 2.4, dynamic settlements of up to approximately ½ inch may affect the CUP-18 and -22A sites during an earthquake event. The remaining three sites are more susceptible to significant dynamic settlements during an earthquake event. Larger dynamic settlements, on the order of 2 inches at CUP-10A and CUP-19, and 4 inches at CUP-41-4, are anticipated during an earthquake event if these sites are not mitigated. These dynamic settlements are in addition to the settlements estimated for the building loads described above. Long-term consolidation settlements are not likely due to the granular nature of much of the subsurface soils, and the stiffness and overconsolidation of clayey soils.

***Mat Foundations*:** Effects from differential dynamic settlements at the CUP-10A, -19 and -41-4 sites may be limited by supporting the structures at these sites on structurally rigid mat foundations. A mat foundation is a large concrete slab, designed by a structural engineer for specific use, to interface one or more columns or pieces of equipment with the foundation soil. It may encompass the entire foundation footprint or only a portion. The mat contact stresses are generally lower than other shallow foundation types due to distribution of stress over a larger area and stress compensation from excavated soil. Thickness and reinforcement of the mat foundation should be in accordance with the recommendations of a structural engineer. The appropriate allowable contact pressure(s) beneath the mat foundations will vary with their size, shape, and other factors. To limit foundation static settlements to less than ½ inch for dead and live loads and less than 1 inch for total loads including wind and seismic, the contact pressure beneath the mats should not exceed the allowable bearing capacities as recommended in Table 7 – Allowable Bearing Capacities for Grade Beams and Shallow Footings. Mat foundations typically experience some deflection due to loads placed on the mat and the reaction of the soils underlying the mat. A design coefficient of subgrade reaction, $\mathbf{K_{v1}}$, of 260 kips per cubic foot (kcf) in compacted fill soils may be used for evaluating such deflections at the subject sites. This value is based on a square foot area and should be adjusted for the planned mat size. The coefficient of subgrade reaction, $\mathbf{K_B}$, for a mat of a specific dimension may be evaluated using the following equation:

$$\mathbf{K_{B}, = K_{v1} [(B+1)/2B]^2 [(1+0.5(B/L)/1.5]}$$

where **B** is the width and **L** is the length of the foundation measured in feet.

Mat foundations bearing on fill may be designed using a coefficient of friction of 0.4 (total frictional resistance equals coefficient of friction times the dead load). The allowable lateral resistance can be taken as the sum of the frictional resistance and passive resistance provided the passive resistance does not exceed two-thirds of the total allowable resistance. For mat foundations, we recommend a passive resistance value of 300 psf per foot of depth, with a value not to exceed 3,000 psf. The passive resistance may be increased by one-third when considering loads of short duration such as wind or seismic forces.

***Post-Tensioned Foundations*:** Effects from differential dynamic settlements at the CUP-10A, -19 and -41-4 sites may be limited through the application of post-tensioning in reinforcing, and hence, increasing the structural rigidity of grade beams / shallow footings. Thickness and reinforcement of a post-tensioned foundation should be in accordance with the recommendations of a structural engineer.

6.3 Densification Improvements. Dynamic settlements of loose granular soils at CUP-10A, -19, and -41-4 are anticipated during an earthquake event if these sites are not mitigated. An estimate of the amount of dynamic settlement and the depth to the zone of susceptible soils are provided in Table 8 - Densification Improvements to Mitigate Dynamic Settlements. If the structures cannot be designed to withstand this amount of settlement, densification may be an option to improve susceptible soils. Due to the existing pipelines at the sites, it may be difficult to improve the soils without causing settlement of the pipelines or otherwise damaging them. Once the site layouts are finalized and the existing pipelines accurately located, we can provide further recommendations regarding densification improvements.

TABLE 8 – DENSIFICATION IMPROVEMENTS TO MITIGATE DYNAMIC SETTLEMENTS

Site Location	CUP-10A	CUP-18	CUP-19	CUP-22A	CUP-41-4
Estimated Dynamic Settlement (inches)	2	¼	2	½	4
Improvement Depth of Loose Granular Soils (feet)	5±	-- (3)	12±	-- (3)	12±
Potential Method(s) of Improvement (1)	RAP RIC OR (2)	-- (3)	RAP RIC	-- (3)	RAP RIC

1. Densification improvement methods are denoted by RAP for Rammed Aggregate Piers and RIC for Rapid Impact Compaction.
2. For the CUP-10A site, conventional method of overexcavation and recompaction (OR) of loose granular soils is also a viable alternative to the above densification improvement methods.
3. Densification improvements are not necessary because the potential for dynamic settlement is low at CUP-18 and -22A.

The loose granular soils at CUP-10A can be mitigated by overexcavation and recompaction. Loose granular soils as encountered in the upper natural levee deposits at CUP-19 and -41-4 are susceptible to dynamic settlements on the order of 2 and 4 inches, respectively, if they are left unmitigated. Since such susceptible materials were encountered at intermediate depths within the upper 12 feet and 8 feet at GB-19 and -41-4, densification improvements and/or intermediate foundation systems may be preferable and more feasible than earth grading involving mass excavation and recompaction of loose materials, or a deep foundation system. Intermediate foundations such as Rammed Aggregate Piers (RAP) and Rapid Impact Compaction (RIC) may be suitable in mitigating the potential for post-earthquake dynamic settlements of loose materials at CUP-19 and -41-4.

RAP is constructed by either replacement (drilling a cavity) or displacement (driving a mandrel) to the depth of treatment, and ramming select aggregate in thin lifts to form compacted aggregate "bulbs" and densified materials surrounding the aggregate (Farrell, et al., 2004 and 2008; Majchrzak, et al., 2004). While the replacement process allows better quality control through visual inspection of drill spoils, the displacement approach eliminates spoils and is suitable for granular materials. Predrilled shafts are typically 24, 30, 33 and 36 inches in diameter. The ramming equipment typically consists of 18- to 27-ton hydraulic excavators equipped with 2,000- to 4,000-pound hydraulic break hammers and specially modified beveled tampers. The hydraulic hammer typically delivers 1 to 2 million ft-lbs of ramming energy per minute to the beveled tamper at 300 to 500 blows per minute. The ramming action increases the lateral stress in the surrounding soil and increases stiffness of the stabilized composite soil mass. The beveled tamper densifies and embeds the crushed aggregate laterally into the sidewalls of the shaft. Densification in both vertical and lateral (radial) directions enhances shear strength, bearing capacity and stiffness of the mitigated soil mass. RAP is typically effective for intermediate treatment depths up to 30 feet. When RAP aggregate is extracted from locally recycled concrete or any of the materials approved by the US Green Building Council (USGBC), points can be earned toward a Green Building certification in accordance with the Leadership in Energy and Environmental Design (LEED) rating system.

RIC is economically viable in recompacting loose materials at intermediate depths beyond practical/feasible reach of conventional mass grading. Similar to the ground improvement principles for RAP, RIC increases bearing capacity, controls dynamic settlement, and reduces potential for liquefaction by increasing density and strength of loose materials within the treatment depth (Kristiansen, 2004; TerraSystems, Inc., undated). RIC, which was originally developed by the British Sheet Piling, Limited in collaboration with the British Ministry of Defence, is an improvement on the process of Deep Dynamic Compaction (DDC) for many applications. Excavator mounted equipment provides controlled impact compaction of the earth by dropping a 7.5-ton weight approximately 4 feet onto a 5-foot diameter tamper at a rate of 40 to 60 times a minute. The energy transfer of RIC to the ground is relatively efficient because its tamper stays in contact with the ground during the impacting sequence. Densification of underlying loose materials is sustained from repeated dynamic impact energy imparted from the compaction tamper. Depth of impact is typically on the order of 10 feet to 20 feet. Treatment depth diminishes with increasing presence of fines in the subsurface materials. It is advantageous to perform RIC after stripping and limited removal of shallow overburden fill.

Quality assurance of the remediation program, which consists of post-treatment density evaluation, is an integral part of the acceptance testing program. Cone penetration testing (CPT) is typically used in providing continuous measurement of the soil density of the improved site.

6.4 **Floor Slabs.** Slabs-on-grade should be supported on a 12-inch thick mat of compacted, engineered fill. Material for engineered fill and compaction requirements are presented in Sections 4.5 and 4.6. For moisture-sensitive flooring, floor slabs resting on soil should be underlain, at a minimum, by a capillary break system. We recommend 6 inches of clean coarse sand or pea gravel. When floor dampness is a concern, such as at CUP-41-4 where elevated moisture content was observed in the near surface soils, floor slabs should be underlain by a vapor barrier and capillary break system. We recommend a system consisting of a 10-mil polyethylene (or equivalent) membrane placed over 6 inches of clean coarse sand or pea gravel. The exposed subgrade should be moistened just prior to the placement of the capillary break system. A sand layer above the moisture barrier to aid in concrete curing should be evaluated by the structural engineer. The slab underlayment including the capillary break can be taken as part of the 12-inch thick pad of compacted, engineered fill described above. Flooring and waterproofing consultants should be consulted for additional slab waterproofing recommendations.

7.0 CORROSION

Schiff Associates performed corrosivity laboratory tests on one soil sample for each of the five subject sites. Their laboratory results are included in Appendix A – Supporting Geotechnical Data. They performed the following tests:

- Resistivity (As-Received and Saturated),
- pH,
- Electrical Conductivity,
- Chemical Analyses of Cations (e.g. Calcium, Magnesium, Sodium)
- Chemical Analyses of Anions (e.g. Carbonate, Bicarbonate, Chloride, Sulfate)
- Chemical Analyses of Ammonium
- Chemical Analyses of Nitrate
- Chemical Analyses of Sulfide
- Oxidation-reduction (Redox) Potential

Electrical resistivities indicate soils are mildly corrosive to ferrous metals. The soil pH values were near neutral. The soluble salt contents of the samples were low, and on-site soils present a negligible sulfate exposure to concrete structures.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 **Existing Underground Utilities.** A number of underground water main pipelines pass beneath and in the vicinity of the proposed sites, including the Baden Merced, California Water Main, Daly City Water Main, San Andreas No. 2, San Andreas No. 3, San Bruno Water Main and Sunset Supply pipelines. Other existing subsurface lines include the SFPUC transmission lines, sanitary sewer and storm sewer lines. Some of these utilities were located and marked prior to our subsurface investigation so that we would not damage them during drilling.

The City may consider remarking these utilities prior to construction of the improvements so they remain visible during earthwork and construction of the subject improvements. Any excavations made adjacent to existing utilities should be backfilled with on-site or imported soil to at least 90 percent relative compaction as evaluated by ASTM D 1557.

8.2 **Vibration and Noise Control During Densification Improvements.** Peak soil particle velocities generated from vibrations during either RAP or RIC will vary with soil type, and will increase as the degree of compaction achieved increases. A test section using the proposed method of densification should be performed prior to production to establish a safe working distance from adjacent vibration-sensitive structures. For protection of existing sensitive underground water main pipelines near the proposed building footprint from ground-borne vibrations induced by either RAP or RIC, the use of open excavated cut-off trenches may be considered in attenuating densification-induced vibrations.

The level of air-borne noise generated by the RAP and RIC equipment in an open site, as well as a hearing protection zone, needs to be evaluated as part of the construction considerations.

8.3 **Surface Drainage.** Proper surface drainage is essential for satisfactory site performance. Positive drainage should be provided and maintained to direct surface water away from building foundations and other site improvements. Positive drainage is defined as a slope of 2 percent or more over a distance of 5 feet or greater away from the foundations, flatwork, and tops of slopes. Runoff should then be directed by the use of swales or pipes into a collective drainage system. Surface water should not be allowed to pond adjacent to footings. We further recommend that the proposed structure be equipped with appropriate roof gutters and downspouts. Downspouts should discharge to a system of closed pipes that transport the collected water to a suitable discharge facility. We recommend that drought tolerant vegetation be used for site landscaping. Irrigation should be kept at levels just sufficient to maintain plant vigor.

9.0 CLOSURE

The conclusions and recommendations presented herein are professional opinions based on geotechnical and geologic data and the project as described. A review by this office of any foundation, excavation, grading plans and specifications, or other work product that relies on the content of this report, together with the opportunity to make supplemental recommendations is considered an integral part of this study. Should unanticipated conditions come to light during project development or should the project change from that described, we should be given the opportunity to review our recommendations.

The findings and professional opinions presented in this report are presented within the limits prescribed by the client, in accordance with generally accepted professional engineering and geologic practices. There is no other warranty, either express or implied, regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

Submitted by:
GEOTECHNICAL CONSULTANTS, INC.

Nick S. Ng, P.E., G.E.
Geotechnical Engineer, GE 2831

REGISTERED PROFESSIONAL ENGINEER
DERON VAN HOFF
No. 2575
Exp. 12/31/10
GEOTECHNICAL
STATE OF CALIFORNIA

4/2/09
Deron J. van Hoff, P.E., G.E.
Geotechnical Engineer, GE 2575

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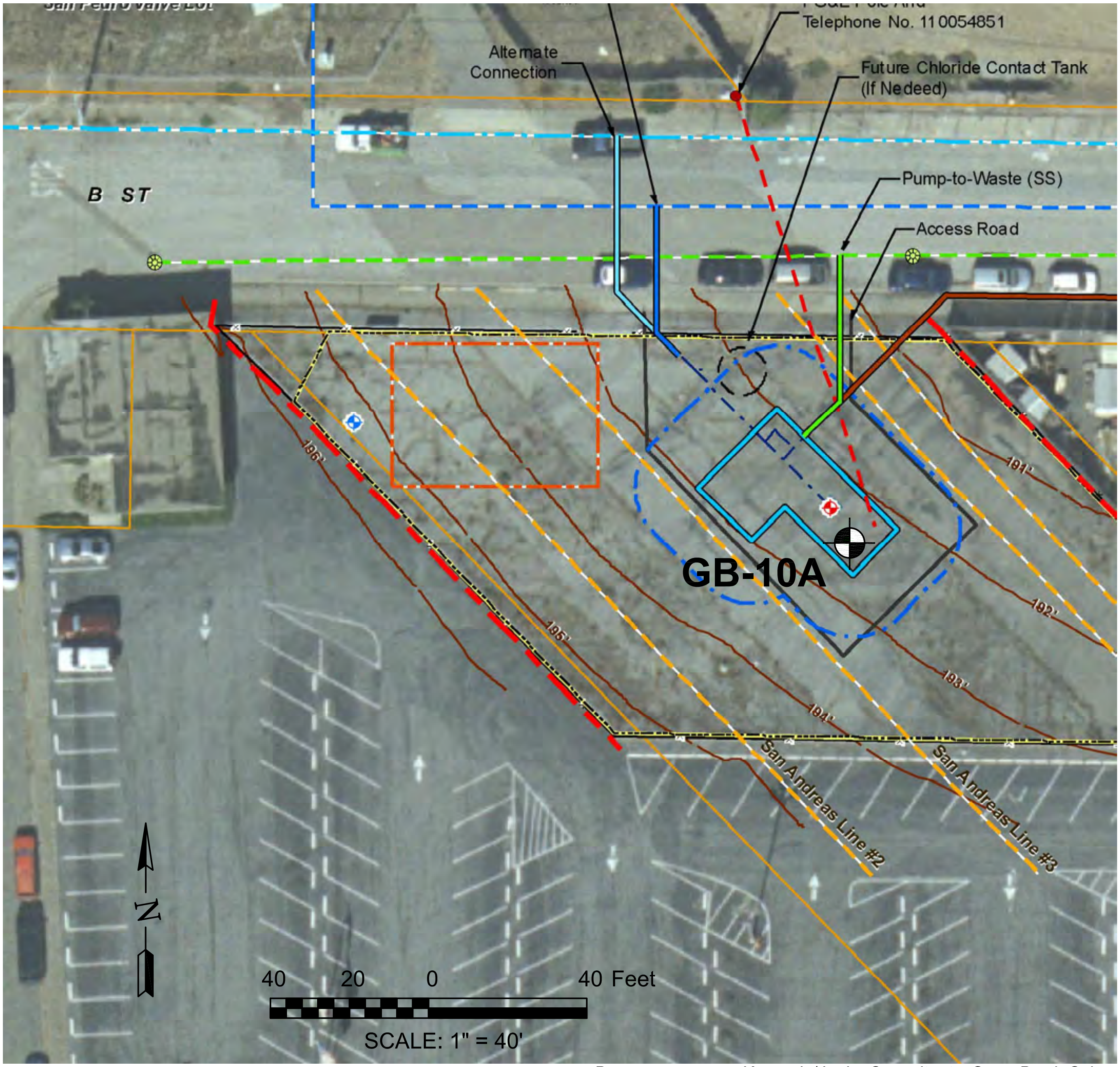
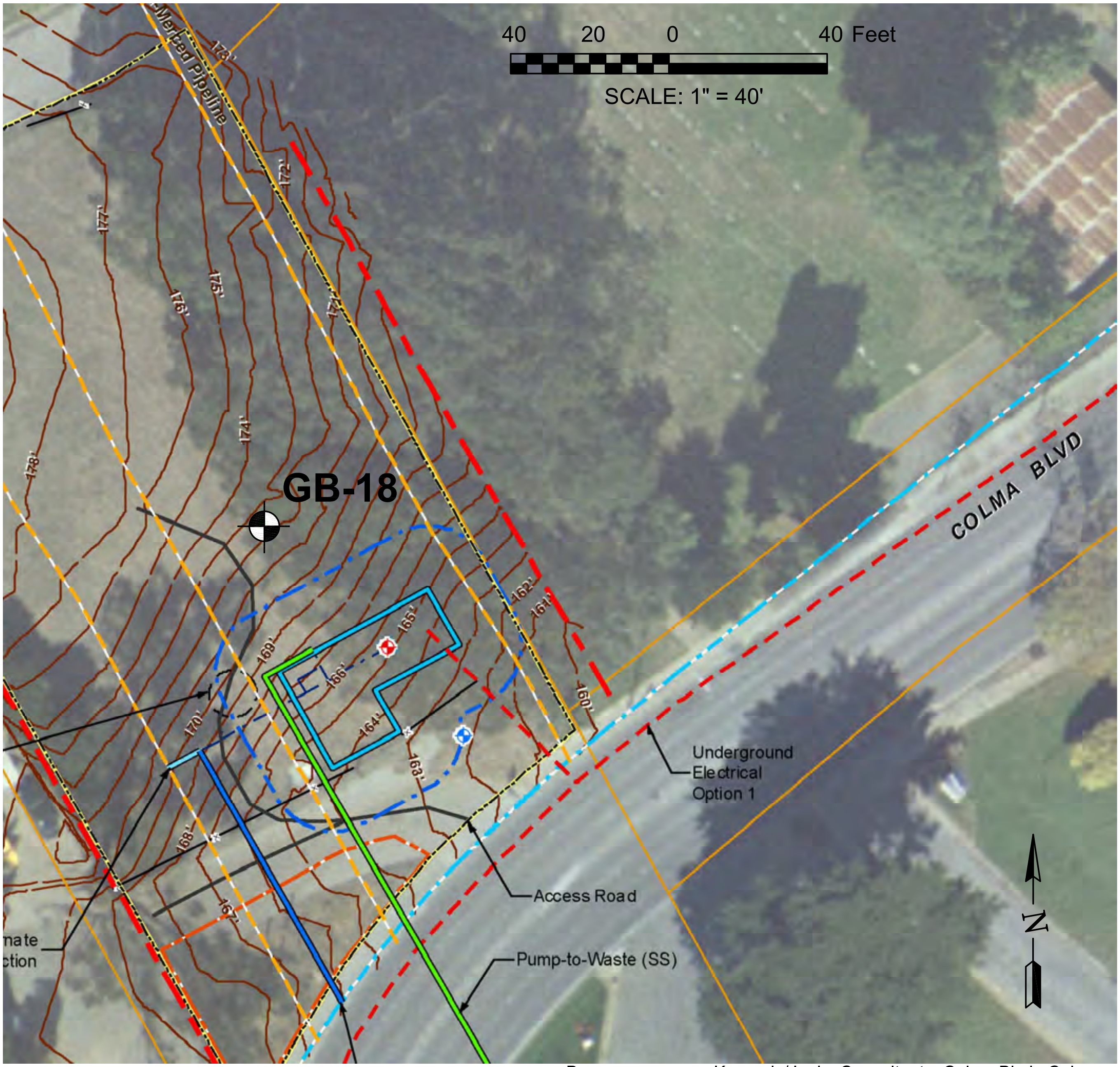


Base map source: Kennedy/Jenks Consultants, Serra Bowl, Colma, CUP-10A location map, dated 2/2/2009.

LEGEND

- Test Well
- Monitoring Well
- GB-10A Geotechnical Boring by Geotechnical Consultants, Inc. in December 2008.
- ConstructionArea
- StagingArea Boundary
- Construction Area-16ft Building Buffer
- BuildingOutline
- AccessRoad
- Proposed Connection Main
- Alternate Connection
- Pump-to-Waste (SS)
- Pump-to-Waste (SD)
- RightOfWay
- Fence
- Topography
- Parcels - San Mateo County
- Transmission Line - SFPUC
- PG&E Pole
- Underground Electrical
- Water - CalWater
- Water - DalyCity
- Stormdrain Catch Basin - DalyCity
- Stormdrain Manhole - DalyCity
- Stormdrain - DalyCity
- Sanitary Sewer Manhole - DalyCity
- Sanitary Sewer - DalyCity

GEOTECHNICAL CONSULTANTS, INC. 500 Sansome St., Suite 402 San Francisco, CA 94111	**BORING LOCATION MAP FOR SITE CUP-10A**	**PLATE 1**
	SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
	APRIL 2009	**SF08034**



Base map source: Kennedy/Jenks Consultants, Colma Blvd., Colma, CUP-18 location map, dated 2/2/2009.

LEGEND

- Test Well
- Monitoring Well
- GB-18 Geotechnical Boring by Geotechnical Consultants, Inc. in December 2008.
- ConstructionArea
- StagingArea Boundary
- Construction Area-16ft Building Buffer
- BuildingOutline
- AccessRoad
- Proposed Connection Main
- Alternate Connection
- Pump-to-Waste (SS)
- Pump-to-Waste (SD)
- RightOfWay
- Fence
- Topography
- Parcels - San Mateo County
- Transmission Line - SFPUC
- PG&E Pole
- Underground Electrical
- Water - CalWater
- Water - DalyCity
- Stormdrain Catch Basin - DalyCity
- Stormdrain Manhole - DalyCity
- Stormdrain - DalyCity
- Sanitary Sewer Manhole - DalyCity
- Sanitary Sewer - DalyCity

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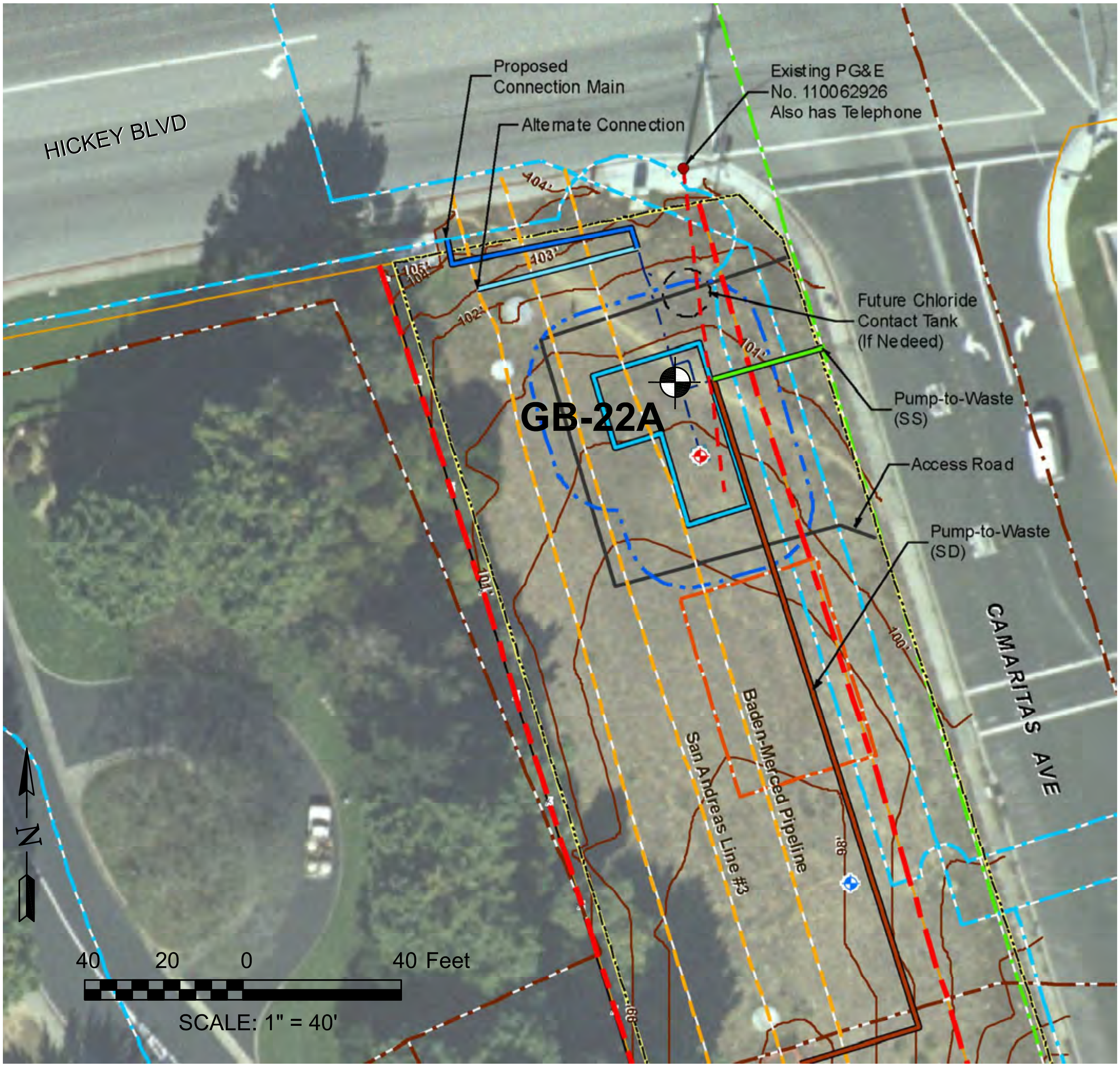
BORING LOCATION MAP FOR SITE CUP-18	PLATE 2
SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
APRIL 2009	SF08034

Base map source: Kennedy/Jenks Consultants, ROW AR Serramonte Blvd., Colma, CUP-19 location map, dated 2/2/2009.

LEGEND

- Test Well
- Monitoring Well
- GB-19 Geotechnical Boring by Geotechnical Consultants, Inc. in December 2008.
- ConstructionArea
- StagingAreaBoundary
- Construction Area-16ft Building Buffer
- BuildingOutline
- AccessRoad
- Proposed Connection Main
- Alternate Connection
- Pump-to-Waste (SS)
- Pump-to-Waste (SD)
- RightOfWay
- Fence
- Topography
- Parcels - San Mateo County
- Transmission Line - SFPUC
- PG&E Transformer
- Underground Electrical
- Water - CalWater
- Water - DalyCity
- Stormdrain Catch Basin - DalyCity
- Stormdrain Manhole - DalyCity
- Stormdrain - DalyCity
- Sanitary Sewer Manhole - DalyCity
- Sanitary Sewer - DalyCity

GEOTECHNICAL CONSULTANTS, INC. 500 Sansome St., Suite 402 San Francisco, CA 94111	**BORING LOCATION MAP FOR SITE CUP-19**	**PLATE 3**
	SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
	APRIL 2009	**SF08034**



Base map source: Kennedy/Jenks Consultants, Hickey Blvd., South San Francisco, CUP-22A location map, dated 2/2/2009.

LEGEND

Test Well	Proposed Connection Main	PG&E Pole
Monitoring Well	Alternate Connection	Underground Electrical
GB-22A Geotechnical Boring by Geotechnical Consultants, Inc. in December 2008.	Pump-to-Waste (SS)	Water - CalWater
ConstructionArea	Pump-to-Waste (SD)	Stormdrain Manhole - South San Francisco
StagingArea Boundary	RightOfWay	Stormdrain - South San Francisco
Construction Area-16ft Building Buffer	Fence	Sanitary Sewer - South San Francisco
BuildingOutline	Topography	
AccessRoad	Parcels - San Mateo County	
	Transmission Line - SFPUC	

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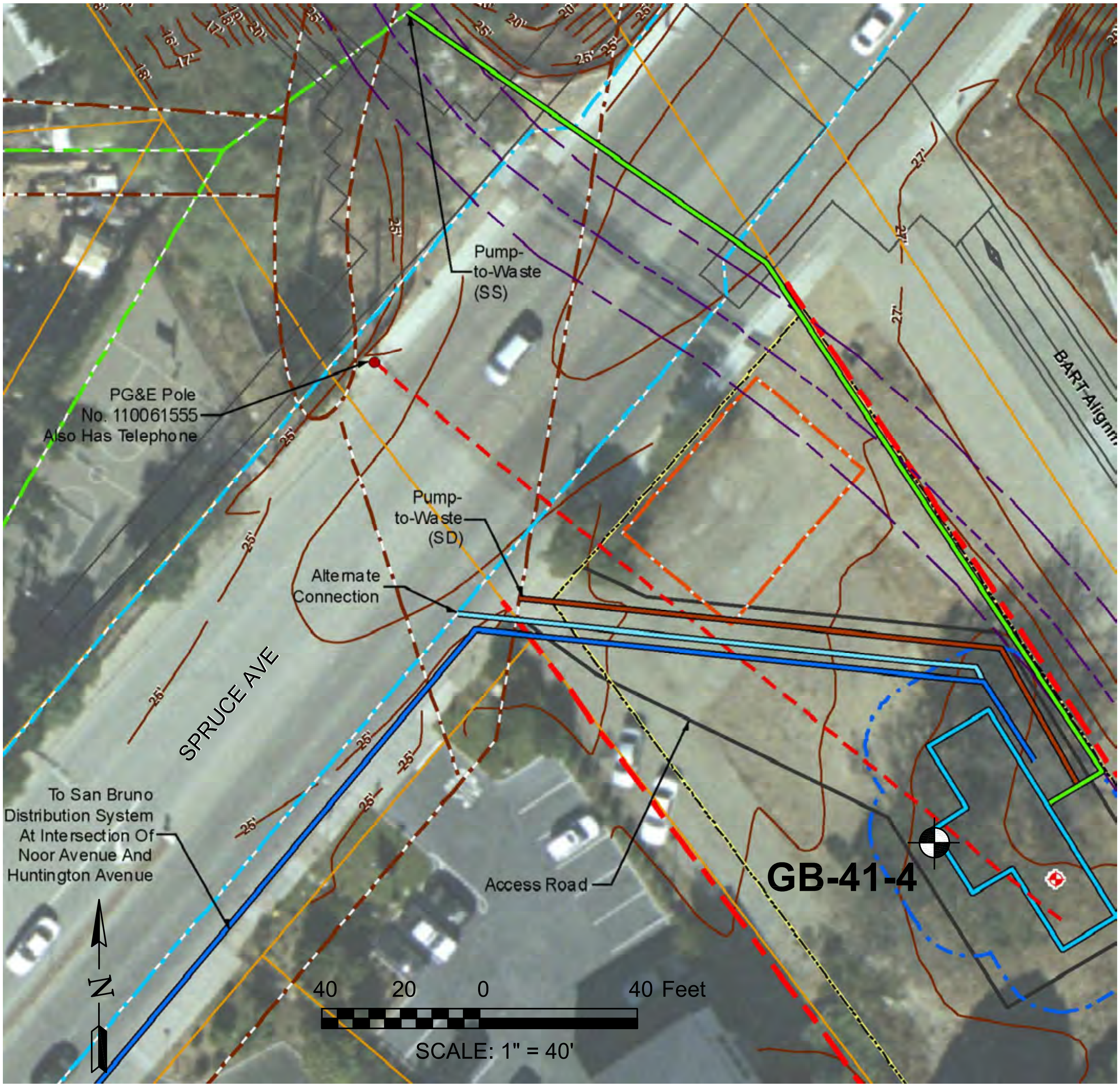
BORING LOCATION MAP FOR SITE CUP-22A	**PLATE 4**
SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
APRIL 2009	**SF08034**



Base map source: Kennedy/Jenks Consultants, SSF Linear Park, San Bruno, CUP-41-4 location map, dated 2/2/2009.

LEGEND

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BORING LOCATION MAP FOR SITE CUP-41-4	PLATE 5
SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
APRIL 2009	SF08034

FINAL GEOTECHNICAL REPORT – CUP WELL LOCATIONS CUP-11A, CUP-23, CUP-36-1, CUP-44-1, AND CUP-M-1, SOUTH WESTSIDE BASIN GROUNDWATER STORAGE AND RECOVERY PROJECT, DECEMBER 2009

GEOTECHNICAL CONSULTANTS, INC.
Geotechnical Engineering • Geology • Hydrogeology

FINAL GEOTECHNICAL REPORT
CUP WELL LOCATIONS CUP-11A, CUP-23, CUP-36-1, CUP-44-1, AND CUP-M-1
SOUTH WESTSIDE BASIN GROUNDWATER STORAGE AND RECOVERY PROJECT
SAN MATEO COUNTY, CA

December 2009

Prepared for:

Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Owner:

San Francisco Public Utilities Commission

SF09020

500 Sansome Street, Suite 402 • San Francisco, CA 94111 • (415) 981-9950

TABLE OF CONTENTS

Page

TABLES

FIGURES

PLATES

APPENDIX A – SUPPORTING GEOTECHNICAL DATA

INTRODUCTION

This geotechnical report presents the findings, conclusions, and recommendations of our geotechnical study performed for proposed buildings at groundwater well stations, including chemical treatment and filtration facilities at five designated groundwater production and monitoring well sites located in the northern part of San Mateo County, California (Figure 1 – Site Location Map). Groundwater monitoring wells have recently been constructed as part of the South Westside Basin Groundwater Storage and Recovery Project (GSR), a project developed through the coordination of the San Francisco Public Utilities Commission (SFPUC) and three partner agencies (California Water Service Company [Cal Water], the City of Daly City, and the City of San Bruno). This geotechnical report is being prepared for Kennedy/Jenks Consultants as part of their design services contract with the SFPUC and represents Phase 2 of the GSR. GTC previously completed subsurface exploration, laboratory testing and analysis at five sites for Phase 1 (GTC, April 2009).

We anticipate that the proposed well station buildings will typically be constructed with concrete masonry units (CMU), although the material selection will depend on the surrounding structures. The preliminary building footprints are as shown in Plates 1 through 5, Boring Location Plans. Geotechnical recommendations for additional improvements such as new pipeline connections and upgrades, which may require additional geotechnical borings, were not part of our scope of work.

WORK PERFORMED

In accordance with our scope of work as documented in the Subcontract Agreement (Amendment No. 3) with Kennedy/Jenks Consultants, Incorporated (KJ) dated August 2009 and subsequent conversations with personnel from KJ, we have completed the scope of work described below:

1. **Exploratory Drilling.** Subsurface conditions were explored by means of drilling one hollow-stem auger boring at each of the five CUP sites designated as CUP-11A, CUP-23, CUP-36-1, CUP-44-1, and CUP-M-1. To maintain consistency with the site numbering, our borings have been accordingly labeled as GB-11A, -23, -36-1, -44-1 and –M-1 for the sites. Boring number, date of drilling, surface elevation and depth for each boring are summarized in Table 1 – Summary of Geotechnical Borings. The surface elevations of the borings were evaluated from topographic maps which were prepared by Chaudhary & Associates from their field surveys performed between March of 2008 and September of 2009. The surface elevations presented in this report are approximate. All elevations on Table 1, and referred to throughout this report (unless otherwise noted), are with respect to 1988 North American Vertical Datum (NAVD 88).

2.

TABLE 1 – SUMMARY OF GEOTECHNICAL BORINGS

Boring	Date Drilled	Approximate Surface Elevation (feet, NAVD 88)	Approximate Depth (feet)
GB-11A	9/28/2009	159.5	35
GB-23	9/25/2009	83.5	50
GB-36-1	9/25/2009	66.5	50
GB-44-1	10/19/2009	111.0	35
GB-M-1	9/28/2009	26.0	40

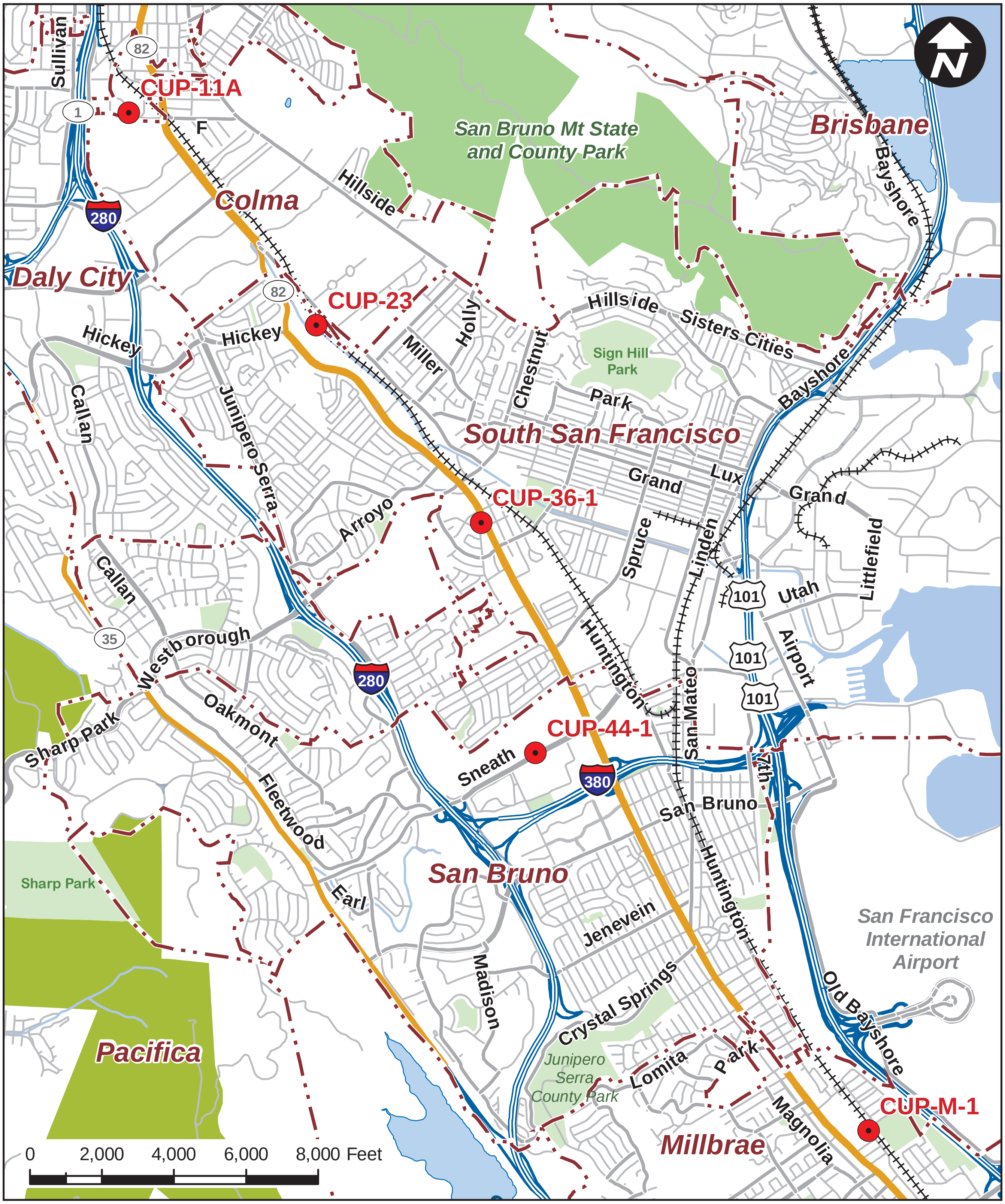
Soil samples were recovered using a split-spoon (Standard Penetration Test) sampler and relatively undisturbed 2 ½ inch diameter sleeve samples using a split-barrel sampler. We visually classified the soil during drilling. Selected samples were transferred to a laboratory for testing. The boring locations are shown on Plates 1 through 5 – Boring Location Plans. Boring logs are presented in Appendix A – Supporting Geotechnical Data as Plates A-1.1 through A-1.5. Upon completion of geotechnical exploration, the drill cuttings were collected in steel drums for analytical testing and appropriate disposal.

3. **Laboratory Testing.** Laboratory testing included moisture, density, grain size analysis, Atterberg limits and corrosion tests on selected soil samples to measure pertinent index and engineering properties. The laboratory test results are presented on the figures in Appendix A, and on the boring logs on Plates A-1.1 through -1.5.

4. **Engineering Analysis.** We analyzed subsurface conditions and laboratory test results, and reviewed regional and local geology and seismicity. Additionally, we analyzed the following geotechnical parameters:

   - Seismic hazards evaluation including strong ground shaking, liquefaction, seismic and dynamic settlements, and seismically-induced landslides;
   - Seismic design parameters in accordance with the 2006 International Building Code;
   - Bearing capacity (allowable and ultimate) and modulus of subgrade reaction (vertical soil springs) for shallow footings and grade beams, and mat foundations; and
   - Lateral earth pressures (active, passive, at-rest, and seismic increment) and base friction coefficients for restrained and unrestrained walls and/or buried footings.

FIGURE 1
SITE LOCATION MAP



5. **Report.** We prepared this report presenting our geotechnical findings, conclusions, and recommendations for the proposed improvements at the five sites for the GSR Phase 2.

Our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

FINDINGS

SITE CONDITIONS

The five sites are located from the north portion (CUP-11A) of the South Westside Groundwater Basin to near the southern boundary (CUP-M-1) in San Mateo County, California. The ground surface along a line which roughly transects the five sites, and parallels El Camino Real, generally descends in a northwest-to-southeast direction from elevations of approximately 160 feet to 20 feet above mean sea level for a distance of approximately 8 miles. Plates will be finalized in the Final Geotechnical Report. All boring locations were cleared of existing underground utilities prior to exploration.

The northernmost site CUP-11A is located southwest of F Street and the Colma BART station in the town of South San Francisco (Figure 1). As indicated on Plate 1 – Boring Location Plan for GB-11A, the site is located on a gentle to moderate east-facing slope. Southwest of the site are the BART parking lots and to the northeast, F Street.

GB-23 is located east of the intersection between Hickey Boulevard and El Camino Real in South San Francisco (Figure 1). As indicated on Plate 2 – Boring Location Plan for GB-23, the site is located on fairly level ground. The site is bounded by the Costco parking lot to the south, a mobile home park to the northwest and the drainage channel abutting the BART underground alignment to the northeast.

GB-36-1 is located to the south of the intersection between El Camino Real and Southwood Drive in the Town of South San Francisco (Figure 1). The general layout of the proposed improvements on Plate 3 – Boring Location Plan for GB-36-1 shows the boring on a gradual northeast-facing slope. The site is near recently re-graded pipeline construction access and is surrounded to the northwest by a parking lot for a funeral home, to the east by a descending slope with vegetation adjacent to El Camino Real and to the south by relatively flat, graded grounds with temporary structures and equipment serving as facilities for this project.

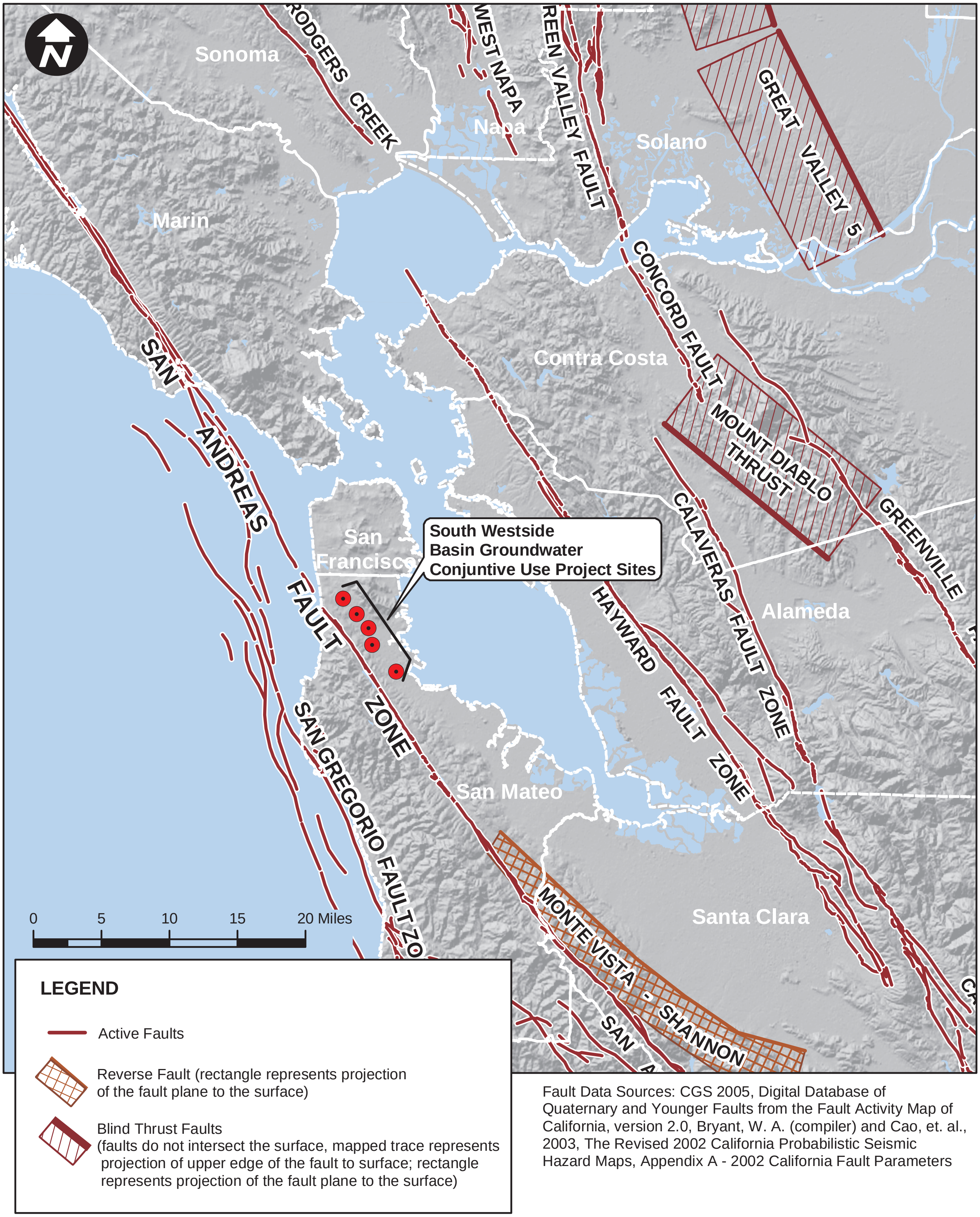
GB-44-1 is located to the south of the main building at the Golden Gate National Cemetery, just north of Sneath Lane in San Bruno (Figure 1). The general layout of the proposed improvements on Plate 4 – Boring Location Plan for GB-44-1 shows a generally level site with a slope some ways to the south, across Sneath Lane. The site is bounded to the south by a sidewalk abutting Sneath Lane and surrounded to the north, east and west by the Golden Gate Cemetery lawn and facilities.

The southernmost site of GB-M-1 is situated in the eastern corner of the parking lot at the Orchard Supply Hardware store at 900 El Camino Real in Millbrae (Figure 1). As shown on Plate 5 - Boring Location Plan for GB-M-1, this site is located in a flat asphalt-paved parking lot. The areas surrounding the site are also relatively flat. The site is surrounded to the northeast by the CalTrain tracks, to the southeast by a small lot containing a communications tower, to the northwest by the Orchard Supply Hardware storage yard, and to the southwest by the Orchard Supply Hardware loading dock and parking lot.

SEISMICITY

The San Francisco Bay Area contains several active faults that could cause strong ground shaking at the project site. Figure 2 – Regional Fault Map shows faults in the vicinity of the sites. The San Andreas Fault Zone – Peninsula Section is the nearest active fault and is located within 1.5 to 1.9 miles of the CUP-11A, CUP-23, CUP-36, CUP-44-1, and CUP-M-1 sites. The San Andreas Fault is a primary component in a complex system of right-lateral, strike-slip faults; including the San Andreas, San Gregorio-Seal Cove, Hayward, and Calaveras faults; collectively known as the San Andreas fault system. The San Andreas, Hayward, and Calaveras faults have produced historic earthquakes resulting in significant ground motion and movement. The San Andreas Fault is capable of producing an earthquake of an estimated maximum magnitude of 7.9M. This segment is estimated to have recurrence intervals on the order of 200 years. A summary of nearby faults is presented in Table 2 – Active and Potentially Active Faults.

FIGURE 2
REGIONAL ACTIVE FAULT MAP



Fault Data Sources: CGS 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0, Bryant, W. A. (compiler) and Cao, et. al., 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps, Appendix A - 2002 California Fault Parameters

TABLE 2 – ACTIVE AND POTENTIALLY ACTIVE FAULTS

Fault	Distance to Fault (miles)					Estimated Maximum Earthquake Magnitude [(1)]	Historic Earthquakes [(2)]	
	GB-11A	GB-23	GB-36-1	GB-44-1	GB-M-1		Year	Magnitude
San Andreas - 1906 rupture Section	1.6 [(3)]	1.8 [(3)]	1.9 [(3)]	1.5 [(3)]	1.7 [(3)]	7.9 [(3)]	1838 1898 1906 1989	6.8 6.2 8.1 7.1
San Andreas – Peninsula Section	1.6	1.8	1.9	1.5	1.7	7.1		
San Andreas – North Section	11.5	13.0	14.3	15.5	18.1	7.6		
San Gregorio-Seal Cove – North Section	5.6	6.2	6.6	6.5	7.5	7.3	N.A.	N.A.
Hayward- North Section	17.1	16.9	16.8	17.2	16.8	6.9	1868	6.8
Hayward – South Section	18.7	18.0	17.4	17.5	16.8	6.9		
Monte Vista-Shannon	20.7	19.2	17.9	16.7	14.1	6.8	N.A.	N.A.
Calaveras – North Section	26.7	26.2	25.8	26.0	25.4	6.8	1861 1955 1979 1984 2007	5.3 5.5 5.9 6.1 5.4
Calaveras – South Section	40.7	39.3	38.1	37.3	35.0	6.2		

(1) Maximum Moment Magnitude based on California Geological Survey (CGS) fault parameters as updated in 2002 (Cao, et al., 2003), or as suggested by the SFPUC's General Seismic Requirements (SFPUC, 2006).

(2) Historic earthquakes listed may have occurred on any one of the listed sections of the associated fault. N.A. – No significant historic earthquakes have occurred on this fault or fault section.

(3) The 1906 rupture event assumes rupture along the North Coast, Peninsula and Santa Cruz Mountains sections to San Juan Bautista. Maximum magnitude is based on the average 5 m displacement during the 1906 event (WGCEP, 2003; Petersen, et al., 1996).

GEOLOGY

The San Francisco Bay Area is located within the Coast Ranges Geomorphic Province of California. Past episodes of tectonism have folded and faulted the bedrock, creating the regional topography of northwest trending ridges and valleys that is characteristic of the Coast Ranges Geomorphic Province. The San Francisco Bay and vicinity occupy a structurally controlled basin within the province. Late Pleistocene and Holocene sediments (less than 1 million years old) were deposited in the basin as it subsided.

All five sites are located in areas mapped as Colma Formation (Brabb, et al., 1998; Bonilla, 1998). Other sedimentary deposits mapped in close proximity to these sites include stream channel deposits and Merced Formation. In addition, a layer of artificial fill was encountered at each site. The geology in the project vicinity is shown on Figure 3 – Regional Geologic Map. Based on a regional geologic study as compiled as a regional geologic cross section of the Westside Basin – Lake Merced (SFPUC, 2008), the Franciscan Complex bedrock is anticipated to be on the order of 600 to 700 feet below ground surface at the sites. Geologic maps (Brabb, et al., 1998) describe the geologic units at and near each boring as follows:

- **af:** Artificial fill – loose to very well consolidated gravel, sand, silt, clay, rock fragments, organic matter, and man-made debris in various combinations and thicknesses which may exceed 30 m; some compacted and quite firm, but fill made before 1965 is nearly everywhere not compacted and consists of simply dumped materials.

- **Qhbm:** Bay mud (Holocene) – soft to stiff clay and silty clay underlying marshland and tidal flats (near Bayshore Freeway), contains few lenses of fine sand, silt, shells, and peat.

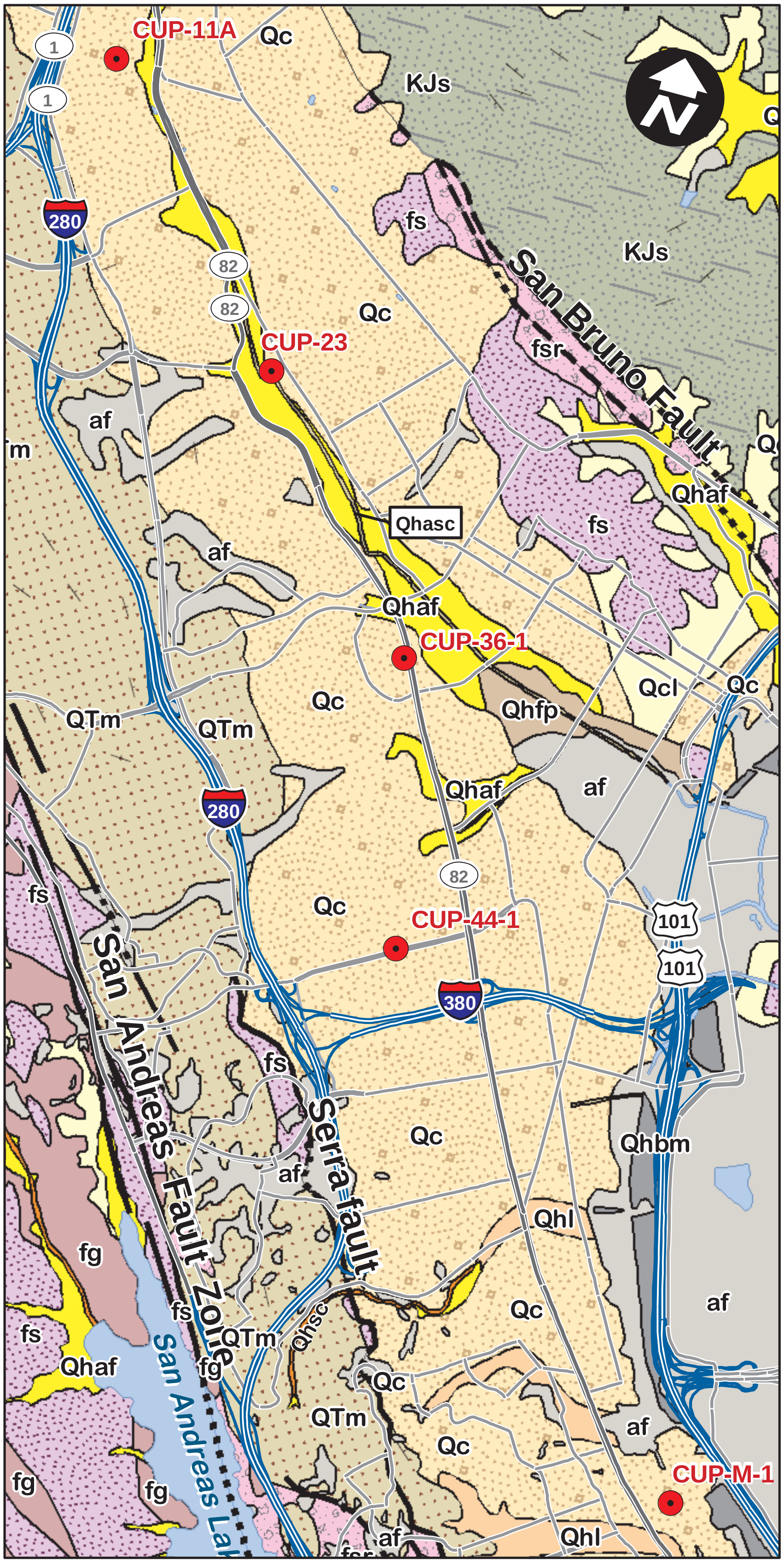
- **Qhl:** Natural levee deposits (Holocene) – loose, moderately to well-sorted sandy or clayey silt grading to sandy or silty clay deposits that border stream channels and slope away to flatter floodplains and basins.

- **Qhfp:** Floodplain deposits (Holocene) – dense sandy to silty clay, with local lenses of coarser material (silt, sand, and pebbles).

- **Qc:** Colma Formation (Pleistocene) – yellowish-gray, gray, yellowish-orange and red-brown, friable to loose, fine- to medium-grained arkosic sand with subordinate gravel, silt and clay; total thickness is typically unknown, but may up to 60 m.

- **QTm:** Merced Formation (lower Pleistocene and upper Pliocene) – medium gray to yellowish gray, yellowish orange, medium- to very fine-grained, poorly indurated to friable sandstone, siltstone, and claystone, with some conglomerate lenses and a few friable beds of white volcanic ash; sandstone is typically silty, clayey, or conglomeratic; fossiliferous conglomerate is well cemented.

FIGURE 3
REGIONAL GEOLOGIC MAP



Source: Brabb et. al., 1998, USGS OFR 98-137.

LEGEND

CUP-11A — Conjuntive Use Project (CUP) Sites

Geologic Units

Historic

- af — Artificial fill
- Qhasc — Artificial stream channels

Holocene

- Qhfp — Floodplain deposits
- Qhaf — Alluvial fan and fluvial deposits
- Qhsc — Stream channel deposits
- Qcl — Colluvium
- Qhbm — Bay mud
- Qhl — Natural levee deposits

Pleistocene

- Qc — Colma Formation

Pleistocene to Pliocene

- QTm — Merced Formation

Cretaceous to Jurassic

- KJs — Unnamed sandstone of San Bruno Mtn.
- fs — Franciscan sandstone
- fg — Franciscan greenstone
- fsr — Franciscan melange

Structual Features

- geologic contact
- fault, approx. located
- fault, certain
- fault, concealed

0 2,000 4,000 6,000 8,000 Feet

EARTH MATERIALS

The exploratory borings for this investigation (GB-11A, -23, -36-1, -44-1 and –M-1) encountered artificial fill which was underlain by poorly to moderately consolidated sandstone of the Colma Formation (Qc). The artificial fill represents disturbed soil and fill materials placed for site grading and pipeline trench backfill.

Artificial Fill. Artificial fill was encountered to depths of approximately 4 feet in borings GB-11A and GB-23 where the local topography is flat. Fill thickness measures 14.5 feet at GB-36-1 where trenching and construction of large diameter pipelines has disturbed the ground to greater depth. Fill at GB-44-1 was approximately 8.5 feet thick. Fill placed for leveling at GB-M-1 is 9 feet thick. The fill was mainly comprised of dry to damp, loose to medium dense, silty sand and sandy silt; A 5 foot thick gravel layer directly underlies the asphalt parking lot at GB-M-1. The origin of sand and silt fill at the sites was likely derived from grading and reuse of on-site, near surface materials of Colma Formation (Qc).

Colma Formation. Soils of the Colma Formation (Qc) were encountered at all five CUP sites below the artificial fill. The Colma Formation soils consisted predominantly of yellowish brown to yellowish gray, damp to moist, medium dense to very dense, silty sand and poorly graded sand with silt. Thin beds of clayey sand, sandy silt, silt, and clayey silt were encountered at the northerly sites (GB-11A, GB-23, GB-36-1 and GB-44-1). Layers of wet clay with sand and clayey gravel were encountered at the bottom of the two more southern borings, GB-44-1 and GB-M-1. Colma Formation soils at the five sites extended to the total depth of exploration (35 to 50 feet). Measured total unit weight for the Colma Formation soils at the five sites ranged from 101 to 115 pcf, with a moisture content ranging from 5 to 17 percent in the granular materials and 11 to 27 percent in the clay and silt layers.

GROUNDWATER

Groundwater was not encountered during drilling of our exploratory borings GB-11A, -23, -36-1 and -44-1 to total depths ranging from 35 to 50 feet. At GB-M-1, groundwater was encountered during drilling on September 28, 2009 at a depth of approximately 23 feet. A summary of our observed groundwater levels is presented in Table 3 – Observed Groundwater Levels. Seasonal variations are expected to cause fluctuations in groundwater levels.

TABLE 3 – OBSERVED GROUNDWATER LEVELS

Boring	Date of Observation	Depth to Groundwater (feet)
GB-11A	9/28/2009	Not Encountered
GB-23	9/25/2009	Not Encountered
GB-36-1	9/25/2009	Not Encountered
GB-44-1	10/19/2009	Not Encountered
GB-M-1	9/28/2009	23

CONCLUSIONS AND RECOMMENDATIONS

1.0 GENERAL

The following sections provide our conclusions and recommendations for evaluation and design of proposed station buildings at the five sites of CUP-11A, -23, -36-1, -44-1 and –M-1. According to preliminary site maps given us by Kennedy/Jenks Consultants, the station buildings at well sites CUP-23, -36-1, and –M-1 house chemical treatment facilities and the station building at well site CUP-44-1 houses filtration facilities. Based on our findings from our geotechnical field investigation, the GB-11A, -23, -36-1, -44-1 and -M-1 sites are underlain by artificial fill and Colma Formation.

We consider the proposed improvements to be geotechnically feasible, provided that our geotechnical recommendations are incorporated into design and construction documents.

2.0 SEISMIC DESIGN CONSIDERATIONS

2.1 **General.** The main seismic hazards at the site are expected to be strong ground shaking and dynamic settlement within isolated zones of loose fill. Our seismic design considerations, including fault rupture, ground shaking, liquefaction and dynamic settlement, inundation by tsunamis, seismically-induced landslides, and seismic design with respect to the 2006 International Building Code (which the 2007 California Building Code has adopted) are provided in the following sections.

2.2 **Fault Rupture.** No active or potentially active faults are known to cross the sites. Consequently, the hazard posed by ground rupture due to fault offset is considered to be negligible.

2.3 **Ground Shaking**. Strong ground shaking will occur at the site as a result of a moderate to large earthquake occurring on one of the active regional faults. The San Andreas Fault is closest to the sites (1.5 to 1.9 miles for all borings; GB-11A, -23, -36-1, -44-1 and -M-1) and therefore has the greatest capability of causing strong ground motions.

The California Geological Survey (CGS, formerly known as California Division of Mines and Geology) and United States Geological Survey (USGS) completed probabilistic seismic hazard maps in 1996 (Petersen et al., 1996), and subsequently updated fault parameters and revised the maps in 2002 (Cao, et al., 2003). USGS provides a web-based program to evaluate the USGS Probabilistic Uniform Hazard

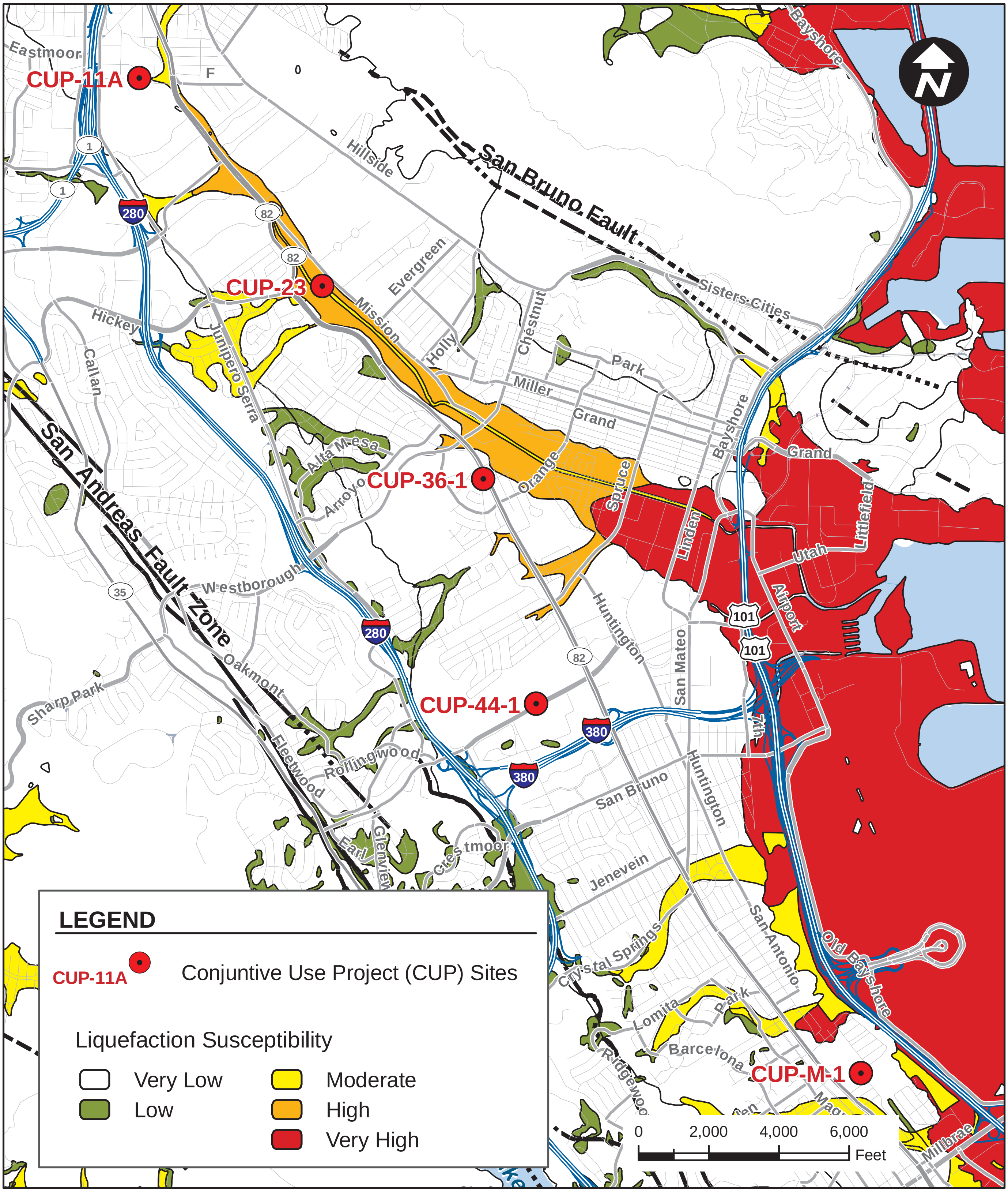
Response Spectra (http://earthquake.usgs.gov/research/hazmaps/design). Based on this data, the peak ground acceleration (PGA) at the site is estimated to be 0.71g for an earthquake having a 10 percent probability of exceedance in 50 years.

2.4 **Liquefaction and Dynamic Settlement.** Liquefaction is a phenomenon wherein a temporary, partial loss of shear strength occurs in a soil due to increases in pore pressure that result from cyclic loading during earthquakes. Saturated, loose to medium dense sands and silty sands are most susceptible to liquefaction. Consequences of liquefaction can include ground settlements, foundation failure, sand boils, and lateral spreading. Dynamic settlement is the densification of saturated and unsaturated soils during strong ground shaking. All soil types are prone to dynamic settlement, though loose, sand and silty sand are most susceptible.

The liquefaction susceptibility, as mapped by Witter et al. (2006), is illustrated on Figure 4 – Liquefaction Susceptibility Map. As can be seen from the figure, boring sites GB-11A, GB-36, GB-44-1, and GB-M-1 lie within a zone mapped as having very low liquefaction susceptibility. The mapped liquefaction susceptibility at site GB-23 is moderate. Because of the regional focus of the liquefaction susceptibility mapping, the data only generally correlates with areas of known liquefaction hazard. The site-specific data from the borings is considered to be more indicative of liquefaction and dynamic settlement hazard. The following discussion further describes this hazard based on our subsurface investigation and laboratory testing program.

Due to the absence of groundwater within the 35 to 50 feet of total exploration depth for each of the exploratory borings GB-11A, -23, -36-1 and -44-1, and the generally dense nature of the Colma Formation below this depth, liquefaction is not considered to be a significant consideration. Despite the observation of groundwater at a depth of 23 feet at the GB-M-1 site, liquefaction is also not considered to be a significant consideration because of the dense and clayey nature of the Colma Formation encountered at this site. Pore pressure generation and liquefaction may occur in isolated pockets of looser material within the Colma Formation, however, the amount of surface settlement resulting from liquefaction is considered to be negligible at the five sites.

FIGURE 4
LIQUEFACTION SUSCEPTIBILITY MAP



Source: Witter, R.C., et. al.., 2006, Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California: U.S. Geological Survey Open-File Report 06-1037

The amount of dynamic settlement for each site has been evaluated based on an anticipated earthquake event having a 10 percent probability of exceedance in 50 years. Dynamic settlement resulting from strong ground shaking at GB-11A and -23 is estimated at less than ¼ inches due to the dense nature of the near-surface Colma Formation beneath a relatively thin stratum of artificial fill. Dynamic settlement of the artificial fill at GB-36-1 is considered relatively significant with an estimate of up to 2 inches, provided proper mitigations are made in accordance with Section 6.1. As a result of medium dense silty sand within the upper 15 feet, dynamic settlement is estimated at 1 inch for GB-44-1. Dynamic settlement resulting at GB-M-1 is estimated at less than 1 ½ inches, as a result of medium dense silty sand in the Colma Formation above the groundwater level. The hazard posed by dynamic settlement is therefore considered to be low at GB-11A and,-23 and moderately high at GB-36-1, -44-1 and –M-1. Flexible pipe connections are recommended to accommodate dynamic settlements due to seismic loading.

2.5 **Inundation by Tsunamis.** Tsunamis are long period waves usually caused by underwater seismic disturbances, volcanic eruptions, or submerged landslides. The disturbance can occur thousands of miles from the San Francisco area, and generate a tsunami wave that affects the site. As tsunami waves approach the coast, they may increase in height to tens of feet.

Flooding due to tsunami is unlikely to occur at GB-11A, -23, -36-1 and -44-1 due to their relatively high ground elevations and distance from the open Northern California coastline. Although GB-M-1 is located on relatively low lying terrain at elevation 26 feet above Mean Sea Level (MSL), the potential of flooding during a tsunami is unlikely because of the distance to San Francisco Bay.

2.6 **Seismically-Induced Landslides.** Based on the flat topography surrounding the sites of GB-23, -44-1 and –M-1, seismically-induced landslide hazards do not exist at these sites. At GB-11A which is located on mildly sloping terrain (on the order of 5:1 horizontal to vertical side slope ratio), seismically-induced landslide hazards are considered not likely because of the dense nature of the subsurface soils and absence of shallow groundwater. Boring GB-36-1 is situated with very mild slopes (on the order of 10:1 horizontal to vertical side slope ratio) to the north and northeast towards the funeral home and El Camino Real. Seismically-induced landslide hazards are considered not likely due to the presence of generally dense granular materials and absence of shallow groundwater.

2.7 **Seismic Design Parameters.** The proposed improvements may be designed in accordance with the International Building Code Static Force Procedure (ICC, 2006) using the seismic parameters as presented in Table 4 – 2006 International Building Code (IBC) Seismic Design Parameters in developing the site seismic response:

TABLE 4 – 2006 INTERNATIONAL BUILDING CODE SEISMIC DESIGN PARAMETERS

	Site GB-11A	Site GB-23	Site GB-36-1	Site GB-44-1	Site GB-M-1
Site Class	C	C	D	D	D
S_s (1) at 0.2-second	2.162	2.129	2.105	2.160	2.105
S_1 (1) at 1-second	1.213	1.180	1.157	1.210	1.158
Site Coefficient F_a	1.0	1.0	1.0	1.0	1.0
Site Coefficient F_v	1.3	1.3	1.5	1.5	1.5

(1) Maximum Considered Earthquake (MCE) Spectral Response Acceleration (in units of g).

3.0 GROUNDWATER

With the exception of exploratory boring GB-M-1, groundwater was not encountered in the remaining exploratory borings. At GB-M-1, groundwater was encountered during drilling at a depth of 23 feet below ground surface. The observation of groundwater at GB-M-1 is consistent with the low lying topography (ground elevations of 25 to 30 feet above mean sea level). It should be noted that groundwater levels are influenced by seasonal variations in precipitation, local irrigation, groundwater pumping and other factors, and are therefore, subject to variation. As the proposed footing foundations are expected to be within the top 5 feet, groundwater is not anticipated within the depth of foundation excavation.

4.0 EARTHWORK

4.1 **General.** Given the earth materials on the project sites encountered during our exploration, the contractor should be able to carry out planned excavations using conventional heavy equipment.

Evaluation of the presence, or absence, and treatment of hazardous materials was not part of this study. If hazardous materials are encountered during excavation, proper handling and treatment during construction will depend on the contaminant type, concentration, and volatility of the contaminated materials.

General geotechnical considerations for site preparation, excavations, temporary shoring and bracing, engineered fill material, engineered fill placement and compaction, pipe bedding, and utility trench backfill are presented in the following sections.

4.2 **Site Preparation.** Site preparation will consist of demolition, excavation and removal of on-site materials such as pavement, concrete, abandoned utilities, and miscellaneous debris in preparation for the foundation excavations. Any creation of holes from the removal of such materials should be backfilled with engineered fill.

Recommendations for engineered fill are provided in Sections 4.5 and 4.6. Also as part of site preparation, the location of active underground utilities should be determined and, if affected by construction activities, should be relocated or protected.

4.3 **Excavations.** We anticipate that excavations for the planned building improvements to extend only a few feet below existing ground elevation. Since GB-11A is located near the foot of mildly sloping terrain, greater excavation may be necessary at this site.

Shallow excavations for the buildings will allow for unshored excavations with adequately sloped sidewalls. Vertically shored walls or braced excavations are anticipated where space constraints may not allow for open, sloped excavations. At a minimum, excavations should be constructed in accordance with the current California Occupational Safety and Health Administration (OSHA) regulations (Title 8, California Code of Regulations) pertaining to excavations. Temporary cut slopes are expected to be stable for configurations described in Title 8 for Type C soils and when unsupported, should be cut back no steeper than 1 ½ horizontal to 1 vertical. All excavations should be closely monitored during construction to detect any evidence of instability.

Care should be taken when excavating near existing utilities and pipelines. Excavations can undermine support of adjacent existing pipelines and other subsurface structures. We recommend that some form of vertical shoring system be considered for excavated sidewalls that are adjacent to existing pipelines or other known buried adjacent structures.

Some of the near surface loose soils at the five sites will likely be removed during excavation for the proposed improvements. If any footings are founded above loose soils, over-excavation of loose soils and replacement with engineered fill may be required. Remediation of loose materials at intermediate depths can be performed using densification improvement methods, as discussed in Section 6.1.

4.4 **Temporary Shoring and Bracing.** The type and design of the shoring will depend on the depth of excavation and excavation-bracing sequence. The shoring and bracing design and installation should be the responsibility of the construction contractor. As a general guideline, construction procedures, excavations, and design and construction of any temporary shoring should comply with the current OSHA Title 8 regulations pertaining to excavations. The shoring and bracing should accommodate surcharge loads that may be imposed by adjacent structures, traffic, or construction activities.

Possible shoring schemes include soldier pile and lagging and steel sheeting, both of which may include internal bracing struts to limit lateral deflections. Such braced and shored excavations will be subjected to lateral earth pressures. Recommended active, at-rest, and passive lateral earth pressures are provided in Section 5.

Horizontal and vertical movements of the ground are possible in the vicinity of the excavations. These movements can generally be reduced to acceptable levels by use of a properly designed and constructed shoring system. Measures should be taken to prevent the loss of sand through the gaps in the shoring or lagging.

4.5 **Engineered Fill Material.** Material for engineered fill should be inorganic, well graded, free of rocks or clods greater than 4 inches in greatest dimension or any other deleterious materials, and have a low potential for expansion. The material should have a liquid limit less than 35, a plasticity index less than 15 and no more than 25 percent passing the No. 200 sieve. Existing on-site soil may be re-used as engineered fill provided it meets the above criteria.

4.6 **Engineered Fill Placement and Compaction.** Engineered fill should be placed in layers no greater than 8 inches in uncompacted thickness, conditioned with water or allowed to dry to achieve a moisture content near optimum, then mechanically compacted to at least 90 percent relative compaction based on ASTM D1557. All engineered fill placed to support footings and the upper 6 inches of engineered fill supporting slabs-on-grade should be mechanically compacted to at least 95 percent relative compaction as determined by ASTM D1557. Specific engineered fill placement requirements exist for GB-36-1 as outlined in Section 6.1. All compaction should be performed using mechanical compaction means; flooding or jetting should not be used as a means to achieve compaction. The ASTM D1557 laboratory compaction tests should be performed at the time of construction to provide a proper basis for compaction control.

4.7 **Pipe Bedding for Small Diameter Pipes.** Pipe bedding should consist of well-graded sand or a sand-gravel mixture. Maximum gravel size should be ½ inch and the bedding material should have less than 12 percent passing the No. 200 sieve. Uniformly graded material such as pea gravel should not be used as pipe bedding material. Pipe bedding should have a minimum thickness of 6 inches beneath the pipe and 6 inches above the pipe. If soft or otherwise unsuitable soils are exposed in the bottom of the trench excavation, the necessity of over-excavation should be evaluated by the project geotechnical engineer. All pipe bedding should be placed to achieve uniform contact with the pipe and mechanically compacted to a minimum relative compaction of 90 percent per ASTM D1557. Flexible pipe connections are recommended to accommodate dynamic settlements due to seismic loading. Estimates of dynamic settlement at each site are provided in Section 2.4 – Liquefaction and Dynamic Settlement.

4.8 **Utility Trench / Pipe Backfill.** Utility and pipe trenches may be backfilled above the pipe zone with excavated on-site soils, provided they meet the gradation requirements of engineered fill. The backfill material should be placed in layers no greater than 8 inches in uncompacted thickness, moisture conditioned or allowed to dry to achieve a moisture content near optimum, then mechanically compacted to at least 90 percent relative compaction based on ASTM D1557. The upper 2 feet should be compacted to at least 95 percent relative compaction in areas where structural or traffic loads are anticipated.

5.0 LATERAL EARTH PRESSURES

5.1 **Active Earth Pressure.** Active earth pressures are imposed by the soil on walls that are unrestrained so that the top of the wall is free to translate or rotate at least 0.004H, where H is the height of the wall. The active earth pressure may be calculated using a design equivalent fluid pressure (EFP) for each of the sites as indicated in Table 5.1 – Active Earth Pressures.

TABLE 5.1 – ACTIVE EARTH PRESSURES

Site Location	**GB-11A**	**GB-23**	**GB-36-1**	**GB-44-1**	**GB-M-1**
Active EFP (1) (pcf)	30	30	30	35	35

1. EFP assumes that excavations do not extend below the groundwater table.

5.2 **At-Rest Earth Pressure.** At-rest pressures should be used for design of walls that are restrained such that the deflections required to develop active earth pressures cannot occur or are undesirable. The at-rest earth pressures may be calculated using a design EFP for each of the sites as indicated in Table 5.2 – At-Rest Earth Pressures.

TABLE 5.2 – AT-REST EARTH PRESSURES

Site Location	**GB-11A**	**GB-23**	**GB-36-1**	**GB-44-1**	**GB-M-1**
At-Rest EFP (1) (pcf)	50	50	50	55	55

1. EFP assumes that excavations do not extend below the groundwater table.

5.3 **Seismic Earth Pressure.** In addition to the active and at-rest pressures, retaining walls should be designed to consider additional earth pressures due to earthquake loading. The increment in earth pressure due to seismic loading, for both restrained and unrestrained below-grade walls, may be calculated using an inverted triangular distribution with the pressure at the top of the wall equal to a design earth pressure (EP) of 50H, wherein H is the height of the wall in feet, and diminishes to zero at the base of the wall, as indicated in Table 5.3 – Seismic Earth Pressures.

TABLE 5.3 – SEISMIC EARTH PRESSURES

Site Location	GB-11A	GB-23	GB-36-1	GB-44-1	GB-M-1
Seismic EP [(1)] at Top of Wall (psf)	50 H [(2)]	50 H [(2)]	50 H [(2)]	55 H [(2)]	55 H [(2)]

1. EFP assumes that excavations do not extend below the groundwater table.
2. H is the height of the wall in feet, and diminishes to zero at the base of the wall.

5.4 **Passive Earth Pressure.** Lateral loads on structures can be resisted by passive pressures that develop against the sides of below-grade structures such as walls or footings. The passive pressure depends on the lateral displacement of the wall or footing. In accordance with FEMA 356 (FEMA, 2000), the ultimate passive pressure is mobilized at a displacement of approximately 6 percent of the wall height. The ultimate passive earth pressure may be calculated using a design EFP that corresponds to the ultimate EFP as long as the structure can be mobilized to such level of displacement and still does not exceed the allowable displacement of the structure. Oftentimes, the displacement to achieve ultimate passive earth pressures exceeds the allowable displacement of the structure. Consequently, a design EFP needs to be reduced when the allowable displacement of the structure is less than 6 percent of the wall height. For displacements of approximately 0.8 and 3 percent of the wall height, the design EFP may be reduced to 50 and 85 percent of the ultimate EFP. Passive pressures computed using these design EFPs may be combined with the base friction mobilized at the concrete-soil interface to resist lateral loading (see Section 5.5). The passive earth pressures may be computed using the following design EFPs as indicated in Table 5.4 – Passive Earth Pressures:

TABLE 5.4 – PASSIVE EARTH PRESSURES

Site Location	GB-11A	GB-23	GB-36-1	GB-44-1	GB-M-1
Passive Ultimate EFP [(1)] at 6% Wall Height Displacement (pcf)	300	280	300	320	320
Passive EFP [(1)] at 3% Wall Height Displacement (pcf)	250	240	250	270	270
Passive EFP [(1)] at 0.8% Wall Height Displacement (pcf)	150	140	150	160	160

1. EFP assumes that excavations do not extend below the groundwater table.

5.5 **Base Friction.** A coefficient of friction of 0.4 may be used for estimating the resistance due to base friction. The coefficient should be multiplied by the dead load only. The passive earth pressure and base friction mobilized at the concrete-subgrade interface may be combined to resist lateral loading.

6.0 FOUNDATIONS

6.1 **Subgrade Preparation.** Subgrades to new shallow foundations for the proposed structures should be prepared to provide a flat, relatively dry, and firm working surface. If any unsuitable materials, such as, soft clays or silts, soils containing organic material, debris or other deleterious materials are encountered at subgrade, they should be over-excavated and restored to grade with engineered fill in accordance with Sections 4.5 and 4.6. The fill soils encountered in our exploratory borings were suitable for support of the proposed improvements provided the upper 12 inches are scarified, moisture conditioned, and recompacted. We recommend that the upper 12 inches of subgrade be scarified, moisture conditioned to near optimum moisture content, and compacted in accordance with Sections 4.5 and 4.6. The subgrade should be free of loose debris and ponded water prior to placing reinforcing steel and concrete.

Dynamic settlements of loose to medium dense granular soils at GB-36-1, -44-1, and -M-1 are anticipated during an earthquake event if these sites are not mitigated. Estimates of dynamic settlement at each site are provided in Section 2.4 – Liquefaction and Dynamic Settlement. Special mitigation measures against settlement at CUP-36-1 require additional over-excavation of artificial fill materials below any foundations. This over-excavation must extend three feet below proposed footing elevation, or, if competent Colma Formation materials are encountered within those three feet, six inches into Colma Formation materials. Engineered fill shall then be placed, moisture treated to near optimum water content and mechanically compacted to 95 percent relative compaction as determined by ASTM D1557.

6.2 **Shallow Foundation Alternatives.** A shallow foundation system is suitable for support of the proposed improvements at the sites. Alternatives for shallow foundation systems include grade beams / shallow footings, mat foundations, and post-tensioned foundations.

Grade Beams / Shallow Footings: Based on the findings from our subsurface evaluation and laboratory testing, the ultimate bearing capacity of soils below new footings within the footprint of proposed buildings varies according the geotechnical characteristics of soils encountered at each site. We recommend an allowable bearing capacity of 3,000 pounds per square foot (psf) for soils below new footings at the GB-11A, -23, -36-1, -44-1 and -M-1 sites. This bearing capacity includes a factor of safety of at least three against bearing failure, and is applicable to newly constructed footings with widths of at least 18 inches and footing embedment of at least 24 inches below lowest adjacent grade.

A static modulus of subgrade reaction of 60 pounds per cubic inch (pci) may be used in order to develop soil springs below the foundation elements. For the lateral resistance of grade beams and footings, the geotechnical design parameters provided in the Lateral Earth Pressures section may be used.

As discussed in Section 2.4, dynamic settlements of up to approximately ¼ inch may affect the GB-11A and -23 sites during an earthquake event. The remaining three sites are more susceptible to significant dynamic settlements during an earthquake event. Larger dynamic settlements, on the order of 1 to 2 inches at GB-36-1, -44-1 and -M-1 are anticipated during an earthquake event if these sites are not mitigated. These dynamic settlements are in addition to the settlements estimated for the building loads described above. Long-term consolidation settlements are not likely due to the granular nature of much of the subsurface soils, and the stiffness and overconsolidation of clayey soils.

***Mat Foundations*:** Effects from differential dynamic settlements at the GB-36-1, 44-1 and M-1 sites may be limited by supporting the structures at these sites on structurally rigid mat foundations. A mat foundation is a large concrete slab, designed by a structural engineer for specific use, to interface one or more columns or pieces of equipment with the foundation soil. It may encompass the entire foundation footprint or only a portion. The mat contact stresses are generally lower than other shallow foundation types due to distribution of stress over a larger area and stress compensation from excavated soil. Thickness and reinforcement of the mat foundation should be in accordance with the recommendations of a structural engineer. The appropriate allowable contact pressure(s) beneath the mat foundations will vary with their size, shape, and other factors. To limit foundation static settlements to less than ½ inch for dead and live loads and less than 1 inch for total loads including wind and seismic, the contact pressure beneath the mats should not exceed the allowable bearing capacities as recommended above for grade beams / shallow foundations. Mat foundations typically experience some deflection due to loads placed on the mat and the reaction of the soils underlying the mat. A design coefficient of subgrade reaction, $\mathbf{K_{v1}}$, of 260 kips per cubic foot (kcf) in compacted fill soils may be used for evaluating such deflections at the sites. This value is based on a square foot area and should be adjusted for the planned mat size. The coefficient of subgrade reaction, $\mathbf{K_B}$, for a mat of a specific dimension may be evaluated using the following equation:

$$\mathbf{K_{B}, = K_{v1} [(B+1)/2B]^2 [(1+0.5(B/L)/1.5]}$$

where **B** is the width and **L** is the length of the foundation measured in feet.

Mat foundations bearing on fill may be designed using a coefficient of friction of 0.4 (total frictional resistance equals coefficient of friction times the dead load). The allowable lateral resistance can be taken as the sum of the frictional resistance and passive resistance provided the passive resistance does not exceed two-thirds of the total allowable resistance.

Post-Tensioned Foundations**:** Effects from differential dynamic settlements at the GB-36-1, -44-1 and -M-1 sites may be limited through the application of post-tensioning in reinforcing, and hence, increasing the structural rigidity of grade beams / shallow footings. Thickness and reinforcement of a post-tensioned foundation should be in accordance with the recommendations of a structural engineer.

6.3 **Floor Slabs.** Slabs-on-grade should be supported on a 12-inch thick mat of compacted, engineered fill. Material for engineered fill and compaction requirements are presented in Sections 4.5 and 4.6. For moisture-sensitive flooring, floor slabs resting on soil should be underlain, at a minimum, by a capillary break system. We recommend 6 inches of clean coarse sand or pea gravel. When floor dampness is a concern, possibly in a low-lying area such as GB-M-1, floor slabs should be underlain by a vapor barrier and capillary break system. We recommend a system consisting of a 10-mil polyethylene (or equivalent) membrane placed over 6 inches of clean coarse sand or pea gravel. The exposed subgrade should be moistened just prior to the placement of the capillary break system. A sand layer above the moisture barrier to aid in concrete curing should be evaluated by the structural engineer. The slab underlayment including the capillary break can be taken as part of the 12-inch thick pad of compacted, engineered fill described above. Flooring and waterproofing consultants should be consulted for additional slab waterproofing recommendations.

7.0 CORROSION

Schiff Associates performed corrosivity laboratory tests on one soil sample for each of the five completed sites. Their laboratory results are included in Appendix A – Supporting Geotechnical Data. They performed the following tests:

- Resistivity (As-Received and Saturated),
- pH,
- Electrical Conductivity,
- Chemical Analyses of Cations (Calcium, Magnesium, Sodium, Potassium)
- Chemical Analyses of Anions (Carbonate, Bicarbonate, Fluoride, Chloride, Sulfate, Phosphate)
- Chemical Analyses of Ammonium
- Chemical Analyses of Nitrate

Electrical resistivities indicate soils range from moderately corrosive to highly corrosive to ferrous metals in GB-11A, -M-1 and -44-1.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Geotechnical Observation of Construction Activities. We should be retained during construction to provide site observation and consultation concerning the condition of the bottom of excavations pertaining to foundation construction and pipeline trench excavation. Foundation grades should be observed and, where necessary, tested under the direction of a qualified geotechnical engineer to verify compliance with final design recommendations. All site preparation work and excavations should also be observed to compare the generalized site conditions assumed in the final design report with those found on site at the time of construction.

8.2 Existing Underground Utilities. A number of underground water main pipelines pass beneath and in the vicinity of the proposed sites. Other existing subsurface lines include the SFPUC transmission lines, sanitary sewer and storm sewer lines. Some of these utilities were located and marked prior to our subsurface investigation so that we would not damage them during drilling.

The City may consider remarking these utilities prior to construction of the improvements so they remain visible during earthwork and construction of the improvements. Any excavations made adjacent to existing utilities should be backfilled with on-site or imported soil to at least 90 percent relative compaction as evaluated by ASTM D 1557.

8.3 Surface Drainage. Proper surface drainage is essential for satisfactory site performance. Positive drainage should be provided and maintained to direct surface water away from building foundations and other site improvements. Positive drainage is defined as a slope of 2 percent or more over a distance of 5 feet or greater away from the foundations, flatwork, and tops of slopes. Runoff should then be directed by the use of swales or pipes into a collective drainage system. Surface water should not be allowed to pond adjacent to footings. We further recommend that the proposed structure be equipped with appropriate roof gutters and downspouts. Downspouts should discharge to a system of closed pipes that transport the collected water to a suitable discharge facility. We recommend that drought tolerant vegetation be used for site landscaping. Irrigation should be kept at levels just sufficient to maintain plant vigor.

9.0 CLOSURE

The conclusions and recommendations presented herein are professional opinions based on geotechnical and geologic data and the project as described. A review by this office of any foundation, excavation, grading plans and specifications, or other work product that relies on the content of this report, together with the opportunity to make supplemental recommendations is considered an integral part of this study. Should unanticipated conditions come to light during project development or should the project change from that described, we should be given the opportunity to review our recommendations.

The findings and professional opinions presented in this report are presented within the limits prescribed by the client, in accordance with generally accepted professional engineering and geologic practices. There is no other warranty, either express or implied, regarding the conclusions, recommendations, and opinions presented in this report.

Submitted by:
GEOTECHNICAL CONSULTANTS, INC.

Dustin Agnew
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
G. NEELAKANTAN
No. 2391
Exp. 9/30/2011
GEOTECHNICAL
STATE OF CALIFORNIA

G. Neelakantan, P.E., G.E.
Geotechnical Engineer 2391

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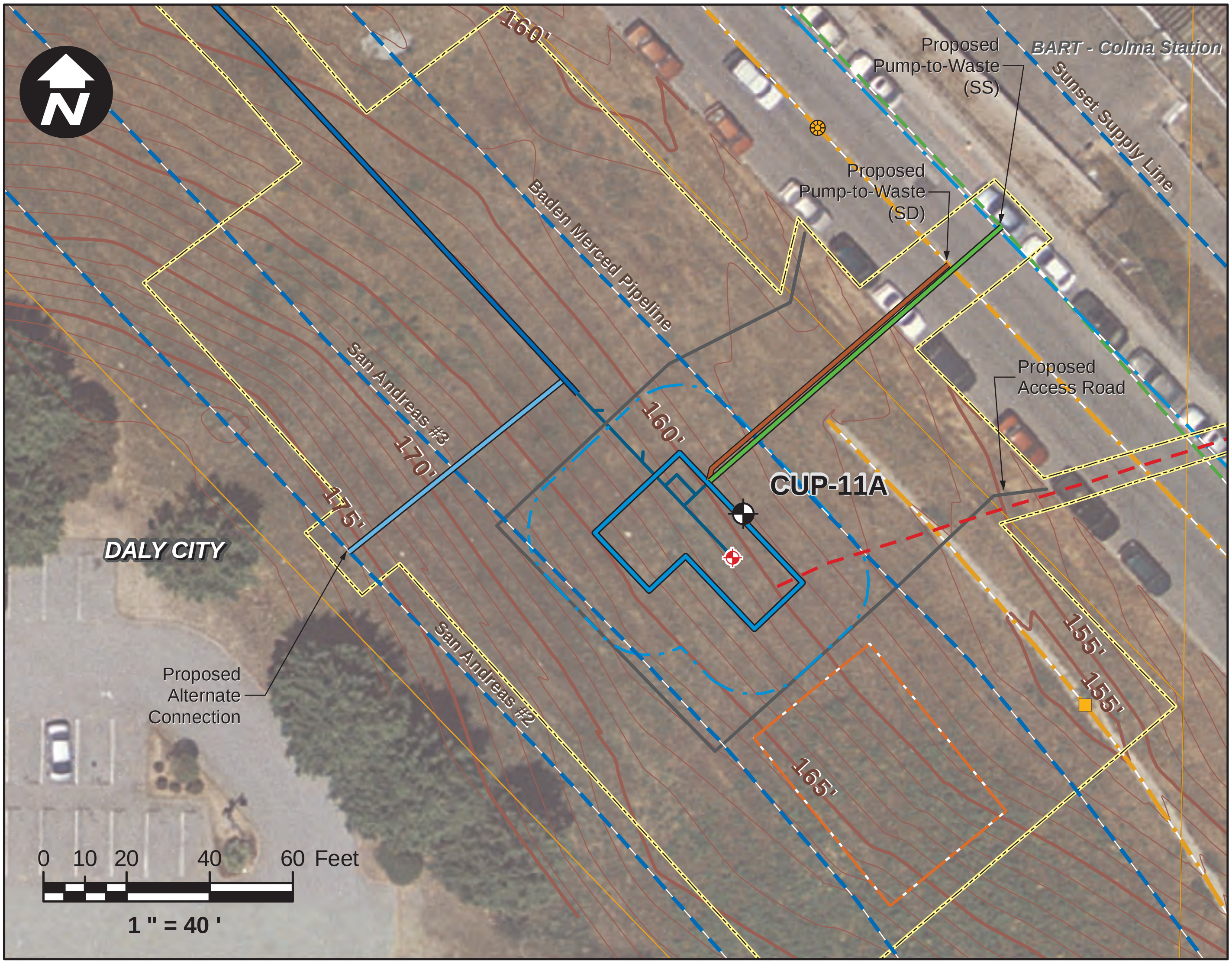
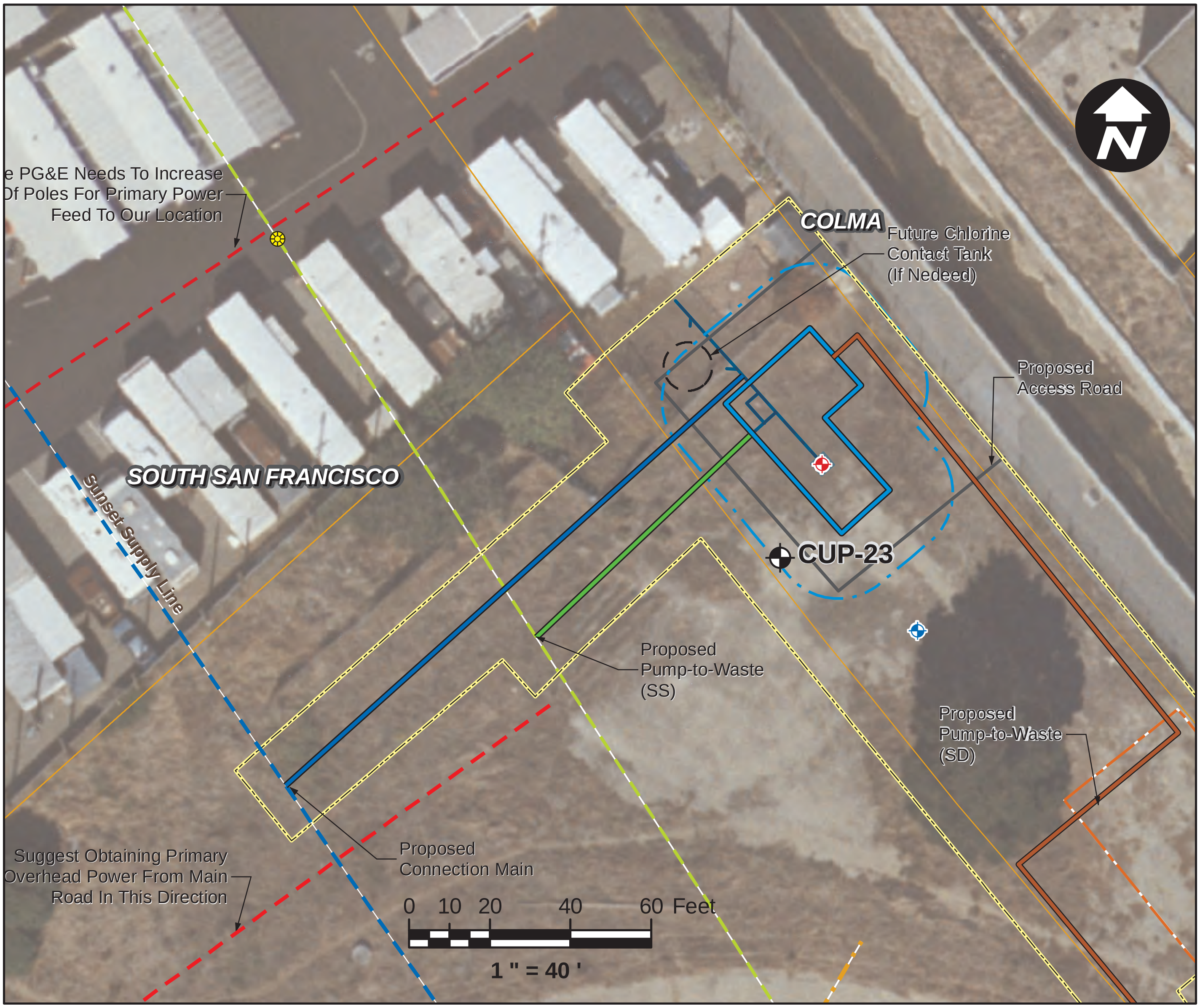


Legend

- Geotecnical Boring by GTC in September 2009.
- Proposed Test Well - Phase 1
- Proposed Construction Area for Test Well and Connections
- Proposed Staging Area Boundary
- Proposed Construction Area-16ft Building Buffer
- Proposed Building with Chemical Treatment
- Existing Parcels - San Mateo County
- Proposed Access Road
- Proposed Connection Main
- Proposed Alternate Connection
- Proposed Pump-to-Waste (SS)
- Proposed Pump-to-Waste (SD)
- Existing 5-Foot Contour Lines
- Existing 1-Foot Contour LInes
- Existing PG&E Pole
- Proposed Underground Electrical
- Existing Transmission Line - SFPUC
- Existing Water - CalWater
- Existing Sanitary Sewer - DalyCity
- Existing Stormdrain Catch Basin - Colma
- Existing Stormdrain Manhole - Colma
- Existing Stormdrain - Colma

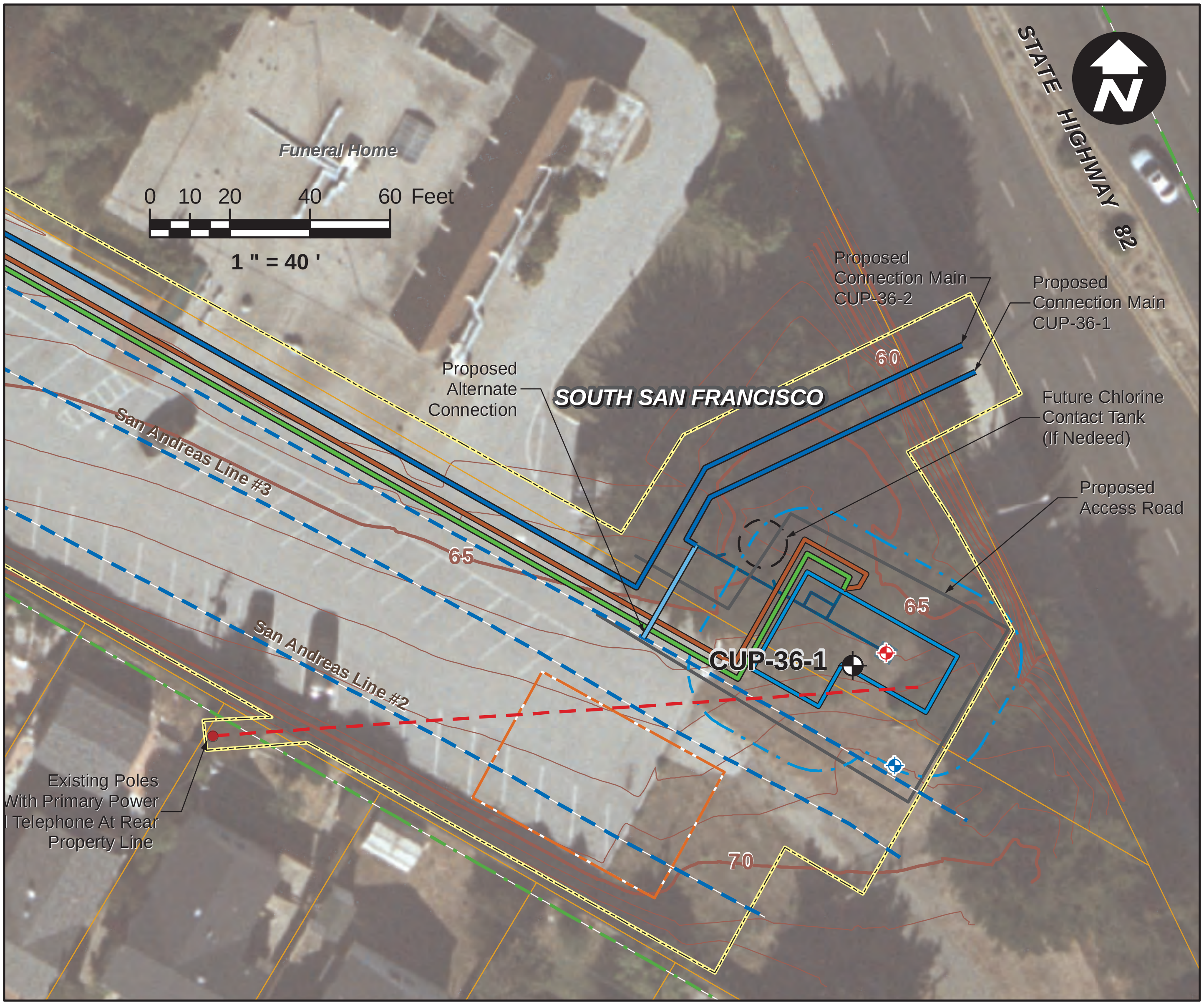
GTC GEOTECHNICAL CONSULTANTS, INC. 500 Sansome St., Suite 402 San Francisco, CA 94111	BORING LOCATION PLAN FOR CUP-11A	PLATE 1
	SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
	DECEMBER 2009	SF09020



Legend

- Geotecnical Boring by GTC in September 2009.
- Proposed Test Well - Phase 2
- Proposed Monitoring Well - Phase 2
- Proposed Construction Area for Test Well & Connections
- Proposed Staging Area Boundary for Well Building
- Proposed Construction Area-16ft Building Buffer
- Proposed Building and Chemical Treatment
- Proposed Access Road
- Existing Parcels - San Mateo County
- Proposed Connection Main
- Proposed Pump-to-Waste (SS)
- Proposed Pump-to-Waste (SD)
- Existing Transmission Line - SFPUC
- Proposed Underground Electrical
- Existing Sanitary Sewer Manhole - DalyCity
- Existing Sanitary Sewer - DalyCity
- Existing Stormdrain - SSF

GEOTECHNICAL CONSULTANTS, INC. 500 Sansome St., Suite 402 San Francisco, CA 94111	BORING LOCATION PLAN FOR CUP-23	PLATE 2
	SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
	DECEMBER 2009	SF09020



Legend

- Geotecnical Boring by GTC in September 2009.
- Proposed Test Well - Phase 2
- Monitoring Well Installed in Phase 1
- Proposed Construction Area for Test Well and Connections
- Proposed Staging Area Boundary for Well Building
- Proposed Construction Area-16ft Building Buffer
- Proposed Building with Chemical Treatment
- Proposed AccessRoad
- Proposed Connection Main
- Proposed Alternate Connection
- Proposed Pump-to-Waste (SS)
- Proposed Pump-to-Waste (SD)
- 5-Foot Contour Lines
- 1-Foot Contour Lines
- Existing Parcels - San Mateo County
- Existing Transmission Line - SFPUC
- Existing PG&E Pole
- Proposed Underground Electrical
- Existing Sanitary Sewer Manhole - SSF
- Existing Sanitary Sewer - SSF

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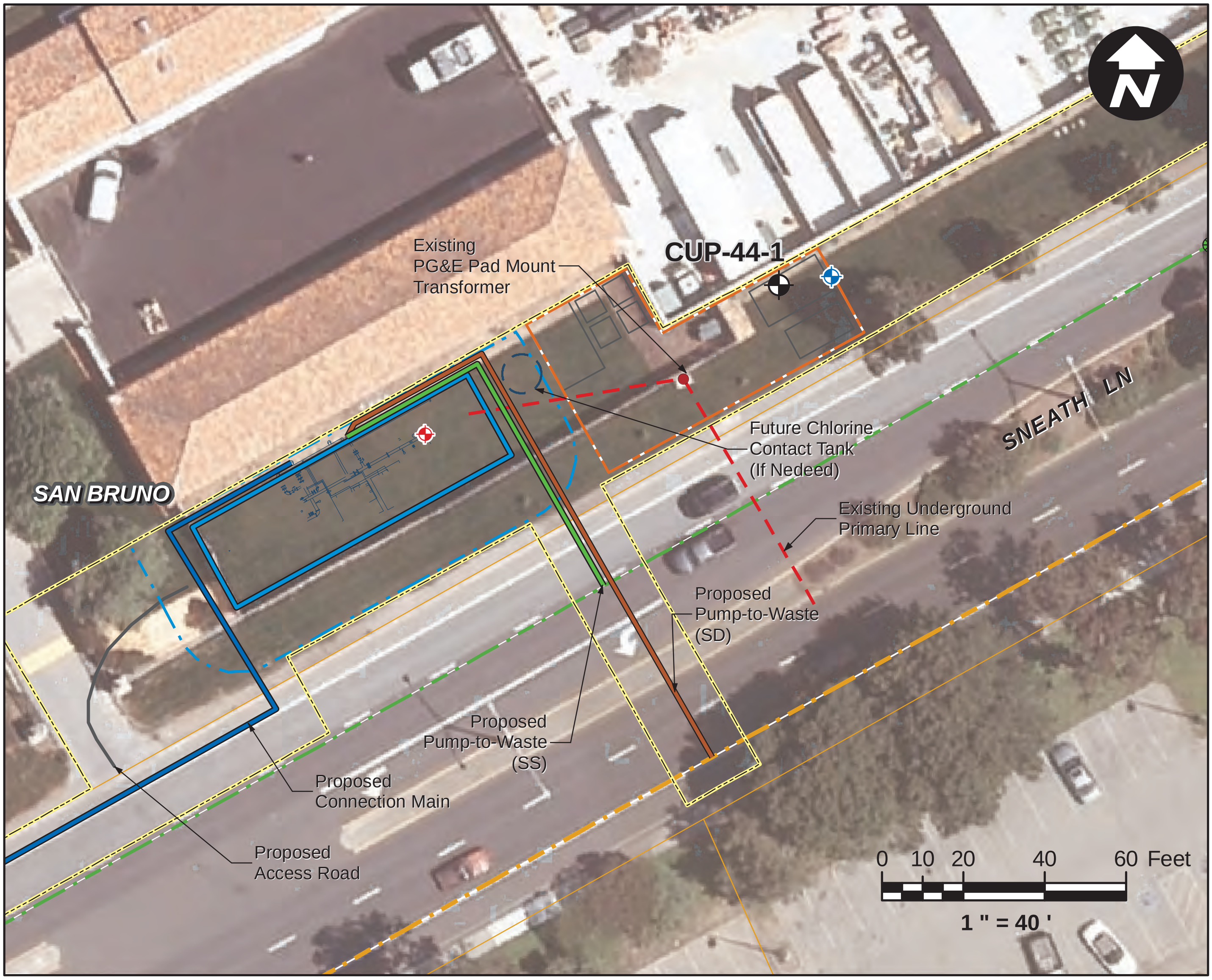
San Francisco, CA 94111

BORING LOCATION PLAN FOR CUP-36-1	PLATE 3
SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
DECEMBER 2009	SF09020



Legend

- Geotecnical Boring by GTC in September 2009.
- Proposed Test Well - Phase 2
- Proposed Monitoring Well - Phase 2
- Proposed Construction Area for Test Well and Connections
- Proposed Staging Area Boundary for Well Building
- Proposed Construction Area-16ft Building Buffer
- Proposed Building with Filtration
- Proposed Access Road
- Proposed Connection Main
- Proposed Alternate Connection
- Proposed Pump-to-Waste (SS)
- Proposed Pump-to-Waste (SD)
- Topography
- Existing Parcels - San Mateo County
- Existing Transmission Line - SFPUC_Surveyed
- Existing PG&E Transformer
- Proposed Underground Electrical
- Existing Water - CalWater
- Existing Catch Basin - San Bruno
- Existing Manhole - San Bruno
- Existing Storm Drain - San Bruno
- Existing Sanitary Sewer Manhole - San Bruno
- Existing Sanitary Sewer - San Bruno

GEOTECHNICAL CONSULTANTS, INC. 500 Sansome St., Suite 402 San Francisco, CA 94111	BORING LOCATION PLAN FOR CUP-44-1	PLATE 4
	SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
	DECEMBER 2009	SF09020

Legend

- Geotecnical Boring by GTC in September 2009.
- Proposed Test Well - Phase 2
- Proposed Monitoring Well - Phase 2
- Proposed Construction Area for Test Well and Connections
- Proposed Staging Area Boundary for Well Building
- Proposed Construction Area-16ft Building Buffer
- Proposed Building with Chemical Building
- Proposed Access Road
- Proposed Connection Main
- Proposed Well Connnection Pipe
- Proposed Alternate Connection
- Proposed Pump-to-Waste (SS)
- Proposed Pump-to-Waste (SD)
- Existing Parcels - San Mateo County
- Transmission Line - SFPUC_Surveyed
- Existing PG&E Pole
- Existing Over Head Electrical
- Proposed Underground Electrical
- Existing Water - DalyCity
- Existing Water - CalWater

GEOTECHNICAL CONSULTANTS, INC. 500 Sansome St., Suite 402 San Francisco, CA 94111	BORING LOCATION PLAN FOR CUP-M-1	PLATE 5
	SOUTH WESTSIDE GROUNDWATER BASIN CUP PROJECT	
	DECEMBER 2009	SF09020

GEOTECHNICAL REPORT – CUP-3A AND CUP-7 SITES, REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT, NOVEMBER 2011 (REVISED JANUARY 2012)

GEOTECHNICAL CONSULTANTS, INC.
Geotechnical Engineering • Geology • Hydrogeology

GEOTECHNICAL REPORT
CUP-3A AND CUP-7 SITES
REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT
SAN MATEO COUNTY, CA

November 2011
(Revised January 2012)

Prepared for:

San Francisco Public Utilities Commission
1155 Market Street
San Francisco, California 94103

Owner:

San Francisco Public Utilities Commission

GTC Project No. SF11004

GEOTECHNICAL CONSULTANTS, INC.
Geotechnical Engineering • Geology • Hydrogeology

Mr. Thomas Hull, S.E.
San Francisco Public Utilities Commission
1155 Market Street
San Francisco, California 94103

November 28, 2011
(Revised January 16, 2012)
GTC Project No. SF11004

Subject: Geotechnical Report
Regional Groundwater Storage & Recovery Project
CUP-3A and CUP-7 Sites
San Mateo County, California

Dear Mr. Hull:

The San Francisco Public Utilities Commission (SFPUC) is planning for the design and construction of proposed improvements to facilitate groundwater well stations, and chemical treatment and filtration facilities at two designated CUP-3A and CUP-7 sites located in northern San Mateo County, California. The proposed wells are part of the Regional Groundwater Storage and Recovery Project. We have previously submitted geotechnical reports for ten other GSR sites located in northern San Mateo County. We prepared this report (revised from the previously submitted report dated November 28, 2011) presenting our geotechnical findings, conclusions, and recommendations for the proposed improvements at the CUP-3A and CUP-7 sites. This report was developed in accordance with Task Order No. 6 of the design services Contract No. CS-998B.

Sincerely,
Geotechnical Consultants, Inc.

Nick S. Ng, G.E.
Senior Geotechnical Engineer

TABLE OF CONTENTS

Page

TABLES

FIGURES

PLATE

APPENDIX A – SUPPORTING GEOTECHNICAL DATA

INTRODUCTION

This geotechnical report presents the findings, conclusions, and recommendations of our geotechnical study performed for proposed buildings to facilitate groundwater well stations, and chemical treatment and filtration facilities at two designated sites, CUP-3A and CUP-7, located in the northern part of San Mateo County, California (**Figure 1 – Site Location Map**). The proposed wells are part of the Regional Groundwater Storage and Recovery Project (GSR), a project being developed through the coordination of the San Francisco Public Utilities Commission (SFPUC) and local partner agencies (i.e., City of Daly City, City of San Bruno, and Cal Water). We have previously performed geotechnical investigations and submitted geotechnical design reports (GTC, 2009a and 2009b) at ten other sites in northern San Mateo County for the project. This geotechnical report is being prepared for the SFPUC as part of Task Order No. 6 of the design services Contract No. CS-998.B.

Although the CUP-44-2 site was initially proposed along with the CUP-7 site for our geotechnical evaluation, we were subsequently instructed by the SFPUC not to pursue our study of the CUP-44-2 site for this task due to issues pertaining to restrictions on accessibility and building layout. Instead, we have been authorized to evaluate the CUP-3A and CUP-7 sites.

We anticipate that the proposed lightly loaded station buildings will typically be constructed with concrete, although the material selection will depend on the surrounding structures. According to the site location and floor plans developed at the 65 percent design progress in June, 2011 (SFPUC, 2011), a new well station building which houses a production well and related chemical treatment facilities are anticipated at the CUP-3A site. The footprint size of proposed well station building is approximately 1,523 square feet (35 feet by 43½ feet). At the CUP-7 site, the well station fenced enclosure is approximately 576 square feet (18 feet by 32 feet). Other improvements located adjacent to each well station exterior include concrete paving, and a transformer pad. The preliminary layout of the proposed well station buildings and related facilities is shown on **Plates 1 and 2 – Exploration Location Plan**. Geotechnical recommendations for additional improvements such as new pipeline connections and upgrades, which may require additional geotechnical borings, were not part of our scope of work.

Our understanding of the project is based on a site visit on July 26, 2011, discussions with the SFPUC Design Team, preliminary 65 percent progress drawings of the project sites, a review of geotechnical information as referenced in this report, and results from our field exploration and laboratory testing programs. The objectives of our geotechnical study are to: (1) review available geotechnical/geologic information in the site vicinity to understand site conditions; (2) perform a subsurface exploration program to classify subsurface soil types, conduct in-situ soil tests, and collect soil samples for geotechnical laboratory testing; and (3) perform geotechnical engineering analyses to assess potential geo-hazards and develop recommendations for the design and construction of the proposed well station facilities.

FIGURE 1 – SITE LOCATION MAP

WORK PERFORMED

In accordance with our proposal dated January 24, 2011, and subsequent discussions with the SFPUC Design Team, we completed the scope of work described below:

1. **Review of Background Information.** We reviewed available plans, and geotechnical and geologic data for the project sites. Based on our review of existing data, we developed a field exploration program as discussed below.

2. **Field Exploration Program.** We explored subsurface conditions by means of drilling one hollow-stem auger boring at each of the CUP-3A and CUP-7 sites. The exploratory locations for the CUP-3A and CUP-7 sites are shown on **Plates 1 and 2 – Exploration Location Plans**, respectively. Details of our exploration program including the site location and exploration number, method of exploration, date of drilling, existing surface elevation, and bottom depth and elevation are presented for each boring in **Table 1 – Summary of Geotechnical Exploration**. The elevations presented on **Table 1**, and referred to throughout this report, are estimated from the topographic contours on the preliminary 65 percent site plans (SFPUC, 2011) and referenced with respect to 1988 North American Vertical Datum (NAVD88).

TABLE 1 – SUMMARY OF GEOTECHNICAL EXPLORATION

Site Location and Exploration No.	Method	Exploration Date	Surface Elevation (feet)[1]	Bottom Depth (feet)	Bottom Elevation (feet)[1]
CUP-3A	Stem Auger	8/8/2011	+190	51.4	+139
CUP-7	Stem Auger	8/8/2011	+132	36.3	+96

1. Surface elevation relative to NAVD88 datum is estimated from the topographic contours on the preliminary 65 percent progress site location plans dated June, 2011 from SFPUC (2011).

We visually classified the soil during drilling. We recovered split-spoon (Standard Penetration Test) samples and relatively undisturbed 2 ½ inch diameter sleeve samples using a split-barrel sampler. Selected samples were transferred to a laboratory for testing. Boring logs are presented on **Plates A-1.1 and A-1.2** in **Appendix A – Supporting Geotechnical Data**.

3. **Laboratory Testing.** We performed moisture, density, grain size analysis, Atterberg limits, direct shear and corrosion tests on selected soil samples to measure pertinent index and engineering properties. The laboratory test results are presented on the figures in **Appendix A**, and on the boring logs on **Plates A-1.1 and A-1.2**.

4. **Engineering Analysis.** We analyzed subsurface conditions and laboratory test results, and reviewed regional and local geology and seismicity. Based on our evaluation, we provided the following geotechnical recommendations for design:

   - Geologic and seismic hazards: Assessment of hazards associated with fault rupture, strong ground shaking, liquefaction, seismically-induced landslide, lateral spread and tsunami, seismic settlement and differential compaction, and recommendations on mitigation measures, where appropriate; and allowable design parameters for short-term seismic loading.
   - Site response spectra: Evaluated seismic design parameters in accordance with the International Building Code Static Force Procedure (ICC, 2009) as adopted in the 2010 California Building Code (ICC, 2010), and ASCE7-05.
   - Allowable and ultimate bearing capacity: Evaluation of allowable and ultimate soil bearing pressures and modulus of subgrade reaction (vertical soil springs) for the anticipated shallow foundation systems (shallow footings with grade beams, and mat foundations).
   - Anticipated settlements: Assessment of total and differential settlements for shallow foundation systems that are anticipated for the proposed well stations. Development of options for mitigating excessive dynamic settlements.
   - Earthwork recommendations: Development of recommendations for site preparation and grading, excavations, engineered fill (including placement and compaction), structural fill, and pipe trenching, bedding and backfilling; and assessment of the suitability of site-excavated material for re-use as fill or backfill material.
   - Lateral earth pressures: Recommendations of design lateral earth (including active, passive, at-rest, and seismic increment) pressures and coefficient(s) of base sliding friction for unrestrained and restrained retaining walls and/or buried footings.
   - Corrosion recommendations: Discussion of the corrosion test results, identification of on-site soils which may cause corrosion or other deleterious effects to concrete or steel.
   - Construction considerations: Discussion pertaining to geotechnical conditions at the project sites including mitigation of excessive dynamic settlements.
   - Groundwater considerations: Discussion of anticipated groundwater conditions during construction.

5. **Report.** We prepared this report presenting our geotechnical findings, conclusions, and recommendations for the proposed improvements at the GSR project sites.

FINDINGS

SITE CONDITIONS

The two GSR project sites are located at northern San Mateo County, California. The CUP-3A site is located within the northeast portion of the Lake Merced Golf Club in Daly City, California, and is surrounded at about 30 feet to the east by Interstate 280 (I-280), and about 100 feet to the north by parking lot of the 45 Poncetta Drive apartment complex. As indicated on **Plate 1**, the CUP-3A site is situated on a relatively flat, unpaved pad that is currently occupied by an existing public restroom and some buried utility lines (including a PG&E gas transmission pipeline and some water main pipelines). About 20 feet to the west from the nearest edge of the proposed well station building at the site, the relatively flat terrain descends about 8 feet on a 3:1 (horizontal:vertical) slope to a paved driveway that separates the project site from a putting green (lawn). The slope appears to be sparsely planted with trees.

The CUP-7 site is located about 160 feet northeast of the intersection between 87th Street and Park Plaza Drive in Broadmoor, California. The project site which is situated on an undeveloped, grassed area is surrounded with Park Plaza Drive to the west, a 10-foot wide paved walkway and residential units to the south, and a sloping terrain to the north and east. As indicated on **Plate 2**, the CUP-7 site is situated on a relatively flat to mildly sloping terrain that descends north-to-northeast along the Park Plaza Drive orientation. From the northeast corner of the proposed well station fenced enclosure at the CUP-7 site, the terrain descends about 20 feet on an approximately 3:1 (horizontal:vertical) slope in a northeast direction toward the track and field of the Garden Village Elementary School. The slope appears to be densely vegetated with low to moderately tall trees and shrubs. The nearest residential unit is located about 50 feet south of the site.

SEISMICITY

The San Francisco Bay Area contains several active faults that could cause strong ground shaking at the project sites. **Figure 2 – Regional Active Fault Map** shows faults in the vicinity of the project sites. The San Andreas Fault Zone (including the 1906 Rupture Event and Peninsula Segment) is the nearest active fault and is located about 0.8 and 1.4 miles from the CUP-7 and CUP-3A sites, respectively. The San Andreas Fault is a primary component in a complex system of right-lateral, strike-slip faults; including the San Andreas, San Gregorio-Seal Cove, Hayward, and Calaveras faults; collectively known as the San Andreas Fault system. The San Andreas, San Gregorio-Seal Cove, Hayward, and Calaveras Faults have produced measurable historic ground motion and movement. The San Andreas Fault is capable of producing an earthquake of an estimated maximum magnitude of M7.9. This segment is estimated to have recurrence intervals on the order of 200 years. A summary of nearby faults is presented in **Table 2 – Active and Potentially Active Faults**.

FIGURE 2 – REGIONAL ACTIVE FAULT MAP

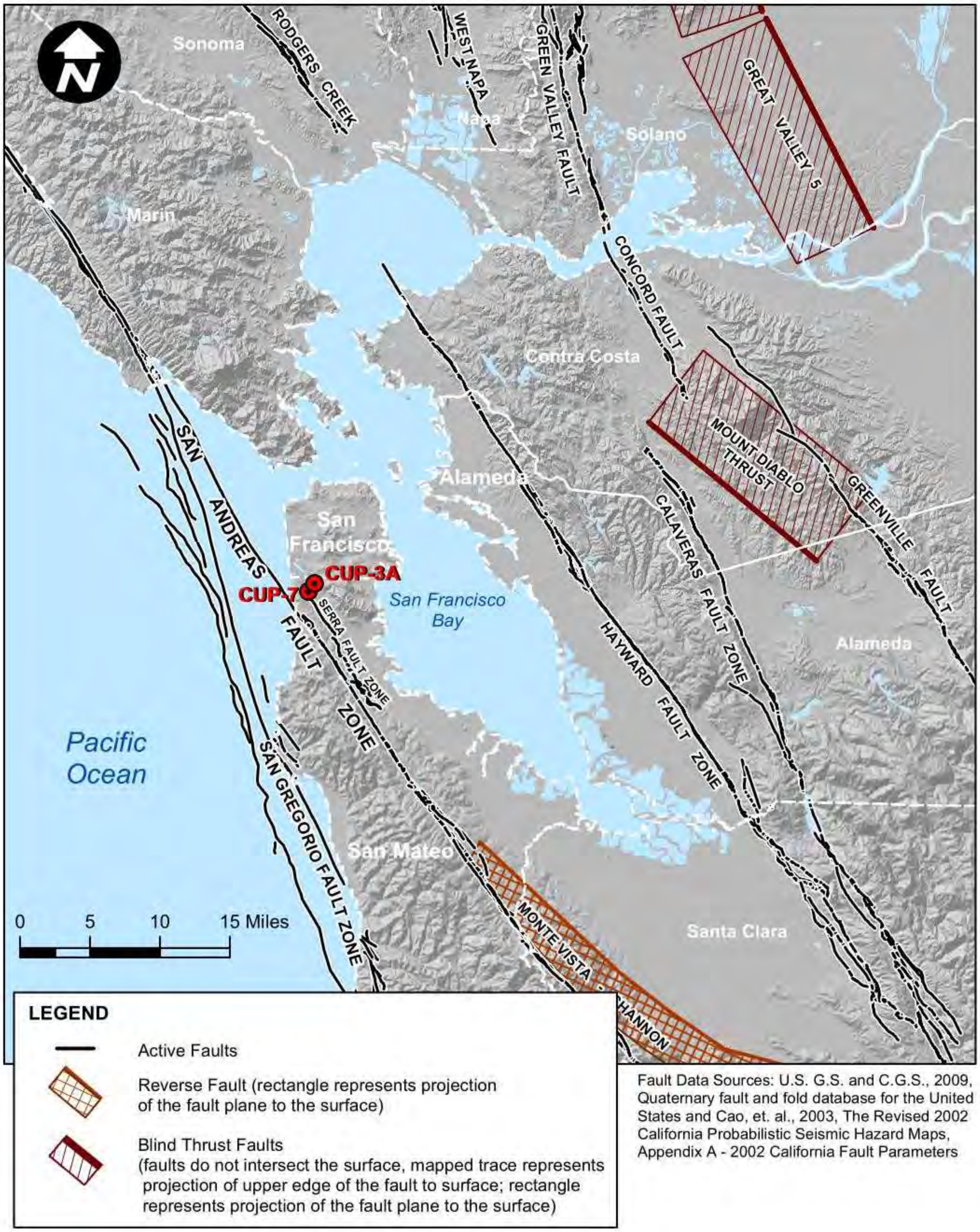


TABLE 2 – ACTIVE AND POTENTIALLY ACTIVE FAULTS

<table>
<tr><th rowspan="2">Fault</th><th colspan="2">Distance to Fault (miles)</th><th rowspan="2">Estimated Maximum Earthquake Magnitude (1)</th><th colspan="2">Historic Earthquakes (2)</th></tr>
<tr><th>CUP-3A</th><th>CUP-7</th><th>Year</th><th>Magnitude</th></tr>
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1898
1906
1989</td><td rowspan="3">6.8
6.2
8.1
7.1</td></tr>
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<tr><td>Hayward- North Section</td><td>16</td><td>16</td><td>6.9</td><td rowspan="2">1868</td><td rowspan="2">6.8</td></tr>
<tr><td>Hayward – South Section</td><td>18</td><td>18</td><td>6.9</td></tr>
<tr><td>Monte Vista-Shannon</td><td>20</td><td>20</td><td>6.8</td><td>n.a.</td><td>n.a.</td></tr>
<tr><td>Calaveras – North Section</td><td>26</td><td>26</td><td>6.8</td><td rowspan="2">1861
1955
1979
1984
2007</td><td rowspan="2">5.3
5.5
5.9
6.1
5.4</td></tr>
<tr><td>Calaveras – South Section</td><td>40</td><td>40</td><td>6.2</td></tr>
</table>

(1) Maximum Moment Magnitude based on California Geological Survey (CGS) fault parameters as updated in 2002 (Cao, et al., 2003), or as suggested by the SFPUC's General Seismic Requirements (SFPUC, 2006).
(2) Historic earthquakes listed may have occurred on any one of the listed sections of the associated fault; n.a. (not applicable) indicates that no significant historic earthquakes have occurred on this fault or fault section.
(3) The 1906 rupture event assumes rupture along the North Coast, Peninsula and Santa Cruz Mountains sections to San Juan Bautista. Maximum magnitude is based on the average 5 m displacement during the 1906 event (WGCEP, 2003; Petersen, et al., 1996). Site-to-fault distances are based on the USGS 2008 updated National Seismic Hazard Mapping Program (Petersen et al., 2008) and interactive de-aggregation at URL https://geohazards.usgs.gov/deaggint/2008/.

GEOLOGY

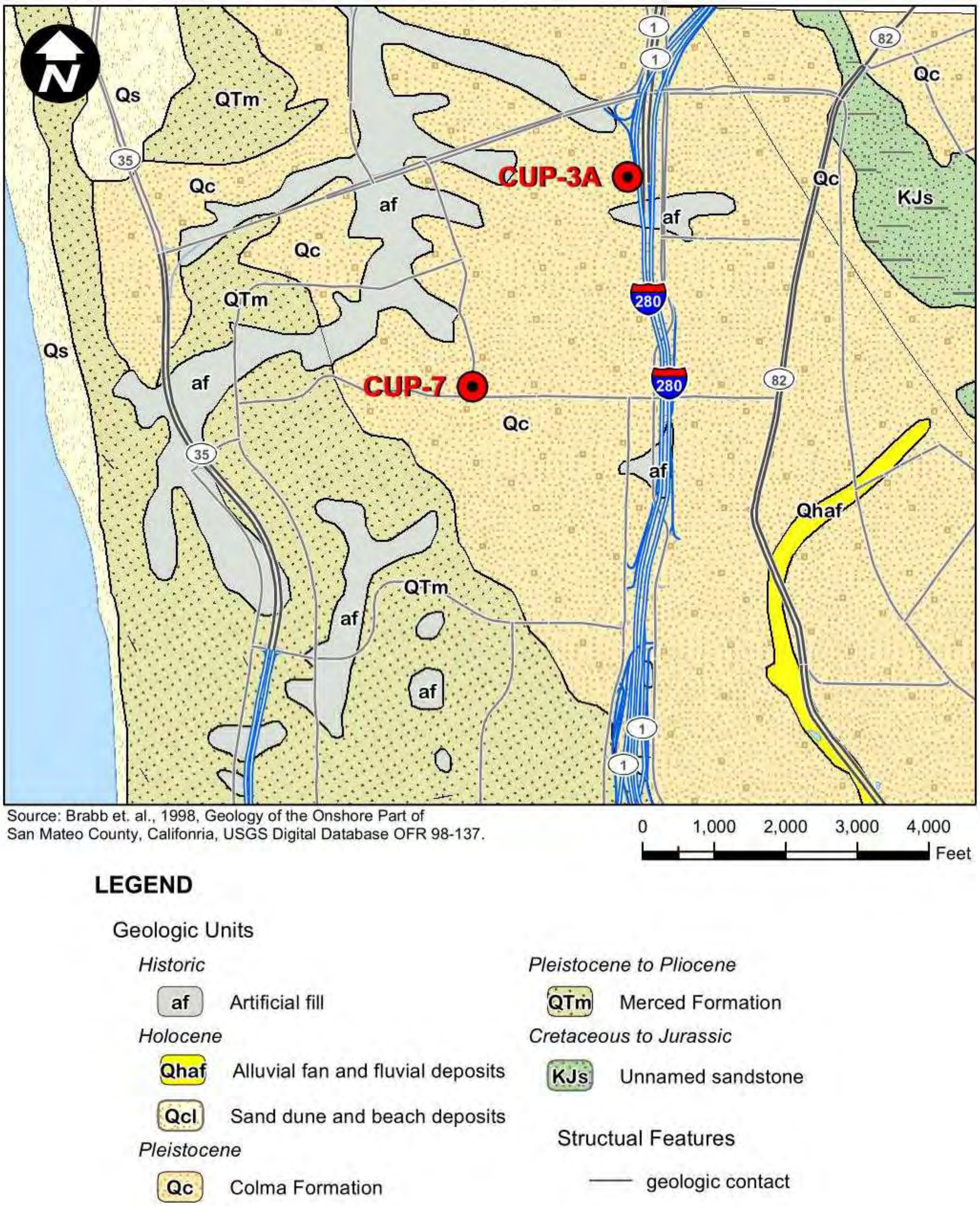
The San Francisco Bay Area is located within the Coast Ranges Geomorphic Province. Past episodes of tectonism have folded and faulted the bedrock, creating the regional topography of the northwest trending ridges and valleys characteristic of the Coast Ranges Geomorphic Province. The San Francisco Bay and vicinity occupy a structurally controlled basin within the province. Late Pleistocene and Holocene sediments (less than 1 million years old) were deposited in the basin as it subsided.

The two project sites are located in areas mapped as Colma Formation (Brabb, et al., 1988). Other sedimentary deposits mapped in close proximity to the sites include Merced

Formation, Sand Dune and Beach Deposits, and Unnamed Sandstone. A layer of artificial fill was encountered at each site. The geology in the project vicinity is shown on **Figure 3 – Regional Geologic Map**. Based on a regional geologic study as compiled as a regional geologic cross section of the Westside Basin – Lake Merced (SFPUC, 2008), the Franciscan Complex bedrock is anticipated to be on the order of 600 to 700 feet below ground surface at the sites. Geologic maps (Brabb, et al., 1998) describe the geologic units at and near each boring as follows:

- **af:** Artificial fill (Historic) – loose to very well consolidated gravel, sand, silt, clay, rock fragments, organic matter, and man-made debris in various combinations and thicknesses which may exceed 30 m; some compacted and quite firm, but fill made before 1965 is nearly everywhere not compacted and consists of simply dumped materials.
- **Qs:** Sand Dune and Beach Deposits (Holocene) – predominantly loose, medium- to coarse-grained, well-sorted sand but also includes pebbles, cobbles, and silt; thickness is typically less than 6 m in most places, but in other places may exceed 30 m.
- **Qc:** Colma Formation (Pleistocene) – yellowish-gray, gray, yellowish-orange and red-brown, friable to loose, fine- to medium-grained arkosic sand with subordinate gravel, silt and clay; total thickness is typically unknown, but may up to 60 m.
- **QTm:** Merced Formation (lower Pleistocene and upper Pliocene) – medium gray to yellowish gray, yellowish orange, medium- to very fine-grained, poorly indurated to friable sandstone, siltstone, and claystone, with some conglomerate lenses and a few friable beds of white volcanic ash; sandstone is typically silty, clayey, or conglomeratic; fossiliferous conglomerate is well cemented.
- **KJs:** Unnamed Sandstone (Cretaceous or Jurrasic) – dark gray to yellowish brown greywacke interbedded with shale in approximately equal amounts; unit resembles some Franciscan greywacke (fs) but bedding is better developed herein; the unit is exposed in San Bruno Mountain, where it is about 1,000 m thick.

FIGURE 3 – REGIONAL GEOLOGIC MAP



EARTH MATERIALS

The exploration for this investigation encountered artificial fill (af) which was underlain by Colma Formation (Qc). The artificial fill represents disturbed soil and fill materials previously placed during site grading at the project sites. The exploratory locations are shown on **Plates 1 and 2**.

Artificial Fill (af). Artificial fill consisting of medium dense, poorly grade fine grained sand with silt was encountered to a depth of about 8 feet in boring CUP-7. The grade at the Garden Village Elementary School track and field is located about 20 feet below the CUP-7 site. The origin of fill at the site was likely derived from grading and reuse of on-site, near surface materials of Colma Formation (Qc).

At boring CUP-3A, artificial fill consisted of an upper 20 feet of loose to dense, poorly graded fine sand with silt, and a remainder 11 feet of dense, silty fine sand. Judging from distinctly lower density and less fines content, the upper 20 feet of looser materials may likely have been derived from more recent activities such as, grading and reuse of on-site, near surface artificial fill around the Lake Merced Golf Course, and construction of an elevated pad for the existing public restroom building. In comparison to the upper fill, the lower stratum of fill with higher density and higher fines content are closer in resemblance to the engineering properties of the underlying Colma Formation.

At the project sites, measured total unit weights ranged from 101 to 113 pounds per cubic foot (pcf) and moisture contents ranged from 4 to 12 percent.

Colma Formation. Soils of the Colma Formation (Qc) were encountered below the artificial fill at the two project sites. The Colma Formation soils consisted predominantly of yellowish, reddish and grayish brown, dense to very dense, silty fine grained sand with oxide staining. An isolated layer of medium dense, silty fine sand was observed within the upper portion of the Colma Formation at CUP-3A. Colma Formation soils at the two sites extended to the total depth of exploration (36.3 to 51.4 feet). A moisture content ranging from 9 to 18 percent was measured in the Colma Formation soils at the two sites.

GROUNDWATER

Groundwater was not encountered during auger drilling of the two exploratory borings CUP-3A and CUP-7. Groundwater levels are likely to be influenced by seasonal variations in precipitation, percolations from storm water runoff and local irrigation, groundwater pumping and other factors, and are therefore expected to fluctuate considerably from the observed groundwater levels.

CONCLUSIONS AND RECOMMENDATIONS

1.0 GENERAL

The following sections provide our conclusions and recommendations for evaluation and design of the proposed well station buildings at two sites of CUP-3A and CUP-7. According to preliminary 65 percent drawings (SFPUC, 2011), proposed improvements at CUP-3A consist of a well station building that houses facilities such as, a production well and chemical treatment equipment, concrete paving, and transformer pad. Proposed improvements at CUP-7 consist of a fenced pad with a production well and electrical equipment. Based on findings from our geotechnical field investigation, the project sites are underlain by artificial fill (af) and Colma Formation (Qc).

We consider the proposed improvements to be geotechnically feasible, provided that our geotechnical recommendations are incorporated into design and construction documents.

2.0 SEISMIC DESIGN CONSIDERATIONS

2.1 **General.** The main seismic hazards at the site are expected to be strong ground shaking and seismic settlement and differential compaction within the loose to medium dense portion of fill and upper Colma Formation. Our seismic design considerations, including fault rupture, ground shaking, liquefaction, seismic settlement and dynamic (differential compaction) settlement, inundation by tsunamis, seismically-induced lateral spreading, and seismic design with respect to the 2009 International Building Code (which the 2010 California Building Code has adopted) and ASCE7-05 are provided in the following sections.

2.2 **Fault Rupture.** No active or potentially active faults are known to cross the subject sites. Consequently, the hazard posed by ground rupture due to fault offset is considered to be negligible.

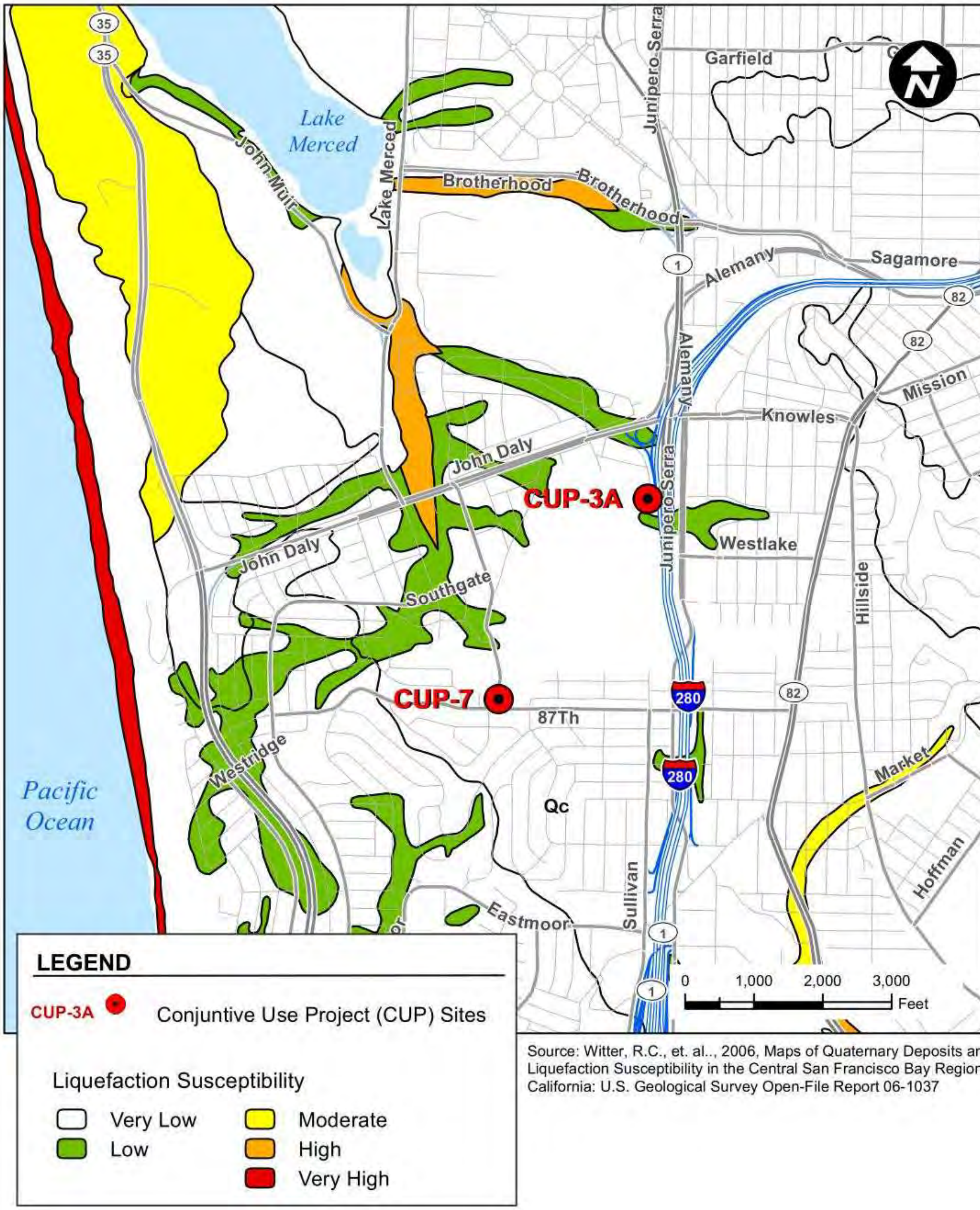
2.3 **Ground Shaking**. Strong ground shaking will occur at the site as a result of a moderate to large earthquake occurring on one of the active regional faults. The San Andreas Fault is closest to the sites at about 0.8 and 1.4 miles to the southwest from CUP-7 and CUP-3A sites, respectively. Based on de-aggregation of seismic sources from the probabilistic seismic hazard analysis (USGS, 2008), the Northern San Andreas Fault and San Gregorio-Seal Cove Fault segments of the San Andreas Fault system are the only individual fault segments that each contributes more than 2 percent to the overall mean hazard at various spectral periods from 0 to 5 seconds. Therefore, the San Andreas Fault system has the greatest capability of causing strong ground motions. Of the two segments of the San Andreas Fault system, the Northern San Andreas Fault segment with an event magnitude M7.9 and shorter source-to-side distances of 0.8 to 1.4 miles is the dominant event relative to the smaller event magnitude M7.3 at longer source-to-site distances of 5.2 to 5.8 miles for the San Gregorio-Seal Cove Fault segment.

The California Geological Survey (CGS, formerly known as California Division of Mines and Geology) and United States Geological Survey (USGS) completed probabilistic seismic hazard maps in 1996 (Petersen et al., 1996), and subsequently updated fault parameters and revised the maps in 2002 (Cao, et al., 2003, and WGCEP, 2003) and 2008 (Petersen, et al, 2008, and WGCEP, 2008). USGS provides a web-based program to evaluate the USGS Probabilistic Uniform Hazard Response Spectra (http://earthquake.usgs.gov/research/hazmaps/design). Based on the 2008 USGS update, the peak ground acceleration (PGA) at a 975-year return period (an earthquake event having a 5 percent probability of exceedance in 50 years) is estimated to be 0.82g and 0.87g for the CUP-3A and CUP-7 sites, respectively. PGA at the Maximum Credible Earthquake (MCE) level for the two sites are controlled by the dominant event of the Northern San Andreas Fault segment with a magnitude M7.9 and R0.8 to R1.4 miles, as discussed above and based on seismic de-aggregation of the PSHA (USGS, 2008). To evaluate PGA at the MCE level, the 2008 Next Generation Attenuation (NGA08) method (EERI, 2008) provides estimated PGA of 0.80g and 0.84g which correspond to the upper limits at the 84th percentile deterministic level (median plus one standard deviation) for the dominant earthquake event. For this study, PGA corresponding to 0.80g and 0.84g are used for geotechnical earthquake engineering evaluation at the CUP-3A and CUP-7 sites, respectively.

2.4 Liquefaction and Dynamic Settlement. Liquefaction is a phenomenon wherein a temporary, partial loss of shear strength occurs in a soil due to increases in pore pressure that result from cyclic loading during earthquakes. Saturated, loose to medium dense sands and silty sands are most susceptible to liquefaction. Consequences of liquefaction can include ground settlements, foundation failure, sand boils, and lateral spreading. Dynamic settlement is the densification of saturated and unsaturated soils during strong ground shaking. All soil types are prone to dynamic settlement, though loose, sand and silty sand are most susceptible.

Liquefaction: The liquefaction susceptibility, as mapped by Witter et al. (2006), is illustrated on **Figure 4 – Liquefaction Susceptibility Map**. As can be seen from the figure, the CUP-3A site lies within a zone mapped as having very low to low liquefaction susceptibility. A zone of very low liquefaction susceptibility is mapped for the CUP-7 site. Because of the regional focus of the liquefaction susceptibility mapping, the data only generally correlates with areas of known liquefaction hazard. The site-specific data from the borings is considered to be more indicative of liquefaction and dynamic settlement hazard. The following paragraphs further describe this hazard based on our subsurface investigation and laboratory testing program.

FIGURE 4 – LIQUEFACTION SUSCEPTIBILITY MAP



Source: Witter, R.C., et. al.., 2006, Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California: U.S. Geological Survey Open-File Report 06-1037

Due to the absence of groundwater within the total exploration depths of about 36 to 51 feet at the two project sites and material density that generally increases with depth, liquefaction is not considered to be a significant consideration for the Colma Formation below these depths. As discussed earlier in this report, groundwater levels are likely to be influenced by rainfall and storm water runoff, and are expected to fluctuate considerably from the observed groundwater levels. Hence, liquefaction susceptibility has to be considered for higher groundwater conditions as recommended in Section 3. In evaluating liquefaction susceptibility of the materials explored from the borings at the project sites, we have conservatively assumed groundwater levels of 20 feet at CUP-3A, and 10 feet at CUP-7. Below an assumed groundwater level of 10 feet, the dense to very dense silty sand of the Colma Formation encountered in boring CUP-7 is not susceptible to liquefaction. The dense silty sand of the artificial fill encountered below an assumed groundwater level of 20 feet in boring CUP-3A is also not susceptible to liquefaction. An isolated layer/pocket of medium dense silty sand within the upper portion the Colma Formation at a depth of about 35 feet is not considered to pose significant risk of seismic induced reconsolidation settlement to the site. Volumetric reconsolidation settlement is not considered to be significant for the soil below a groundwater depth of 10 feet in boring CUP-7. Results from our liquefaction analysis are presented on **Table 3 – Summary of Dynamic Settlements**.

Our liquefaction analysis has been conducted using the Simplified Cyclic Stress Ratio module within the SHAKE2000 computer program for one-dimensional analysis of geotechnical earthquake engineering problems (Geomotions, 2011). Detailed information regarding the analysis methods can be found in the following references: Cetin and Seed (2000 and 2004), Cetin et al. (2004), Moss et al. (2006), Seed et al. (1985 and 2003), Seed and Idriss (1971), and Youd et al. (2001 and 2003).

Dynamic Settlement of Dry Sand: Seismically induced dynamic settlements at CUP-3A are estimated at 4 inches, due to the presence of up to 20 feet of unsaturated, loose to medium dense fill sand near the surface. At CUP-7, such dynamic settlements are estimated at ¾ inch. Differential settlements (over a distance of 80 feet) are estimated to be 1 inch at CUP-3A and ¼ inch at CUP-7. Differential settlements can be linearly interpolated from these estimated values when the dimensions (distances) of the proposed improvement footprint are less than 80 feet. Results of our dynamic settlements of dry sands are presented on **Table 3 – Summary of Dynamic Settlements**.

Our evaluation of dynamic differential compaction settlement of unsaturated sand has been conducted in conjunction with liquefaction analysis using the Simplified Cyclic Stress Ratio module within the SHAKE2000 computer program for one-dimensional analysis of geotechnical earthquake engineering problems (Geomotions, 2011). For unsaturated sand layers, the volumetric strains for a site-specific dominant earthquake magnitude other than the reference magnitude M7.5 are calculated by multiplying the site-specific volumetric strains with correction factors as recommended by Tokimatsu and Seed (1987). These adjusted volumetric strains are doubled to account for the effects from multi-directional shaking. Detailed information regarding the calculation method can be found in the above references.

Total Seismic Settlement: Total seismic settlement is the cumulative of volumetric reconsolidation settlement of saturated sand due to liquefaction and dynamic settlement of dry sand. Since volumetric reconsolidation settlement due to liquefaction is not considered as likely to occur at the two project sites, the total seismic settlement is equivalent to the dynamic settlement of dry sand. The results indicate the propensity for dynamic (compaction) settlement of dry sand is similar for the two groundwater conditions. Results of total and differential dynamic settlements are presented on **Table 3 – Summary of Dynamic Settlements**.

In addition to the estimated seismic settlements presented above, pockets of loose unsaturated granular soil which may be encountered during subgrade preparation should be removed to reduce potential for uneven seismic densification. Based on our evaluation, the hazard posed by differential settlement due to dynamic settlement resulting from liquefaction of saturated sand and dynamic settlement of unsaturated sand is considered to be moderate for CUP-3A and low for CUP-7. Measures for mitigating excessive seismically induced settlements for the project sites are addressed in **Section 6**.

TABLE 3 – SUMMARY OF DYNAMIC SETTLEMENTS

	CUP-3A		CUP-7	
	Groundwater Depth		Groundwater Depth	
	20 feet	50 feet	10 feet	50 feet
Volumetric Reconsolidation (inches)	0	--[1]	0	--[1]
Dynamic Dry Sand Settlement (inches)	4	4	½	¾
Total Dynamic Settlement (inches)	4	4	½	¾
Differential Dynamic Settlement (inches) [2]	1	1	¼	¼

1. Liquefaction does not occur in unsaturated soil above the lower groundwater depth of 50 feet.
2. Differential dynamic settlements can be linearly interpolated from these estimated values when the dimensions (distances) of the proposed improvement footprint are less than 80 feet.

2.5 Inundation by Tsunamis. While tsunamis can be triggered by various sources such as an earthquake, a landslide, a volcanic eruption, or even a large meteor crashing into the ocean, the most common trigger is related to a large, submarine earthquake that creates a significant upward movement of the sea floor to result in a rise of water at the ocean surface (CGS, 2009). As the mound of water, which can travel up to 500 miles per hour in the open ocean, approaches the shoreline, it slows down to about 30 miles per hour and builds up significantly in amplitude (height). Hence, a tsunami hazard mitigation program which includes emergency preparedness and evacuation is essential to areas that have been identified as potentially susceptible to inundation from tsunami.

The project sites are not mapped within areas that are potentially susceptible to tsunami inundation (CalEMA, 2009). Given that the project site elevations are well above the Mean Sea Level (MSL) and they are located at distances in excess of one mile from the nearest Pacific Ocean coastal area to the west, the project sites are not considered to be potentially susceptible to inundation from tsunami.

2.6 **Seismically-Induced Landsliding and Lateral Spreading.** Although an embankment (about 8-foot high, descending on an about 3:1 slope) is located about 20 feet to the west from the nearest edge of the proposed well station building at the CUP-3A site, the potential susceptibility of the site to lateral spreading toward the embankment free face is considered low because the isolated layer of potentially liquefiable medium dense within the Colma Formation at a depth of 35 feet is located well below the toe of the 8-foot tall embankment.

At the CUP-7 site, the terrain can be characterized as mildly sloping (descending about 13:1) along the Park Plaza Drive, and an embankment (about 20-foot high) that descends on an about 3:1 slope from the northeast corner of the proposed building footprint to the Jefferson Elementary School track and field. The potential susceptibility of the CUP-7 site to lateral spreading is considered to be low because Colma Formation soil at this site is not susceptible to liquefaction.

An evaluation of static stability of the slopes at the CUP-3A and CUP-7 sites using the method of stability charts by Janbu (USACE, 2003) indicates stable slopes with factors of safety (FOS) in excess of 2. Roots from vegetation/shrubs and low to moderately tall trees along the slopes at the two project sites provide additional strengthening of the near surface soil mass and may reduce the potential for surficial sloughing. A confluence of the above factors suggests that the potential for seismically-induced instability of the slope (including landsliding and lateral spreading) is considered to be low at the two project sites.

2.7 **Seismic Design Parameters.** The proposed improvements may be designed in accordance with the International Building Code Static Force Procedure (ICC, 2009) as adopted in the 2010 California Building Code (ICC, 2010) using the seismic parameters presented in **Table 4 – Seismic Design Parameters**. Based on our exploration, a Site Class D has been designated for the CUP-3A site, and a Site Class C for CUP-7. The seismic design parameters have been developed for the ASCE7-05 Maximum Considered Earthquake using the Earthquake Ground Motion Parameters Application (Version 5.1.0) as developed by the USGS (2011).

TABLE 4 – SEISMIC DESIGN PARAMETERS

	CUP-3A	CUP-7
Mapped Spectral Acceleration		
S_s at 0.2-second	2.096	0.875
S_1 at 1-second	1.149	2.186
Site Adjustment Factor		
Site Class	D	C
Site Coefficient F_a	1.0	1.0
Site Coefficient F_v	1.5	1.3
Site Adjusted Spectral Acceleration		
SMs = F_a x S_s	2.096	2.186
SM1 = F_v x S_1	1.724	1.607
Design Spectral Acceleration		
SDs = 2/3 x SMs	1.397	1.457
SD1 = 2/3 x SM1	1.149	1.071

3.0 GROUNDWATER

Groundwater was not encountered during drilling at the two CUP-3A and CUP-7 borings. Groundwater levels are influenced by seasonal variations in precipitation, percolations from storm water runoff and local irrigation, groundwater pumping and other factors, and are therefore, subject to variation. To account for seasonal variations, we recommend conservative design groundwater levels for structural design purposes as presented in **Table 5 – Recommended Design Groundwater Levels**.

Groundwater related design issues such as hydrostatic pressures on shoring elements (if implemented), excavation dewatering, and hydrostatic uplift pressures on the proposed buildings are not anticipated for excavations less than 5 feet below the ground surface. For excavations exceeding the design groundwater depths, the contractor should anticipate groundwater inflow that may require dewatering. For intermediate excavations between 5 feet and the design groundwater depths, the contractor should anticipate the possibility of inflow of groundwater seepage.

TABLE 5 – RECOMMENDED DESIGN GROUNDWATER LEVELS

Proposed Site Location	Design Groundwater Depth (feet)
CUP-3A	20
CUP-7	10

4.0 EARTHWORK

4.1 **General.** Given the earth materials on the project site encountered during our exploration, the contractor should be able to carry out planned excavations using conventional heavy equipment.

Evaluation of the presence, or absence, and treatment of hazardous materials was not part of this study. If hazardous materials are encountered during excavation, proper handling and treatment during construction will depend on the contaminant type, concentration, and volatility of the contaminated materials.

General geotechnical considerations for site preparation, excavations, temporary shoring and bracing, engineered fill material, engineered fill placement and compaction, pipe bedding, and utility trench backfill are presented in the following sections.

4.2 **Site Preparation.** Site preparation will consist of demolition, excavation and removal of on-site materials such as pavement, concrete, abandoned utilities, and miscellaneous debris in preparation for the foundation excavations. Any creation of holes from the removal of such materials should be backfilled with engineered fill. Recommendations for engineered fill are provided in Sections 4.5 and 4.6. Also as part of site preparation, the location of active underground utilities should be determined and, if affected by construction activities, should be relocated or protected.

4.3 **Excavations.** We anticipate that excavations for the planned building improvements to extend up to no more than a few feet below existing ground elevation. Shallow excavations for the proposed facilities will allow for unshored excavations with adequately sloped sidewalls. Vertically shored walls or braced excavations are anticipated where space constraints may not allow for open, sloped excavations. At a minimum, excavations should be constructed in accordance with the current California Occupational Safety and Health Administration (OSHA) regulations (Title 8, California Code of Regulations) pertaining to excavations. Temporary cut slopes are expected to be stable for configurations described in Title 8 for Type C soils and where unsupported should be cut back no steeper than 1 ½ horizontal to 1 vertical. All excavations should be closely monitored during construction to detect any evidence of instability.

Care should be taken when excavating near existing utilities and pipelines. Excavations can undermine support of adjacent existing pipelines and other subsurface structures. We recommend that some form of vertical shoring system be considered for excavated sidewalls that are adjacent to existing pipelines or other known buried adjacent structures.

Some of the near surface loose soils at the project sites will likely be removed during excavation for the proposed improvements. If any footings are founded above loose or soft soils, overexcavation of loose or soft soils and replacement with engineered fill may be required.

4.4 **Temporary Shoring and Bracing.** The type and design of the shoring will depend on the depth of excavation and excavation-bracing sequence. The shoring and bracing design and installation should be the responsibility of the construction contractor. As a general guideline, construction procedures, excavations, and design and construction of any temporary shoring should comply with the current OSHA Title 8 regulations pertaining to excavations. The shoring and bracing should accommodate surcharge loads that may be imposed by adjacent structures, traffic, or construction activities.

Possible shoring schemes include soldier pile and lagging and steel sheeting, both of which may include internal bracing struts to limit lateral deflections. Such braced and shored excavations will be subjected to lateral earth pressures. Recommended active, at-rest, and passive lateral earth pressures are provided in Section 5.

Horizontal and vertical movements of the ground are possible in the vicinity of the excavations. These movements can generally be reduced to acceptable levels by use of a properly designed and constructed shoring system. Measures should be taken to prevent the loss of sand through the gaps in the shoring or lagging.

4.5 **Engineered Fill Material.** Material for engineered fill should be inorganic, well graded, free of rocks or clods greater than 4 inches in greatest dimension or any other deleterious materials, and have a low potential for expansion. The material should have a liquid limit less than 35, a plasticity index less than 15 and no more than 25 percent passing the No. 200 sieve. Existing on-site soil may be re-used as engineered fill provided it meets the above criteria.

4.6 **Engineered Fill Placement and Compaction.** Engineered fill consisting of existing on-site fill which meets the requirements above should be placed in layers no greater than 8 inches in un-compacted thickness, conditioned with water or allowed to dry to achieve moisture content near optimum, then mechanically compacted to at least 90 percent relative compaction based on ASTM D1557. All engineered fill placed to support footings and the upper 6 inches of engineered fill supporting slabs-on-grade should be mechanically compacted to at least 95 percent relative compaction as determined by ASTM D1557. All compaction should be performed using mechanical compaction means; flooding or jetting should not be used as a means to achieve compaction. The ASTM D1557 laboratory compaction tests should be performed at the time of construction to provide a proper basis for compaction control.

4.7 **Structural Backfill.** Structures extending below grade should be backfilled with structural fill to a minimum width of two feet beyond the foundation footprint. Structural backfill should meet the following gradation:

Sieve Size	Percent Passing
3 inches	100
1½ inches	80 to 100
#4	50 to 100
#16	40 to 90
#50	10 to 60
#200	0 to 10

Backfill should be moisture conditioned to within two percent above optimum, placed in layers not exceeding 8 inches in uncompacted uniform thickness, and mechanically compacted to 90 percent relative compaction per ASTM D1557.

4.8 **Pipe Bedding for Small Diameter Pipes.** Pipe bedding should consist of well-graded sand or a sand-gravel mixture. Maximum gravel size should be ½ inch and the bedding material should have less than 12 percent passing the No. 200 sieve. Uniformly graded material such as pea gravel should not be used as pipe bedding material. Pipe bedding should have a minimum thickness of 6 inches beneath the pipe and 6 inches above the pipe. If soft or otherwise unsuitable soils are exposed in the bottom of the trench excavation, the necessity of over-excavation should be evaluated by the project geotechnical engineer. All pipe bedding should be placed to achieve uniform contact with the pipe and a minimum relative compaction of 90 percent per ASTM D1557.

4.9 **Utility Trench / Pipe Backfill.** Utility and pipe trenches may be backfilled above the pipe zone with excavated on-site soils, provided they meet the gradation requirements of engineered fill. The backfill material should be placed in layers no greater than 8 inches in uncompacted thickness, moisture conditioned or allowed to dry to achieve a moisture content near optimum, then mechanically compacted to at least 90 percent relative compaction based on ASTM D1557. The upper 2 feet should be compacted to at least 95 percent relative compaction in areas where structural or traffic loads are anticipated.

5.0 LATERAL EARTH PRESSURES

General. Structural components that extend below ground surface, such as concrete vaults, below-grade walls, and the sides of shallow foundations, will experience lateral earth pressure from the soil and hydrostatic pressure from any existing groundwater. Recommendations for the active, at-rest, passive, and seismic earth pressures, and coefficient of base friction to resist active and at-rest loads are summarized on **Table 6 – Lateral Earth Pressures**, and discussed in the following sections. Because the anticipated excavations will be limited to a depth not exceeding about 5 feet, and the design groundwater level is expected to be below 5 feet, hydrostatic pressures have not been considered.

Active Earth Pressure. Active earth pressures are imposed by the soil on below-grade structures that are unrestrained so that the top of the wall is free to translate or rotate at least 0.004H, where H is the height of the wall. The active earth pressure may be calculated using a design equivalent fluid pressure (EFP) of 40 pcf at the project sites.

At-Rest Earth Pressure. At-rest pressures should be used for design of below-grade structures that are restrained such that the greater deflections that are mobilized to develop the lesser active earth pressures cannot occur (or are undesirable). The at-rest earth pressures may be calculated using a design EFP of 60 pcf at the project sites.

Seismic Earth Pressure. In addition to the active and at-rest pressures, below-grade structures should be designed to consider additional earth pressures due to earthquake loading. The increment in earth pressure due to seismic loading, for both restrained and unrestrained below-grade structures, may be calculated using an inverted triangular distribution with the pressure at the top of the below-grade structures equal to a design earth pressure (EP) of 35H at the project sites, wherein H is the height of the buried structure in feet, and diminishes linearly with depth to zero at the base of the buried structure.

Passive Earth Pressure. Lateral loads can be resisted by passive pressures that develop against the sides of below-grade structures. The passive pressure depends on the lateral displacement of the wall or footing. In accordance with FEMA 356 (FEMA, 2000), the ultimate passive pressure is mobilized at a displacement of approximately 6 percent of the wall height. The ultimate passive earth pressure may be calculated using a design EFP that corresponds to the ultimate EFP as long as the structure can be mobilized to such level of displacement and still does not exceed the allowable displacement of the structure. Oftentimes, the displacement to achieve ultimate passive earth pressures exceeds the allowable displacement of the structure. Consequently, a design EFP needs to be reduced when the allowable displacement of the structure is less than 6 percent of the wall height. For displacements of approximately 0.8 and 3 percent of the wall height, the design EFP may be reduced to 50 and 85 percent of the ultimate EFP. Passive pressures computed using these design EFPs may be combined with the base friction mobilized at the concrete-soil interface to resist lateral loading. Passive earth pressures at the project sites may be computed using the design EFP of 400, 340 and 200 pcf for allowable wall displacements of about 6, 3 and 0.8 percent of wall height, respectively.

Base Friction. A coefficient of friction of 0.4 may be used for estimating the resistance due to base friction at the project sites. The coefficient should be multiplied by the dead load only. The passive earth pressure and base friction mobilized at the concrete-subgrade interface may be combined to resist lateral loading.

TABLE 6 – LATERAL EARTH PRESSURES

Lateral Pressures and Base Friction	CUP-3A	CUP-7
Active Equivalent Earth Pressure (pcf)	40	40
At-Rest Equivalent Earth Pressure (pcf)	60	60 pcf
Seismic Active Earth Pressure[2] (pcf)	35H [2,3]	35H [2,3]
Passive Equivalent Earth Pressure:		
Allowable Displacement 0.06 H[3] (psf)	400	400
Allowable Displacement 0.03 H[3] (psf)	340	340
Allowable Displacement 0.008 H[3] (psf)	200	200
Base Friction Factor	0.4	0.4

1. No hydrostatic effect assuming structural embedment remains above a depth of 5 feet.
2. The seismically induced active earth pressure increment should be applied to the wall as an inverted triangular distribution that decreases linearly from the top to zero at the bottom.
3. H is buried structure height relative to the finished exterior grade adjacent to the buried structure.

6.0 FOUNDATIONS

6.1 Subgrade Preparation. Subgrades to new shallow and deep foundations for the proposed structures should be prepared to provide a flat, relatively dry, and firm working surface. If any unsuitable materials, such as, soft clays or silts, soils containing organic material, debris or other deleterious materials are encountered at subgrade, they should be over-excavated and restored to grade with engineered fill in accordance with Sections 4.5 and 4.6. The fill soils encountered in our exploratory borings were suitable for support of the proposed improvements provided the upper 12 inches are scarified, moisture conditioned, and recompacted. We recommend that the upper 12 inches of subgrade be scarified, moisture conditioned to near optimum moisture content, and compacted in accordance with Sections 4.5 and 4.6. The subgrade should be free of loose debris and ponded water prior to placing reinforcing steel and concrete.

Although long term consolidation settlement is considered minor due to the granular nature of the fill materials, dynamic settlements of loose to medium dense granular soils at CUP-3A and CUP-7 are anticipated during an earthquake event if these sites are not mitigated. Estimates of dynamic settlement at each site are provided in Section 2.4 and Table 3. Special mitigation measures against dynamic settlement at two project sites require additional over-excavation of artificial fill materials below any foundations. This over-excavation must extend at least three feet below proposed footing elevation. Engineered fill shall then be placed, moisture treated to near optimum water content and mechanically compacted to 95 percent relative compaction as determined by ASTM D1557.

6.2 Shallow Foundation Alternatives. A shallow foundation system is suitable for support of the proposed improvements at the CUP-7 site as long as recommendations in Section 6.1 are incorporated into design. Alternatives for shallow foundation systems include grade beams / shallow footings, mat foundations, and post-tensioned foundations. Since a significant dynamic settlement on the order of 4 inches anticipated at the CUP-3A site is due to the loose sandy fill in the upper 20 feet, ground improvement may be needed at this site for a shallow foundation system. Ground improvement strategies such as, in situ densification methods of Geopiers and Rapid Impact Compaction, may not be very feasible because: 1) they may be cost prohibitive due to a significant treatment depth of at about 20 feet; and 2) they may generate vibration related impacts to adjacent structures during construction. Earthwork grading to excavate and recompact the upper 5 feet of loose fill beneath the proposed building footprint at CUP-3A is more appropriate from a cost standpoint in reducing the differential settlement from 1 inch to ¼ inch (and total settlement from 4 inches to 1 inch). Other alternatives to overexcavation and recompaction of the upper 5 feet of loose fill may include a more costly deep foundation system which will be discussed in Section 6.4.

Grade Beams / Shallow Footings: Based on the findings from our subsurface evaluation and laboratory testing, we recommend an allowable bearing capacity of 2,500 pounds per square foot (psf) for soils below new footings at the CUP-3A and CUP-7 sites as long as the recommendations for subgrade preparation in Section 6.1 are incorporated into the design. This bearing capacity includes a factor of safety of at least three against bearing failure, and is applicable to newly constructed footings with widths of at least 18 inches and footing embedment of at least 24 inches below lowest adjacent grade.

A static modulus of subgrade reaction of 60 pounds per cubic inch (pci) may be used in order to develop soil springs below the foundation elements. For the lateral resistance of grade beams and footings, the geotechnical design parameters provided in the Lateral Earth Pressures section may be used.

As discussed in Section 2.4, differential dynamic settlement is relatively minor on the order of ¼ inch at the CUP-7 site during an earthquake event. The remaining CUP-

3A site is more susceptible to a differential dynamic settlement on the order of 1 inch during an earthquake event if the site is not mitigated. To reduce this to a minor amount on the order of ¼ inch, the site should be mitigated by overexcavating and recompacting the upper 5 feet of soil below grade to develop a mass of densified soil beneath the proposed building at CUP-3A. Long-term consolidation settlements are not likely due to the granular nature of much of the subsurface soils. Therefore, total dynamic settlements are approximately equivalent to the estimated dynamic settlements at the two project sites. After site mitigation via overexcavating and recompacting the upper 5 feet of soil at CUP-3A, the total dynamic settlement is expected to reduce from 4 inches to 1 inch, and the differential settlement from 1 inch to ¼ inch. Total settlements due to dead loads and normal duration live loads are expected to be less than ¼ inch, and are likely to occur during or immediately after construction.

***Mat Foundations*:** Effects from differential dynamic settlements at the two project sites may be limited by supporting the structures at these sites on structurally rigid mat foundations. A mat foundation is a large concrete slab, designed by a structural engineer for specific use, to interface one or more columns or pieces of equipment with the foundation soil. It may encompass the entire foundation footprint or only a portion. The mat contact stresses are generally lower than other shallow foundation types due to distribution of stress over a larger area and stress compensation from excavated soil. Thickness and reinforcement of the mat foundation should be in accordance with the recommendations of a structural engineer. The appropriate allowable contact pressure(s) beneath the mat foundations will vary with their size, shape, and other factors. Without mitigating the upper 5 feet at loose fill at CUP-3A, a mat foundation system may limit foundation differential settlements to less than 3/4 inch for dead and live loads and less than 1 inch for total loads including wind and seismic, as long as the contact pressure beneath the mats should not exceed the allowable bearing capacities as recommended above for grade beams / shallow foundations. Mat foundations are not anticipated at CUP-7. Mat foundations typically experience some deflection due to loads placed on the mat and the reaction of the soils underlying the mat. A design coefficient of subgrade reaction, $\mathbf{K_{v1}}$, of 260 kips per cubic foot (kcf) in compacted fill soils may be used for evaluating such deflections at the sites. This value is based on a square foot area and should be adjusted for the planned mat size. The coefficient of subgrade reaction, $\mathbf{K_B}$, for a mat of a specific dimension may be evaluated using the following equation:

$$\mathbf{K_B, = K_{v1}\ [(B+1)/2B]^2\ [(1+0.5(B/L)/1.5]}$$

where **B** is the width and **L** is the length of the foundation measured in feet.

Mat foundations bearing on fill may be designed using a coefficient of friction of 0.4 (total frictional resistance equals coefficient of friction times the dead load). The allowable lateral resistance can be taken as the sum of the frictional resistance and passive resistance provided the passive resistance does not exceed two-thirds of the total allowable resistance.

***Post-Tensioned Foundations*:** Effects from differential dynamic settlements at the two project sites may be limited through the application of post-tensioning in reinforcing, and hence, increasing the structural rigidity of grade beams / shallow footings. Thickness and reinforcement of a post-tensioned foundation should be in accordance with the recommendations of a structural engineer.

6.3 Floor Slabs. Slabs-on-grade should be supported on a 12-inch thick mat of compacted, engineered fill. Material for engineered fill and compaction requirements are presented in Sections 4.5 and 4.6. For moisture-sensitive flooring, floor slabs resting on soil should be underlain, at a minimum, by a capillary break system. We recommend 6 inches of clean coarse sand or pea gravel. When floor dampness is a concern, floor slabs should be underlain by a vapor barrier and capillary break system. We recommend a system consisting of a 10-mil polyethylene (or equivalent) membrane placed over 6 inches of clean coarse sand or pea gravel. The exposed subgrade should be moistened just prior to the placement of the capillary break system. A sand layer above the moisture barrier to aid in concrete curing should be evaluated by the structural engineer. The slab underlayment including the capillary break can be taken as part of the 12-inch thick pad of compacted, engineered fill described above. Flooring and waterproofing consultants should be consulted for additional slab waterproofing recommendations.

6.4 Deep Foundations. To mitigate significant dynamic settlement at the CUP-3A site, a deep foundation system that may include feasible alternatives such as, driven precast concrete piles (DPCP) and closed-end pipe piles, may be used to transfer building loads to a competent material of the Colma Formation for end bearing support at a depth of at least 40 feet. Should deep foundation be considered for design at the CUP-3A site, we would like to be given an opportunity in providing design consultation services/support to the structural engineer in providing geotechnical design parameters for evaluating the pile foundation system, as appropriate.

7.0 CORROSION

Schiff Associates performed corrosivity laboratory tests on two soil samples. Their laboratory results are included in **Appendix A – Supporting Geotechnical Data**. They performed the following tests:

- Resistivity (As-Received and Saturated)
- pH
- Electrical Conductivity
- Chemical Analyses of Cations (e.g. Calcium, Magnesium, Sodium)
- Chemical Analyses of Anions (e.g. Carbonate, Bicarbonate, Chloride, Sulfate)
- Chemical Analyses of Ammonium

- Chemical Analyses of Nitrate
- Chemical Analyses of Sulfide
- Oxidation-reduction (Redox) Potential

Electrical resistivities indicate soils are moderately corrosive to ferrous metals at the CUP-3A site and mildly corrosive at the CUP-7 site. The soil pH values indicate moderately alkaline soils at the CUP-3A site and slightly acidic soils at the CUP-7 site. Based on the pH values, the sites are classified as non-corrosive. The soluble salt contents of the samples are low indicating a low corrosion potential, and on-site near-surface soils present a negligible sulfate exposure to concrete structures. Based on the criteria in the Caltrans Corrosion Guidelines (Caltrans, 2003), the two project sites would not be classified as a corrosive site based on testing of near-surface soil samples.

8.0 CONSTRUCTION CONSIDERATIONS

8.1 Geotechnical Observation of Construction Activities. We should be retained during construction to provide site observation and consultation concerning the condition of the bottom of excavations pertaining to foundation construction and pipeline trench excavation. Foundation grades should be observed and, where necessary, tested under the direction of a qualified geotechnical engineer to verify compliance with final design recommendations. All site preparation work and excavations should also be observed to compare the generalized site conditions assumed in the final design report with those found on site at the time of construction.

8.2 Existing Underground Utilities. A number of underground water main pipelines pass beneath and in the vicinity of the proposed sites. Other existing subsurface lines include the SFPUC transmission lines, and sanitary and storm sewer lines. A PG&E gas transmission pipeline is located near the CUP-3A site. Some of these utilities were located and marked prior to our exploration to avoid damaging them during drilling.

The City may consider remarking these utilities prior to construction of the improvements so they remain visible during earthwork and construction of the improvements. Any excavations made adjacent to existing utilities should be backfilled with on-site or imported soil to at least 90 percent relative compaction (ASTM D 1557).

8.3 Surface Drainage. Proper surface drainage is essential for satisfactory site performance. Positive drainage should be provided and maintained to direct surface water away from building foundations and other site improvements. Positive drainage is defined as a slope of 2 percent or more over a distance of 5 feet or greater away from the foundations, flatwork, and tops of slopes. Runoff should then be directed by the use of swales or pipes into a collective drainage system. Surface water should not be allowed to pond adjacent to footings. We further recommend that the proposed structure be equipped with appropriate roof gutters and downspouts. Downspouts should discharge to a system of closed pipes that transport the collected water to a suitable discharge facility. We recommend that drought tolerant vegetation be used for site landscaping. Irrigation should be kept at levels just sufficient to maintain plant vigor.

9.0 CLOSURE

The conclusions and recommendations presented herein are professional opinions based on geotechnical and geologic data and the project as described. A review by this office of any foundation, excavation, grading plans and specifications, or other work product that relies on the content of this report, together with the opportunity to make supplemental recommendations is considered an integral part of this study. Should unanticipated conditions come to light during project development or should the project change from that described, we should be given the opportunity to review our recommendations.

The findings and professional opinions presented in this report are presented within the limits prescribed by the client, in accordance with generally accepted professional engineering and geologic practices. There is no other warranty, either express or implied.

Submitted by:
GEOTECHNICAL CONSULTANTS, INC.

Reviewed by:
G. Neelakantan, P.E., G.E
Geotechnical Engineer, GE 2391

Nick S. Ng, P.E., G.E.
Geotechnical Engineer, GE 2831

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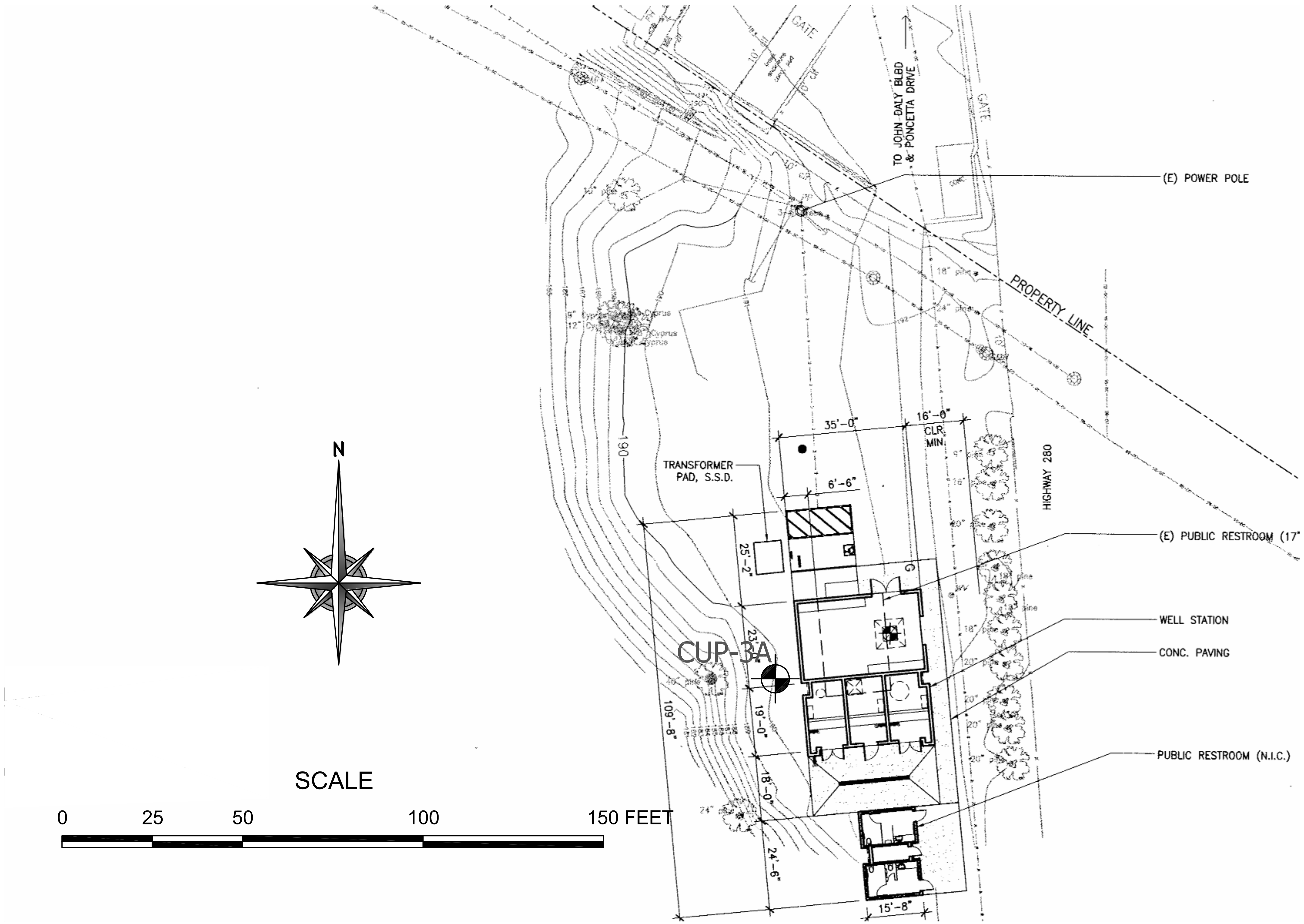
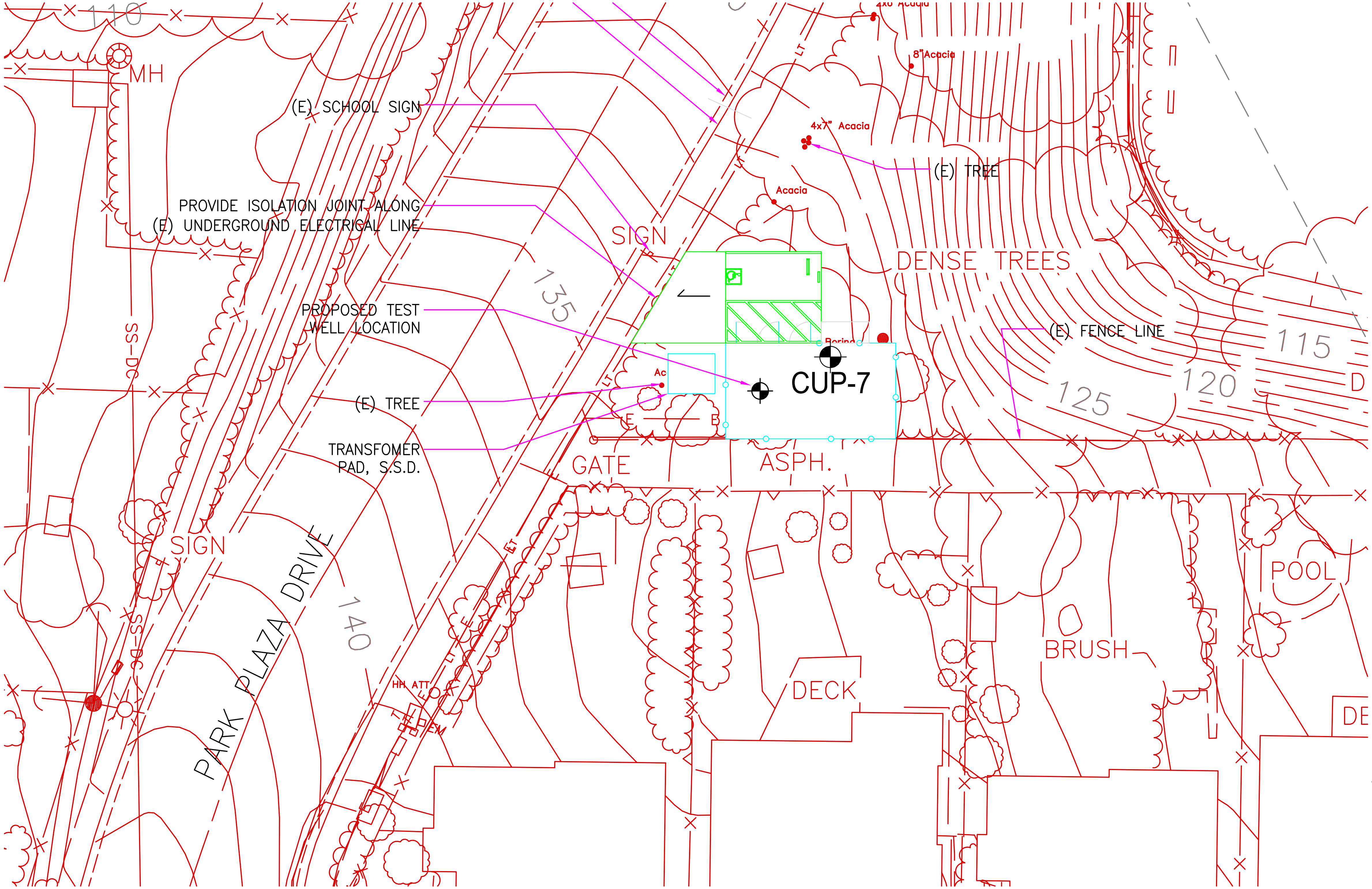


LEGEND

CUP-3A — Geotechnical boring performed by Geotechnical Consultants, Inc. on August 8, 2011.

Source: San Francisco Public Utilities Commission, 2011, 65% Progress Print, Site Plan, CUP-3A, Lake Merced Golf Club, Daly City, Regional Groundwater Storage and Recovery Project, Contract No. WD-2600, Sheet No. A-1.0, June.

GEOTECHNICAL CONSULTANTS, INC. 500 Sansome Street, Suite 402 San Francisco, CA 94111	EXPLORATION LOCATION PLAN	PLATE 1
	REGIONAL GROUNDWATER STORAGE & RECOVERY PROJECT, CUP-3A SITE	
	JANUARY 2012	SF11014



LEGEND

CUP-7 — Geotechnical boring performed by Geotechnical Consultants, Inc. on August 8, 2011.

N

SCALE

0 25 50 75 FEET

Source: San Francisco Public Utilities Commission, 2011, 65% Progress Print, Site Plan, CUP-7, Park Plaza, Regional Groundwater Storage and Recovery Project, Contract No. WD-2600, Sheet No. A-4.0, June.

GEOTECHNICAL CONSULTANTS, INC. 500 Sansome Street, Suite 402 San Francisco, CA 94111	EXPLORATION LOCATION PLAN	PLATE 2
	REGIONAL GROUNDWATER STORAGE & RECOVERY PROJECT, CUP-7 SITE	
	JANUARY 2012	SF11014

Appendix H

Groundwater Technical Reports

Kennedy/Jenks Consultants

303 Second Street, Suite 300 South
San Francisco, California 94107
415-243-2150
FAX: 415-896-0999

Technical Memorandum 10.1

Groundwater Modeling Analysis

for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

18 April 2012

Prepared for

San Francisco Public Utilities Commission
525 Golden Gate Avenue, 10th Floor
San Francisco, CA 94102

K/J Project No. 0864001

Supplemental Explanation for Hydrographs - TM10.1

This supplemental explanation is prepared to address discrepancies on several graphs presented in TM 10.1.

First, the x-axis on several graphs showing model results was shifted. The x-axis is named Scenario Year which should correspond to a water year[1]. However, the graph template was plotted using a calendar year, so the intervals on the x-axis represent the period from January to December. The result is that the graph is shifted 3-months later relative to Scenario Year.

Second, the shaded area representing the Design Drought was added manually and because of this process, it was not presented consistently on the graphs. By definition per the PEIR, the 8.5-year Design Drought includes one Hold year before the 7.5-year Take period. In addition, the Design Drought needs to be shifted 3-months later for the x-axis issue to be consistent with the model output. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.

The following is a list of figures in TM 10.1 where the Design Drought shaded area is shown slightly different and does not match the correct display of the Design Drought. The figures should be viewed based on the correct representation of the Design Drought as explained above.

- Figures 10.1-6 through 10.1-13 (a total of eight figures) have the shifted x-axis. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.
- Attachment 10.1-B hydrographs with model simulated groundwater levels have the shifted x-axis. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.
- Attachment 10.1-G graphs showing model simulated lake levels have the shifted x-axis. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.

[1] A water year is October 1 of the previous year to September 30 of the current (named) year.

18 April 2012

Task 10.1 Technical Memorandum

San Francisco Public Utilities Commission

Groundwater Modeling Analysis for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Prepared for: Greg Bartow and Jeff Gilman, SFPUC

Prepared by: Sevim Onsoy and Michael Maley, Kennedy/Jenks Consultants

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1. Introduction

This Technical Memorandum (TM) was prepared to document work performed by Kennedy/Jenks Consultants (Kennedy/Jenks) for the San Francisco Public Utilities Commission (SFPUC) pursuant to the amended Task Order (TO) authorizations CUW30103-TO-1.12 of the Regional Groundwater Storage and Recovery (GSR) Project and CUW30102-TO-2.7 of the San Francisco Groundwater Supply (SFGW) Project. These projects are funded by the SFPUC's Water System Improvement Program (WSIP).

1.1. Purpose

The main purpose of this TM is to document the setup and application of the groundwater modeling analysis being prepared to evaluate groundwater issues for the GSR and SFGW Projects. For evaluating conditions at Lake Merced, the Lake Merced Lake-Level Model (refer to as the Lake-Level Model) was also used as the primary tool. The existing Westside Basin Groundwater-Flow Model (referred to as the Westside Basin Groundwater Model) (HydroFocus 2007, 2009, and 2011) was used as a quantitative tool to support analyses necessary for the groundwater issues that may occur during the implementation of the proposed GSR and SFGW Projects. The specific objectives of this TM are as follows:

- To provide a brief overview of the existing Westside Basin Groundwater Model and the Lake-Level Model
- To present the model scenario assumptions and modifications made to the model to develop the model scenarios
- To present and evaluate the results from the simulated model scenarios

This TM documents how the model was applied and provides an assessment for the application of the model results to specific groundwater issues that may result from the implementation of the proposed GSR and SFGW Projects. The evaluation of the model results with respect to these potential groundwater issues are presented in separate TMs listed below.

- Task 10.2 Assessment of Groundwater-Surface Water Interactions for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project
- Task 10.3 Assessment of Seawater Intrusion for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project
- Task 10.4 Changes in Groundwater Levels and Storage for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project
- Task 10.5 Assessment of Pumping Induced Land Subsidence for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project
- Task 10.6 Assessment of Changes in Groundwater Quality for the Regional Groundwater Storage and Recovery Project
- Task 10.7 Well Interference Analysis for the Regional Groundwater Storage and Recovery Project and Cumulative Analysis
- Task 10.8A Updated Analysis of Well Pumping Influences for the San Francisco Groundwater Supply Project and Cumulative Analysis

1.2. General Approach

The overall scope of Task 10.1 was to model scenarios by applying the previously-developed Westside Basin Groundwater Model, by HydroFocus (2007, 2009, and 2011), as a supporting tool to assess potential physical effects that may result from the GSR and SFGW Project operations. The Westside Basin Groundwater Model is a regional, basin-wide groundwater model of the Westside Groundwater Basin (Westside Basin) in western San Francisco and San Mateo County. The Westside Basin Groundwater Model developed by HydroFocus (2007, 2009, and 2011) for the City of Daly City (Daly City) was reviewed with assistance from the California Water Services Company (Cal Water), the City of San Bruno (San Bruno) and SFPUC, and the model was accepted for use in selected applications by all parties. Therefore, the Westside Basin Groundwater Model is a publicly available tool that is capable of supporting water resources planning and management on an ongoing basis (HydroFocus 2007, 2009, and 2011).

The Lake-Level Model is a spreadsheet based water balance model that has been used for evaluating conditions at Lake Merced. The model has been used for various studies of Lake Merced by EDAW, Inc., and Talavera & Richardson (2004), LSCE (2008), Kennedy/Jenks (2009a, and 2009b), and Jacobs Associates (2011a and 2011b).

The hydrogeological conceptual model that forms the basis for the Westside Basin Groundwater Model is based on the *Task 8B Technical Memorandum No.1 Hydrologic Setting of the Westside Basin* (TM#1) (LSCE, 2010). A summary of the hydrogeological conceptual model is presented in this TM to provide the context necessary for evaluating the model assumptions and setup.

Five model scenarios were constructed and simulated to evaluate potential groundwater and related hydrological effects from the GSR and SFGW Projects and from the cumulative scenario, which involves the GSR and SFGW Projects and other reasonably foreseeable future projects (e.g., the Vista Grande Drainage Basin Improvements Project as assessed by Jacobs Associates (2011a, 2011b) and the City of Daly City (2012)). The proposed GSR and SFGW Project pumping assumptions were incorporated into the groundwater model scenarios to evaluate the response of the model to projected pumping conditions under the proposed projects and the cumulative scenario and to analyze long-term regional basin-wide changes in groundwater levels and storage. The Lake-Level Model was applied to the five scenarios to evaluate potential groundwater-surface water interactions resulting from the proposed projects and the cumulative scenario.

The activities undertaken in Task 10.1 are summarized below:

- **Documentation of Model Scenario Assumptions** – The proposed five model scenarios simulated include Scenario 1 (also referred to as Existing Conditions without SFPUC Projects), Scenario 2 (GSR Project), Scenario 3a and Scenario 3b (SFGW Project), and Scenario 4 (Cumulative Scenario). Model assumptions for the five scenarios were developed. Potential model modifications to the recently updated Westside Groundwater Model were evaluated, particularly with respect to assumptions regarding pumping and recharge resulting from the hydrological data used in the model scenarios.
- **Model Scenario Simulations** – This included setting up, running, and post-processing the five proposed model scenarios using the Westside Basin Groundwater Model. The model setup and model assumptions used in the five model scenarios are described in Sections 5 and 6.

  During the development of the proposed future model scenarios, modeling assumptions and modifications were reviewed and approved by SFPUC prior to running the model scenarios. In addition, the major model assumptions that were used in the scenarios were presented to the Partner Agencies (PAs) for the GSR Project (Daly City, Cal Water, and San Bruno), and the San Francisco Planning Department, Environmental Planning Division (EP) for their review and approval prior to running the model for each scenario.
- **Lake Merced Lake-Level Model Scenario Simulations** – The Lake-Level Model has been developed by SFPUC and others for the purpose of evaluating the feasibility of potential future projects on maintaining lake level in Lake Merced. Because of this history of use, the Lake-Level Model was used as the primary tool to evaluate the effects of the GSR and SFGW Projects and other reasonably foreseeable future projects on Lake Merced. The Lake-Level Model is a spreadsheet-based water balance model and offers a more realistic conceptualization of the water balance of the lake than the MODFLOW model. The model has been calibrated to historical measured lake levels and applied in this analysis to simulate the five scenarios that involve the GSR and SFGW Project scenarios and other reasonably foreseeable future projects. The model development, assumptions, and modifications are described in Section 8.

A brief overview of the proposed GSR and SFGW Projects and the hydrogeologic setting in the Westside Basin are presented in Sections 2 and 3, respectively. The Westside Basin Groundwater Model is the primary tool used for evaluating the effects of the SFGW, GSR and other reasonably foreseeable future projects with respect to key groundwater issues. The discussion in Sections 4, 5, 6 and 7 focuses on the Westside Basin Groundwater Model. The Lake-Level Model is only used to evaluate the effects of the GSR and SFGW Projects and other reasonably foreseeable future projects on Lake Merced lake levels. Section 8 presents the development and application of the Lake-Level Model for easier reference.

2. GSR and SFGW Project Description

This section provides brief background information on the proposed projects that are considered as part of the model scenarios presented in this TM. The proposed projects include the GSR and SFGW Projects, and other reasonably foreseeable future projects that are considered as part of the Cumulative Scenario.

2.1. GSR Project

The GSR Project is a conjunctive use project that would increase groundwater supplies in the southern portion of the Westside Basin during periods of drought when SFPUC surface water supplies become limited (MWH, 2008). The GSR Project is based on the concept of providing available supplemental surface water from the SFPUC Regional Water System to the PAs. This water would be used by the PAs instead (or "in-lieu") of pumping groundwater from the Westside Basin, thereby increasing the amount of groundwater that would be stored in the aquifer. During periods of drought, both the PAs and SFPUC would pump groundwater from the Westside Basin. The SFPUC plans to install 16 new production wells for the GSR Project to recover the stored groundwater.

The GSR Project is sponsored by SFPUC in coordination with the PAs. The PAs historically have pumped groundwater from the southern portion of the Westside Basin (referred to as the South Westside Basin) for municipal purposes. Daly City and San Bruno serve municipal water demand in their respective cities. Cal Water serves South San Francisco, Colma, and a very small part of Daly City.

For SFPUC, the GSR Project will ultimately develop enough groundwater pumping capacity to produce 8,100 acre-feet per year (afy), or 7.2 million gallons per day (mgd), in addition to groundwater extraction from existing PA wells (MWH, 2008). The project will be designed to provide up to 60,500 acre-feet (af) of stored water from the GSR Project wells to meet SFPUC system demands during the last 7.5 years of SFPUC's Design Drought. The total duration of the Design Drought is 8.5 years. SFPUC anticipates that it will exercise its dry-year supplies after the first year of drought. Therefore, the storage is assumed to be used over the last 7.5 years of the Design Drought. The combined pumping rate (7.2 mgd) and duration (7.5 years) are consistent with the SFPUC's dry-year demands as described in the Urban Water Management Plan (SFPUC, 2010).

The SFPUC and PAs have developed the Draft GSR Project Operating Agreement (Draft GSR Operating Agreement) that is summarized in Attachment 10.1-A. The Draft GSR Operating Agreement can only be approved if the San Francisco Planning Commission certifies the Project Environmental Impact Report (EIR) and the SFPUC as the project sponsor approves the project. Following these actions, the SFPUC, Daly City, Cal Water, and San Bruno can then consider approval of the GSR Operating Agreement.

Under the Draft GSR Operating Agreement, the SFPUC would "store" water in the South Westside Basin through the mechanism of in-lieu recharge by providing supplemental surface water to the PAs as a substitute for the PAs groundwater pumping. The supplemental water deliveries would result in up to 60,500 af of "put" credits that would accrue to the SFPUC Storage Account. During shortages of SFPUC system water due to drought, emergencies or scheduled maintenance, or if the SFPUC Storage Account is at its full capacity of 60,500 af, the PAs would return to pumping from their existing wells. If a positive balance exists in the SFPUC Storage Account and there is a drought, then the SFPUC could also pump during this take period using the GSR Project wells installed by the SFPUC.

2.1.1. Put/Take/Hold Sequence

The GSR Project uses a “put/take/hold” sequence representing in-lieu groundwater recharge during wet years and groundwater extraction during dry years. The Hetch Hetchy and Local Simulation model (HH/LSM), which was used extensively for long term planning purposes in the SFPUC’s WSIP Program Environmental Impact Report (PEIR), outputs a put/take/hold sequence on a monthly basis together with a track of the volume of water stored in the SFPUC Storage Account (SFPUC, 2007; SFPUC, 2009a). As described below, the SFPUC Storage Account defines the amount of supplemental SFPUC system water that is stored in the groundwater basin, based on the amount of supplemental surface water deliveries to the PAs. The PEIR underpins the WSIP as a whole, and any individual WSIP project (including the GSR and SFGW Projects) must be as consistent with the PEIR as is practicable.

For reference, put/take/hold periods within the HH/LSM monthly sequence and this TM are defined as follows:

- A put period is a period where there are no water shortages and there is sufficient capacity in the SFPUC Storage Account for that account to be recharged. During put periods, the PAs would receive supplemental surface water from the SFPUC and reduce their groundwater pumping. As a result, the SFPUC surface water would be used “in-lieu” of groundwater pumping, and the reduced pumping would effectively increase the volume of groundwater in storage that would be available during dry years or an extended drought.
- A take period is a dry period when water shortages are triggered and water is taken from the SFPUC Storage Account. During these take periods, both the proposed GSR Project wells and the PA wells would extract groundwater. The SFPUC would recover groundwater that has already been “stored” or “banked” during put periods by pumping the proposed 16 GSR Project production wells in the South Westside Basin. In addition, the PAs would return to their typical groundwater pumping.
- A hold period is a period where there are no water shortages, but the SFPUC Storage Account is “full” and supplemental water deliveries do not occur. During hold periods, the PAs would return to their typical groundwater pumping, and the GSR Project wells would pump only small amounts to exercise the wells.
- In the PEIR, the put/take/hold conditions are defined as annual periods that run from July 1 to June 30 of the following calendar year. Therefore, the model scenarios start in July to simulate full annual put, take, or hold sequence.

2.1.2. SFPUC Storage Account

The SFPUC Storage Account represents the volume of water that is stored during put periods as defined by the amount of supplemental surface water deliveries made to the PAs. The in-lieu recharge is assumed to match the amount of supplemental water deliveries to the PAs with no losses in the SFPUC Storage Account except during take periods of groundwater pumping. Accruals in the SFPUC Storage Account would be recorded based on metered, in-lieu surface water deliveries and corresponding metered decreases in groundwater pumping below "designated quantities" agreed to by the PAs (Attachment 10.1-A).

A "Full SFPUC Storage Account" represents approximately 60,500 af of supplemental surface water deliveries to the PAs that are stored (or banked) in the basin in-lieu of groundwater pumping. This amount is based upon the designed operation of the GSR Project supplying an average of 7.2 mgd over the Design Drought (MWH, 2008). When 60,500 af of groundwater is stored in the basin, the SFPUC Storage Account would be considered full, and no additional supplemental water deliveries would occur.

The SFPUC has developed an 8.5-year Design Drought for planning purposes. Over this 8.5-year period, the SFPUC anticipates it will exercise its dry year supplies after the first year of the drought. Therefore, the 60,500 af of storage is assumed to be used over the 7.5 years of the Design Drought, with the GSR Project wells operating at a maximum capacity of 7.2 mgd.

The GSR Project and the Cumulative Scenario involve the Full SFPUC Storage Account of 60,500 af to maintain consistency of analysis with the PEIR studies and the assumptions made in the HH/LSM runs (SFPUC, 2007; SFPUC, 2009a). To achieve the Full SFPUC Storage Account, the model scenarios involving the GSR Project simulate the PA wells pumping at their reduced put period rates until the in-lieu recharge banked in the basin reaches the Full SFPUC Storage Account of 60,500 af. This amount includes the existing SFPUC Storage Account of approximately 20,000 af[1] at the beginning of the simulation (i.e., June 2009 initial conditions), and then adds approximately 40,500 af to the SFPUC Storage Account during the model simulation (assuming a put rate of 5.52 mgd by the PA wells that is equivalent to 80 percent of the total PA pumping of 6.9 mgd). Using the put rate of 5.52 mgd, it would take approximately 6.5 years (or 79 months) to reach the Full SFPUC Storage Account condition of 60,500 af[2].

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[1] The accrued volume in the SFPUC Storage Account at the start of the model scenarios is approximately 20,000 acre-feet (af) based on records of in-lieu exchange with the Partner Agencies (PAs) prior to July 2009.

[2] Assuming the initial SFPUC Storage Account of 20,000 af in June 2009 and the put rate of 5.52 mgd (or 6,182 afy), it would take 79 months, or approximately 6.5 years, to reach the Full SFPUC Storage Account of 60,500 af. This is equivalent to the difference in the Full SFPUC Storage Account and the initial SFPUC Storage Account (40,500 af = 60,500 af – 20,000 af) divided by the put rate (5.52 mgd = 6,182 afy).

2.2. SFGW Project

The SFGW Project would provide a reliable, local source of high-quality groundwater in the northern portion of the Westside Basin (North Westside Basin) to supplement the San Francisco municipal water system.

The SFGW Project would construct up to six wells and associated facilities in the western part of San Francisco and extract an annual average of up to 4.0 mgd of water from the North Westside Basin (SFPUC, 2009b). The extracted groundwater, which would be used both for regular and emergency water supply purposes, would be blended in small quantities with imported surface water before entering the municipal drinking water system for distribution. The SFGW Project includes two phases. Phase one would build four new groundwater wells at the Lake Merced Pump Station, West Sunset Playground, South Sunset Playground, and the Golden Gate Park Central Pump Station. Phase two would modify two existing irrigation wells (South Windmill Replacement and North Lake) in Golden Gate Park. With the future implementation of the Westside Recycled Water Project, North Lake and South Windmill Replacement wells in Golden Gate Park would be used to produce municipal supply as part of the SFGW Project, and irrigation pumping would be replaced with recycled water. If the Westside Recycled Water Project is not implemented, then phase two of SFGW Project would not occur.

2.3. Vista Grande Drainage Basin Improvement Project

The City of Daly City prepared the Vista Grande Drainage Basin Alternatives Analysis in 2011 based on the recommendations of the Vista Grande Watershed Plan (City of Daly City, 2012). The purpose of the alternatives analysis is to develop and evaluate alternatives that will reduce or eliminate flooding, reduce erosion along Lake Merced, and provide other potential benefits such as habitat enhancement and lake level augmentation. The recommended program outlined in the plan includes construction of a new stormwater tunnel, construction of a detention basin in Westlake Park, and potential for treatment wetlands in San Francisco to treat stormwater for diversion from the Vista Grande Canal to Lake Merced (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012).

For the analysis of the GSR and SFGW Projects, the use of Lake Merced as part of the stormwater project for Daly City is considered to be one of the reasonably foreseeable future projects that are included as part of the Cumulative Scenario. Other cumulative projects are discussed in Section 5.4.

3. Physical Setting

Understanding the hydrogeological conceptual model is important in assessing the results of the numerical Westside Basin Groundwater Model and the Lake-Level Model. This section provides a brief overview of the physical conditions within the project areas of the proposed GSR and SFGW Projects to provide necessary context in evaluating the setup and application of the model scenarios. The hydrogeologic conditions described include the regional geologic setting, aquifer formations, and surface water features. In addition, a brief discussion of the historical and recent pumping conditions in the basin is provided. A more detailed description of the regional geologic setting can be found in *Technical Memorandum No. 1: Hydrologic Setting of the Westside Basin* (LSCE, 2010).

3.1. Westside Groundwater Basin

The groundwater basin beneath the western part of San Francisco from the vicinity of Golden Gate Park and extending southeasterly into San Mateo County is identified in the California Department of Water Resources (DWR) Bulletin 118 as both the Merced Valley Basin and the Westside Basin (DWR, 2003). Since it is more commonly known as the Westside Basin, this designation is used in this TM. In addition, more recent DWR initiatives use the Westside Basin name (e.g., California Statewide Groundwater Elevation Monitoring Program). Figure 10.1-1 shows the boundary of the Westside Basin.

For discussion purposes in this TM, the Westside Basin, which covers about 40 square miles in area, has been divided into northern and southern portions at the San Francisco County-San Mateo County line. This subdivision is a political division, which is not representative of a physical boundary, and is not meant to imply that there is any restriction of groundwater flow between the two areas. The portion of the basin that lies within San Francisco County is referred to as the North Westside Basin, which has an area of approximately 15 square miles (Figure 10.1-1). The portion of the basin that lies within San Mateo County is referred to as the South Westside Basin with an area of approximately 25 square miles underlying Daly City, Colma, South San Francisco, San Bruno, Millbrae, and Burlingame (Figure 10.1-1) (SFPUC, 2010).

The Westside Basin is bounded by bedrock highs in Golden Gate Park to the north and at Coyote Point to the south (DWR, 2003; Rogge, 2003; San Bruno, 2007). San Bruno Mountain and San Francisco Bay form the eastern boundary of the Basin (Cal Water, 2006). The San Andreas Fault and Pacific Ocean form the western boundary, and its southern limit is defined by a bedrock high that separates it from the San Mateo Plain Groundwater Basin (DWR, 2003; Rogge, 2003; San Bruno, 2007). The Westside Basin opens to the Pacific Ocean on the northwest and San Francisco Bay on the southeast. The major structural features include the San Andreas Fault system and the Serra Fault.

3.2. Aquifers

The Westside Basin includes five major geologic formations: Franciscan Complex, Merced Formation, Colma Formation, Dune Sands, and Bay Deposits (LSCE, 2010). Groundwater development in the Westside Basin primarily occurs in various aquifer units in the Colma and Merced Formations from the Golden Gate Park area, through Daly City and South San Francisco, to San Bruno. The Merced Formation is the primary water-producing aquifer in the Basin (LSCE, 2006). Within the two major water bearing zones in the Westside Basin, there are multiple smaller aquifer zones that are delineated vertically by different sand and clay layers within the Merced and Colma formations. The thickness and extent of these interbedded sand and clay layers vary spatially throughout the Westside Basin. The aquifer units in the Westside Basin are further described in TM#1 (LSCE, 2010).

All of the municipal groundwater extraction wells in Daly City, South San Francisco, and San Bruno are screened in the deeper, semi-confined to confined aquifers in the Merced Formation, where the water quality is better than in shallower aquifers (San Bruno, 2007). The Colma Formation is of interest because Lake Merced is incised within this formation (LSCE, 2006).

For discussion purposes, the aquifer units are informally designated as the Shallow Aquifer, the Primary Production Aquifer, and the Deep Aquifer. The Shallow Aquifer is limited to the vicinity of Lake Merced and the area north towards Golden Gate Park, and the Primary Production Aquifer is generally present throughout much of the Westside Basin (LSCE, 2010). In the North Westside Basin, aquifer units are separated by two distinctive fine-grained units, known as the -100-foot clay and the W-clay (LSCE, 2004). In the Daly City area, the -100-foot clay is absent, and the aquifer system is primarily composed of the Primary Production Aquifer overlying the W-Clay and the Deep Aquifer underlying the W-Clay. Further to the south in the South San Francisco area, the W-Clay is absent and the Primary Production Aquifer is split into shallow and deep units that are separated by a thick fine-grained unit at an elevation of approximately 300 feet below mean sea level (msl). The Primary Production Aquifer in the San Bruno area is located at an elevation less than -200 feet, and it underlies a thick, surficial predominantly fine-grained unit comprised of clay, sandy clay, and sand beds (LSCE, 2010).

3.3. Groundwater Flow

Groundwater levels and the general direction of groundwater flow vary in the Westside Basin. At the northern end of the Westside Basin, groundwater in the Shallow Aquifer tends to flow in a westerly direction towards the Pacific Ocean. From South San Francisco southward to Burlingame in the vicinity of San Francisco Bay, groundwater within shallow units overlying the Primary Production Aquifer generally flows east towards San Francisco Bay (Rogge, 2003; San Bruno, 2007). Groundwater from the vicinity of Lake Merced north to Stern Grove and Golden Gate Park is encountered at relatively shallow depths (ranging from approximately 5 to 60 feet), while south of Lake Merced the depth to groundwater can exceed 300 feet (LSCE, 2006).

Based on groundwater level data measured during spring and fall 2009 monitoring events, groundwater elevation contours were prepared for the Shallow Aquifer and the Primary

Production Aquifer and presented in the 2009 Westside Basin Groundwater Monitoring Report (SFPUC, 2010). The 2009 groundwater elevation contour maps also include data from three monitoring wells that were installed by SFPUC in 2009 in the South Westside Basin in Daly City, San Bruno, and Millbrae. The contours of groundwater elevation for the Shallow Aquifer exhibit westerly groundwater flow directions both in spring and fall 2009, with higher groundwater elevations in the eastern portion of the aquifer than the western portion near the Pacific Coast. No significant differences in flow directions were identified through the spring and fall 2009.

Based on the spring and fall 2009 monitoring events, the contours of groundwater elevation for the Primary Production Aquifer exhibit westerly groundwater flow directions in the North Westside Basin, similar to the Shallow Aquifer, and a southerly flow direction from the Lake Merced area towards Daly City and South San Francisco. The southerly groundwater flow gradient between Daly City and South San Francisco appears to be relatively flat as compared to the steep gradient between Lake Merced and Daly City (SFPUC, 2010; LSCE, 2010).

3.4. Lakes

The most notable surface water feature of the Westside Basin is Lake Merced, located in southwestern San Francisco (Figure 10.1-1). Lake Merced is a freshwater lake, bounded by Skyline Boulevard, Lake Merced Boulevard, and John Muir Boulevard, approximately 0.25 mile east of the Pacific Ocean. Lake Merced is a major natural habitat for many species of birds and waterfowl and a regional recreational venue offering fishing, boating, bicycling, and wildlife viewing. The lake, composed of four water bodies named North Lake, East Lake, South Lake, and Impound Lake, is incised within the upper portion of the Shallow Aquifer, representing a surface expression of groundwater table. In the early 1990s several investigations were conducted and have continued on a regular basis to investigate and monitor the lake levels and lake-aquifer interactions (LSCE, 2002, 2004, and 2010).

Pine Lake is a small, shallow lake approximately three acres in size, located north-northeast of Lake Merced in the westernmost portion of Stern Grove and Pine Lake Park. Groundwater produced by the Stern Grove well is used for maintaining water levels in Pine Lake (personal comm., Jeff Gilman, 2010).

Golden Gate Park, located in the North Westside Basin, contains several artificial lakes that are used for recreation and are lined with clay to minimize leakage; however, several of the lakes reportedly leak a considerable amount of water to the water table (Yates et al., 1990). Groundwater pumped from the three Golden Gate Park wells (Elk Glen, North Lake, and South Windmill Replacement wells) is used for irrigation and for maintaining the artificial lakes (personal comm., Jeff Gilman, 2011).

3.5. Groundwater Pumping

Groundwater pumping in the Westside Basin occurs for municipal, irrigation and other non-potable uses (golf courses, zoo, parks, and cemeteries). Groundwater pumping is the most significant groundwater outflow component for the Westside Basin. Almost all historical groundwater development in the Westside Basin has been in the South Westside Basin for municipal supply in Daly City, South San Francisco, and San Bruno and golf course and cemetery irrigation. Total municipal pumping in the Westside Basin was about 7,500 afy from the mid-1970s to the mid-1980s, and then ranged from 6,000 afy to 8,000 afy until 2001. From 2002 to 2007, total municipal pumping fluctuated greatly as a result of the In-Lieu Recharge Demonstration Study conducted by SFPUC, Daly City, Cal Water (in South San Francisco), and San Bruno (LSCE, 2005; LSCE, 2010). Historical trends and recent pumping conditions for municipal, irrigation, and other non-potable pumping are summarized below. Groundwater pumping in the Basin is described in detail in TM#1 (LSCE, 2010).

Daly City – Groundwater pumping by Daly City increased from about 1,000 afy to nearly 5,000 afy between 1950 and 1970. Since then, groundwater pumping has ranged between approximately 3,000 afy and 5,000 afy, where it remained until October 2002, when an increase in deliveries from SFPUC's Regional Water System were made available to replace the majority of Daly City's groundwater supply as part of the In-Lieu Recharge Demonstration Study (LSCE, 2005). Daly City pumping totaled about 3,600 af for 2008 (LSCE, 2010). Supplemental water deliveries by SFPUC to Daly City resumed in 2009. Daly City pumping was approximately 1,667 af in 2009 (SFPUC, 2010) and 1,743 af in 2010 (SFPUC, 2011). Based on the long-term pumping records from 1959 to 2009, the median pumping by Daly City is estimated to be 3.78 mgd (or approximately 4,235 af).

Cal Water – Groundwater pumping by Cal Water in South San Francisco has progressively declined from about 2,200 afy in 1947, to about 1,600 afy in 1969, to about 1,200 afy in 2002. The decreases in groundwater pumping have been offset by increases in SFPUC's Regional Water System deliveries. In early 2003, groundwater pumping in South San Francisco was discontinued as part of the In-Lieu Recharge Demonstration Study (LSCE, 2005) that ended in early 2005 in South San Francisco. Groundwater pumping for municipal supply in South San Francisco resumed on a limited basis in March 2008 and totaled 206 af during 2008 (LSCE, 2010). Groundwater pumping by Cal Water was 380 af in 2009 (SFPUC, 2010) and 453 af in 2010 (SFPUC, 2011). Based on the long-term pumping records from 1959 to 2009, the median pumping by Cal Water is estimated to be 1.18 mgd (or approximately 1,320 af).

San Bruno – Pumping in San Bruno ranged from approximately 1,000 afy to 2,300 afy from 1950 to the late 1990s and from 1,700 afy to 3,100 afy from the late 1990s through 2001. In 2002, San Bruno decreased groundwater pumping to approximately 1,240 af and further decreased groundwater production to about 550 af in 2003 and 2004 as part of the In-Lieu Recharge Demonstration Study (LSCE, 2005). San Bruno pumping resumed to about 1,800 afy to 2,300 afy after cessation of the In-Lieu Recharge Demonstration Study in early 2005 (LSCE, 2010). Groundwater pumping by San Bruno was 2,379 af in 2009 (SFPUC, 2010) and 2,364 af in 2010 (SFPUC, 2011). Based on the long-term pumping records from 1959 to 2009, the median pumping by San Bruno is estimated to be 1.88 mgd (or approximately 2,110 af).

Irrigation and Other Non-Potable Groundwater Pumping – Groundwater has historically been developed for irrigation supply and other non-potable uses in the Westside Basin, most notably on golf courses around Lake Merced, cemeteries in Colma, at the San Francisco Zoo, and in Golden Gate Park. In 2005, the delivery of recycled water for irrigation largely reduced groundwater use at the golf courses around Lake Merced, leaving the cemeteries, California Golf Club, San Francisco Zoo, and Golden Gate Park as the notable pumpers for irrigation and other non-potable uses at an estimated 3,000 afy (SFPUC, 2009c; Carollo, 2008).

Given the estimated historical irrigation pumping of about 6,000 afy, total combined pumping of groundwater for municipal and irrigation uses is estimated to have ranged from 12,000 afy to 14,000 afy from the mid-1980s through 2001. During the In-Lieu Recharge Demonstration Study conducted by SFPUC in coordination with the PAs from October 2002 to March 2005, municipal pumping by Daly City, Cal Water, and San Bruno was reduced as a result of SFPUC's supplemental surface water deliveries to the PAs in-lieu of municipal pumping by the PAs. Total pumping (municipal and irrigation) in 2005 was estimated to range from 5,500 af to 6,500 af. Total pumping between 2006 and 2010 remained below 9,000 af, ranging from 5,400 af in 2006 to 8,500 af in 2008. Total pumping in the Westside Basin in 2009 was estimated to be 6,800 af (SFPUC, 2010).

4. Westside Basin Groundwater Model

The Westside Basin Groundwater Model is a regional, basin-wide groundwater model of the Westside Groundwater Basin in western San Francisco and San Mateo County (Figure 10.1-2).

4.1. History of Model Development

The Westside Basin Groundwater Model was first developed through Daly City's 2002-2003 AB303-funded investigation of the Westside Groundwater Basin (City of Daly City, 2003). During the period 2003-2007, additional work funded by Daly City, San Bruno, Cal Water, and SFPUC further developed and calibrated the model (HydroFocus, 2007). In 2009, a revised groundwater model (version 2.1) was released that included several corrections and improvements to the model's historical pumping data set with no adjustments to the modeled aquifer parameter values (HydroFocus, 2009). The most recent modeling work (version 3.1) includes an updated historical calibration and a no-project scenario that is documented in detail by HydroFocus (2011). A brief summary of the 2011 updates includes the following:

- Historical Simulation – The updated Historical Simulation (version 3.1) simulates monthly hydrologic conditions during the period October 1958 through September 2009. The simulation period is discretized into monthly stress periods. The Historical Simulation was extended from 47 years to 51 years, with the extended model period covering December 2005 to September 2009.
- Updated Model Parameters – During model calibration, several corrections, modifications and improvements were made to the model structure, aquifer parameters and boundary conditions based on new data and from review of model performance. Modifications are noted in the following with more detailed discussion of the model in Section 4.2.
- 2008 No-Project Scenario – This scenario is based on a 47-year simulation period that uses the hydrologic conditions from October 1958 to December 2005 using the calibrated Historical Simulation version 3.1

The Historical Simulation calibration period of 51 years covers various types of hydrological events ranging from wet periods to droughts of different magnitude and duration, allowing adequate time for analyzing basin response under various hydrological conditions.

The 2008 No-Project Scenario assumes no new projects but includes new supply wells, planned operational changes in the magnitude and spatial distribution of pumping, and existing recycled water projects as of May 2008. The 2008 No-Project Scenario was used as the starting point for developing Scenario 1 (or the Existing Conditions) for this modeling analysis.

4.2. Model Overview

This section summarizes the model representation of the Westside Basin, including the model extent, model layer structure, aquifer properties used in the model, and model boundary conditions. This is intended as an overview of the detailed discussion of the model representation reported previously by HydroFocus (2007, 2009, and 2011). These aspects of the model remain the same and were not modified for the purposes of the modeling analysis documented in this TM.

4.2.1. Model Structure

The Westside Basin Groundwater Model was constructed using MODFLOW 2000, a finite-difference numerical modeling software developed by the United States Geological Survey (USGS) (Harbaugh et al., 2000). Model coordinates are based on the California State Plane Zone 3 coordinate system of the North American Datum of 1983 (NAD 83), in units of feet. The vertical datum is the National Geodetic Vertical Datum of 1929 (NGVD 29). All model inputs are based on English units for length (feet) and time (days) (HydroFocus, 2007).

The model domain is the geographical area covered by the numerical model. The model domain is mostly consistent with the extent of the Westside Basin and extends into the Pacific Ocean along the western boundary and San Francisco Bay along the eastern boundary, as shown in Figure 10.1-2.

The model grid provides the mathematical structure for developing and operating the numerical model. The Westside Basin Groundwater Model domain is divided into a set of grid cells (grid discretization), containing 189 rows and 126 columns. The cells in horizontal directions have variable dimensions ranging from 250 feet near Lake Merced to 1,000 feet near the model edges.

Model layers provide vertical resolution for the model to simulate variations in groundwater elevations and aquifer stresses with depth. In the vertical direction, the Westside Basin Groundwater Model is composed of five layers to characterize the conceptual basin geology. Figure 10.1-3 shows the representation of the model layering superimposed on the regional north-to-south subsurface cross-section. The upper surface of the model represents the land surface topography, and the bottom of Model Layer 5 represents the bedrock surface elevation. Land surface elevations were determined using digital elevation models (DEM) that specify land surface elevation at horizontal locations uniformly spaced about 90 feet apart (HydroFocus, 2007, 2009, and 2011).

For the Westside Basin Groundwater Model version 3.1, adjustments to the model layering were completed to incorporate new data. Top and bottom model layer elevations were updated using information from recently installed monitoring wells, new depth-to-bedrock information, and updated hydrogeologic sections (HydroFocus, 2011).

4.2.2. Aquifer Properties

Aquifer properties (e.g., horizontal and vertical hydraulic conductivity, specific storage, and specific yield) describe the physical characteristics of the aquifer and the hydraulic properties that control groundwater flow. The numerical model requires that these properties are defined for every active cell in the model. In the Westside Basin Groundwater Model version 3.1, adjustments were made to calibrate horizontal and vertical conductivity values in the parameter zones; no changes were made to specific yield or specific storage. These are discussed in greater detail in the HydroFocus report (2011).

In the Westside Basin Groundwater Model, Model Layer 1 was specified as convertible and Model Layers 2 through 5 were specified as confined. Under the convertible conditions, MODFLOW calculates the transmissivity of each model cell as the assigned hydraulic conductivity multiplied by the saturated thickness as defined by the simulated groundwater elevation and the bottom of the model layer, and the storage coefficient is the specific yield (Harbaugh et al., 2000). For the confined Model Layers 2 through 5, the transmissivity is the product of the layer thickness and hydraulic conductivity, and the storage coefficient is the product of layer thickness and specific storage.

Each model layer in the Westside Basin Groundwater Model was divided into subareas (also referred to as parameter zones) within which aquifer parameters are assumed to be uniform. The delineation of the parameter zones and calibrated aquifer parameters associated with the parameter zones as used in the updated Historical Simulation and the 2008 No-Project Scenario were described by HydroFocus (2007, 2009, and 2011). The parameter zones were modified in version 3.1 to account for updated geologic information and the spatial distribution of new monitoring well locations (HydroFocus, 2011).

4.2.3. Boundary Conditions

Model boundary conditions represent areas where groundwater enters and exits the model domain. Boundary condition data must be entered for each stress period at each boundary condition cell, other than no-flow cells. The model boundaries in the existing Historical Simulation and the 2008 No-Project Scenario are represented as follows:

- Groundwater pumpage in the model was represented using the well package. In the MODFLOW well package, the monthly groundwater pumping extraction rates are specified in the model cell and layer corresponding to each well location and for each stress period. A detailed description of the MODFLOW well package can be found elsewhere (Harbaugh et al., 2000).
- The MODFLOW drain package was included to represent shallow groundwater discharge from Model Layer 1 in the Bay Plain subarea. Evidence for shallow groundwater and seepage includes groundwater encountered in shallow monitoring wells (for example, at leaky underground storage tank sites), sustained baseflow in the Colma Creek gauging record (1 to 2 cubic feet per second (cfs)), and the visible presence of creek channels and ditches inland throughout the Bay Plain as far west as Highway 101 (HydroFocus, 2011).
- Lake Merced was simulated with the lake package (MODFLOW 2000 LAK3 package) to simulate the hydraulic interaction between Lake Merced and the adjoining groundwater system, and to estimate the amount of inflow and outflow across the lakebed. The lake package consists of several data sets (e.g., initial lake level, inflows to and outflows from

the lake such as rainfall, evaporation, runoff, lake additions, and withdrawals) to couple the groundwater flow system with the lake water budget and to calculate lake levels and inflow and outflow across the lakebed. Documentation of the MODFLOW LAK3 package can be found in Merritt and Konikow (2000).

- Rainfall, temperature, and municipal water use input data sets for the Soil Moisture Budget (SMB) model were extended to include the period January 2006 through September 2009. The SMB is used to estimate recharge from precipitation and return flows and is entered into the model using the MODFLOW recharge package. In version 3.1, changes were made to simulate rainfall and the spatial temperature distribution, which resulted in an about 7-percent decrease in average rainfall in the Westside Basin relative to version 2.1 over the historical model period from 1959 and 2009 (HydroFocus, 2011).
- The Serra Fault was represented as a no-flow boundary in the southwest and as a horizontal flow barrier in the northwest. The San Andreas Fault was represented as a no-flow boundary.
- Groundwater seepage from the lakes and ponds in Golden Gate Park was represented using the MODFLOW well package as a specified flux boundary that adds water to the aquifer at a constant rate equal to the measured leakage rate (HydroFocus, 2007). A seepage investigation found that total lake leakage was 627 acre-feet per year (SFRPD, 1994).
- San Francisco Bay and the Pacific Ocean were represented as constant head boundaries with head values of zero feet NGVD 29.
- No-flow boundaries were specified along the northern edge of the onshore part of the basin boundary near Golden Gate Park, near the eastern end of Golden Gate Park, the southern boundary, and the onshore part of the eastern boundary.

4.3. Summary of Model Strengths and Limitations

A calibrated numerical model, such as the Westside Basin Groundwater Model, is considered capable of reasonable simulation quality. However, when evaluating model results, it is important to consider the strengths and limitations of the model. This section summarizes the strengths and limitations of the Westside Basin Groundwater Model based on previous modeling analyses, reports, and documentation (HydroFocus, 2007, 2009, and 2011).

4.3.1. Version 3.1 Model Calibration

Simulated groundwater levels in version 3.1 were calibrated to the available measured groundwater elevations collected during the simulation period at various locations throughout the Basin (HydroFocus, 2011). After the model was recalibrated, the basin-wide root-mean-square-error (RMSE) was reduced from 25.8 to 18.9 feet. The RMSE is a statistical measure that evaluates the average difference (or residual) between modeled and observed groundwater levels and provides a measure of the overall error in the model. Therefore, the calibration results indicate that, on average, modeled groundwater levels are within about 19 feet of observed water levels. The RMSE represents about 4 percent of the total range in observed water levels across the model. This ratio shows how the model error relates to the overall hydraulic gradient across the model. Typically, a calibration is considered good when this ratio is below 15 percent (ESI, 2001).

Another calibration measure is the residual mean, which includes positive and negative residuals depending on whether the modeled results are higher or lower than the measured groundwater levels. The residual mean provides a measure of the average deviation between modeled and observed water levels. In version 3.1, the residual mean is fairly small and positive (1.6 feet) indicating simulated water levels are on average slightly higher than the observed water levels. These calibration results indicate that the updated model is a reasonable tool for basin-scale analyses and comparisons of water resources management alternatives. Some degree of difference or residual between the observed and model simulated groundwater elevations is expected because residuals may be due in part to localized effects or data quality issues.

4.3.2. Model Strengths

The Westside Basin Groundwater Model was developed to assist basin-wide data interpretation and system understanding and is considered a reliable data analysis tool for various purposes. The model provides a means to synthesize data and integrate processes that potentially influence groundwater conditions. It was developed over a period of several years under the oversight of several technical groups. The model input represents agreed-upon conceptual hydrogeologic and water use conditions as presently understood in the Westside Groundwater Basin. The model was calibrated using more than 2,000 observed monthly water levels in 125 wells representing a broad range of locations, depths and hydrologic conditions. The numerical model provides information and insights that cannot be obtained from available field measurements and/or analytical tools without the capability to synthesize and integrate all processes that potentially influence groundwater conditions (HydroFocus, 2011).

As suggested by HydroFocus (2007), the strongest predictive ability of the existing model is in relative changes over time, rather than absolute predictions of water levels. Therefore, this regional model is most capable of analyzing differences in water level rather than the actual groundwater elevation output by the model. In addition, HydroFocus (2007) states that the model is best suited for assessing groundwater levels and storage changes over large parameter zones, which vary in size from 476 acres to nearly 10,000 acres, as the Historical Simulation calibration was performed with the average conditions in these zones in mind. In other words, the model may not be able to re-create the groundwater elevations at local areas or at a single well correctly, but the composite statistics of that well and many others nearby are much more accurate and representative. As described by HydroFocus (2007), the model was initially developed as a tool to assist with the following types of evaluations and groundwater management scenarios:

- Regional (basin-wide) data interpretation and system understanding:
  - Basin management decisions.
  - Monitoring networks and existing data gaps.
- Regional water supply project operations (for example, conjunctive use and local groundwater water projects) by assessing the following types of changes due to changes in pumping rates and patterns:
  - Changes in water table and deeper groundwater elevations (magnitude and trends).
  - Changes in Lake Merced water levels (magnitude and trends).
  - Changes in the quantity of water stored in the basin.
  - Changes in the water budget and potential for saltwater (or seawater) intrusion.

For evaluating effects of a proposed future project, the Westside Basin Groundwater Model is considered useful in simulating the relative effect of possible conjunctive use or groundwater supply projects in the Westside Basin. As mentioned by HydroFocus (2007), planning analyses based on projected future conditions, such as the future modeling scenarios, are typically based on the relative differences between two projected conditions. The advantage of analyzing relative differences is that it minimizes the effects of model uncertainty. It is therefore preferable to employ the Westside Basin Groundwater Model to analyze relative changes (for example, compare the differences between simulated “no project” and “with project” scenarios) rather than using the model to predict absolute groundwater elevations, localized aquifer storage changes, or Lake Merced water levels.

4.3.3. Model Limitations

Overall, version 3.1 of the model is considered an appropriate quantitative tool for evaluating groundwater conditions in the Westside Basin. However, there are some specific areas of the weakness and/or limitations in the model and model calibration that are summarized below based on previous studies and modeling analysis by HydroFocus (2007, 2009, and 2011), and subsequently identified during this analysis.

Despite improvements in the historical calibration in version 3.1 (HydroFocus, 2011), the model subareas with the highest RMSE are the Colma and San Bruno subareas. This is attributed to historical water level measurement limitations, model scaling, and uncertainty in vertical hydraulic conductivity and vertical hydraulic gradients. Therefore, the model results should be evaluated with care to account for the higher potential uncertainty of model results in the San Bruno and Colma areas.

During the Historical Simulation calibration, the simulation of lake levels in Lake Merced improved slightly from version 2.1 to 3.1. The model generally reproduces the lake levels and trends during the period from 1972 to 1995. During the first 14 years (1958 to 1972) and the last 13 years of the simulation (1996 to 2009), simulated lake levels were consistently 2 to 3 feet higher than measured data, but with some differences as high as 7 feet. The model is considered useful in simulating the relative effect of possible regional groundwater supply projects on Lake Merced levels; however, the simulation of lake level management scenarios with the objective of projecting absolute lake levels is not recommended.

The MODFLOW lake package does not include a mechanism to simulate the control of a lake level via a spillway. Although not a large issue for the historical simulations, some of the future case scenarios have the potential for lake levels to increase to the level of the spillway. Without a spillway mechanism, MODFLOW will allow the lake levels to rise to levels that are not physically possible. This also could have an impact on shallow groundwater levels due to groundwater-surface water interactions with the lake. Scenarios where the lake level rises above the level of the spillway require an iterative process whereby the lake package inputs are adjusted until the lake levels remain below the level of the spillway. Because of these limitations, the Lake-Level Model discussed in Section 8 was used for evaluating the effects of the GSR and SFGW Projects, and other reasonably foreseeable future projects.

In reviewing the model structure in the Golden Gate Park area, it was found that the aquifer thickness in the model was substantially thinner than was found in the Golden Gate Park Central Pump Station test well. Based on this test well, it appears that the model does not account for data from deep exploratory borings drilled in January 2010 and presented in a geologic cross-section J-J' in *Task 8B Technical Memorandum No. 1: Hydrologic Setting of the Westside Basin* (LSCE, 2010). The model uses only Model Layer 1 in the central and eastern parts of Golden Gate Park, whereas pumping tests of production wells show confined aquifer behavior. In addition, compilation of pumping test results shows that the horizontal hydraulic conductivity (K_h) values used by the Westside Basin Groundwater Model in the North Westside Basin are lower than those obtained from measured data. It is recommended that future revisions to the model should include updating the model layer inputs in the Golden Gate Park area to be consistent with the existing hydrogeologic data. This is an important area for evaluating the SFGW Project; therefore, model results for Golden Gate Park will need to be evaluated with care because the model may overestimate the simulated drawdowns from the future proposed wells in this area.

In version 3.1, the MODFLOW drain package was used to reduce the degree to which simulated groundwater levels were above the topographic surface representing potential flooding situations. Flooded cells periodically occurred where the aquifer is thin or in areas characterized by a shallow water table, and these can often be ignored because the model resolution is not fine enough to capture the topographic pattern of the surface.

Other weaknesses that have been subsequently identified during this investigation relate to the boundary conditions where the model interacts with the Pacific Ocean and San Francisco Bay. These boundary conditions were set to a constant head of zero elevation in the existing Westside Basin Groundwater Model. This characterization does not handle the density difference between seawater and freshwater, or the wedged shape of possible seawater intrusion (see Task 10.3 TM). In addition, the constant head boundary condition is located on the landward side of the coast, rather than the seaward side; this prescription is overly rigid, preventing the near-ocean water levels from behaving dynamically. HydroFocus (2007) states that "model results should be interpreted with caution near constant head boundaries like the Pacific Ocean or San Francisco Bay."

As mentioned above, for evaluating effects of a future project compared to the conditions without the project, the model could help assess the relative differences between two projected conditions. However, it should be noted that because model scenario runs are a projection of assumed future hydrologic conditions relative to assumed no project conditions, it is always understood that the simulated relative changes in groundwater levels and aquifer storage may not equal the actual changes determined from future observed hydrologic conditions (HydroFocus, 2007).

5. Model Scenario Descriptions

A calibrated numerical model, such as the Westside Basin Groundwater Model, is considered capable of reasonable quality simulations. The numerical model can serve as a useful quantitative tool for future planning, management, and evaluation of technical issues related to groundwater resources.

Five model scenarios were set up and simulated under Task 10.1. Table 10.1-1 provides a summary of the model scenario descriptions. The main model assumptions in each scenario are described in the following subsections, and further details on the model setup and assumptions are provided in Section 6 below. The amount of groundwater pumping is the major model input that varies among the simulated MODFLOW model scenarios. Table 10.1-2 presents a summary of pumping assumptions used in each of the five model scenarios. The Lake-Level Model is the primary tool used to evaluate the effects of each of the five scenarios listed in Table 10.1-1. Section 8 provides a detailed description of Lake-Level Model development and assumptions and model results in evaluating the effects of the GSR and SFGW Projects and other reasonably foreseeable projects.

5.1. Scenario 1 – Existing Conditions

Scenario 1 was set up and simulated to represent the Existing Conditions and does not include the SFPUC Projects (both GSR and SFGW Projects). Scenario 1 is based on a new hydrologic sequence proposed by SFPUC over a 47.25-year simulation period and initial conditions representative of June 2009. Total pumping assumptions made under Scenario 1 are summarized in Table 10.1-2.

A detailed description of the model assumptions and modifications for Scenario 1 is provided in Section 6. The 2008 No-Project Scenario developed by HydroFocus (2011) was used as the starting point for the development of Scenario 1. However, there are some important differences between Scenario 1 and the HydroFocus 2008 No-Project Scenario. These differences are listed below:

- In order to allow all five model scenarios to be directly comparable, Scenario 1 uses a new hydrologic sequence. The HydroFocus 2008 No-Project Scenario used an exact repeat of the historical hydrology from October 1958 to December 2005. As described further in Section 6.3, the new hydrologic sequence has a period of 47.25 years. It was established by rearranging the historical monthly sequence of hydrologic conditions available from the HydroFocus modeling analysis (2011) and includes the 8.5-year Design Drought period for the GSR Project, consistent with the PEIR (SFPUC, 2007; SFPUC, 2009a).
- Initial conditions for groundwater levels and Lake Merced represent June 2009 conditions for Scenario 1, compared to September 2002 used in the 2008 No-Project Scenario. As described further in Section 6.4, the initial conditions are based on the June 2009 water levels from the updated calibrated Historical Simulation by HydroFocus

(2011). June 2009 groundwater levels as initial conditions represent the accrued SFPUC Storage Account of approximately 20,000 af at the start of the model scenarios.

- Pumping assumptions for the PA production wells were modified to incorporate the pumping assumptions representative of the Existing Conditions. Pumping by the PAs for the Existing Conditions is 6.84 mgd, compared to 6.9 mgd assumed in the 2008 No-Project Scenario. PA pumping under the Existing Conditions was derived from the median values of individual agency pumping over the historical period from 1959 to 2009. Under the Existing Conditions, the pumping distribution among each of the PA wells and the vertical distribution of pumping by model layers are essentially the same as in the HydroFocus 2008 No-Project Scenario (2011).
- In order to be consistent with the new hydrologic sequence, the SMB pre-processing model for estimating groundwater recharge and irrigation was revised. The SMB model uses precipitation, temperature, evapotranspiration and municipal water supply as inputs. As explained further in Section 6.5, the simulated monthly recharge resulting from municipal water use in municipal areas was revised based on the results of the revised SMB. Scenario 1 uses the same future municipal water use as projected in the 2008 No-Project Scenario, but that municipal water use was rearranged in order to reflect the new hydrologic sequence.
- Monthly irrigation pumping estimates were modified for the Existing Conditions as a result of the revised SMB to be consistent with the new hydrologic sequence. Monthly irrigation pumping in Scenario 1 is based on the results of the revised SMB. Further modification to the irrigation pumping simulated by the revised SMB was then made to account for actual pumping data for the following irrigation wells: Golden Gate Park irrigation wells (Elk Glen, North Lake, and South Windmill Replacement wells), California Golf Club No.2, Zoo No.5, Edgewood Development Center well, and Stern Grove well (Section 6.6).
- As a result of the revised SMB for the Existing Conditions, the Lake Merced lake package was modified consistent with the new hydrologic sequence, as explained further in Section 6.9. The modified lake package for Scenario 1 assumes no lake additions but accounts for water withdrawals from the lake when the lake levels are in excess of the lake spillway. In comparison, the HydroFocus 2008 No-Project Scenario assumes no Vista Grande stormwater diversions into Lake Merced and no other water additions to the lake.

5.2. Scenario 2 – GSR Project

Scenario 2 simulates the future operation of the GSR Project. The model was set up and simulated based on the new hydrologic sequence (Section 6.3) and identical assumptions for irrigation pumping as in Scenario 1, as presented in Table 10.1-2. The total PA pumping was assumed to be 6.9 mgd. This PA pumping rate is assumed to result in no appreciable storage change in the South Westside Basin (HydroFocus, 2011). For consistency with the PEIR, Scenario 2 was simulated based on the hydrologic sequence that also includes the GSR Project's Design Drought hydrology, as described below (SFPUC, 2007; SFPUC, 2009a). Descriptions of the hydrologic sequence and Design Drought hydrology are pertinent to all scenarios and are presented below in Section 6.3. Table 10.1-2 summarizes pumping assumptions made for the proposed GSR Project wells and the PA wells under Scenario 2. Irrigation pumping assumptions under Scenario 2 remain the same as in Scenario 1 (Existing Conditions), as further discussed in Section 6. The proposed GSR Project municipal well locations are shown in Figure 10.1-4. Table 10.1-3 provides a summary of pumping capacities for the proposed GSR Project municipal wells. GSR Project wells would pump at 7.23 mgd during take periods and at 0.04 mgd during put and hold years to exercise the wells.

5.2.1. Partner Agency Wells

Locations of the PA municipal wells are shown in Figure 10.1-4. Table 10.1-4 lists the PA municipal wells that are assumed to be pumping under the modeling scenarios and analysis.

As presented in the pumping summary in Table 10.1-2, total pumping by the PAs under Scenario 2 was assumed to be 6.9 mgd during take and hold years, based on the designated pumping amounts provided by the PAs to SFPUC as part of the GSR Project. The PA wells are planned to pump up to 20 percent of the take period volume during put periods to allow for well exercising and to avoid encrustation (MWH, 2008). As a result, the PA pumping during put periods would be reduced to 1.38 mgd, resulting in approximately 5.52 mgd of in-lieu stored water in the basin during a put year. Pumping by the PAs is consistent with the 2008 No-Project Scenario by HydroFocus (2011).

5.2.2. In-Lieu Recharge Demonstration Study

A brief overview of the In-Lieu Recharge Demonstration Study conducted by the SFPUC in coordination with the PAs from October 2002 to March 2005 is provided herein as this study is pertinent to the GSR Project, the accrued SFPUC Storage Account, and the initial conditions of June 2009 used for the model scenarios. The In-Lieu Recharge Demonstration Study involved delivery of supplemental surface water from SFPUC to reduce the PAs groundwater pumping. The reduced pumping effectively increased the volume of groundwater in storage (LSCE, 2005).

The purpose of the study was to evaluate the response of the Basin to the resultant in-lieu natural recharge resulting from reduced pumping. After the completion of the In-Lieu Recharge Demonstration Study, the SFPUC continued to deliver supplemental surface water to Cal Water through January 2007 and to Daly City through April 2007. The accrued volume in the SFPUC Storage Account at the start of the model scenarios in June 2009 is approximately 20,000 af based on records of in-lieu exchange with the PAs prior to July 2009. Table 10.1-5 presents the amount and timing of supplemental surface water deliveries to the PAs from October 2002 to April 2007, as provided by the SFPUC (personal comm., Greg Bartow, 2010). No supplemental deliveries were conducted from May 2007 to May 2009.

5.3. Scenarios 3a and 3b – SFGW Project

Scenarios 3a and 3b represent the SFGW Project scenarios and consist of the assumptions used for Scenario 1, with the added assumption of future operation of the SFGW Project. Two model scenarios were set up and simulated based on differing pumping assumptions for the proposed SFGW Project wells, as a result of the availability of recycled water to replace groundwater that is currently used for irrigation in Golden Gate Park.

Approximate locations of the proposed SFGW Project wells are shown in Figure 10.1-4. Table 10.1-6 lists the well identifications and proposed well pumping capacities for the SFGW Project municipal wells. As summarized in Table 10.1-2, Scenario 3a would pump four of the six proposed wells at 3.0 mgd, while the other two SFGW Project wells would remain as irrigation wells and their irrigation pumping rates would be the same as in Scenario 1 (Existing Conditions). Under Scenario 3b, the six proposed project wells would pump at the 4.0 mgd pumping target. Irrigation pumping assumptions at the other irrigation wells under Scenarios 3a and 3b remain the same as in the Existing Conditions, as further discussed in Section 6.6.

For the purpose of the SFGW Project modeling scenarios, the location of the Golden Gate Park Central Pump Station well for Scenarios 3a and 3b was slightly modified by relocating the well in the model to the adjacent model grid cell to the west, where the model layer becomes thicker and accommodates the assigned pumping by the well. As discussed earlier (Section 4.3.3), the aquifer thickness assigned by the model in the vicinity of this well was thinner than the data obtained from a test well and other nearby exploratory borings.

5.4. Scenario 4 – Cumulative Scenario

Scenario 4 is the Cumulative Scenario that includes the assumed operation of the GSR and SFGW Projects, projected pumping for the PAs and third party pumpers, and other reasonably foreseeable future projects. Reasonably foreseeable projects that are considered include (1) the Vista Grande Drainage Basin Improvements Project, and (2) the Holy Cross cemetery future build-out with its anticipated increase in irrigation pumping. The Cumulative Scenario assumes the same hydrologic sequence and initial conditions for groundwater levels and Lake Merced as Scenario 1. Total pumping assumptions for Scenario 4 are summarized in Table 10.1-2. As mentioned above, Scenario 4 assumes the operations of the GSR Project and SFGW Project; thus, it includes the combined pumping from both proposed projects. As presented in Table 10.1-2, the total PA pumping rates for each PA under Scenario 4 are the same as those under Scenario 2. Pumping assumptions by the PAs and locations of pumping wells account for reasonably foreseeable plans for future proposed wells by Daly City, Cal Water and San Bruno. For the SFGW Project, the pumping assumptions under Scenario 4 are the same as pumping assumptions under Scenario 3b (Table 10.1-2). A detailed description of pumping assumptions is provided in Section 6.7 for the GSR Project wells and the PA municipal wells and in Section 6.8 for the SFGW Project wells.

6. Westside Basin Groundwater Model Setup

Because of the complexity of a natural system, assumptions are necessary to define the model domain, aquifer properties and boundary conditions required for the numerical model. Therefore, a model is a simplification of the natural system. The quality of a model is highly dependent upon the accuracy of the conceptual understanding of the hydrogeology and the quality and quantity of the data.

This section presents a summary of the modeling assumptions that are common to all five model scenarios developed, modifications made to the model scenarios compared to the 2008 No-Project Scenario that was previously developed by HydroFocus (2011), and detailed pumping assumptions used for the PA municipal wells, the proposed GSR and SFGW Project municipal wells.

6.1. Common Modeling Assumptions

Modeling assumptions used in the five model scenarios that remain the same as in the 2008 No-Project Scenario are as follows:

- The model domain and grid discretization, model layer structure, and stress period setup are the same as in the 2008 No-Project Scenario (HydroFocus, 2011).
- All of the five model scenarios use the same boundary conditions (e.g., no-flow and constant-head boundary conditions) as in the 2008 No-Project Scenario (HydroFocus, 2011).
- The five modeling scenarios simulate the new hydrologic sequence that covers 47.25 years of monthly hydrologic conditions (a total of 567 monthly stress periods) by rearranging the historical hydrologic conditions available in the HydroFocus 2008 No-Project Scenario and Historical Simulation (2011).
- Land use conditions assumed in all of the future model scenarios are the same as in the 2008 No-Project Scenario, which simulates land use conditions as of May 2008. Therefore, land use zones and recharge zones used in all of the model scenario setups are the same as in the 2008 No-Project Scenario (HydroFocus, 2011).
- All five model scenarios simulate the hydraulic connection between Lake Merced and the surrounding groundwater system based on the lake and aquifer properties that were used in the 2008 No-Project Scenario (HydroFocus, 2011). The lake geometry and key variables used in the lake package remain the same as previously reported by HydroFocus (2007) (see Table 3 in the HydroFocus 2007 Report).
- All model scenarios assume ongoing pumping for the existing irrigation wells similar to the pumping assumptions in the 2008 No-Project Scenario. Modifications made to irrigation pumping assumptions are introduced in Section 6.2 and described further in Section 6.6.

6.2. Modifications to 2008 No-Project Scenario

Modifications to the 2008 No-Project Scenario were made to construct the model scenarios. The major modifications are listed below and described in the following sections:

- Hydrologic data based on the new hydrologic sequence (Section 6.3);
- Initial conditions used for groundwater levels (Section 6.4);
- Revised SMB analysis consistent with the hydrologic sequence and resulting modifications made to the recharge package (Section 6.5), the lake package (Section 6.9), and the irrigation pumping assumptions (Section 6.6);
- Pumping assumptions to incorporate the GSR Project (Section 6.7) and SFGW Project (Section 6.8). The 2008 No-Project Scenario (HydroFocus, 2011) assumes water use conditions as of May 2008 while the modeling scenarios presented here simulate water use conditions as of June 2009 as a representation of the publication of the Notice of Preparation (NOP) for the GSR Project in June 2009 and the NOP for the SFGW Project in December 2009; and
- Initial conditions for Lake Merced and modifications made for the lake spillways (Section 6.9).

The modifications made for the hydrologic sequence, initial conditions, and the revised SMB analysis are common to all five scenarios. Monthly irrigation pumping demand for the model scenarios was revised based on the results of the revised SMB analysis, to be consistent with the hydrologic sequence. The methodology developed by HydroFocus in the 2008 No-Project Scenario (2011) was used to revise the SMB and estimate the monthly irrigation demand for each irrigation well. Minor modifications were made to selected irrigation wells to update the irrigation demand estimated by the revised SMB to account for the actual data for those wells, as described in Section 6.6 as part of the irrigation pumping assumptions.

6.3. Hydrology

The five model scenarios use the same 47.25-year hydrologic sequence so that model scenario results are all directly comparable. This sequence is based on historical hydrological conditions and includes the 8.5-year Design Drought period used in the PEIR (SFPUC, 2007; SFPUC, 2009a). The 8.5-year Design Drought repeats the December 1975 to March 1978 drought period following the dry hydrologic conditions of July 1987 to November 1992. To incorporate the Design Drought, the historical hydrologic sequence was rearranged. The rearranged hydrologic sequence used for the five model scenarios presented in this analysis consists of the following:

- July 1996 to September 2003
- October 1958 to November 1992
- December 1975 to June 1978
- July 2003 to September 2006

The following is the rationale for developing the new hydrologic sequence and maintaining a consistency with the PEIR and the associated HH/LSM design drought run (SFPUC, 2007; SFPUC, 2009a).

As part of the initial conditions, the SFPUC Storage Account has approximately 20,000 af in storage in 2009 based on the past pilot program and agreed upon water exchanges. In order to identify a starting point for the rearranged hydrologic sequence that is consistent with the prior PEIR analyses for the GSR Project, the HH/LSM results were analyzed to identify a time when the simulated SFPUC Storage Account value was approximately 20,000 af. This was done in order to identify a starting condition that is equivalent to the actual SFPUC Storage Account value in July 2009. The analysis identified that this SFPUC Storage Account value occurs in the HH/LSM simulation at the beginning of July 1996 following the prolonged dry years (or take periods) during the 1987 to 1992 drought.

For the model scenarios involving the GSR Project (Scenarios 2 and 4), the Design Drought begins with the Full SFPUC Storage Account of 60,500 af in storage. This means that the SFPUC Storage Account must be “filled” from its 20,000 af initial condition to the “full” 60,500 af condition during the early part of the model simulation. The simplest way to accomplish this objective is to start the GSR Project and the Cumulative Scenario in put periods in order to simulate the filling of the SFPUC Storage Account. Filling of the SFPUC Storage Account therefore occurs during the first “block” of the rearranged hydrologic sequence (i.e., July 1996 to September 2003). Following the filling of the SFPUC Storage Account, the rearranged hydrologic sequence continues with October 1958 to November 1992. For this period, the put/take/hold conditions for the GSR Project are also based upon the HH/LSM output, and the SFPUC Storage Account is full at the beginning of the Design Drought.

The Design Drought is developed by repeating the period from December 1975 to March 1978 and incorporating it into the rearranged hydrologic sequence following November 1992. The PEIR design drought analysis ended in March 1978; however, the rearranged hydrologic sequence continues the Design Drought through June 1978 to maintain a complete rainfall year. To accommodate the Design Drought, the period from December 1992 to July 1995 is not included in the sequence, which is consistent with the PEIR analysis. Since the SFPUC Storage Account is depleted in 7.5 years, it does not cover the complete hydrologic year in the eighth year of the drought. Therefore, the final six months of the eighth year of the Design Drought (January to June 1978) are defined as hold months.

In the PEIR analysis, the Design Drought simulation ended at the end of the Design Drought. For these simulations, the Design Drought is followed by a period of put years. This period (from July 2003 to September 2006) is long enough to bring the SFPUC Storage Account back to 20,000 af at the end of the model scenarios. The July 2003 to September 2006 period is used because it is considered appropriate to keep a multi-year block of rainfall years together. Analysis of observed reservoir storage data was required in order to confirm that the period from July 2003 to September 2006 could be considered a put period. This analysis was necessary because the available HH/LSM simulations do not include this time period.

Rearranging the historical hydrologic sequence in the manner described above is justifiable because weather patterns are generally random. There is no reason that a historical hydrology sequence would repeat exactly in the future. For the rearrangement of the historical hydrologic sequence, the modified sequence was kept as simple as possible by maintaining long continuous blocks of the historical hydrologic sequences. Except for the Design Drought, individual rainfall years were kept together. The rearranged sequences start in either July or October in order to be consistent with the California climate.

The rearranged hydrologic sequence was evaluated with respect to the total rainfall at the Lake Merced precipitation station. This analysis examined the cumulative departure of total precipitation relative to the long-term average (Figure 10.1-5). The historic period of the original hydrologic sequence from October 1958 to December 2005 was near normal. The cumulative departure relative to the long-term average was less than 0.2 inch or 0.04 inch per year over the 47.25-year interval. For the rearranged hydrologic sequence, the cumulative departure is a deficit of 19.4 inches or 0.4 inch per year over the 47.25-year interval. The deficit is due to repeating the December 1975 to June 1978 drought period as part of the Design Drought. This repeat period replaces the December 1992 to June 1995 period, which has higher rainfall. Since most groundwater recharge is related to precipitation, this provides for a conservative evaluation of groundwater conditions during this period.

6.4. Initial Conditions

Initial conditions are the groundwater elevations assigned for each active model cell in each model layer at the beginning of model simulations. For all five model scenarios, model-simulated June 2009 groundwater levels from the HydroFocus Historical Simulation (2011) were used as the initial conditions. The MODFLOW model uses monthly time steps and the model is set to start in July 2009; therefore, June 2009 represents the month prior to model initiation. The calibrated model simulation of June 2009 represents the best characterization of groundwater elevations for the entire basin as is required for the model.

All five scenarios use the same June 2009 initial conditions in order to allow a direct comparison of the model scenario results. The initial condition of June 2009 represents the SFPUC Storage Account of 20,000 af that was stored between 2002 and 2009 (personal comm., Greg Bartow, 2010) during the In-Lieu Recharge Demonstration Study.

6.5. Recharge

For all five model scenarios, the recharge pre-processor SMB model was used to revise recharge consistent with the hydrologic sequence and revised results were entered into the model using the MODFLOW recharge package. This approach was based on the same pre- and post-processing approach developed by HydroFocus (2011). All five scenarios use the same revised recharge package.

In the Westside Basin Groundwater Model, pre-processing programs (e.g., SMB) were used to simulate the spatial and temporal distribution of groundwater recharge. Hydrologic processes simulated by the SMB model include municipal water deliveries, rainfall, runoff, infiltration, soil moisture storage, potential evapotranspiration, irrigation, pipe leaks, and deep percolation. The SMB model uses climate and water delivery data to calculate the temporal and spatial distribution of deep percolation. The final product generated by the SMB is a single model input data set representing monthly groundwater recharge time-series (recharge package) for input to the uppermost active model layer (Model Layer 1). In the Westside Basin Groundwater Model, recharge was distributed to recharge zones as delineated by HydroFocus. A detailed description of the pre-processing programs and the delineated recharge zones is previously reported by HydroFocus (2007, 2009, and 2011).

In the 2008 No-Project Scenario by HydroFocus, simulated monthly groundwater recharge in irrigated areas was also generated using the SMB model. As described earlier, the land use conditions and recharge zones assumed in Scenario 1 and the project model scenarios are the same as in the 2008 No-Project Scenario. However, altered hydrology in the new hydrologic sequence (including the Design Drought) leads to changes in the rate of groundwater recharge in irrigated areas. To account for the change in the monthly groundwater recharge model inputs, the MODFLOW recharge package in the 2008 No-Project Scenario was modified. It should be noted that in the 2008 No-Project Scenario, simulated monthly recharge in municipal areas is determined from both municipal water use and the historical temperature and rainfall data, as described by HydroFocus (2011). Municipal water use consists of both surface water and groundwater pumping for municipal use. For all five model scenarios, total municipal water use was assumed to remain the same as in the 2008 No-Project Scenario. Therefore, in all five model scenarios, monthly groundwater recharge that would result from municipal water use is essentially the same as in the 2008 No-Project Scenario, but altered according to the new hydrologic sequence.

6.6. Irrigation and Non-Potable Groundwater Pumping

This section describes modeling assumptions for irrigation and other non-potable pumping used in the model scenarios. The PA pumping assumptions and the project specific assumptions are presented separately in subsequent sections.

Irrigation and non-potable pumping assumptions were modified from the 2008 No-Project Scenario as a result of running the SMB model to be consistent with the new hydrologic sequence. A summary of the irrigation and non-potable pumping assumptions used in the model scenarios is presented in Table 10.1-2.

In the HydroFocus 2008 No-Project Scenario (2011), irrigation pumping for wells without metered data records was based on the monthly demand estimated by the SMB model. As mentioned earlier, rainfall, temperature, and municipal water use are input data sets for the SMB. As a result of changes in the hydrologic data used in the model scenarios, the SMB-estimated irrigation demand was updated to generate irrigation demand estimates that are consistent with the new hydrologic sequence. In the model scenarios, the SMB model was run with the input data sets that were rearranged according to the hydrologic sequence, following the same approach developed by HydroFocus (2011).

Minor modifications were made to the revised estimates of irrigation pumping resulting from the SMB model run to account for pumping data that are representative of actual pumping conditions, based on information provided by SFPUC. These modifications include the Golden Gate Park irrigation wells (Elk Glen, North Lake, and South Windmill Replacement), California Golf No.02, the Edgewood Development Center well, Zoo No.05, and the Stern Grove well, as described below:

- **Golden Gate Park Irrigation Wells** – The 2008 No-Project Scenario (HydroFocus, 2011) estimates Golden Gate Park irrigation at approximately 1.12 mgd (or 1,252 afy), based on metered data provided by SFPUC. For the Existing Conditions, irrigation pumping in Golden Gate Park was adjusted upward to approximately 1,280 afy to match 2008 meter data, which is the most recent and complete metered record that is representative of actual pumping. Pumping in each of the three individual wells was increased with the following pumping distribution among the wells to maintain the same proportion of total pumping as in the pumping distribution used in the 2008 No-Project Scenario.
    - Elk Glen – increased pumping from 0.011 to 0.081 mgd (from 12 to 91 afy).
    - North Lake – increased pumping from 0.302 to 0.563 mgd (338 to 631 afy).
    - South Windmill Replacement – decreased pumping from 0.805 to 0.498 mgd (902 to 558 afy).
- **California Golf Club No.02** – decreased pumping from 0.212 mgd to 0.192 mgd (from 237 to 215 afy), based on rates provided verbally by the California Golf Club (personal comm., Rick Kavakoff, 2009).
- **Zoo No.5** – decreased pumping from 0.404 to 0.321 mgd (from 452 to 360 afy), as provided by the SFPUC based on the average of 2005, 2006, 2007, and 2008 data (SFPUC, 2009c).
- **Edgewood Development Center** – increased pumping from 0.007 to 0.009 mgd (from 8 to 10 afy) (personal comm., Jeff Gilman, 2009).
- **Stern Grove Well** – reduced pumping from 0.042 to 0.0043 mgd (from 47 to 4.8 afy) to account for the new information available about the use of the well as a supplemental water source for Pine Lake (written comm., Jeff Gilman, 2010). The well is assumed to be pumped approximately four days per year, as needed, to maintain the water level in Pine Lake at 31.5 feet (City Datum).

6.6.1. SFGW Project Scenarios

Irrigation and non-potable pumping assumptions for Scenario 1 and Scenarios 3a and 3b are essentially the same, except changes described below.

- For Scenario 3a, the Stern Grove well irrigation pumping is increased from 0.0043 mgd to 0.012 mgd (from 4.8 to 13.6 afy) for Scenario 3a, which represents 0.008 mgd (8.8 af) more pumping than Scenario 1. Based on the monthly pumping assumptions provided by SFPUC, the Stern Grove well would pump seven months (January, May, June, July, August, September, and October) with pumping rates ranging from 1.1 af per month to 2.3 af per month.

- For Scenario 3b, the Stern Grove well irrigation pumping is increased from 0.0043 mgd to 0.013 mgd (from 4.8 to 14.8 afy) for Scenario 3b, which represents 0.009 mgd (10 af) more pumping than Scenario 1. Based on the monthly pumping assumptions provided by SFPUC, the Stern Grove well would pump seven months (January, May, June, July, August, September, and October) with pumping rates ranging from 1.2 af per month to 2.5 af per month.

The Stern Grove well pumping volumes under Scenarios 3a and 3b are based on the supplemental water needed to maintain the water level in Pine Lake at 31.5 feet (City Datum), based on information provided by SFPUC. Pumping of the Stern Grove well is proportional to the total pumping of the SFGW Project, in which the total pumping in Scenario 3a is less than the total pumping in Scenario 3b.

6.6.2. Cumulative Scenario

Irrigation and non-potable pumping assumptions for Scenario 3b and Scenario 4 are essentially the same, except changes described below.

- Based on the results of the revised SMB, the long-term average irrigation demand by Holy Cross cemetery was estimated at 0.19 mgd (212 afy) for Scenario 1 and the GSR and SFGW Project scenarios (Scenarios 2, 3a, and 3b). The Cumulative Scenario required further adjustments to take into account the planned future build-out in the Holy Cross cemetery. Based on the potential future build-out at the Holy Cross cemetery, additional pumping of 0.04 mgd (or 45 afy) was estimated for the Cumulative Scenario. The Holy Cross cemetery build-out was projected to be at a rate of about 1.5 acre per year from 2010 to 2030 (total of 30 acres over 20 years) (personal comm., Roger Appleby, 2010). With a conservative irrigation rate of 1.5 af per acre, the additional estimated future irrigation pumping rate was estimated to be 45 afy (or 0.04 mgd).

6.7. GSR Project

The GSR Project is sponsored by the SFPUC in collaboration with the three PAs (Cal Water, Daly City, and San Bruno), who operate their own municipal supply wells and purchase wholesale water from SFPUC's Regional (surface) Water System. The overall objective of the GSR Project is to develop a new dry-year groundwater supply that can be utilized at a rate of 7.2 mgd (or 8,100 afy) above the existing municipal groundwater pumping over a 7.5-year drought period. Water would be stored in the aquifer through in-lieu recharge equal to the reduction in pumping by the PAs made possible by supplemental SFPUC surface water supplies delivered in wet and normal years.

6.7.1. GSR Project Pumping

Figure 10.1-4 shows the locations of the proposed GSR Project municipal wells that were incorporated into the model scenarios involving the GSR Project. Table 10.1-7 shows the total pumping volumes assumed for the proposed GSR Project municipal wells during the put/take/hold sequence. The general assumption is that pumping in each GSR Project well would be reduced in duration to 4 hours per month for well exercising during put and hold periods. For the purpose of these modeling scenarios, month-to-month pumping was assumed to be constant, with no seasonal pumping variations.

Table 10.1-8 shows the assumed pumping distribution by model layers for each of the GSR Project wells. The general assumptions made to allocate the pumping vertically take into account the proposed well screen intervals in conjunction with the hydraulic conductivity differences in Model Layers 4 and 5. Where the W-clay is present, it was assumed that the screen footage in Model Layers 1 through 4 was given the double weighting above the W-clay that it is below the W-clay in Model Layer 5, except at TW-CUP-10A, where the proposed screen is only planned for the zone above the W-clay. For areas without the W-clay, e-logs were reviewed to determine how to allocate pumping (either equal weighting for all screens or double the weighting from the upper screen). The pumping allocation was based on the fact that the calibrated horizontal hydraulic conductivity (K_h) values are generally 8 feet/day in Model Layers 3 and 4 compared to 4 feet/day in Model Layer 5 (HydroFocus, 2011). Moreover, based on the conceptual understanding of the subsurface geology, review of the available well logs, analysis of footage of screen in various layers times weighting factors, it appears that the majority of pumping in practice is derived from depths corresponding to Model Layer 4.

6.7.2. Partner Agency Pumping

Figure 10.1-4 shows the locations of the PA municipal puping wells that were incorporated into the five model scenarios. The locations of the proposed wells were based on the information provided by Cal Water and Daly City to SFPUC.

The total pumping by the PAs for Scenario 2 is 6.9 mgd, compared to 6.84 mgd under Scenario 1 (Table 10.1-2). As shown in Table 10.1-1 and 10.1-2, the total PA pumping assumptions used for the GSR Project under Scenarios 2 and 4 are essentially the same, but the locations of the PA municipal pumping wells used for each scenario vary slightly, as shown in Table 10.1-7 and discussed below.

- **San Bruno** - Under Scenarios 2 and 4, San Bruno would continue to pump its existing five wells (SB-No.15, SB-No.16, SB-No.17, SB-No.18, and SB-No.20). As of early 2012, San Bruno was evaluating the potential to replace SB-No.15 and had identified several potential replacement sites. Since the GSR Project EIR modeling can only assume one location for the replacement of SB-No.15, it was agreed that the current location of SB-No.15 was reasonable to use because the current SB-No.15 location is the closest location to the proposed GSR Project wells and thus provides a conservative analysis by concentrating pumping in that area (i.e., the GSR Project proposed well at Golden Gate National Cemetery is about a quarter mile north of SB-No.15).

Another alternate location was about one mile northwest of the proposed GSR Project well at the SFPUC Millbrae Facility (CUP-M-1). However, CUP-M-1 is expected to have the lowest pumping rate (about 160 gpm as shown in Table 10.1-3) of all of the GSR Project wells because the saturated thickness at this location is less than areas where the proposed GSR Project wells to the north are located. Thus, it would not be conservative to use this as the replacement location for SB-No.15 for this analysis.

- **Daly City** – Under Scenario 2, Daly City plans to pump the five existing wells (Jefferson, Vale, Daly City No.4, Westlake, and Junipero Serra), but Scenario 4 accounts for Daly City's future plans to use two proposed wells (Daly City A Street Replacement well and Daly City No.4 Replacement well). Under Scenario 4, Daly City total pumping would be the same as Scenario 2, but using four existing wells (Jefferson, Vale, Westlake, and Junipero Serra) and the two proposed wells.
- **Cal Water** – Under Scenario 2, Cal Water proposes to pump five wells, including three of the existing wells (SSF1-19, SSF1-20, and SSF1-21) and two proposed wells (SSF1-22 and SSF1-23), based on the information provided by Cal Water to SFPUC. Under Scenario 2, three existing wells (SSF1-14, SSF1-17, and SSF1-18) were assumed to be out of production. Based on the documents provided by Cal Water, SSF1-14 and SSF1-17 were reported inactive, and SSF1-18 was reported to be replaced with the proposed well SSF1-23. The existing well SSF1-15 was assigned "zero" pumping based on the information from Cal Water that indicates the well will be destroyed due to age and contaminants. Under Scenario 4, Cal Water was assumed to be pumping the two existing wells (SSF1-20 and SSF1-21) and two proposed wells (SSF1-22 and SSF1-23). Based on the information provided by Cal Water, proposed wells SSF1-24 and SSF1-25 are considered redundant and no pumping was assigned to these wells for the purpose of the Cumulative Scenario.

Table 10.1-7 shows the total pumping at each PA municipal well during the put/take/hold sequence. Pumping during put periods was assumed to be 20 percent of the take period pumping in each well. For San Bruno wells, the pumping distribution among the individual wells and the monthly pumping distribution for each well are the same for Scenarios 1, 2 and 4, and they are assumed to be proportional to those in the 2008 No-Project Scenario (HydroFocus, 2011). Under Scenario 2, Daly City pumping distribution among the wells is the same as Scenario 1 and follows the same distribution as in the 2008 No-Project Scenario (HydroFocus, 2011). Under Scenario 4, total pumping by Daly City was distributed among the six wells evenly. Under Scenario 2, pumping among the individual Cal Water wells was determined based on the pumping rates provided by Cal Water and inputs from SFPUC. For Scenario 4, pumping among the individual Cal Water municipal wells was determined based on pumping rates provided by Cal Water for each well.

Table 10.1-8 presents the pumping distribution by model layers for each PA municipal well. For the existing PA municipal wells, vertical pumping distribution by model layers is the same as in the 2008 No-Project Scenario. The four Cal Water proposed wells (SSF1-22, SSF1-23, SSF1-24, and SSF1-25) would be similar in nature to the existing wells SSF1-20 and SSF1-21 and would be located in the vicinity of the existing wells, based on the information provided by Cal Water to SFPUC. In light of the estimated screen zones of 380 to 570 feet below ground surface (bgs) for the proposed wells, which are similar to existing wells SSF1-20 and SSF1-21, under Scenarios 2 and 4, the depth distribution of the Cal Water pumping by model layers for the proposed wells was assumed to be similar to that for the existing wells SSF1-20 and SSF1-21.

6.7.3. Put/Take/Hold Sequence

In the modeling scenarios involving the GSR Project (Scenarios 2 and 4), the hydrologic sequence follows the put/take/hold sequence to simulate in-lieu groundwater recharge during wet years and groundwater extraction during dry years. As described earlier, the HH/LSM, which was used extensively for long-term planning purposes in the SFPUC's PEIR, outputs a put/take/hold sequence on a monthly basis and tracks the volume of water stored in the SFPUC Storage Account (SFPUC, 2007; SFPUC, 2009a). The following is the description of the put/take/hold sequence used in the hydrologic sequence for the model scenarios, compared to the original put/take/hold in the HH/LSM run:

- The original HH/LSM put/take/hold sequence is based on the in-lieu recharge rate (or put rate) of 7.23 mgd. This put rate is equal to the rate of groundwater pumping during a take period in the HH/LSM simulation run. For the current modeling scenarios, on the other hand, the in-lieu recharge rate during a put year is 5.52 mgd and the rate of groundwater extracted during a take year is 7.23 mgd. The pumping rate of 5.52 mgd represents the 80 percent of total PA pumping of 6.9 mgd during a put period. As a result of the differences in the put rate, the hydro sequence has slightly longer put periods for the model scenarios compared to the original HH/LSM model outputs. The longer put periods are used in order to ensure the volume of put in the current modeling scenarios is not less than the volume of put in the HH/LSM outputs.
- In the PEIR, the put/take/hold conditions are defined as annual periods that run from July to June. The put/take/hold sequence used for the GSR Project under Scenario 2 and the Cumulative Scenario is consistent with this approach.
- The put/take/hold sequence used in the current modeling scenarios includes the Design Drought period as used in the SFPUC's PEIR.
- The put/take/hold sequence in the current modeling scenarios includes a recovery period (put period) following the Design Drought that brings the SFPUC Storage Account back to the same value as the initial condition (20,000 af). This allows a direct comparison of groundwater conditions with respect to the SFPUC Storage Account at the beginning and the end of the GSR Project under Scenario 2 and the Cumulative Scenario.

- The put/take/hold sequence used in the current modeling scenarios starts with a put condition for the GSR Project and the Cumulative Scenario. This is done in order to simulate the filling of the SFPUC Storage Account to the “full” condition (60,500 af) prior to the Design Drought.

The put/take/hold sequence used in the current modeling scenarios is presented in Table 10.1-9. The Design Drought is represented by the 7.5-year period of take months from Simulation Year 36 through 44.

6.8. SFGW Project

The SFGW Project consists of the development of up to 4.0 mgd of local San Francisco groundwater in the North Westside Basin as a regular and emergency drinking water supply. The WSIP primary level-of-service goal for the SFGW Project is to increase the long-term water supply available to the SFPUC.

As shown in Table 10.1-2, the PA pumping assumptions used for the SFGW Project scenarios (Scenarios 3a and 3b) are the same as Scenario 1. These assumptions are covered in Section 5.1 and are not discussed further in this section.

6.8.1. SFGW Project Pumping

Figure 10.1-4 shows the locations of the six proposed SFGW Project municipal wells that were incorporated into the model scenarios involving the SFGW Project. Table 10.1-6 shows the normal design and average pumping capacity for the SFGW Project municipal wells. Table 10.1-10 shows the percent pumping distribution for each well under Scenarios 3a and 3b. Pumping by each SFGW Project municipal well was estimated by distributing the total monthly pumping (combined pumping for the four wells for Scenario 3a and for the six wells for Scenario 3b) among the wells proportional to each well’s normal design pumping capacity.

The model layer-by-layer pumping distribution for the SFGW Project wells is presented in Table 10.1-8. Pumping among the model layers was distributed proportional to the layer thicknesses and the screened intervals of the wells (i.e., construction details) as provided by the SFPUC. In locations where the screened interval spans the entire model layer, pumping was distributed proportional to the layer thickness. When the well screen falls within only a portion of the model layer, pumping was distributed proportional to the length of well screen within that layer. Table 10.1-11 shows calculated monthly pumping by each SFGW Project well for Scenarios 3a and 3b. Monthly pumping varies, but total pumping remains the same annually (i.e., 3.0 mgd for Scenario 3a and 4.0 mgd for Scenario 3b).

Pumping assumptions for the three existing Golden Gate Park wells (Elk Glen, North Lake, and South Windmill Replacement wells) under Scenarios 3a and 3b are summarized in Tables 10.1-2, 10.1-6, and 10.1-10. If recycled water were available for irrigation, the Elk Glen well would not pump (Table 10.1-2), while the North Lake and South Windmill Replacement wells would pump at 0.50 mgd and 0.65 mgd, respectively, for municipal supply (Table 10.1-10). Without recycled water for irrigation, all three existing wells would pump at a total combined rate of approximately 1.14 mgd based on the monthly irrigation pumping assumptions used in the Existing Conditions (Table 10.1-2).

6.9. Lake Merced

Lake Merced is an important hydrological feature in the Westside Basin. It is simulated in the Westside Basin Groundwater Model using the MODFLOW Lake Package, generally following the conditions used for the 2008 No-Project Scenario. Details regarding the MODFLOW simulation of Lake Merced are discussed in Sections 6.9.1 through 6.9.3.

Lake Merced water levels are also simulated using the Lake-Level Model, as discussed in Section 6.9.5. Lake Merced level management operations are considered as a reasonably foreseeable future project under Scenario 4 (Cumulative Scenario) and discussed in Section 6.9.4. The current understanding of the Lake Merced management operations is that it will raise and maintain Lake Merced water levels up to an elevation of 9.5 feet (City Datum) (18.12 feet NGVD 29) with supplemental water derived from stormwater diverted from Daly City's Vista Grande Canal.

6.9.1. Model Modifications to Lake Package

For the model scenarios, monthly runoff entering Lake Merced from Harding Park Golf Course and nearby residential areas was estimated based on the results from the revised SMB model and revised results were imported into the model using the MODFLOW Lake Package (LAK3). In the 2008 No-Project Scenario, monthly runoff entering the lake is extracted from the SMB model. Following the same approach developed by HydroFocus (2011), the SMB model was revised to update the lake package consistent with the new hydrologic sequence. Similar to the 2008 No-Project Scenario, all five model scenarios, except the Cumulative Scenario, assume no Vista Grande stormwater diversions into Lake Merced and no other water additions to the lake.

The MODFLOW Lake Package was further modified for initial lake levels and lake spillway, compared with the 2008 No-Project Scenario, as described separately in the following subsections 6.9.2 and 6.9.3.

6.9.2. Initial Lake Condition

For all model scenarios, the initial Lake Merced water level was set to match the simulated June 2009 lake level from the version 3.1 Historical Simulation (HydroFocus, 2011). Simulated rather than measured (observed) Lake Merced lake levels are used because this change improves the model performance by ensuring that the lake levels are in equilibrium with groundwater conditions in the model. If this approach were not used, then there may be undesirable effects in the water balance and nearby groundwater levels as the model works to achieve a new equilibrium with the different initial lake condition. The initial lake level at South Lake was set to 17.95 feet (NGVD 29). The San Francisco City Datum (City Datum) is another reference datum commonly used for Lake Merced lake level measurements. Relative to the City Datum, the initial lake level at South Lake was set to 9.33 feet (City Datum).

6.9.3. Model Modifications for the Lake Spillway

The MODFLOW Lake Package does not include a mechanism to simulate the control of a lake level with a spillway. Without a spillway mechanism, MODFLOW would allow the lake levels to rise to levels that are not physically possible, which could affect the simulated shallow groundwater levels (due to groundwater-surface water interactions with the lake) and the overall Westside Basin water balance. For all five model scenarios, there were instances where the MODFLOW-simulated Lake Merced lake level was above the level of the spillway. Therefore, scenarios were run iteratively by adjusting the Lake Package input file to remove excess water from the lake (as lake spills) until the lake levels remained below the level of the spillway. This approach is different than the 2008 No-Project Scenario, which assumed no spills from the lake.

For Scenarios 1, 2, 3a and 3b, the existing Lake Merced water spillway elevation of 21.62 feet (NGVD 29, or 13.0 feet City Datum) was used. For Scenario 4, the projected modified spillway elevation of 18.12 feet (NGVD 29, or 9.5 feet City Datum) was used based on documentation for the Vista Grande Drainage Basin Alternatives Analysis project for Daly City (Brown and Caldwell, 2010, Jacobs Associates, 2011a, 2011b; City of Daly City, 2012).

The MODFLOW Lake Package uses a water balance method to calculate inflows and outflows from the lake outside of the groundwater contribution (e.g., precipitation, stormwater runoff, evaporation, and direct water additions and withdrawals). These values are defined in the Lake Package by the user prior to the model input files. The inflows and outflows from the groundwater contribution are calculated by MODFLOW.

To adjust for the spillway, the outflows that represent the lake spills (i.e., direct water withdrawals) in the Lake Package were increased iteratively until the MODFLOW-simulated lake levels stayed below the level of the spillway for consecutive months. A single month where the lake level was less than 0.1 foot above the spillway was allowed.

6.9.4. Cumulative Scenario

For the Cumulative Scenario (Scenario 4), the use of Lake Merced as part of the Vista Grande Drainage Basin Alternatives Analysis project for Daly City is considered to be a reasonably foreseeable future project. Daly City's Vista Grande Drainage Basin Alternatives Analysis recommended the alternative, in which stormwater flow from the Vista Grande Canal would be diverted to Lake Merced (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012).

Daly City evaluated 24 potential scenarios for the Lake Merced Alternative for various flow configurations related to the presence or absence of a wetland and the level of the spillway (Brown and Caldwell, 2010). Given that the Lake Merced Alternative scenarios are still in the initial design stage, a scenario that provides an average flow to the lake is considered acceptable given that averages have been used for assumptions in other instances (e.g., the PA pumping assumptions). The 75 cfs Daly City scenario was selected for use in this modeling analysis. 75 cfs represents a cutoff volume, so that all flow down the Vista Grande Canal exceeding this cutoff volume would be diverted to Lake Merced (Brown and Caldwell, 2010). Stormwater discharges into Lake Merced occur when water flows in the Vista Grande Canal exceed the cutoff volume and are diverted into the Lake Merced. These flows occur periodically in response to large storms, and were calculated as part of the Vista Grande Drainage Basin Alternatives Analysis (Brown and Caldwell, 2010) based on historical precipitation data. Stormwater flows were calculated to occur as diversions to Lake Merced in every year, and range from 19 to 681 afy with an average of 207 afy (Brown and Caldwell, 2010). These flows were added to the MODFLOW Lake Package as an input into Lake Merced as stormwater discharges.

The Lake Merced Alternative scenarios also include provisions for an engineered wetland and modification of the Lake Merced spillway (Brown and Caldwell, 2010). In the 75 cfs scenario, the average baseflow in the Vista Grande Canal is assumed to be diverted into an engineered wetland for treatment and then discharged to Lake Merced on an ongoing basis. Baseflows have been estimated to range from 18 to 26 af per month (Kennedy/Jenks, 2009). These were also added to the MODFLOW Lake Package as an input into Lake Merced.

Finally, the 75 cfs scenario contains a provision to lower the spillway out of Lake Merced by 3.5 feet from an elevation of 21.62 to 18.12 feet (NGVD 29), or from 13.0 feet to 9.5 feet (City Datum). Spillway discharges at the lower spillway elevation were calculated using the methodology described in Section 6.9.3.

6.9.5. Use of Lake Merced Results

As mentioned in Section 4, the Westside Basin Groundwater Model has the ability to reproduce long-term trends in the Lake Merced lake levels as shown in the Historical Simulation by HydroFocus (2011), but there is uncertainty in estimating absolute lake levels. Comparisons between simulated and observed lake levels show differences that range from -2.0 to 7.0 feet. The model generally reproduces the trends and relative changes seen in the historical data for Lake Merced during the period from 1972 to 1995. During the first 14 years (1958 to 1972) and the last 13 years of the simulation (1996 to 2009), simulated lake levels were consistently 2 to 3 feet higher than measured data and show periods of divergence between historical and measured trends. The MODFLOW model is considered useful in simulating the relative effect of possible regional groundwater supply projects on Lake Merced levels; however, the simulation of lake level management scenarios with the objective of projecting absolute lake levels is not recommended.

Because of these issues with the MODFLOW representation of Lake Merced, the Lake-Level Model, discussed in Section 8, is also used to simulate the Lake Merced water levels for the five model scenarios.

7. MODFLOW Model Scenario Results

The results of MODFLOW model simulations for all five scenarios are presented in this section. The evaluation of these results with respect to specific groundwater issues is discussed in the following TMs:

- Task 10.2 for assessment of groundwater-surface water interactions
- Task 10.3 for assessment of seawater intrusion
- Task 10.4 for changes in groundwater levels and storage
- Task 10.5 for assessment of pumping induced land subsidence
- Task 10.6 for assessment of changes in groundwater quality

7.1. Documentation of Model Results

The model results are typically presented based on the water year (from October of the previous calendar year through September). The simulation period is 47 years and three months. The first three months of the simulation period from July 2009 to September 2009 are considered as Year Zero (0), and are excluded in the summary tables. This exclusion is made because the partial data would bias model result statistics (e.g., annual average, annual minimum, and annual maximum). The model results are presented for scenario years 1 through 47.

7.1.1. Hydrographs

The Westside Basin Groundwater Model can be used to report groundwater levels specific to each of the five model layers. To facilitate this analysis, model-simulated groundwater levels corresponding to Model Layers 1 and 4 are presented, because they are representative of the response of the unconfined and Primary Production aquifers, respectively.

Model-simulated hydrographs from selected key representative monitoring well locations were prepared across the entire groundwater basin. Twelve representative monitoring locations (shown in Figure 10.1-4) were used to show model-simulated groundwater elevations. This is a subset of the 125 observation wells present in the model.

Attachment 10.1-B presents hydrographs for the 12 selected well locations to demonstrate results from the individual model scenarios, and also to compare the results of the project model scenarios (Scenarios 2, 3a, 3b, and 4) relative to the Existing Conditions (Scenario 1). Attachment 10.1-B includes hydrographs of model-simulated absolute water levels at the 12 selected locations for Model Layers 1 through 5, and of the water levels from the five scenarios for Model Layers 1 and 4 relative to the Existing Conditions. These hydrographs are included to show how the pumping assumptions in the various scenarios result in changes in the hydrologic conditions of the Westside Basin. Model Layer 1 results provide information about expected changes to the Shallow Aquifer (where present) and to unconfined groundwater conditions; whereas, Model Layer 4 results give an indication of simulated groundwater level changes anticipated in the confined Primary Production Aquifer portion of the model. Model Layer 5 also encompasses portions of the Deep Aquifer, but it is not laterally continuous and thus not as well-suited for evaluation as is Model Layer 4 output.

7.1.2. Volumetric Water Budgets

Volumetric water budget graphs and tables were prepared for each of the five scenarios for the entire simulation period. The water budget (also referred to as water balance or hydrologic budget) presented in this TM shows the major components of inflows to and outflows from the Westside Basin. Water budget analysis was conducted at three different regional scales listed below and results are presented in the following subsections:

- Westside Basin
- North and South Westside Basins
- Five water budget zones that are collectively referred to as the "Developed Subbasin" by HydroFocus (2011)

7.1.2.1. Westside Basin Water Budget

Attachment 10.1-C presents annual water budget graphs and summary tables as well as annual and net changes in groundwater storage for each of the five scenarios for the entire Westside Basin. Average, maximum, and minimum annual inflows and outflows are summarized for each of the five scenarios in Table 10.1-12. The average values in the summary tables represent the average annual inflows and outflows for the simulation period based on the water year. As mentioned earlier, model results for the first partial year (July to September) are excluded in the summary tables. The minimum and maximum values represent the minimum and maximum annual inflows and outflows, respectively, for the simulation period. Results in Attachment 10.1-C are summarized on an annual basis to show the annual water balance itemized into individual major inflows and outflows. The annual change in groundwater storage is also tabulated and plotted. The negative values for the annual change in groundwater storage represent a decline in the groundwater storage, while the positive values represent an increase in groundwater storage. It should be noted that the net change in groundwater storage graphs represent values relative to the beginning of the simulation. Groundwater storage at the beginning of the simulation is set to zero ("0"); thus, changes in the basin storage are reported relative to the beginning storage. Since the model scenarios use the same initial conditions, the zero basin storage at the beginning of the simulation corresponds to the same basin storage values for the five model scenarios, each starting with the same June 2009 initial condition that is representative of the SFPUC Storage Account of 20,000 af.

7.1.2.2. North and South Westside Basin Water Budgets

A zone budget analysis was performed to summarize model results for the North Westside Basin and South Westside Basin separately. The U.S. Geological Survey post-processor ZONEBUDGET (Harbaugh, 1990) was used to extract the simulated volumetric water budget (summed over the five model layers). Two water budget zones are separated south of the San

Francisco-San Mateo County line to represent the North and South Westside Basins. As mentioned earlier, this division is not intended to represent a physical boundary, but is used merely for the convenience of representing the model results spatially. The model cells representing Lake Merced are all located in the North Westside Basin. Therefore, the flow between the lake and the surrounding aquifer system is accounted for as part of the North Westside Basin water budget only. Attachment 10.1-D presents volumetric water budget graphs and tables for the North and South Westside Basins separately, and are presented in the same way as for the entire Westside Basin. In addition to the water budget components (inflows and outflows), two components are presented to keep track of flow exchanges between the North and South Westside Basins, as shown in the summary tables and annual water balance graphs.

7.1.2.3. Developed Subbasin Water Budgets

Similar to the approach taken by HydroFocus (2011), a water budget zone analysis was conducted to summarize volumetric budgets for the five water budget zones that are collectively referred to as the “Developed Subbasin” by HydroFocus. The U.S. Geological Survey post-processor ZONEBUDGET (Harbaugh, 1990) was used to extract the simulated volumetric water budget (summed over the five model layers) for the San Francisco, Daly City, Colma, South San Francisco, and San Bruno water budget zones. These water budget zones encompass the inland area where all municipal water supply wells are located. The boundaries of the Developed Subbasin represent the institutional boundaries that coincide with the most intensely developed water use areas within the basin. This water budget zone analysis presents results for ten different sub-areas, including the aforementioned five zones in the Developed Subbasin and five adjacent sub-areas (beneath the Pacific Ocean, San Francisco Bay Plain, south of San Bruno in Millbrae and Burlingame areas, and across the Serra Fault). Attachment 10.1-E presents results of the water budget zone analyses for the ten sub-areas for each of the five scenarios. Each summary table presents the annual average inflows, outflows, and the net change (in units of afy) over the entire simulation period. The major inflows include recharge, seepage from Lake Merced and inflow from San Francisco Bay and the Pacific Ocean (represented by constant head). The major outflows include pumping, outflow to San Francisco Bay and Pacific Ocean, and seepage to Lake Merced. The summary tables also show the net flow to or from the Developed Subbasin and the adjacent sub-areas.

7.1.3. Groundwater Elevation Contour Maps

Contour maps of the model simulated groundwater elevation data were generated at selected key time periods. Model simulated groundwater elevation contour maps are presented in Attachment 10.1-F to show the model response to various pumping stresses and recovery periods, such as at the end of simulation (for all scenarios), and at the end of the Design Drought with the long-term take period (for Scenarios 2 and 4, each involving the GSR Project). These groundwater elevation contour maps demonstrate general and regional trends in groundwater flow directions and localized cones of depression around the primary pumping areas. Contour maps of the simulated groundwater elevation data were plotted for Model Layer 1 (for Scenarios 1, 3a, 3b, and 4) and Model Layer 4 (for Scenarios 1, 2, and 4) to represent the model response in the unconfined and deeper aquifers in the basin. Contour maps of the simulated groundwater elevation maps in Model Layer 1 were generated to demonstrate the model response in the SFGW Project area in the North Westside Basin where the Shallow Aquifer and unconfined groundwater conditions exist. Contour maps of the simulated groundwater elevation maps in Model Layer 4 generally represent the model response in the Primary Production Aquifer that is present in the GSR Project area in the South Westside Basin.

Dry cells shown on the contour maps for Model Layer 1 define areas where MODFLOW-simulated groundwater elevations are below the bottom of the layer. Dry cells do not necessarily imply dewatering the aquifer. During the model simulation, simulated heads can oscillate, in which cells convert from wet to dry and then convert back from dry to wet.

7.1.4. Lake Hydrographs

Hydrographs for Lake Merced water levels were prepared for all of the five model scenarios using the Lake-Level Model discussed in Section 8. A composite graph showing results of all scenarios on a single graph based on the Lake-Level Model is shown in Section 8.2. The lake hydrographs for each model scenario are also presented in Attachment 10.1-G. To be consistent with the datum used in the Westside Basin Groundwater Model and the groundwater elevation hydrograph results from that model, lake levels are shown using both the NGVD 29 datum and the City Datum. All five scenarios account for water removal from the lake to keep the lake levels below the spillway. As described earlier, the lake spillway is assumed to be 13 feet (City Datum) for Scenarios 1, 2, 3a, and 3b, and to be 9.5 feet (City Datum) for Scenario 4. Because of limitations in the MODFLOW Lake Package (Section 4.3.3), the results of the Lake-Level Model are considered the most appropriate for analysis of groundwater-surface water interactions at Lake Merced.

7.2. Model Scenario Assessment

Model results were reviewed to check that simulated results from individual scenarios are appropriate and consistent with model inputs. General trends observed in groundwater levels, water balances, and resulting changes in groundwater storage were checked for consistency among model scenarios.

7.2.1. Model Convergence

All of the future model scenarios met the mathematical convergence criteria specified in the existing Westside Groundwater Flow Model in all time steps. Therefore, the model-simulated results converged appropriately, and the resulting water balance was considered acceptable.

7.2.2. Assessment of Model Scenario Results

Groundwater pumping assumptions used to develop the model scenarios are the significant model inputs that differentiate one scenario from another and can be used as a measure to check consistency among scenarios. Simulated groundwater levels are expected to vary depending on the magnitude of pumping applied and the spatial and temporal distribution of pumping.

Figure 10.1-6 presents simulated groundwater levels for the model scenarios for Model Layer 1 at a monitoring well located in Golden Gate Park (SWM-GS). Figure 10.1-7 shows simulated differences in groundwater elevations at the same location relative to the Existing Conditions (Scenario 1). Given the proximity of this monitoring well to a proposed SFGW Project municipal well (South Windmill Replacement), groundwater levels in the vicinity of this well are expected to be most heavily influenced by the SFGW Project operations, while the GSR Project operations are not expected to have much effect. Therefore, Scenarios 3a, 3b, and 4 results are expected to be similar to each other throughout the simulation period. Since the SFGW Project pumping operations propose to produce additional year-round groundwater supply in the North Westside Basin compared to the Existing Conditions, groundwater levels resulting from Scenarios 3a, 3b, and 4 would be expected to be lower than those of the Existing Conditions in this area. The model results shown in Figures 10.1-6 and 10.1-7 are consistent with these expected results.

On the other hand, due to the large distance between the SWM-GS monitoring location and the GSR Project operations in the South Westside Basin, the overall effect of the GSR Project pumping on groundwater levels in Golden Gate Park area would be expected to be minor (i.e., groundwater levels for Scenario 2 would be similar to those for the Existing Conditions). As also shown in Figures 10.1-6 and 10.1-7, all hydrographs start at the same level, as expected, representing the same initial conditions used in all five scenarios. As the simulation time elapses, groundwater levels for Scenarios 1 and 2 behave in similar ways at the location of this monitoring well because of the minor effect of the GSR Project operations on this location. Similarly, as the simulation time progresses, Scenarios 3a, 3b, and 4 show similar trends since the results are more influenced by the SFGW Project operations at this location. The model results shown in Figures 10.1-6 and 10.1-7 are consistent with these expected results.

Figures 10.1-8 and 10.1-9 show the model-simulated groundwater elevations for Model Layer 4 in the Daly City area (DC-A St), which would be subject to influence from the proposed GSR Project operations and possibly to the proposed pumping for the SFGW Project . Because of its location, the effect of the GSR Project on groundwater levels at the DC-A St monitoring location would be expected to be greater compared to that of the SFGW Project. As expected, the SFGW Project alone would result in a small, incremental decline in groundwater levels as a result of the year-round additional pumping compared to Scenario 1, while the effects of the GSR Project would vary significantly depending on the timing of the put/take/hold sequence and the associated pumping assumptions. Figures 10.1-8 and 10.1-9 demonstrate the expected results, where the effect of the GSR Project would be more pronounced at this location. As expected, model–simulated groundwater levels decline during take periods, recover during put periods, and return to the trends seen in Scenario 1 during hold periods.

Figures 10.1-10 and 10.1-11 show the model-estimated aggregate change in groundwater storage and changes in groundwater storage relative to the Existing Conditions (Scenario 1). All five scenarios start with the same initial conditions of June 2009; thus, the storage plots start with zero to indicate the beginning of the simulation. As discussed earlier, the June 2009 groundwater levels account for the SFPUC Storage Account of 20,000 af in the basin, but do not account for basin hydraulic inefficiencies and potential storage losses. This subject is described in TM 10.4.

As shown in Figures 10.1-10 and 10.1-11, groundwater storage results for Scenario 1 and Scenarios 3a and 3b follow similar trends of general decline, with the decline in Scenarios 3a and 3b greater than that under Scenario 1, due to the increased pumping under the SFGW Project. The aggregate changes in groundwater storage of Scenarios 3a and 3b are similar, as expected, with a slightly greater decline in Scenario 3a. This is in response to the seasonal irrigation pumping in Golden Gate Park under Scenario 3a, compared to Scenario 3b, which assumes regular municipal pumping from the two proposed SFGW Project wells and supplemental recycled water to replace the irrigation pumping in Golden Gate Park. Due to the combined pumping assumed under the Cumulative Scenario (Scenario 4), the change in storage would be greater under the Cumulative Scenario compared to Scenario 1, and compared to Scenario 2 (GSR Project) or Scenarios 3a and 3b (SFGW Project) alone. As expected, the trend in model-simulated groundwater storage decline is similar for Scenarios 2 and 4. The additional storage decline in Scenarios 2 and 4 compared to Scenario 1 is due to the take periods during the 7.5-year Design Drought, but the overall decline is greater under Scenario 4 than Scenario 2 because of the greater combined pumping of the GSR and SFGW Projects in Scenario 4. Similar to the effects seen on groundwater levels, the resulting changes in groundwater storage from the scenarios involving the GSR Project are primarily controlled by the put/take/hold sequence.

Figure 10.1-12 shows the net change in groundwater pumping relative to the Existing Conditions (Scenario 1). As expected for Scenario 2, additional pumping varies as a function of the put/take/hold sequence, where pumping goes below the Existing Conditions rates during put periods, goes above the Existing Conditions rates during take periods, and returns to similar rates as in the Existing Conditions during hold periods. Scenario 4 shows trends similar to Scenario 2, but pumping is greater due to the addition of Scenario 3b pumping for the SFGW Project to Scenario 4; as a result, the hold period pumping under Scenario 4 returns to levels similar to Scenario 3b, as opposed to those of the Existing Conditions.

7.3. Application of Model Scenario Results

In the context of the modeling scenarios and related analyses, the Westside Basin Groundwater Model is considered a useful tool for simulating the relative effect of model scenarios such as those presented in this TM.

It is most useful to evaluate the relative changes of the model results presented here. Scenario 1 represents the Existing Conditions that provides a basis of comparison for evaluating the relative change both with and without the SFPUC Projects in Scenario 2 (GSR Project), Scenarios 3a and 3b (SFGW Project), and Scenario 4 (Cumulative Scenario). Given the same hydrologic sequence and the same initial conditions used in all five model scenarios, the model scenarios can be directly compared to the Existing Conditions. Simulated relative changes in groundwater levels and aquifer storage may not equal the actual changes determined from future observed hydrologic conditions, as also mentioned by HydroFocus (2007).

8. Lake Merced Lake-Level Model

Because of concerns about the ability of MODFLOW (Westside Basin Groundwater Model) to accurately simulate lake levels in Lake Merced, the analysis also utilizes the Lake-Level Model. A more complete discussion of the development of the Lake-Level Model is included in Attachment 10.1-H. Below is a summary of the application of this model to the evaluation of Lake Merced for the analysis of the GSR and SFGW Projects and the Cumulative Scenario.

8.1. Background on the Lake Merced Lake-Level Model

The Lake-Level Model is a spreadsheet-based water balance model. The model sums up the inflows and outflows from Lake Merced on a monthly time scale. The water balance components are each calculated independently. The sum represents the net change in water volume in the lake for that month. Based on this net change in water volume, a new lake level is calculated. A positive net change represents an increase in the lake level, whereas a negative net change represents a decrease in lake level.

The Lake-Level Model was calibrated to historical lake levels over a 70-year period from October 1939 to June 2009. This period includes a variety of hydrological conditions including wet, normal and dry precipitation years, flood events, and periods of high and low lake levels corresponding to a variety of conditions that are considered representative of future conditions. Overall, the Lake-Level Model closely follows both the long-term and short-term trends by demonstrating a very strong correlation of the magnitude of both annual and seasonal fluctuations reasonably well. The comparison of simulated and historical lake levels between October 1939 and June 2009 is discussed in more detail in the technical memorandum documenting the development of the Lake-Level Model, which is included as Attachment 10.1-H.

The Lake-Level Model previously has been used to support the Vista Grande Drainage Basin Alternatives Analysis in 2011 (Brown and Caldwell, 2010, Jacobs Associates, 2011a, 2011b). Some minor modifications have been made to the historical calibration analysis as part of this study, which primarily deal with shifting the basis for precipitation from the Mission Dolores to the Lake Merced Pump Station precipitation gauges. These changes are documented in Attachment 10.1-H.

8.2. Simulation of the GSR and SFGW Projects

For the analysis of the Existing Conditions and the GSR and SFGW Projects (Scenarios 1, 2, 3a and 3b), the Lake-Level Model was based on the historical calibration analysis model but with modifications to the natural hydrology with new provisions to simulate other reasonably foreseeable future projects. The water-balance components that constitute the natural background hydrology, such as precipitation, groundwater inflow/outflow, evaporation, and transpiration, are the foundation for the Lake-Level Model. However, some modifications were necessary for the analysis of the GSR and SFGW Projects to account for potential future conditions rather than historical conditions. These modifications include:

- The same 47.25-year rearranged hydrologic sequence that was used for the MODFLOW scenarios (see Section 6.3). The model inputs for the natural hydrology were based on the same historical data for the appropriate months in the sequence.
- Initial Lake Merced level is set to the measured June 2009 lake level of 14.32 feet (NGVD 29) or 5.7 feet (City Datum).
- The approach used for the groundwater inflow to and outflow from Lake Merced was changed to use the water balance values of groundwater inflow to and outflow from Lake Merced based on the corresponding scenario of the MODFLOW model. Using the MODFLOW water balance results is considered a more reliable approach because the proposed changes incorporate conditions, such as the in-lieu recharge from the GSR Project, that do not have a historical equivalent.

The Lake-Level Model results for Scenarios 1, 2, 3a and 3b are discussed in Attachment 10.1-G, and a composite hydrograph showing the Lake Merced water levels for these scenarios is shown in Figure 10.1-13.

8.3. Simulation of the Vista Grande Drainage Basin Improvements

For this analysis, the Vista Grande Drainage Basin Improvements project is considered a reasonably foreseeable future project as part of the Cumulative Scenario (Scenario 4). In addition to the conditions used in Scenarios 1, 2, 3a and 3b, Scenario 4 required additional modifications to accommodate the Vista Grande Drainage Basin Improvements project.

The primary component of the Vista Grande Drainage Basin Improvements project is the diversion of stormwater flows directly into Lake Merced. As discussed in Section 6.9.4, Scenario 4 incorporates the 75 cfs scenario of the Vista Grande Drainage Basin Improvements project. Below is a summary of how the various aspects of the Vista Grande Drainage Basin Improvements project are addressed in the Lake-Level Model.

Stormwater discharges into Lake Merced would occur when discharge rates in the Vista Grande Canal exceed 75 cfs, and the excess flows would be diverted into Lake Merced. These flows occur periodically in response to large storms, and were calculated as part of the Vista Grande Drainage Basin Alternatives Analysis based on historical precipitation data (Brown and Caldwell, 2010, Jacobs Associates, 2011a, 2011b). Stormwater flows (greater than 75 cfs) were calculated to occur in every year, and range from 19 to 681 afy with an average of 207 afy (Brown and Caldwell, 2010). These stormwater flows were input directly into the Lake-Level Model as an inflow to Lake Merced. The Lake-Level Model was modified to incorporate the flows provided by Brown and Caldwell, and these changes are included here.

The Lake Merced Alternative scenarios of the Vista Grande Drainage Basin Improvements project also include provisions for an engineered wetland and modification of the Lake Merced spillway (Brown and Caldwell, 2010). In the 75 cfs scenario, the average baseflow in the Vista Grande Canal is assumed to be diverted into an engineered wetland for treatment and then discharged to Lake Merced on an ongoing basis. Typical flows in the Vista Grande Canal, or baseflow, would be continuously diverted through an engineered wetland for treatment prior to discharge into Lake Merced. Baseflows have been estimated to range from 18 to 26 af per month (Kennedy/Jenks, 2009). These were also added to the Lake-Level Model.

The Lake-Level Model results for Scenario 4 are presented in Attachment 10.1-G, and a composite hydrograph showing the Lake Merced water levels for these scenarios is shown in Figure 10.1-13.

8.4. Strengths and Limitations of the Lake Merced Lake-Level Model

The primary strength of the Lake-Level Model is that it has a more realistic conceptualization of the lake than does the MODFLOW Lake Package, and has been calibrated to historical data (Attachment 10.1-H). The primary conceptualization strengths include the followings:

- The Lake-Level Model has a significantly stronger correlation to the measured Lake Merced lake levels than the MODFLOW model over the 1958 to 2009 model calibration period. The MODFLOW model has periods where the simulated lake levels differ from the measured data by 3 to 6 feet. The improved performance by the Lake-Level Model is attributed to more site-specific and detailed handling of the hydrologic conditions. The relative strengths of the Lake-Level Model compared to the MODFLOW model for simulating Lake Merced are discussed in more detail in Attachment 10.1-H.
- The Lake-Level Model uses the measured June 2009 lake level of 5.7 feet (City Datum) as the starting condition. The MODFLOW model needs to use the calibrated model lake level of 9.33 feet (City Datum) to maintain equilibrium and not create mass balance issues. Therefore, the Lake-Level Model is more consistent with the Existing Conditions.
- The Lake-Level Model has a mechanism to account for the loss of water over the spillway that is automatically invoked anytime the lake level reaches the spillway level.
- The Lake-Level Model uses measured lake levels whereas the MODFLOW model needs to use simulated lake levels from the Historical Simulation.
- Estimates of stormwater runoff from the surrounding areas are calculated more realistically, allowing for variability of land use and other factors.
- The physical characterization of the lake accounts for changing lake surface area with changing lake levels, which is not available in the MODFLOW Lake Package.
- Evapotranspiration is allowed to vary depending on temperature data, based on whether the month is above, near, or below average.

The primary limitation of the Lake-Level Model is that the groundwater-surface water interactions are based upon an assumption of overall groundwater conditions. This is addressed in the analysis for the GSR and SFGW Projects and for the Cumulative Scenario, by changing this assumption and replacing it with the MODFLOW-generated water balance results for inflows to and outflows from Lake Merced. This change provides a more realistic estimation of groundwater-surface water interactions, especially for the proposed GSR and SFGW Project scenarios that do not necessarily have a historical precedent.

In light of the modeling strengths listed above and the better performance of the Lake-Level Model in simulating lake levels, the Lake-Level Model is considered to be a more appropriate modeling approach and is the primary tool for evaluating the effects of the GSR and SFGW Projects and the Cumulative Scenario on Lake Merced.

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Figure List

Table List

Attachment List

Attachment 10.1-F	Model Scenario Groundwater Elevation Contour Maps for Selected Time Periods
Attachment 10.1-G	Model Scenario Lake Hydrographs from Lake Merced Lake- Level Model
Attachment 10.1-H	Lake Merced Lake-Level Model Development Technical Memorandum

Figures

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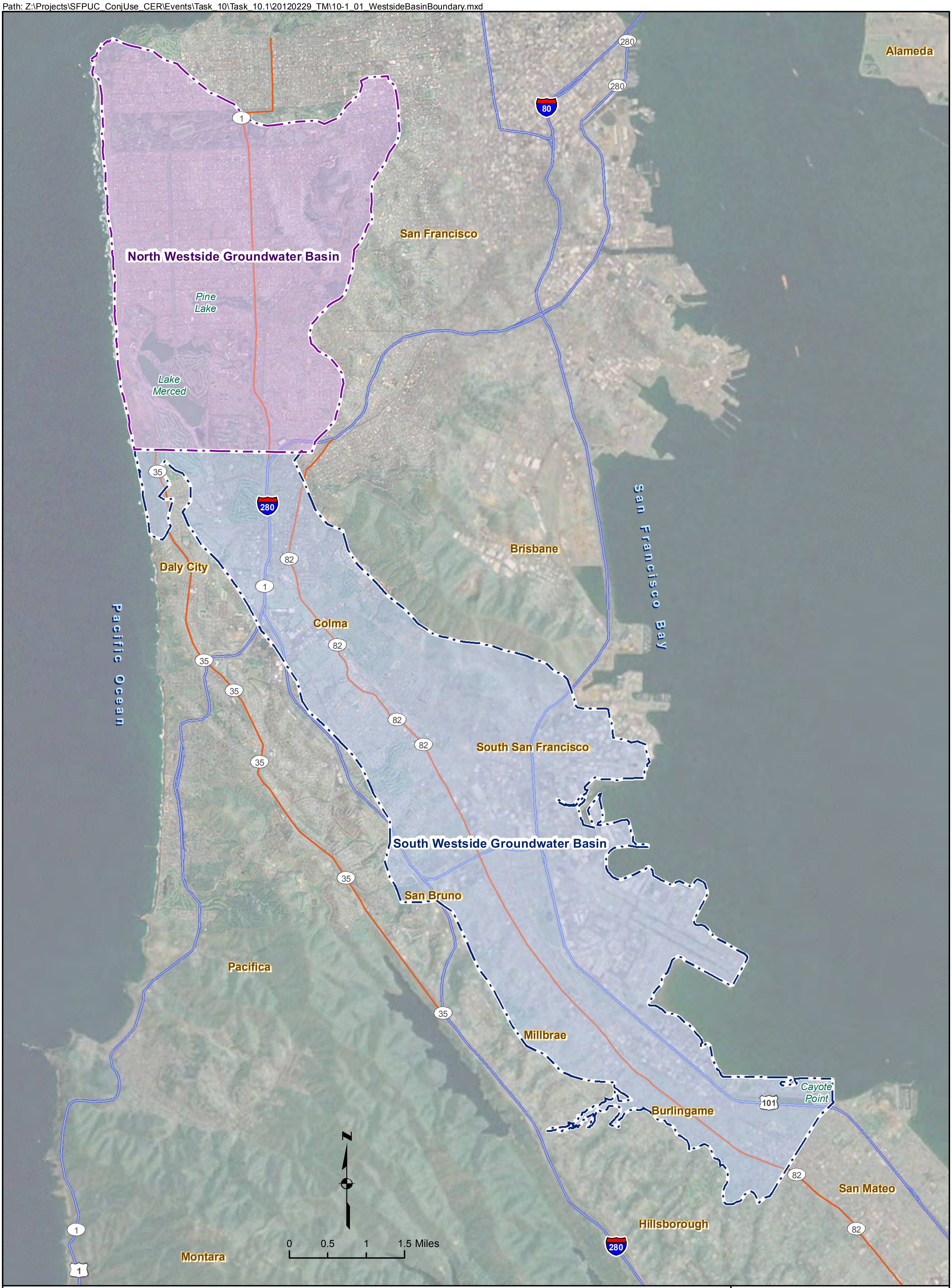

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CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
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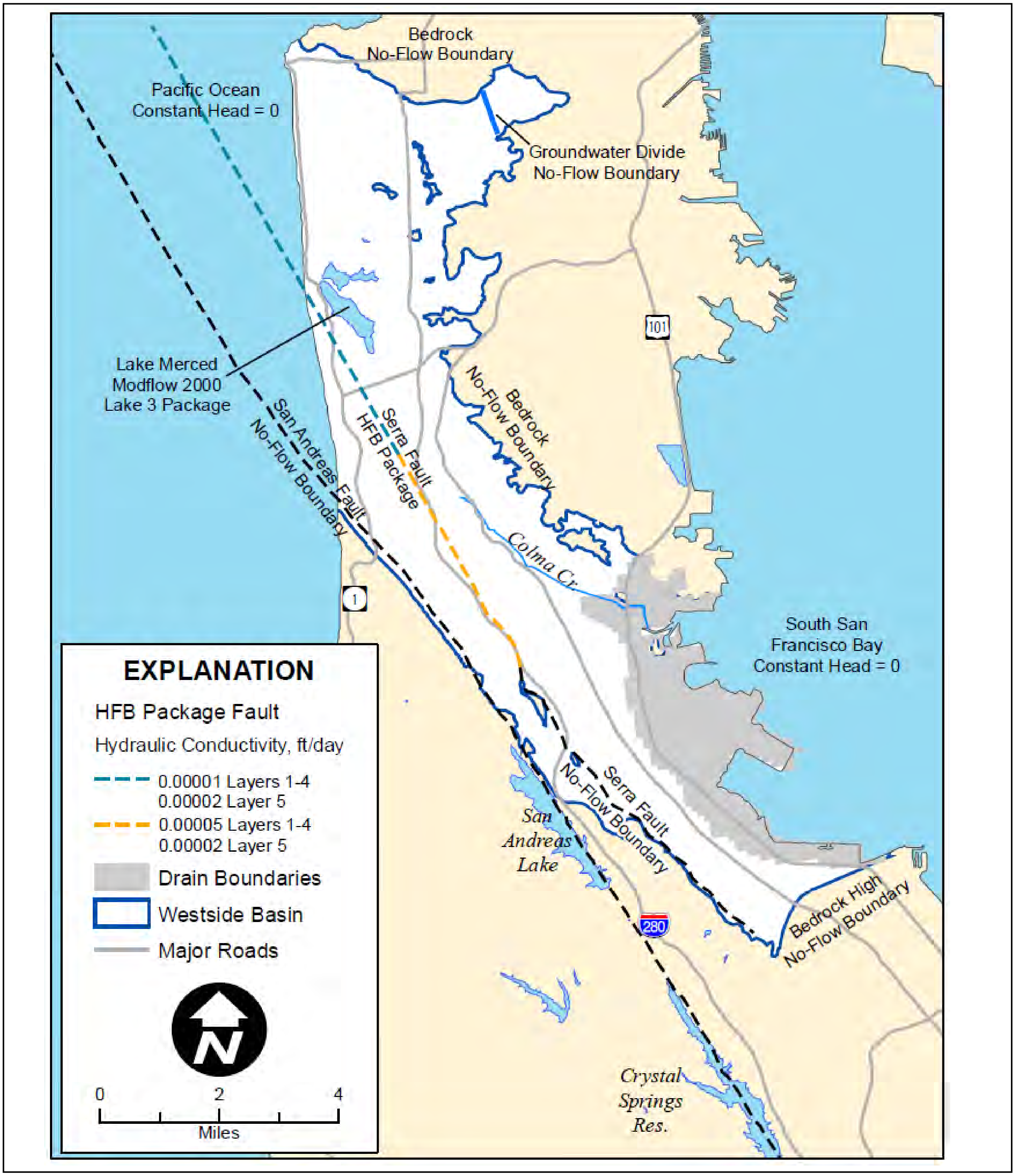
WESTSIDE GROUNDWATER BASIN BOUNDARY NORTH AND SOUTH WESTSIDE BASINS

Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Figure **10.1-1**

Date April 2012



Source: Westside Basin Groundwater-Flow Model; Updated Model and 2008 No Project Simulation Results, HydroFocus, May 2011.

Kennedy/Jenks Consultants

Regional Groundwater Storage and Recovery Project
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Westside Basin Groundwater-Flow Model Boundary

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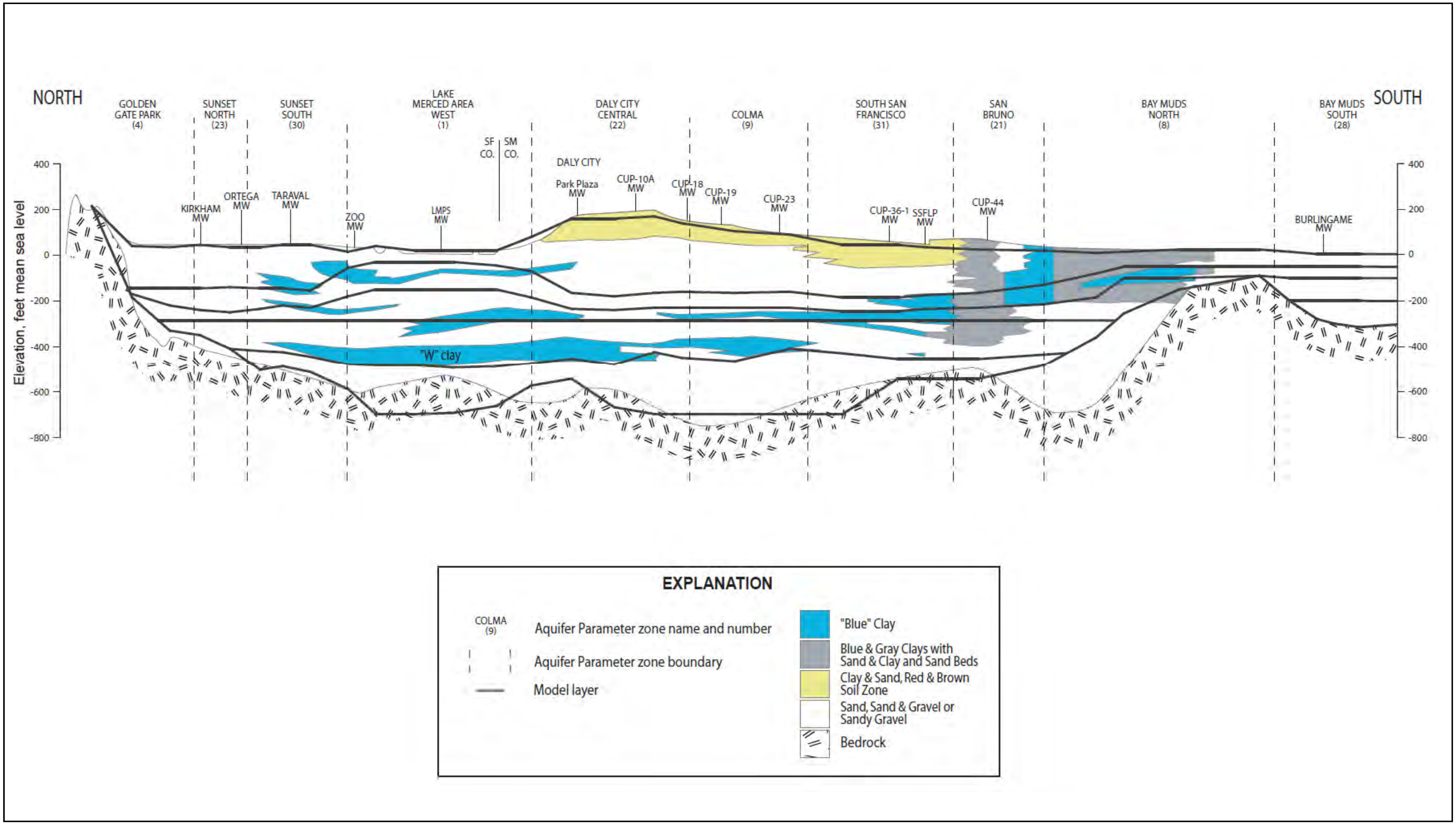
April 2012
Figure 10.1-2



Source: Westside Basin Groundwater-Flow Model; Updated Model and 2008 No Project Simulation Results, HydroFocus, May 2011.
Note: Modification from North South Geologic Cross Section, Final Task 8B technical Memorandum No.1, Hydrologic Setting of the Westside Basin, LSCE, May 2010.

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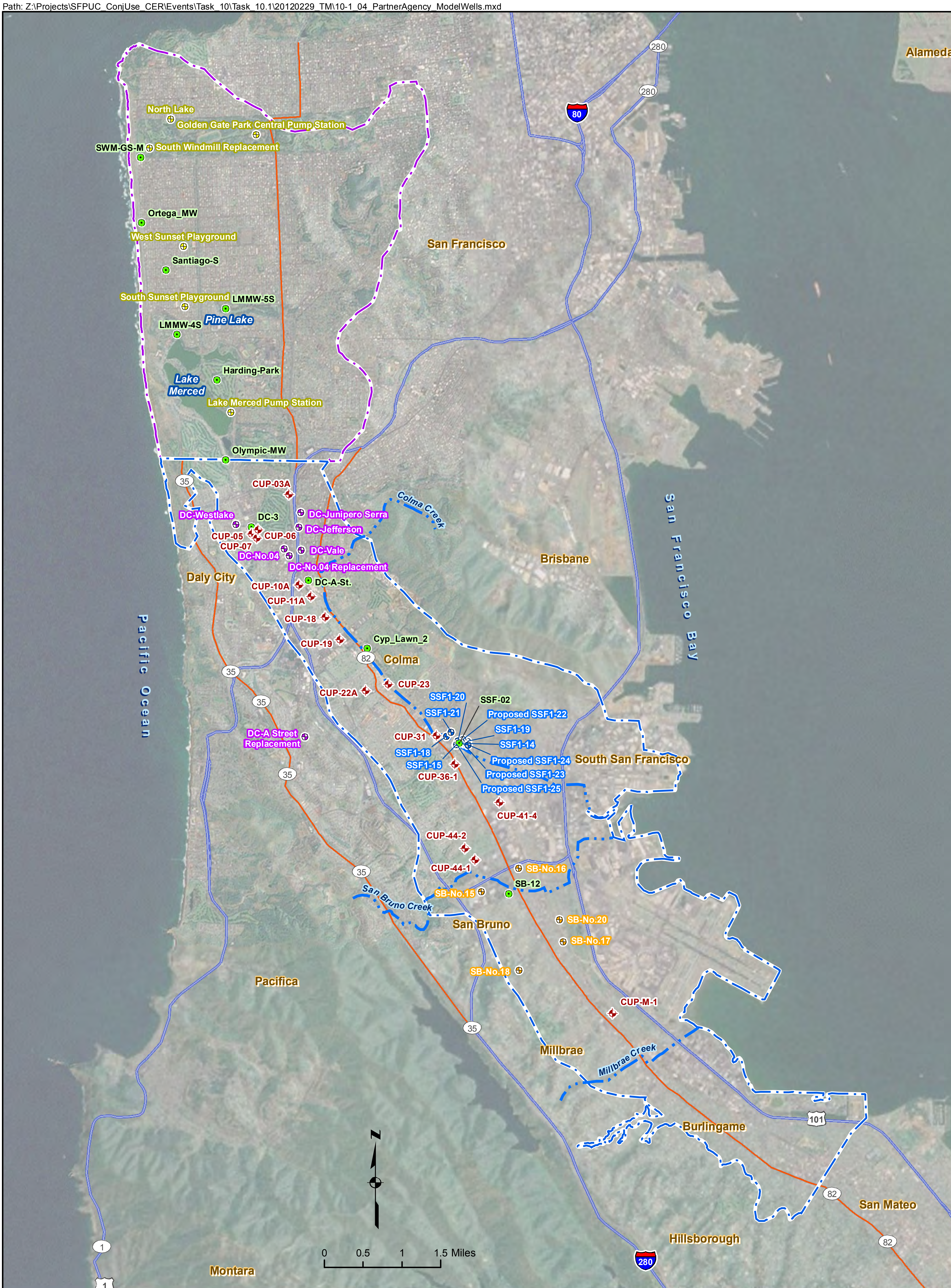
Westside Basin Groundwater-Flow Model Layer Structure and Regional Subsurface Hydrogeology

K/J 0864001
April 2012
Figure 10.1-3

Path: Z:\Projects\SFPUC_ConjUse_CER\Events\Task_10\Task_10.1\20120229_TM\10-1_04_PartnerAgency_ModelWells.mxd



Aerial Photo Source: World Imagery from ESRI. Copyright:© 2009 ESRI, AND, TANA, UNEP-WCMC

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- Selected Representative Monitoring Wells
- Cal Water Municipal Wells
- Daly City Municipal Wells
- San Bruno Municipal Wells
- South Westside Groundwater Basin
- North Westside Groundwater Basin

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

LOCATIONS OF PARTNER AGENCY WELLS, PROPOSED GSR AND SFGW PROJECT MUNICIPAL WELLS, AND SELECTED REPRESENTATIVE MONITORING WELLS WITH MODEL RESULTS

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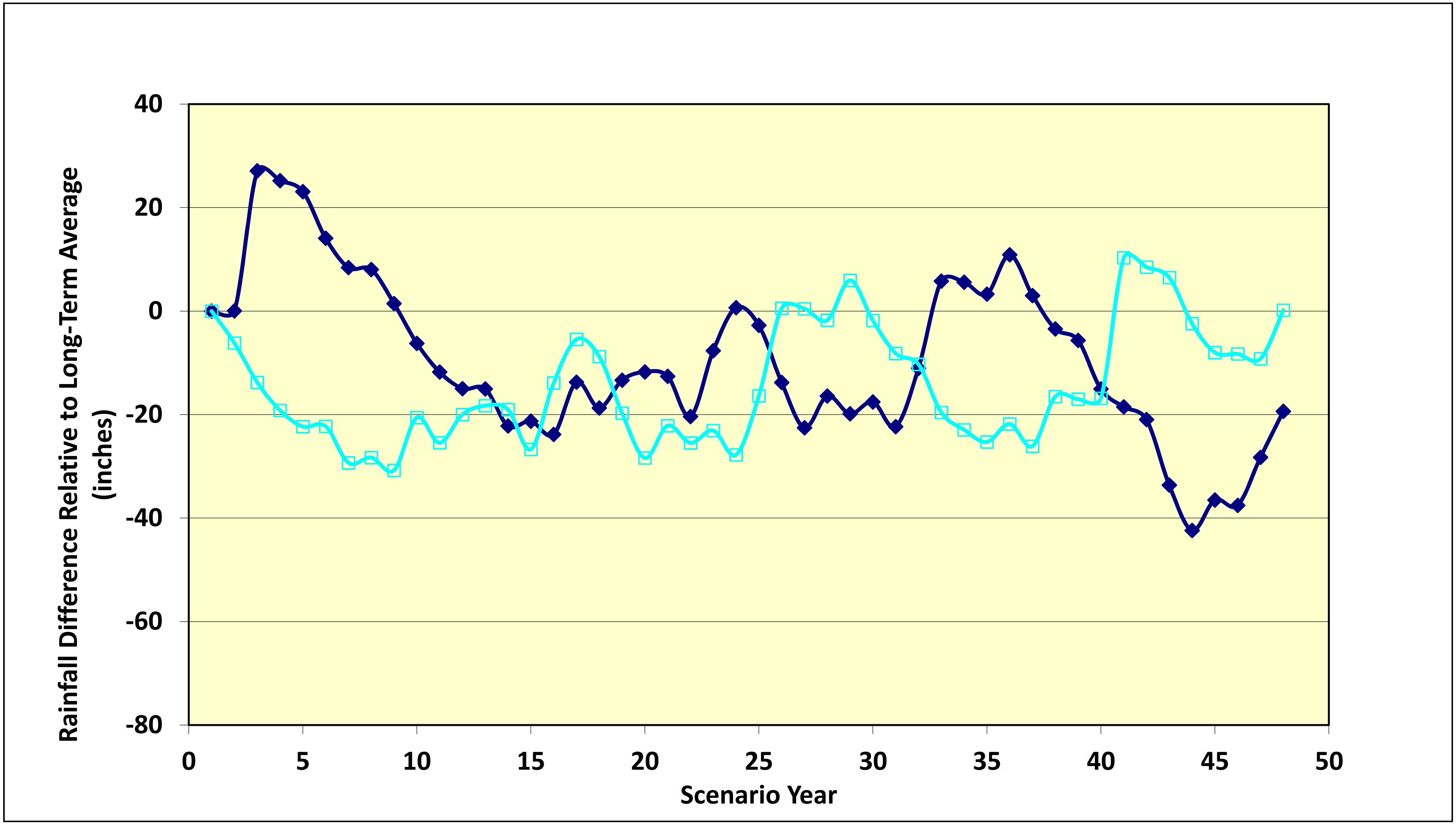
Figure **10.1-4**

Date April 2012



Cumulative Rainfall (inches):

Rearranged Hydrologic Sequence

Historical 1958 to 2005 Precipitation Data

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Cumulative Rainfall Departure Curve Analysis for Historical and Rearranged Hydrological Sequence

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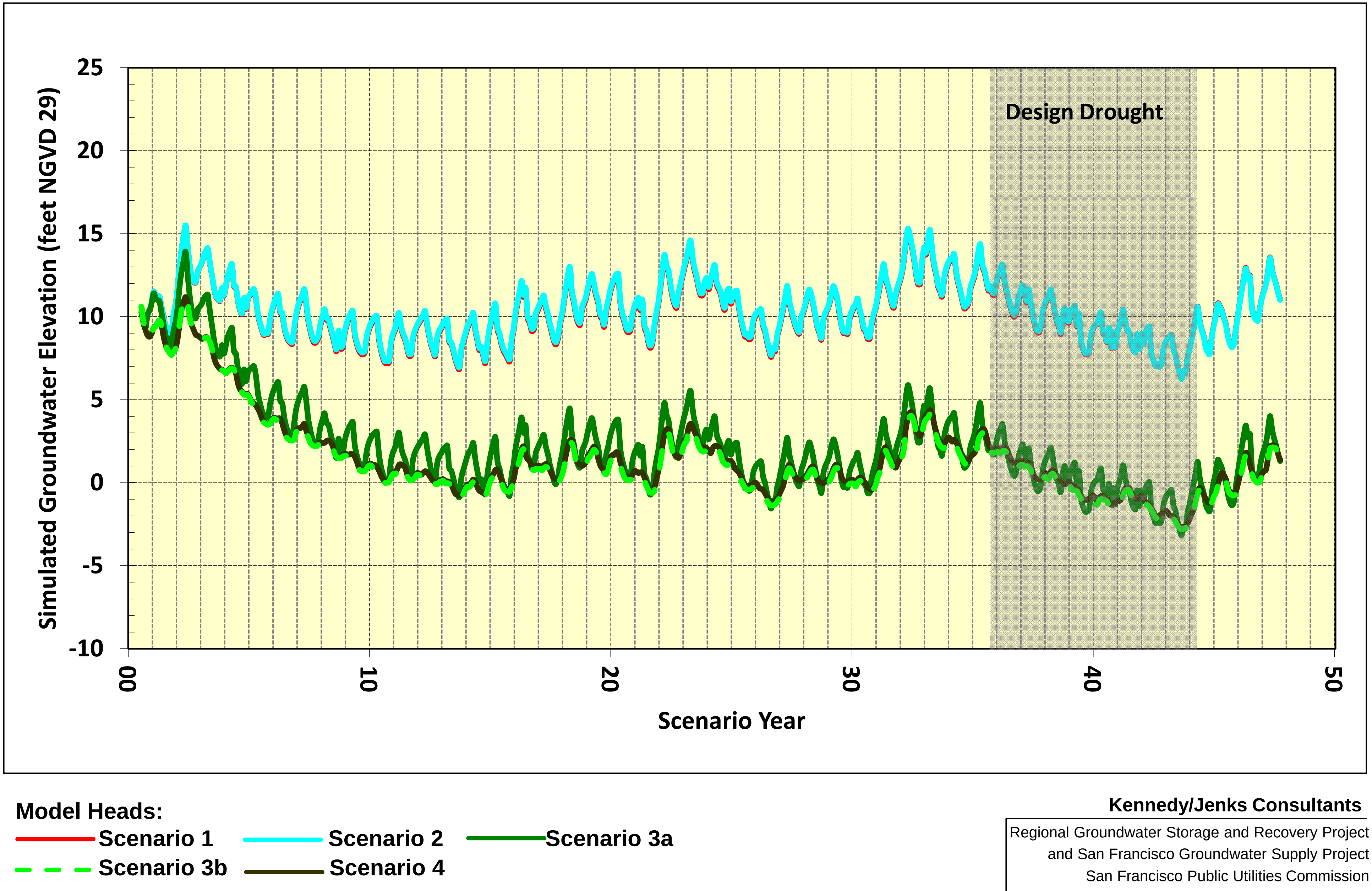
Figure 10.1-5



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Model-Simulated Groundwater Elevations at SWM-GS-M (Model Layer 1)

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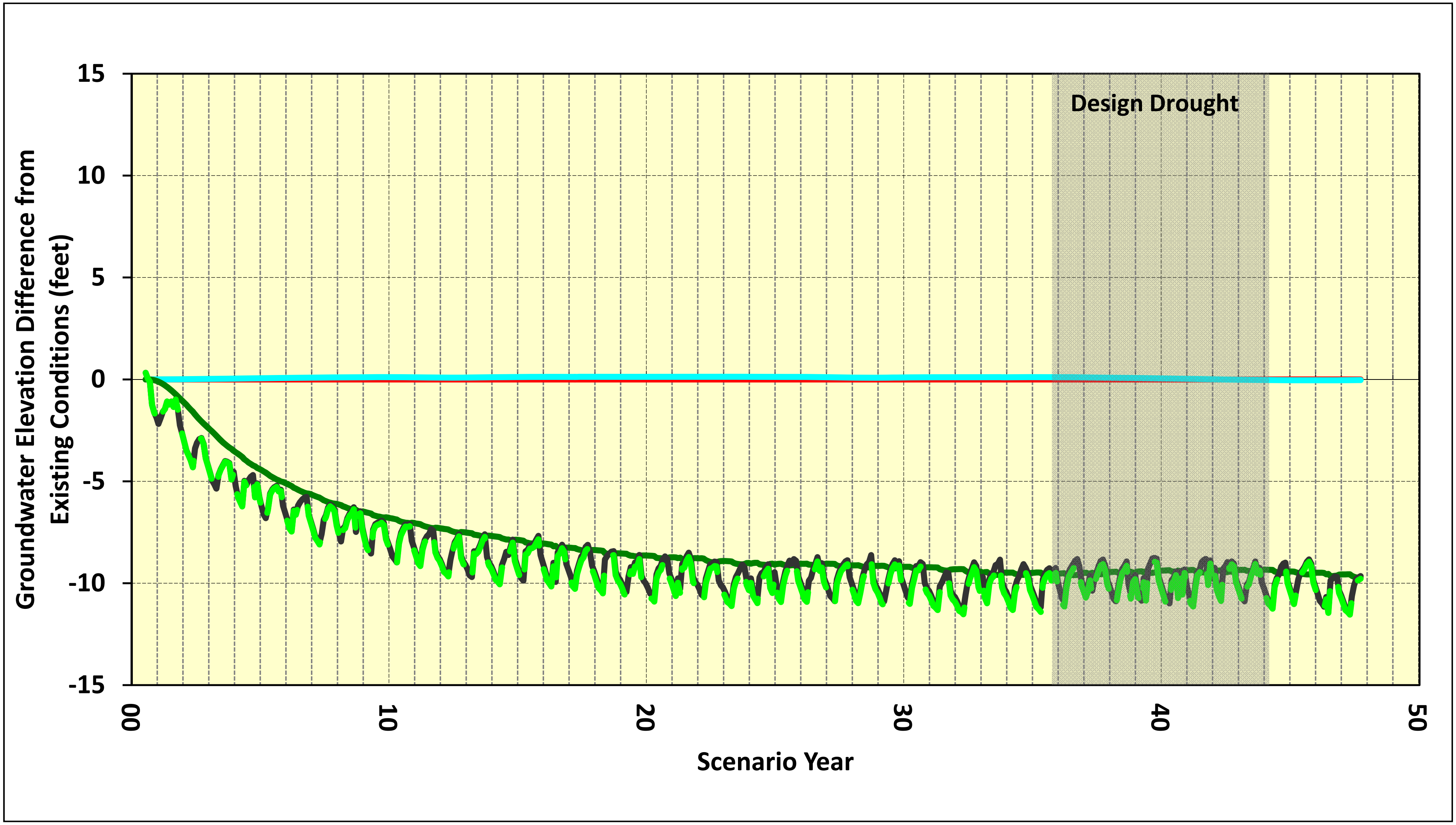
Figure 10.1-6



Model Heads:

Scenario 1 | Scenario 2 | Scenario 3a
Scenario 3b | Scenario 4

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Model-Simulated Groundwater Elevations Relative to Existing Conditions at SWM-GS-M (Model Layer 1)

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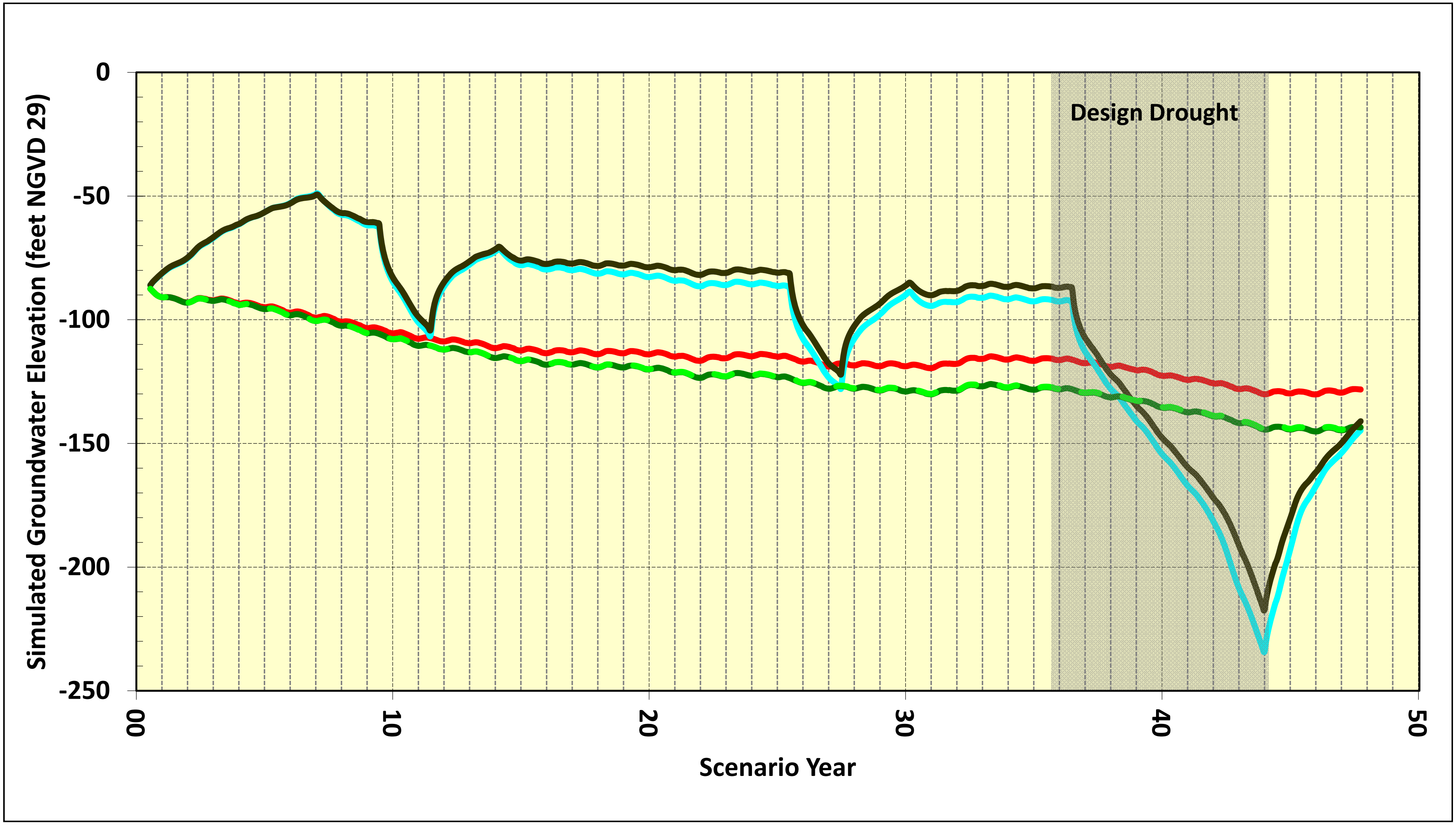
Figure 10.1-7



Model Heads:

Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

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Model-Simulated Groundwater Elevations at DC-A St (Model Layer 4)

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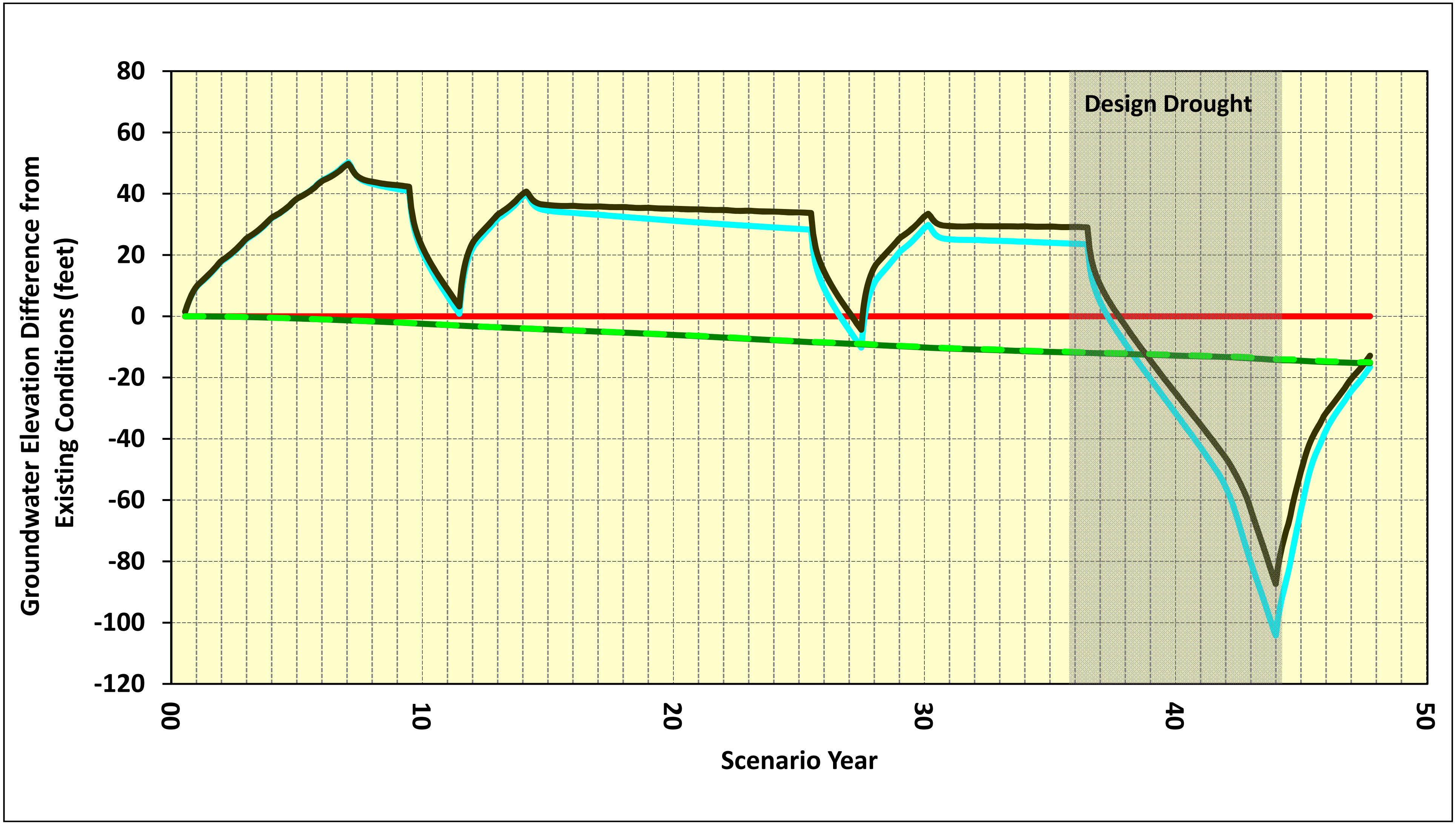
Figure 10.1-8



Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Model-Simulated Groundwater Elevations Relative to Existing Conditions at DC-A St (Model Layer 4)

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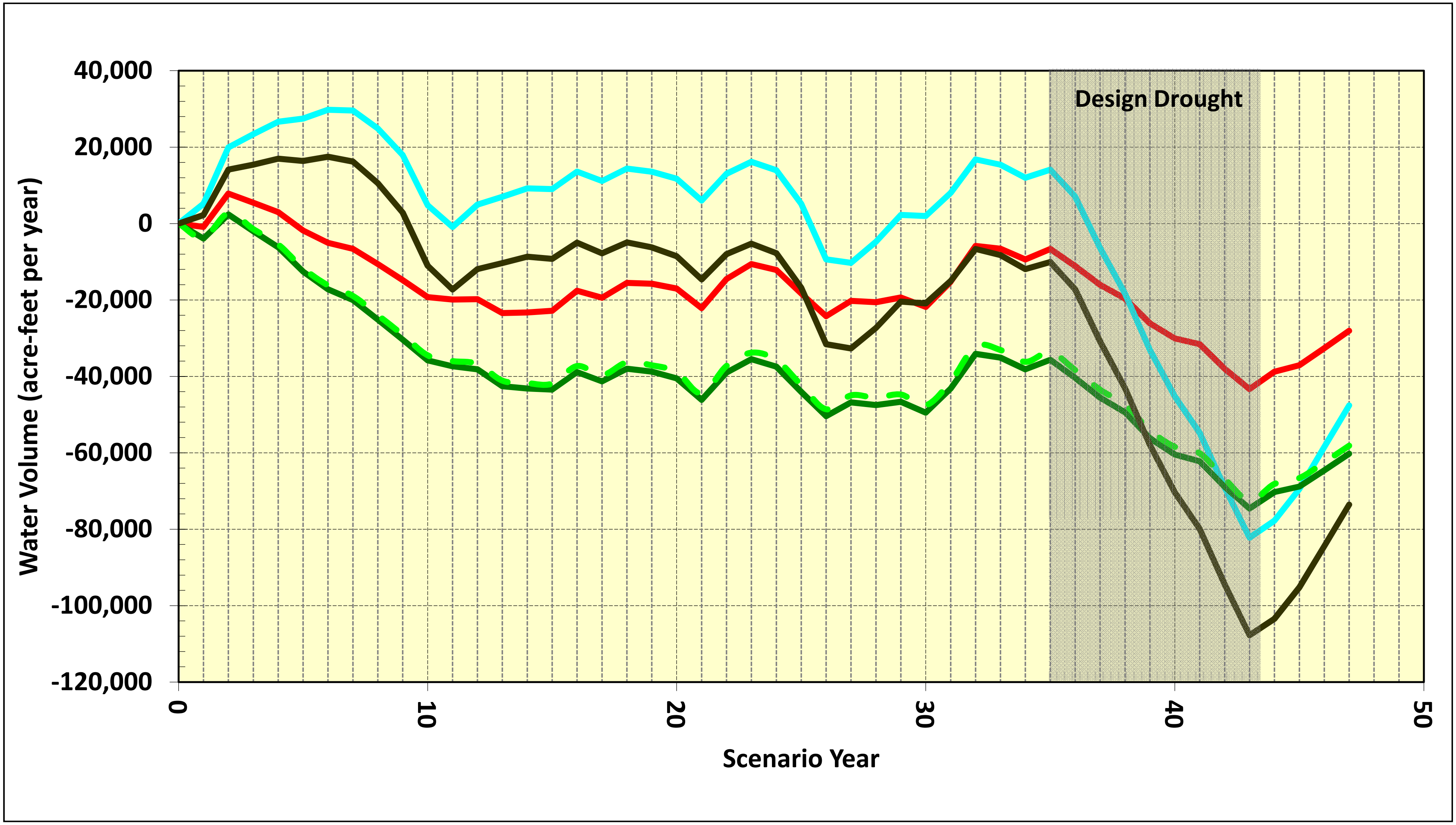
Figure 10.1-9



Aggregate Storages:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Model-Simulated Aggregate Change in Groundwater Storage

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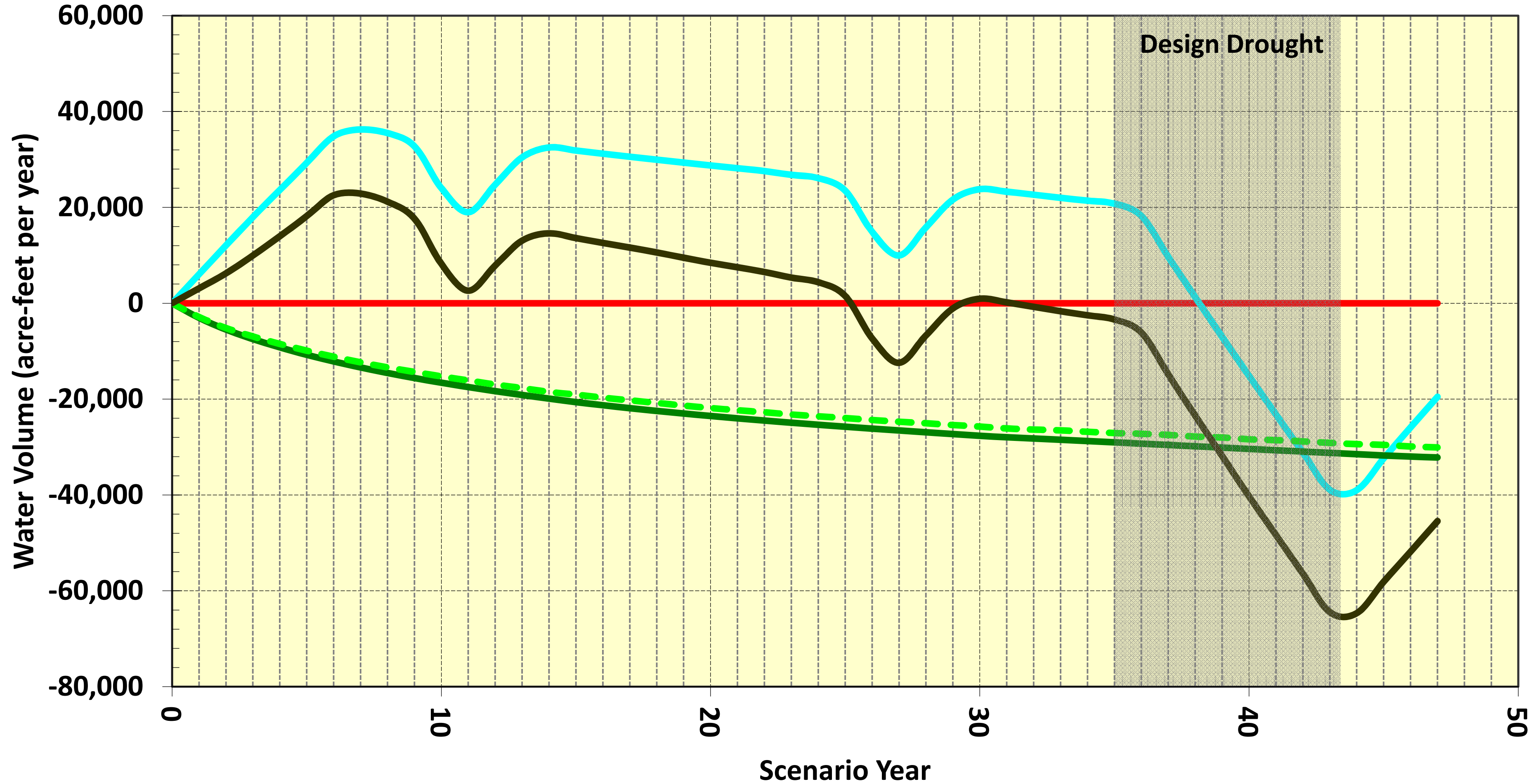
Figure 10.1-10



Aggregate Storages:
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

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Model-Simulated Aggregate Change in Groundwater Storage Relative to Existing Conditions

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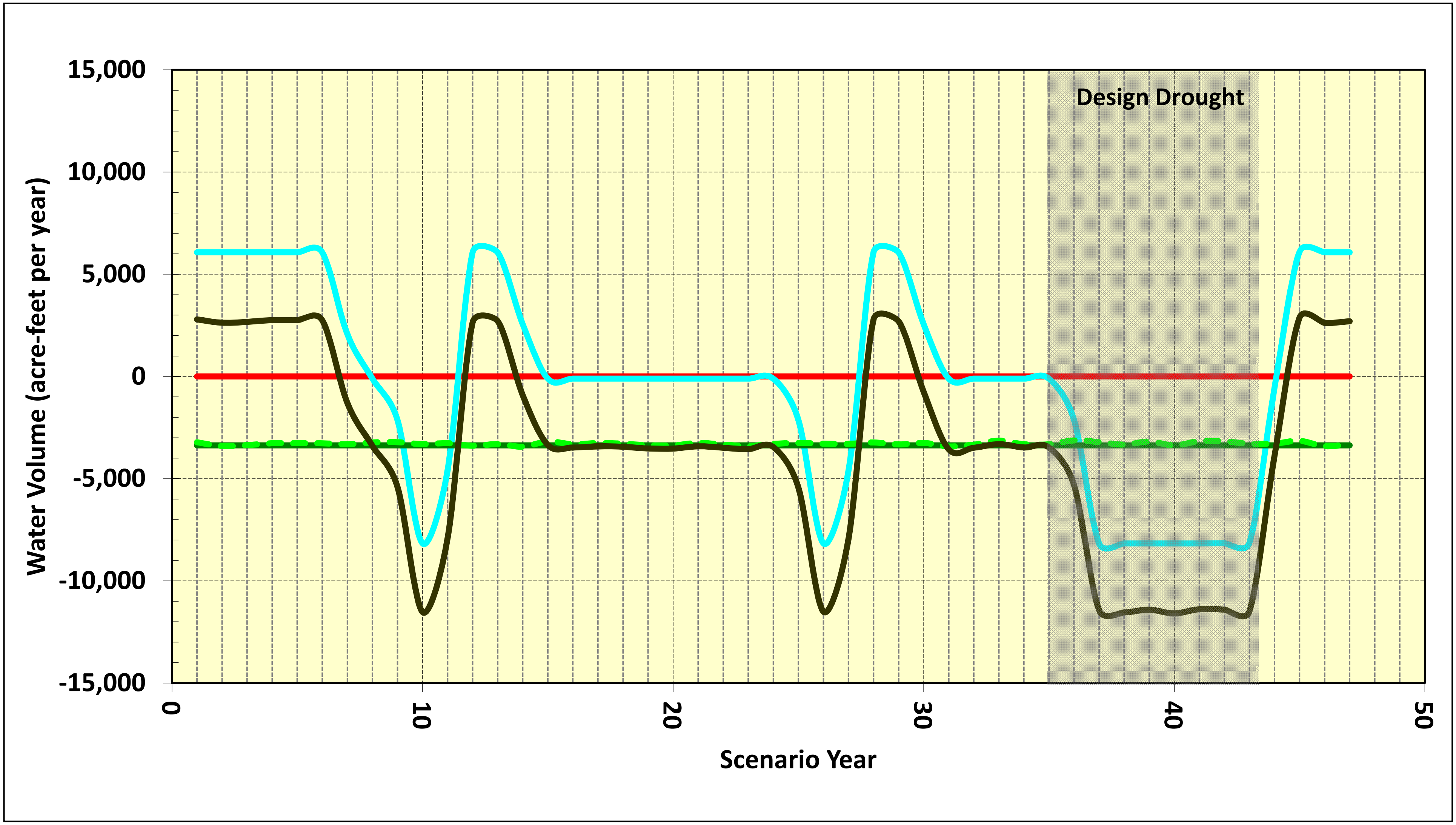
Figure 10.1-11



Pumping Relative to Existing Conditions:

Scenario 1 | Scenario 2 | Scenario 3a
Scenario 3b | Scenario 4

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Model-Simulated Net Change in Groundwater Pumping Relative to Existing Conditions

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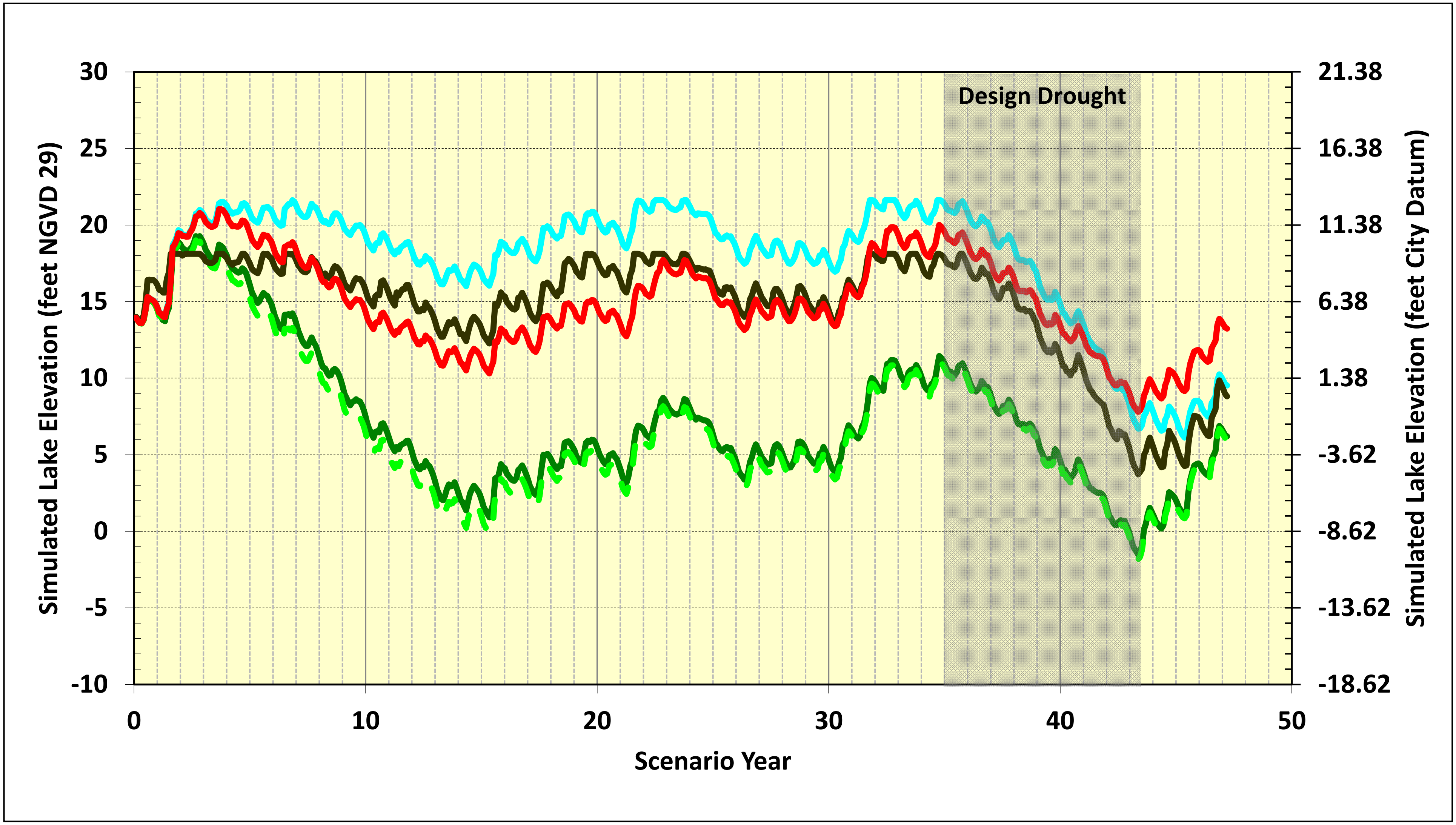
Figure 10.1-12



Model Lake Elevations:

Scenario 1 | Scenario 2 | Scenario 3a

Scenario 3b | Scenario 4

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Model-Simulated Lake Merced Lake Elevations Based on Lake Merced Lake-Level Model

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Figure 10.1-13

Tables

Table 10.1-1: Summary of Model Scenario Descriptions

Ref No.	Assumption	Scenario 1 - Existing Conditions	Scenario 2 - GSR	Scenario 3a/3b - SFGW	Scenario 4 - Cumulative
1	Source Model	2008 No-Project Scenario (HydroFocus, May 2011, ver. 3.1) was used as the basis with changes made for Scenario 1, as listed below.	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
2	Hydrology	Use the following sequence of historical hydrology provided by SFPUC (personal comm. between David Cameron and Michael Maley, 2011). Total model Scenario duration is 47 years and 3 months, constructed as follows: - Jul 1996 to Sep 2003 - Oct 1958 to Nov 1992 - Dec 1975 to Jun 1978 (to form the last two years of the Design Drought) - Jul 2003 to Sept 2006 (recovery period after the Design Drought)	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
3	Initial Groundwater Conditions	Model simulated June 2009 groundwater levels from the HydroFocus Historical Model (May 2011, ver. 3.1). This is selected because the available field measured groundwater elevation data for June 2009 were too sparse to construct adequate new groundwater elevation maps of sufficient detail necessary for assigning initial model conditions to all model layers and model cells. Therefore, an approximation method was developed that used the model to generate the initial groundwater elevations.	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
4	Initial Lake Merced Conditions	Model simulated June 2009 Lake Merced levels (17.95 ft NGVD 1929 or 9.33 ft City Datum at South, North, and Impound Lakes) from the HydroFocus Historical Simulation (May 2011, ver. 3.1). The reason SFPUC is proposing to use the simulated rather than measured (observed) Lake Merced water level is because this change will improve the model performance. Specifically, the use of simulated starting conditions will ensure that the model is in equilibrium. It is appropriate to use simulated starting conditions because the intent of the Model is to evaluate relative change and trends (rather than absolute changes and trends).	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
5	Lake Merced Lake Package	Lake package was revised consistent with the revised hydrological sequence; No stormwater inputs.	Same as Scenario 1	Same as Scenario 1	Lake package was revised consistent with the new hydrological sequence. The groundwater models use the Daly City proposed scenario "75 cfs Scenario with Completed Wetlands" (which includes wetlands and a spillway at 9.5 feet City Datum).
6	Recharge Package	Soil Moisture Budget (SMB) and recharge package were revised consistent with the revised hydrological sequence.	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
7	Partner Agency Total Pumping	6.84 mgd total pumping, based on the median of each agency pumping from 1959-2009. Pumping distributed among individual wells based on HydroFocus 2008 No-Project Scenario. - Daly City: 3.78 mgd - San Bruno: 1.88 mgd - Cal Water: 1.18 mgd	6.9 mgd total pumping - the amount of pumping determined to result in no appreciable storage change in the South Westside Basin (HydroFocus, 2011). - Daly City: 3.43 mgd - San Bruno: 2.10 mgd - Cal Water: 1.37 mgd	Same as Scenario 1 - 6.84 mgd total pumping	Same as Scenario 2 - 6.9 mgd total pumping
8	Daly City Municipal Wells	Daly City Jefferson Daly City Vale Daly City Westlake Daly City Junipero Serra Daly City No.4	Daly City Jefferson Daly City Vale Daly City Westlake Daly City Junipero Serra Daly City No.4	Daly City Jefferson Daly City Vale Daly City Westlake Daly City Junipero Serra Daly City No.4	Daly City Jefferson Daly City Vale Daly City Westlake Daly City Junipero Serra Daly City No.4 Replacement Daly City A Street Replacement
9	Cal Water Municipal Wells	SSF1-14 SSF1-15 SSF 1-17 (inactive) SSF1-18 SSF1-19 SSF1-20 SSF1-21 SSF1-22 SSF1-23	SSF1-15 SSF1-19 SSF1-20 SSF1-21 SSF1-22 SSF1-23	SSF1-14 SSF1-15 SSF 1-17 (inactive) SSF1-18 SSF1-19 SSF1-20 SSF1-21 SSF1-22 SSF1-23	SSF1-20 SSF1-21 SSF1-22 SSF1-23 SSF1-24 SSF1-25
10	San Bruno Municipal Wells	San Bruno No.15 San Bruno No.16 San Bruno No.17 San Bruno No.18 San Bruno No.20	San Bruno No.15 San Bruno No.16 San Bruno No.17 San Bruno No.18 San Bruno No.20	San Bruno No.15 San Bruno No.16 San Bruno No.17 San Bruno No.18 San Bruno No.20	San Bruno No.15 San Bruno No.16 San Bruno No.17 San Bruno No.18 San Bruno No.20
11	Irrigation pumping except changes noted below from Ref No. 12 through 17.	SMB was revised and irrigation pumping rates updated as necessary based on the results of the SMB, except for specific values noted in Ref No. 12 through 17 below.	Same as Scenario 1	Same as Scenario 1, except changes noted below (see the GGP irrigation [Ref. No. 12] and Stern Grove well pumping [Ref. No. 16]).	Same as Scenario 1, except changes noted below (see the GGP irrigation [Ref. No. 12] and Holy Cross irrigation [Ref. No. 17]).
12	Golden Gate Park (GGP) irrigation wells - Elk Glen, South Windmill, and North Lake	Modified irrigation pumping, based on 2008 metered data, provided by SFPUC (personal comm. between Jeff Gilman and Sevim Onsoy, 2011). Total pumping of 1.14 mgd (or 1,279 afy). - Elk Glen: 0.081 mgd (91 afy) - South Windmill: 0.498 mgd (558 afy) - North Lake: 0.563 mgd (631 afy)	Same as Scenario 1	Scenario 3a assumes same pumping assumptions as Scenario 1; Scenario 3b assumes no irrigation pumping from the three GGP wells.	Assumes no irrigation pumping from the three GGP wells.
13	California Golf No. 02	Revised irrigation pumping from 198 afy to 215 afy (from 0.18 mgd to 0.19 mgd), based on pumping rates provided verbally by the California Golf Club (personal comm. between Rick Kavakoff and Pete Leffler,2009).	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
14	Edgewood Development Center	Revised irrigation pumping from 8 afy to 10 afy (from 0.007 mgd to 0.009 mgd), based on pumping rates provided by SFPUC (personal comm. between Jeff Gilman and Sevim Onsoy, 2009).	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
15	Zoo. No.5	Revised from 447 to 360 afy (from 0.399 mgd to 0.321 mgd), based on average of 2005 - 2009, based on inputs provided by SFPUC (personal comm. between Jeff Gilman and Sevim Onsoy, 2011).	Same as Scenario 1	Same as Scenario 1	Same as Scenario 1
16	Stern Grove Well	Reduced pumping from 47 afy to 4.8 afy (from 0.042 mgd to 0.0043 mgd) for this well to account for the new information available about the use of this well as a supplemental water source for Pine Lake, based on inputs provided by SFPUC (personal comm. between Jeff Gilman and Sevim Onsoy, 2010).	Same as Scenario 1	Pumping reduced from 47 afy to 13.6 afy (from 0.042 mgd to 0.012 mgd) for Scenario 3a, which is 8.8 acre-feet more than under Scenario 1. Similarly, pumping reduced from 47 afy to 14.8 afy (from 0.042 mgd to 0.013 mgd) for Scenario 3b, which is 10 acre-feet more than under Scenario 1. These pumping values are based on the supplemental water needed to maintain the water level in Pine Lake at 31.5 feet (City Datum), as discussed in the CDM report (January, 2011).	Same as Scenario 3b
17	Holy Cross	Irrigation pumping rates are based on the results of the revised SMB. The resulting annual average pumping is 0.19 mgd (212 afy).	Same as Scenario 1	Same as Scenario 1	Additional pumping of 45 afy (0.04 mgd) estimated based on the future projected buildout (personal comm. between Roger Appleby and Pete Leffler, 2010).

Key:
afy - acre-feet per year
SMB - Soil Moisture Budget
GGP - Golden Gate Park
GSR - Regional Groundwater Storage and Recovery
mgd - million gallons per day
SFGW - San Francisco Groundwater Supply

Table 10.1-2: Summary of Model Scenario Pumping Assumptions

Model Scenarios		Scenario 1 Existing Conditions	Scenario 2 GSR	Scenario 3a SFGW	Scenario 3b SFGW	Scenario 4 Cumulative
Establish Initial Conditions		Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence
	June 2009 Condition	√	√	√	√	√
Model Scenario Simulation Period						
	47.25 years (including Design Drought) Hydrologic Sequence: July 1996 to September 2003 -> October 1958 to November 1992 -> December 1975 to June 1978 -> July 2003 - September 2006		√	√	√	√
Pumping Assumptions for Municipal Use						
PA Municipal Wells (mgd)						
	"Take" Periods	6.84	6.90	6.84	6.84	6.90
	"Put" Periods	6.84	1.38	6.84	6.84	1.38
	"Hold" Periods	6.84	6.90	6.84	6.84	6.90
GSR Project Proposed Municipal Wells (mgd)						
	"Take" Periods	0.0	7.23	0.0	0.0	7.23
	"Put" Periods	0.0	0.04	0.0	0.0	0.04
	"Hold" Periods	0.0	0.04	0.0	0.0	0.04
SFGW Project Proposed Municipal Wells (mgd)						
	Year-Round Pumping	0.0	0.0	3.0	4.0	4.0
Total Municipal Pumping (PA + GSR + SFGW)						
	"Take" Periods	***6.84***	***14.13***	***9.84***	***10.84***	***18.13***
	"Put" Periods	***6.84***	***1.42***	***9.84***	***10.84***	***5.42***
	"Hold" Periods	***6.84***	***6.94***	***9.84***	***10.84***	***10.94***
Irrigation and Other Non-Potable Pumping Assumptions (mgd)[1]						
Golden Gate Park	Elk Glen (GGP)	0.081	0.081	0.081	0.000	0.000
	South Windmill (GGP)	0.498	0.498	0.498	0.000	0.000
	North Lake (GGP)	0.563	0.563	0.563	0.000	0.000
	Sub-Total	***1.142***	***1.142***	***1.142***	***0.000***	***0.000***
Golf Courses	Burlingame Golf Club	0.150	0.150	0.150	0.150	0.150
	California Golf No. 02	0.192	0.192	0.192	0.192	0.192
	Green Hills No. 05	0.099	0.099	0.099	0.099	0.099
	Lake Merced Golf No. 01	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 02	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 03	0.010	0.010	0.010	0.010	0.010
	Olympic Club No. 09[2]	0.002	0.002	0.002	0.002	0.002
	SF Golf West	0.035	0.035	0.035	0.035	0.035
	Sub-Total	***0.495***	***0.495***	***0.495***	***0.495***	***0.495***
Cemeteries	Cypress Lawn No. 02	0.020	0.020	0.020	0.020	0.020
	Cypress Lawn No. 03	0.144	0.144	0.144	0.144	0.144
	Eternal Home	0.013	0.013	0.013	0.013	0.013
	Hills of Eternity No. 02	0.020	0.020	0.020	0.020	0.020
	Holy Cross No. 03[3]	0.190	0.190	0.190	0.190	0.230
	Home of Peace No. 02	0.039	0.039	0.039	0.039	0.039
	Italian Cemetery	0.033	0.033	0.033	0.033	0.033
	Olivet	0.098	0.098	0.098	0.098	0.098
	Woodlawn No. 02	0.085	0.085	0.085	0.085	0.085
	Sub-Total	***0.641***	***0.641***	***0.641***	***0.641***	***0.681***
Other	Hillsborough Residents No. 1-12	0.291	0.291	0.291	0.291	0.291
	Edgewood Development Ctr.	0.009	0.009	0.009	0.009	0.009
	Zoo No.05	0.321	0.321	0.321	0.321	0.321
	Stern Grove	0.004	0.004	0.012	0.013	0.013
	Sub-Total	***0.626***	***0.626***	***0.634***	***0.635***	***0.635***
Total Irrigation and Other Non-Potable Pumping		***2.90***	***2.90***	***2.91***	***1.77***	***1.81***

Key:
afy - acre-feet per year
mgd - million gallons per day
PA - Partner Agencies
GGP - Golden Gate Park
GSR - Regional Groundwater Storage and Recovery
SFGW - San Francisco Groundwater Supply
SFPUC - San Francisco Public Utilities Commission

Notes:
(1) Pumping wells that are listed identify the wells in the model scenarios whose pumping assumptions were modified compared to the 2008 No-Project Scenario by HydroFocus (May, 2011, ver. 3.1), as a result of revised Soil Moisture Budget (SMB). Pumping rates for the three wells in the GGP, California Golf No. 02, Edgewood Development Center, Zoo No. 05, and Stern Grove wells were further modified compared to the results of revised SMB.
(2) Olympic Club No. 09 values include pumping for both Olympic Golf Club wells.
(3) Holy Cross No. 3 well irrigation pumping for Scenarios 1, 2, 3a, and 3b is based on the results of revised SMB. Based on the projected future build-out at the Holy Cross cemetery, an additional pumping of 0.04 mgd (45 afy) was estimated to occur under Scenario 4 (Cumulative).

Table 10.1-3: Regional Groundwater Storage and Recovery Project Proposed Municipal Wells

Well No.	Well Site	NOP Well Site[1]	Location	Estimated Pumping Capacity (gpm)[2]
1	CUP-3A	1	Daly City	400
2	CUP-5	3	Daly City	300
3	CUP-6	2	Daly City	300
4	CUP-7	4	Daly City	300
5	CUP-10A	5	Daly City	400
6	CUP-11A	6	Daly City	400
7	CUP-18	7	Colma	400
8	CUP-19	8	Colma	400
9	CUP-22A	10	South San Francisco	330
10	CUP-23	9	South San Francisco	330
11	CUP-31	11	South San Francisco	220
12	CUP-36-1	12	South San Francisco	220
13	CUP-41-4	13	South San Francisco	220
14	CUP-44-1	15	San Bruno	330
15	CUP-44-2	14	San Bruno	330
16	CUP-M-1	16	Millbrae	160

Key:
gpm - gallons per minute
NOP - Notice of Preparation

Notes:
(1) NOP of the EIR for the Regional Groundwater Storage and Recovery Project dated June 24, 2009.
(2) Estimated pumping capacities based on the Final Conceptual Engineering Report prepared for the Regional Groundwater Storage and Recovery Project (MWH, 2008).

Table 10.1-4: Partner Agency Municipal Pumping Wells

Location	Well Name	Note
Daly City Municipal Wells		
Daly City	Daly City Jefferson	Existing
Daly City	Daly City Vale	Existing
Daly City	Daly City Westlake	Existing
Daly City	Daly City Junipero Serra	Existing
Daly City	Daly City No. 4	Existing
Daly City	Daly City No. 4 Replacement	Proposed Replacement
Daly City	Daly City A Street Replacement	Proposed Replacement
Cal Water Municipal Wells		
South San Francisco	SSF1-14	Existing
South San Francisco	SSF1-15	Existing
South San Francisco	SSF1-17 (inactive)	Existing
South San Francisco	SSF1-18	Existing
South San Francisco	SSF1-19	Existing
South San Francisco	SSF1-20	Existing
South San Francisco	SSF1-21	Existing
South San Francisco	SSF1-22	Proposed
South San Francisco	SSF1-23	Proposed
South San Francisco	SSF1-24 (redundant)	Proposed
South San Francisco	SSF1-25 (redundant)	Proposed
San Bruno Municipal Wells		
San Bruno	San Bruno No. 15	Existing
San Bruno	San Bruno No. 16	Existing
San Bruno	San Bruno No. 17	Existing
San Bruno	San Bruno No. 18	Existing
San Bruno	San Bruno No. 20	Existing

Table 10.1-5: SFPUC Supplemental Surface Water Deliveries

Date	Cal Water (af)	Daly City (afy)	San Bruno (af)
October-2002	0.0	189.2	0.0
November-2002	0.0	241.5	0.0
December-2002	0.0	250.2	0.0
January-2003	0.0	258.5	72.1
February-2003	77.9	225.7	183.6
March-2003	86.3	248.7	203.3
April-2003	83.5	240.9	196.7
May-2003	86.3	248.3	203.3
June-2003	83.5	240.7	196.7
July-2003	86.3	248.2	203.3
August-2003	86.3	248.9	198.1
September-2003	83.5	239.7	196.7
October-2003	86.3	250.9	190.2
November-2003	41.7	0.0	24.2
December-2003	0.0	0.0	0.0
January-2004	0.0	0.0	0.0
February-2004	0.0	0.0	0.0
March-2004	0.0	0.0	0.0
April-2004	86.3	250.9	150.8
May-2004	83.5	259.2	203.3
June-2004	86.3	280.2	144.3
July-2004	83.5	289.8	203.3
August-2004	86.3	291.4	203.3
September-2004	86.3	282.6	196.7
October-2004	83.5	324.6	203.3
November-2004	86.3	267.0	196.7
December-2004	83.5	286.8	203.3
January-2005	86.3	0.0	203.3
February-2005	86.3	251.6	137.7
March-2005	77.9	285.7	0.0
April-2005	86.3	252.4	0.0
May-2005	83.5	285.8	0.0
June-2005	86.3	276.3	0.0
July-2005	83.5	286.6	0.0
August-2005	86.3	287.4	0.0
September-2005	86.3	278.8	0.0
October-2005	83.5	288.0	0.0
November-2005	86.3	280.1	0.0
December-2005	83.5	297.7	0.0
January-2006	86.3	286.7	0.0
February-2006	86.3	261.4	0.0
March-2006	77.9	289.2	0.0
April-2006	86.3	277.9	0.0
May-2006	83.5	0.0	0.0
June-2006	86.3	0.0	0.0
July-2006	83.5	318.4	0.0
August-2006	86.3	264.9	0.0
September-2006	86.3	259.2	0.0
October-2006	83.5	264.9	0.0
November-2006	86.3	275.4	0.0
December-2006	83.5	286.0	0.0
January-2007	86.3	284.9	0.0
February-2007	0.0	250.7	0.0
March-2007	0.0	251.8	0.0
April-2007	0.0	235.1	0.0
May-2007 to Dec-2009	No supplemental water deliveries		
Total	***3,685***	***12,541***	***3,914***

Source: Data provided by SFPUC.

Key: af - acre-feet

Note: This table contains SFPUC's monthly supplemental water deliveries to Daly City, Cal Water, and San Bruno from October 2002 to December 31, 2009. The supplemental water deliveries account for the SFPUC Storage Account of 20,000 acre-feet of water stored in the basin through the In-Lieu Demonstration Study.

Table 10.1-6: San Francisco Groundwater Supply Project Proposed Municipal Wells

Well No.	Well Name	Normal Design Pumping Capacity		Average Pumping Rate Based on 4.0 mgd Total[1]	
		gpm	mgd	gpm	mgd
1	Lake Merced Pump Station	600 (17 hour/day)	0.61	299	0.43
2	South Sunset Playground	500	0.72	317	0.46
3	West Sunset Playground	650	0.94	412	0.59
4	GGP Central Pump Station	1,500	2.16	951	1.37
5	South Windmill Replacement	1,000	1.44	451	0.65
6	North Lake	500	0.72	347	0.50
	Total	**-**	***6.59***	**-**	***4.00***

Key:
gpm - gallons per minute
mgd - million gallons per day
GGP - Golden Gate Park

Notes:
(1) Six SFGW Project wells included in the table would be pumping for project target pumping rate at 4.0 mgd.

Table 10.1-7: Proposed Pumping Rate Assumptions for Regional Groundwater Storage and Recovery Project Proposed Municipal Wells and Partner Agency Municipal Wells

		Scenario 1 Scenario 3a/3b - SFGW	Scenario 2 GSR				Scenario 4 Cumulative			
Location	Well Site/ Well Name	Pumping Year Round (mgd)	Pumping During "Take" Periods (mgd)	Pumping During "Put" Periods (mgd)	Pumping During "Hold" Periods (mgd)	In-Lieu Recharge During "Put" Periods (mgd)	Pumping During "Take" Periods (mgd)	Pumping During "Put" Periods (mgd)	Pumping During "Hold" Periods (mgd)	In-Lieu Recharge During "Put" Periods (mgd)
Regional Groundwater Storage and Recovery Project Proposed Municipal Wells										
Daly City	CUP-3A	-	0.57	0.003	0.003	-	0.57	0.003	0.003	-
Daly City	CUP-5	-	0.43	0.002	0.002	-	0.43	0.002	0.002	-
Daly City	CUP-6	-	0.43	0.002	0.002	-	0.43	0.002	0.002	-
Daly City	CUP-7	-	0.43	0.002	0.002	-	0.43	0.002	0.002	-
Daly City	CUP-10A	-	0.57	0.003	0.003	-	0.57	0.003	0.003	-
Daly City	CUP-11A	-	0.57	0.003	0.003	-	0.57	0.003	0.003	-
Colma	CUP-18	-	0.57	0.003	0.003	-	0.57	0.003	0.003	-
Colma	CUP-19	-	0.57	0.003	0.003	-	0.57	0.003	0.003	-
South San Francisco	CUP-22A	-	0.47	0.003	0.003	-	0.47	0.003	0.003	-
South San Francisco	CUP-23	-	0.47	0.003	0.003	-	0.47	0.003	0.003	-
South San Francisco	CUP-31	-	0.32	0.002	0.002	-	0.32	0.002	0.002	-
South San Francisco	CUP-36-1	-	0.32	0.002	0.002	-	0.32	0.002	0.002	-
South San Francisco	CUP-41-4	-	0.32	0.002	0.002	-	0.32	0.002	0.002	-
San Bruno	CUP-44-1	-	0.47	0.003	0.003	-	0.47	0.003	0.003	-
San Bruno	CUP-44-2	-	0.47	0.003	0.003	-	0.47	0.003	0.003	-
Millbrae	CUP-M-1	-	0.23	0.001	0.001	-	0.23	0.001	0.001	-
	Sub-Total		***7.23***	***0.04***	***0.04***	***-***	***7.23***	***0.04***	***0.04***	***-***
Partner Agency Municipal Wells										
Daly City Municipal Wells										
Daly City	Daly City Jefferson	0.72	0.65	0.13	0.65	0.52	0.57	0.11	0.57	0.46
Daly City	Daly City Vale	0.98	0.89	0.18	0.89	0.71	0.57	0.11	0.57	0.46
Daly City	Daly City Westlake	0.76	0.69	0.14	0.69	0.55	0.57	0.11	0.57	0.46
Daly City	Daly City Junipero Serra	0.95	0.86	0.17	0.86	0.69	0.57	0.11	0.57	0.46
Daly City	Daly City No. 4	0.38	0.34	0.07	0.34	0.27	-	-	-	-
Daly City	Daly City No.4 Replacement	-	-	-	-	-	0.57	0.11	0.57	0.46
Daly City	Daly City A Street Replacement	-	-	-	-	-	0.57	0.1	0.6	0.5
	Sub-Total	***3.78***	***3.43***	***0.69***	***3.43***	***2.74***	***3.43***	***0.69***	***3.43***	***2.74***
Cal Water Municipal Wells										
South San Francisco	SSF1-14	0.13	-	-	-	-	-	-	-	-
South San Francisco	SSF1-15	0.09	0.0	0.0	0.0	0.0	-	-	-	-
South San Francisco	SSF1-17 (inactive)	0.00	-	-	-	-	-	-	-	-
South San Francisco	SSF1-18	0.23	-	-	-	-	-	-	-	-
South San Francisco	SSF1-19	0.23	0.17	0.03	0.17	0.14	-	-	-	-
South San Francisco	SSF1-20	0.22	0.16	0.03	0.16	0.13	0.26	0.05	0.26	0.21
South San Francisco	SSF1-21	0.28	0.22	0.04	0.22	0.18	0.29	0.06	0.29	0.23
South San Francisco	SSF1-22	0.00	0.48	0.10	0.48	0.38	0.48	0.10	0.48	0.38
South San Francisco	SSF1- 23	0.00	0.34	0.07	0.34	0.27	0.34	0.07	0.34	0.27
South San Francisco	SSF1-24 (redundant)	-	-	-	-	-	Per Cal Water letter to SFPUC dated Jan 19, 2011, this well is shown redundant			
South San Francisco	SSF1-25 (redundant)	-	-	-	-	-	Per Cal Water letter to SFPUC dated Jan 19, 2011, this well is shown redundant			
	Sub-Total	***1.18***	***1.37***	***0.27***	***1.37***	***1.10***	***1.37***	***0.27***	***1.37***	***1.10***
San Bruno Municipal Wells										
San Bruno	San Bruno No. 15	0.23	0.25	0.05	0.25	0.20	0.25	0.05	0.25	0.20
San Bruno	San Bruno No. 16	0.49	0.55	0.11	0.55	0.44	0.55	0.11	0.55	0.44
San Bruno	San Bruno No. 17	0.24	0.27	0.05	0.27	0.22	0.27	0.05	0.27	0.22
San Bruno	San Bruno No. 18	0.26	0.29	0.06	0.29	0.24	0.29	0.06	0.29	0.24
San Bruno	San Bruno No. 20	0.66	0.73	0.15	0.73	0.59	0.73	0.15	0.73	0.59
	Sub-Total	***1.88***	***2.10***	***0.42***	***2.10***	***1.68***	***2.10***	***0.42***	***2.10***	***1.68***
	Total Partner Agency Pumping	***6.84***	***6.90***	***1.38***	***6.90***	***5.52***	***6.90***	***1.38***	***6.90***	***5.52***

Key:
GSR - Regional Groundwater Storage and Recovery
mgd - million gallons per day
Shaded cells identify municipal pumping wells that are not applicable and not considered for a given model scenario.

Table 10.1-8: Depth Distribution of Pumping by Model Layers

Location	Well Site/Well Name	Depth Distribution of Pumping (Fraction in Model Layer 1 - 5)					Total
		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	
Regional Groundwater Storage and Recovery Project Proposed Municipal Wells							
Daly City	CUP-3A	0.00	0.00	1.00	0.00	0.00	1.00
Daly City	CUP-5	0.00	0.00	0.10	0.60	0.30	1.00
Daly City	CUP-6	0.00	0.00	0.10	0.70	0.20	1.00
Daly City	CUP-7	0.00	0.00	0.15	0.55	0.30	1.00
Daly City	CUP-10A	0.00	0.00	0.50	0.50	0.00	1.00
Daly City	CUP-11A	0.00	0.00	0.40	0.50	0.10	1.00
Colma	CUP-18	0.00	0.00	0.35	0.55	0.10	1.00
Colma	CUP-19	0.00	0.00	0.20	0.60	0.20	1.00
South San Francisco	CUP-22A	0.00	0.00	0.20	0.80	0.00	1.00
South San Francisco	CUP-23	0.00	0.00	0.20	0.80	0.00	1.00
South San Francisco	CUP-31	0.00	0.00	0.00	0.70	0.30	1.00
South San Francisco	CUP-36-1	0.00	0.00	0.00	0.75	0.25	1.00
South San Francisco	CUP-41-4	0.00	0.00	0.00	0.80	0.20	1.00
San Bruno	CUP-44-1	0.00	0.00	0.00	0.80	0.20	1.00
San Bruno	CUP-44-2	0.00	0.00	0.05	0.75	0.20	1.00
Millbrae	CUP-M-1	0.00	0.00	0.50	0.50	0.00	1.00
Daly City Municipal Wells							
Daly City	Daly City Jefferson	0.00	0.00	0.12	0.73	0.15	1.00
Daly City	Daly City Vale	0.00	0.00	0.15	0.70	0.15	1.00
Daly City	Daly City Westlake	0.00	0.00	0.15	0.56	0.29	1.00
Daly City	Daly City Junipero Serra	0.00	0.43	0.57	0.00	0.00	1.00
Daly City	Daly City No. 4	0.00	0.50	0.32	0.18	0.00	1.00
Daly City	Daly City No. 4 Replacement	0.00	0.50	0.32	0.18	0.00	1.00
Daly City	Daly City A Street Replacement	0.00	0.06	0.29	0.65	0.00	1.00
Cal Water Municipal Wells							
South San Francisco	SSF1-19	0.00	0.19	0.12	0.50	0.19	1.00
South San Francisco	SSF1-20	0.00	0.00	0.00	0.48	0.52	1.00
South San Francisco	SSF1-21	0.00	0.00	0.00	0.50	0.50	1.00
South San Francisco	SSF1-22	0.00	0.00	0.00	0.50	0.50	1.00
South San Francisco	SSF1-23	0.00	0.00	0.00	0.50	0.50	1.00
South San Francisco	SSF1-24	0.00	0.00	0.00	0.50	0.50	1.00
South San Francisco	SSF1-25	0.00	0.00	0.00	0.50	0.50	1.00
San Bruno Municipal Wells							
San Bruno	San Bruno No. 15	0.00	0.16	0.16	0.54	0.14	1.00
San Bruno	San Bruno No. 16	0.00	0.00	0.00	0.80	0.20	1.00
San Bruno	San Bruno No. 17	0.00	0.00	0.00	0.72	0.28	1.00
San Bruno	San Bruno No. 18	0.00	0.11	0.44	0.34	0.11	1.00
San Bruno	San Bruno No. 20	0.00	0.00	0.00	0.55	0.45	1.00
San Francisco Groundwater Supply Project Proposed Municipal Wells							
San Francisco	Lake Merced Pump Station	0.00	0.00	0.00	1.00	0.00	1.00
San Francisco	South Sunset Playground	0.21	0.38	0.16	0.26	0.00	1.00
San Francisco	West Sunset Playground	0.60	0.34	0.06	0.00	0.00	1.00
San Francisco	GGP Central Pump Station(1)	1.00	0.00	0.00	0.00	0.00	1.00
San Francisco	South Windmill Replacement	0.45	0.54	0.01	0.00	0.00	1.00
San Francisco	North Lake	0.44	0.17	0.39	0.00	0.00	1.00

Key:
GGP - Golden Gate Park

Note:
(1) All pumping assigned to Layer 1 because the HydroFocus Model (May 2011, ver. 3.1) assumes only one model layer in this vicinity.

Table 10.1-9: Put/Take/Hold Sequence for Model Scenarios

Scenario Year	No. of Months	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
0	3										put	put	put
1	15	put	put	put	put	put	put	put	put	put	put	put	put
2	27	put	put	put	put	put	put	put	put	put	put	put	put
3	39	put	put	put	put	put	put	put	put	put	put	put	put
4	51	put	put	put	put	put	put	put	put	put	put	put	put
5	63	put	put	put	put	put	put	put	put	put	put	put	put
6	75	put	put	put	put	put	put	put	put	put	put	put	put
7	87	put	put	put	put	hold	hold	hold	hold	hold	hold	hold	hold
8	99	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
9	111	hold	hold	hold	hold	hold	hold	hold	hold	hold	take	take	take
10	123	take	take	take	take	take	take	take	take	take	take	take	take
11	135	take	take	take	take	take	take	take	take	take	put	put	put
12	147	put	put	put	put	put	put	put	put	put	put	put	put
13	159	put	put	put	put	put	put	put	put	put	put	put	put
14	171	put	put	put	put	put	hold	hold	hold	hold	hold	hold	hold
15	183	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
16	195	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
17	207	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
18	219	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
19	231	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
20	243	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
21	255	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
22	267	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
23	279	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
24	291	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
25	303	hold	hold	hold	hold	hold	hold	hold	hold	hold	take	take	take
26	315	take	take	take	take	take	take	take	take	take	take	take	take
27	327	take	take	take	take	take	take	take	take	take	put	put	put
28	339	put	put	put	put	put	put	put	put	put	put	put	put
29	351	put	put	put	put	put	put	put	put	put	put	put	put
30	363	put	put	put	put	put	hold	hold	hold	hold	hold	hold	hold
31	375	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
32	387	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
33	399	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
34	411	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
35	423	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold	hold
36	435	hold	hold	hold	hold	hold	hold	hold	hold	hold	take	take	take
37	447	take	take	take	take	take	take	take	take	take	take	take	take
38	459	take	take	take	take	take	take	take	take	take	take	take	take
39	471	take	take	take	take	take	take	take	take	take	take	take	take
40	483	take	take	take	take	take	take	take	take	take	take	take	take
41	495	take	take	take	take	take	take	take	take	take	take	take	take
42	507	take	take	take	take	take	take	take	take	take	take	take	take
43	519	take	take	take	take	take	take	take	take	take	take	take	take
44	531	take	take	take	hold	hold	hold	hold	hold	hold	put	put	put
45	543	put	put	put	put	put	put	put	put	put	put	put	put
46	555	put	put	put	put	put	put	put	put	put	put	put	put
47	567	put	put	put	put	put	put	put	put	put	put	put	put

Table 10.1-10: Pumping Rate Assumptions for San Francisco Groundwater Supply Project Proposed Municipal Wells

Well No.	Well Name	Pumping Rates mgd	Pumping Rates afy	Pumping Proportion Relative to Total
Scenario 3a[(1), (2)]				
1	Lake Merced Pump Station	0.43	482	0.14
2	South Sunset Playground	0.48	544	0.16
3	West Sunset Playground	0.63	707	0.21
4	GGP Central Pump Station	1.45	1,631	0.48
5	South Windmill Replacement [(3)]	-	-	-
6	North Lake [(3)]	-	-	-
	Total	***3.00***	***3,363***	***1.00***
Scenario 3b [(1)]				
1	Lake Merced Pump Station	0.43	482	0.11
2	South Sunset Playground	0.46	512	0.11
3	West Sunset Playground	0.59	665	0.15
4	GGP Central Pump Station	1.37	1,536	0.34
5	South Windmill Replacement	0.65	729	0.16
6	North Lake	0.50	561	0.13
	Total	***4.00***	***4,484***	***1.00***

Key:
afy - acre-feet per year
mgd - million gallons per day
GGP - Golden Gate Park

Notes:
(1) For Scenarios 3a and 3b, the pumping rate for each of the SFGW Project wells is provided by SFPUC.
(2) Four of the SFGW Project wells would be pumping for municipal purposes for the SFGW Project under Scenario 3a.
(3) For Scenario 3a, South Windmill Replacement and North Lake wells would remain as irrigation wells and not be used for municipal pumping as part of the SFGW Project. Irrigation pumping rates by South Windmill Replacement and North Lake wells would be the same as in Scenario 1, and they are accounted for in the irrigation pumping assumptions presented in Table 10.1-2.

Table 10.1-11: Monthly Pumping Rate Assumptions for San Francisco Groundwater Supply Project Proposed Municipal Wells

Scenario 3a							
Month	Lake Merced Pump Station (af)	South Sunset Playground (af)	West Sunset Playground (af)	GGP Central Pump Station (af)	South Windmill Replacement (af)	North Lake (af)	Total Pumping (af)
January	457	515	670	1,545	0	0	3,186
February	485	547	711	1,642	0	0	3,386
March	451	509	662	1,527	0	0	3,150
April	464	523	680	1,570	0	0	3,237
May	500	564	733	1,691	0	0	3,486
June	523	590	767	1,770	0	0	3,651
July	541	610	793	1,830	0	0	3,774
August	524	590	768	1,771	0	0	3,653
September	500	564	734	1,693	0	0	3,491
October	482	543	707	1,630	0	0	3,362
November	433	488	635	1,464	0	0	3,020
December	424	478	622	1,435	0	0	2,959
Annual Average (af)	***482***	***544***	***707***	***1,631***	***0***	***0***	***3,363***
Annual Average (mgd)	***0.43***	***0.48***	***0.63***	***1.45***	***0.00***	***0.00***	***3.0***
Scenario 3b							
	Lake Merced Pump Station (af)	**South Sunset Playground (af)**	**West Sunset Playground (af)**	**GGP Central Pump Station (af)**	**South Windmill Replacement (af)**	**North Lake (af)**	**Total Pumping (af)**
January	457	485	630	1,455	690	531	4,249
February	485	515	670	1,546	734	564	4,515
March	451	479	623	1,438	682	525	4,200
April	464	493	641	1,478	701	540	4,316
May	500	531	690	1,592	755	581	4,648
June	523	556	722	1,667	791	608	4,868
July	541	574	747	1,723	818	629	5,032
August	524	556	723	1,668	792	609	4,871
September	500	531	691	1,594	756	582	4,655
October	482	512	665	1,535	728	560	4,483
November	433	460	597	1,379	654	503	4,026
December	424	450	586	1,351	641	493	3,946
Annual Average (af)	***482***	***512***	***665***	***1,536***	***729***	***561***	***4,484***
Annual Average (mgd)	***0.4***	***0.5***	***0.6***	***1.4***	***0.7***	***0.5***	***4.0***

Key:
af - acre-feet
GGP - Golden Gate Park
mgd - million gallons per day

Table 10.1-12: Summary of Westside Basin Annual Water Balance

Scenarios		Inflow from Bay & Ocean (afy)(1)	Seepage from GGP Lakes (afy)(1)	Rain + Irrigation (afy)(1)	Seepage from Lake Merced (afy)(1)	Outflow to Bay & Ocean (afy)(2)	Wells - Pumping (afy)(2)	Seepage to Lake Merced (afy)(2)	Drains (afy)(2)	Change in Groundwater Storage (afy)(3)
Scenario 1	Average	12	551	14,034	846	-4,172	-10,814	-960	-94	-597
	Maximum	31	558	24,922	1,171	-3,057	-10,230	-634	-68	9,340
	Minimum	5	545	7,618	456	-5,439	-11,398	-1,383	-129	-6,468
Scenario 2	Average	11	551	14,034	640	-4,418	-10,926	-784	-122	-1,013
	Maximum	65	558	24,922	1,498	-2,948	-4,227	-522	-71	14,744
	Minimum	4	545	7,618	351	-5,526	-19,363	-1,453	-176	-14,738
Scenario 3a	Average	403	551	14,034	940	-1,982	-14,189	-946	-93	-1,282
	Maximum	1,123	558	24,922	1,105	-1,115	-13,604	-534	-68	9,072
	Minimum	5	545	7,618	485	-4,731	-14,773	-1,246	-128	-6,755
Scenario 3b	Average	312	626	14,034	950	-2,012	-14,106	-949	-93	-1,237
	Maximum	937	628	24,922	1,116	-1,114	-13,655	-531	-68	9,102
	Minimum	5	618	7,618	485	-4,703	-14,544	-1,257	-128	-6,666
Scenario 4	Average	186	626	14,034	760	-2,181	-14,264	-603	-122	-1,565
	Maximum	681	628	24,922	1,390	-866	-7,671	-325	-71	11,867
	Minimum	5	618	7,618	336	-4,735	-22,607	-1,156	-177	-14,852

Key:
afy - acre-feet per year

Notes:
(1) Positive values define inflows to groundwater basin.
(2) Negative values define outflows from groundwater basin.
(3) Positive change in storage values define increase in groundwater storage; negative change in storage values define decline in groundwater storage.

Attachment 10.1-A

Key Proposed Elements of GSR Project Operating Agreement for EIR Analysis

SUMMARY OF DRAFT GSR PROJECT OPERATING AGREEMENT
February 29, 2012

Under a proposed agreement between the SFPUC and the Partner Agencies for operation of groundwater pumping by these entities from the South Westside Groundwater Basin, the SFPUC would "store" water in the South Westside Groundwater Basin through the mechanism of in-lieu recharge by providing surface water as a substitute for groundwater pumping by the Partner Agencies. As part of its annual April 15 estimate of water supply available to the Regional Water System, the SFPUC would determine and give notice to the Partner Agencies of the availability, anticipated quantities and timing of the in-lieu water deliveries, thereby requiring the Partner Agencies to accept delivery of surface water in lieu of groundwater pumped using their existing wells (generally during wet and normal water years). This determination would take into consideration the amount of groundwater that the Partner Agencies must continue to pump due to water quality blending, distribution system constraints, well maintenance, and other requirements.

During these times when water would be stored in the groundwater basin (Put Periods[1]), the SFPUC could require the Partner Agencies to take delivery of up to 5.52 mgd of in-lieu water using their existing turnouts on SFPUC transmission pipelines in lieu of pumping a like amount of groundwater from their existing facilities. As a result of the in-lieu deliveries, up to 60,500 acre feet of groundwater storage or "put" credits could accrue to the SFPUC Storage Account described below. During shortages of SFPUC system water due to drought, emergencies or scheduled maintenance, the Partner Agencies would return to pumping from their existing wells. In addition, the SFPUC and the Partner Agencies would extract groundwater from the SFPUC Storage Account using the new wells installed by the SFPUC as part of the Project, at a maximum annual volume of 8,100 acre feet withdrawn at an average rate of 7.2 mgd. The SFPUC will not direct pumping during these periods (Take Periods[2]) unless a positive balance exists in the SFPUC Storage Account as described below.

An accounting of the additional storage volumes (the SFPUC Storage Account) accrued during Put Periods would be maintained by the SFPUC as a book account tracking the amount of water that has been stored during normal and wet years and the amount of water pumped from the SFPUC Storage Account during Take Periods. Accruals in the SFPUC Storage Account would be recorded based on metered, in-lieu surface water deliveries and corresponding metered decreases in groundwater pumping below "designated quantities" agreed to by the Partner Agencies. An operating committee would be formed to monitor and track the SFPUC Storage Account, including any losses from the system, and establish annual pumping schedules for Project wells.

As discussed in Section 3.3, the Partner Agencies would continue to maintain and operate their existing wells and associated infrastructure, and could install new or replacement wells in the future if necessary. The Partner Agencies would agree to limit pumping from their existing wells and any new wells to the designated quantities totaling 6.9 mgd over a 5 year averaging period, the estimated modeled volume of municipal pumping that the South Westside Basin can sustain without causing a decline in groundwater levels on an annual average basis and the amounts identified in the respective Partner Agencies Urban Water Management Plans, allocated in the initial year as follows:

[1] Put Periods may also be referred to as Storage Periods in the operating agreement and other documentation concerning the Project.
[2] Take Periods may also be referred to as Recovery Periods in the operating agreement and other documentation concerning the Project.

- Daly City: 3.43 mgd/ 3,840 acre feet per year
- Cal Water: 1.37 mgd/ 1,534 acre feet per year
- San Bruno: 2.1 mgd/ 2,350 acre feet per year

Pumping from the Partner Agency existing facilities during years when the SFPUC has not directed take of water from the SFPUC Storage Account and years where the SFPUC has neither directed take nor put of in lieu groundwater (Hold Periods) could not exceed 7.6 mgd in any year of the 5 year averaging period. This 10% increase over 6.9 mgd could occur as a result of transfer of designated quantities between Partner Agencies, which would be permitted under the operating agreement provided such adjustment received unanimous approval of the operating committee based on actual operating experience that demonstrates that such an increase is consistent with sustainable groundwater basin management.   If a Partner Agency engages in over production, then that agency would be required to (1) take steps to pump less during future years to bring pumping back within the 6.9 mgd aggregate designated quantity; (2) provide a source of water that has the effect of replacing water lost from the Basin due to the over production; or (3) take other actions that may be recommended by the operating committee.

During normal and wet years, Project wells would be operated by the SFPUC or the Partner Agencies only periodically to exercise the wells for maintenance purposes at a rate of approximately 0.04 mgd and the Partner Agencies' would pump their existing wells at a rate of approximately 1.38 mgd to 1.9 mgd. In circumstances where the SFPUC determines that delivery of in-lieu water cannot be made due to a dry year, emergencies, system rehabilitation, scheduled maintenance or malfunctioning of the water system, or upon recommendation of the operating committee established by the operating agreement for purposes of Basin management, the SFPUC may direct the Partner Agencies to extract groundwater from the SFPUC Storage Account using Project wells, in addition to continued pumping from the Partner Agencies' existing wells to meet the remainder of their water supply needs. Pumping from the SFPUC Storage Account by the Partner Agencies and the SFPUC would only occur if a positive balance exists in the SFPUC Storage Account as a result of previous in lieu recharge.

During droughts, Project wells would be operated beginning in the second consecutive year of a multi-year drought, following implementation of the Shortage Allocation Plan. Partner Agency pumping from the SFPUC Storage Account using Project wells during droughts, combined with the remaining reduced surface water deliveries from the Regional Water System to the Partner Agencies, would be limited to the total quantity of water allocated to each Partner Agency under Tier 2 of the Shortage Allocation Plan[3]. Partner Agency pumping during droughts using their existing wells would be limited to their respective Designated Quantities, which in total equal an aggregate volume of 7,724 acre feet per year, extracted at an annual cumulative rate of 6.9 mgd and computed on a 5 year rolling average basis. The specific volumes to be pumped during a drought shown in Figure 3-2 (see Section 3.3.1 above) are based on the Project Operations, but actual volumes in any given year could vary depending on factors including: (1) the final location and capacity of the Project well facilities, (2) the volume of water in the SFPUC Storage Account, and (3) direction from the operating committee regarding which wells should be used, based on the need to avoid well interference and other basin management considerations.

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[3] In the July 2009 WSA, the SFPUC and its wholesale customers adopted a Water Shortage Allocation Plan to allocate water between retail and wholesale customers during system wide shortages of 20% or less (the Tier 1 plan). The specific amount of rationing required by each wholesale customer, including the Participating Pumpers, is determined either by agreement of the wholesale customers themselves (the Tier 2 Plan) or, in the absence of such agreement, by the SFPUC after discussion with the wholesale customers.

The SFPUC would own the Project well facilities, and there would be no change to the Partner Agencies' ownership and operation of their existing and any new well facilities, except to the extent of their agreement regarding cessation and resumption of groundwater pumping as agreed to under a proposed operating agreement. The SFPUC and the Partner Agencies would operate and maintain Project wells connected to their respective water systems. The Partner Agencies may be allowed to use Project facilities for non-Project purposes but only under certain specified conditions where necessary, with approval of the operating committee and only for periods not to exceed 30 days duration. In the event of a sudden, non-drought event such as an earthquake or other catastrophic event, the operating committee may allow Partner Agency use of Project facilities for the duration of the emergency.

Project Operation

As described above, the Project would use vacated storage space in the South Westside Groundwater Basin filled through in lieu recharge during normal and wet years. Neither Project wells nor Partner Agency wells would be pumped in these Put Periods, apart from volumes needed to periodically exercise the wells. Water would accrue in the SFPUC Storage Account based on the metered reduction in each Partner Agency's designated quantity described in section 3.8.1.

When the SFPUC Storage Account is full, defined as 60,500 acre feet, but there is no shortage requiring the SFPUC to pump groundwater from Project wells (Hold Periods), the Project wells installed by the SFPUC would remain inactive apart from well exercising. Existing Partner Agency wells would be pumped at rates not to exceed an annual amount of 6.9 mgd (or up to 7.6 mgd in the event of a 10% increase) in any year of the 5 year periods as described in Section 3.8.1. The Partner Agencies would continue to be able to take delivery of their entitlements to surface water from the SFPUC (their "Individual Supply Guarantees") during these Hold Periods, as the SFPUC Storage Account would remain full.

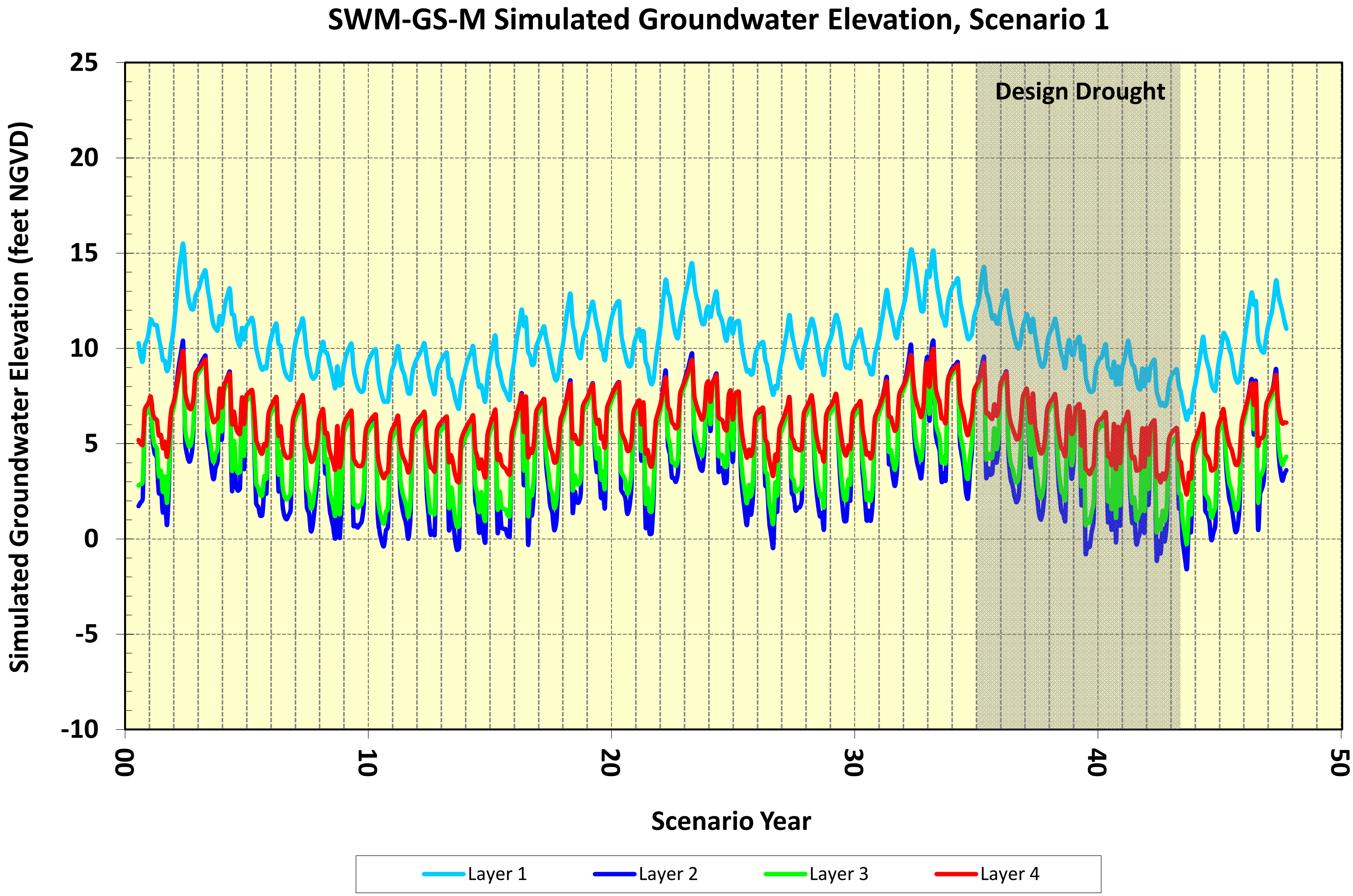
New Project wells installed by the SFPUC would be operated under the following circumstances:

- Beginning in the second dry year of a multiple year drought
- During emergencies
- During system rehabilitation, scheduled maintenance or malfunctioning of the water system
- Upon recommendation of the operating committee established by the operating agreement for purposes of Basin management

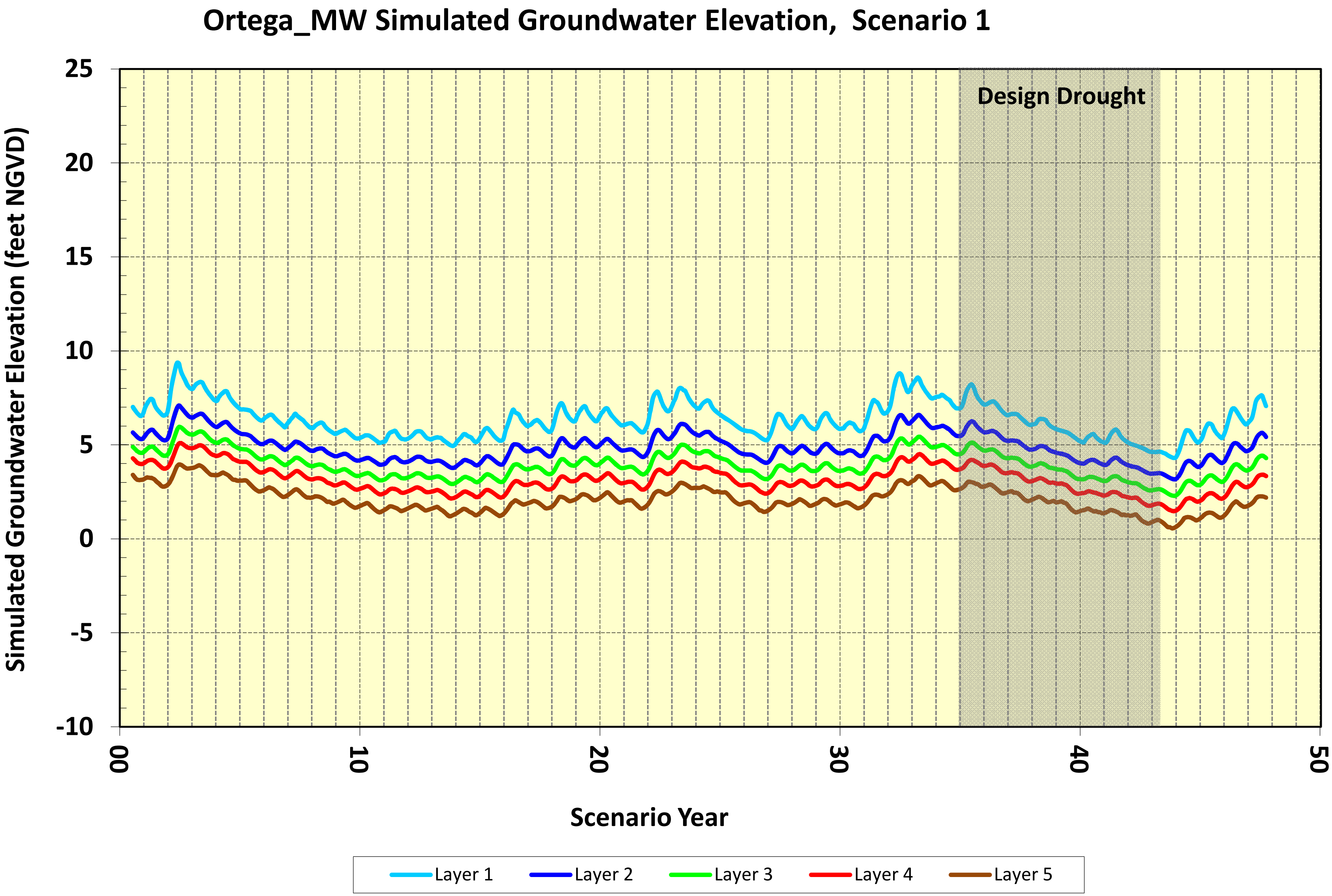
In these circumstances, new Project wells could be operated continuously or for shorter intervals, depending on the need for water. The primary purpose of the Project is to provide a dry year water supply during a multiple year drought. During these Take Periods, when groundwater is pumped to provide a dry year supply, pumping would reduce the balance of water in the SFPUC Storage Account. Project wells would be operated by the Partner Agencies and the SFPUC, depending on whether the water is sent to the Partner Agencies' retail water distribution systems or the SFPUC regional water transmission system. Project wells would only be pumped in Take Periods if there is a positive balance in the SFPUC Storage Account, and that pumping may not exceed 8,100 acre-feet per "supply year," defined as the period from July 1 to June 30 of the following year. Existing Partner Agency wells would be pumped at up to the rates indicated above during Hold Periods and the combined (reduced) deliveries of SFPUC surface water to the Partner Agencies and water pumped by the Partner Agencies from the SFPUC Storage Account using new Project wells would not exceed the Partner Agencies' individual Tier 2 allocations under the Shortage Allocation Plan.

Attachment 10.1-B

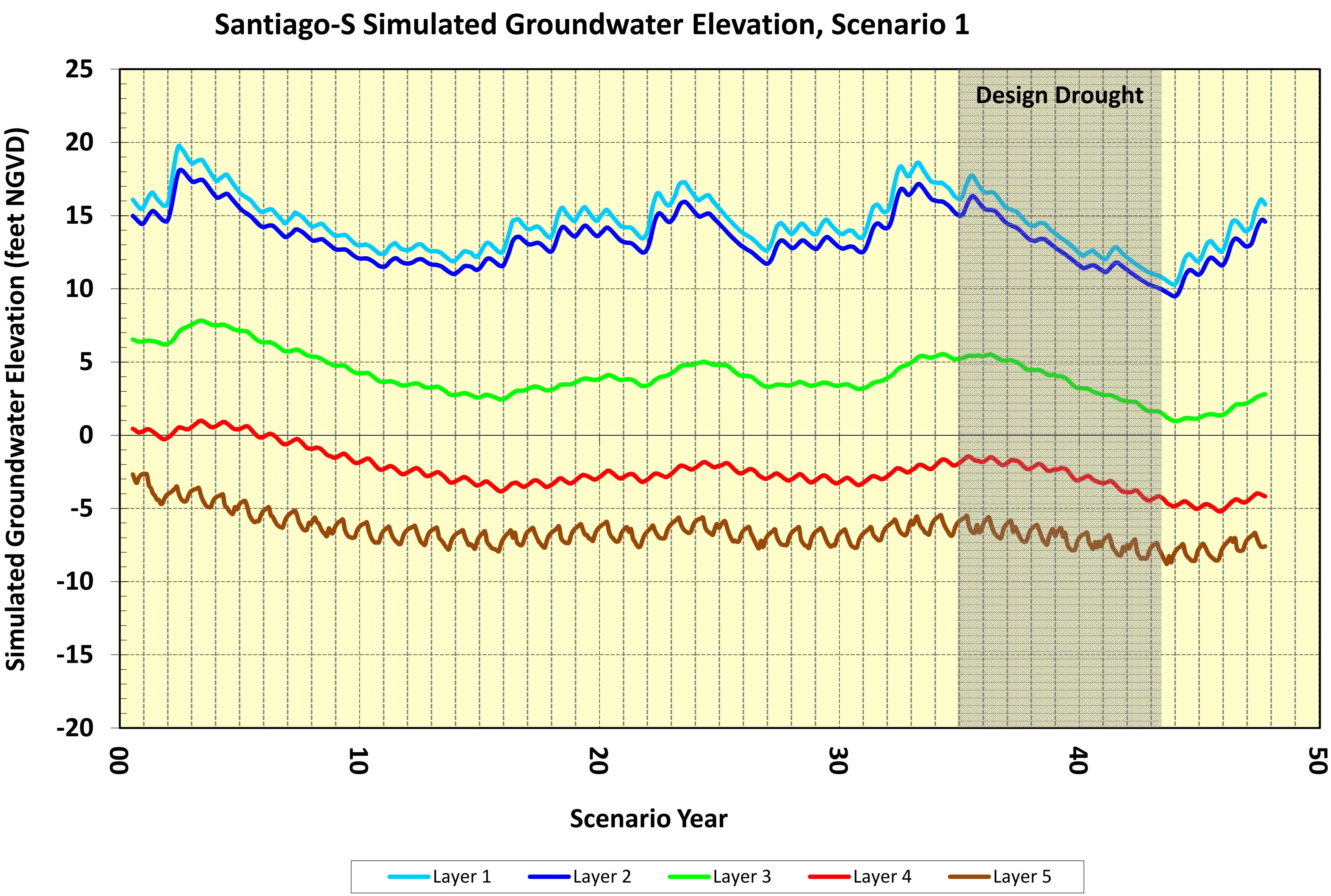
Model Scenario Hydrographs for Selected Locations



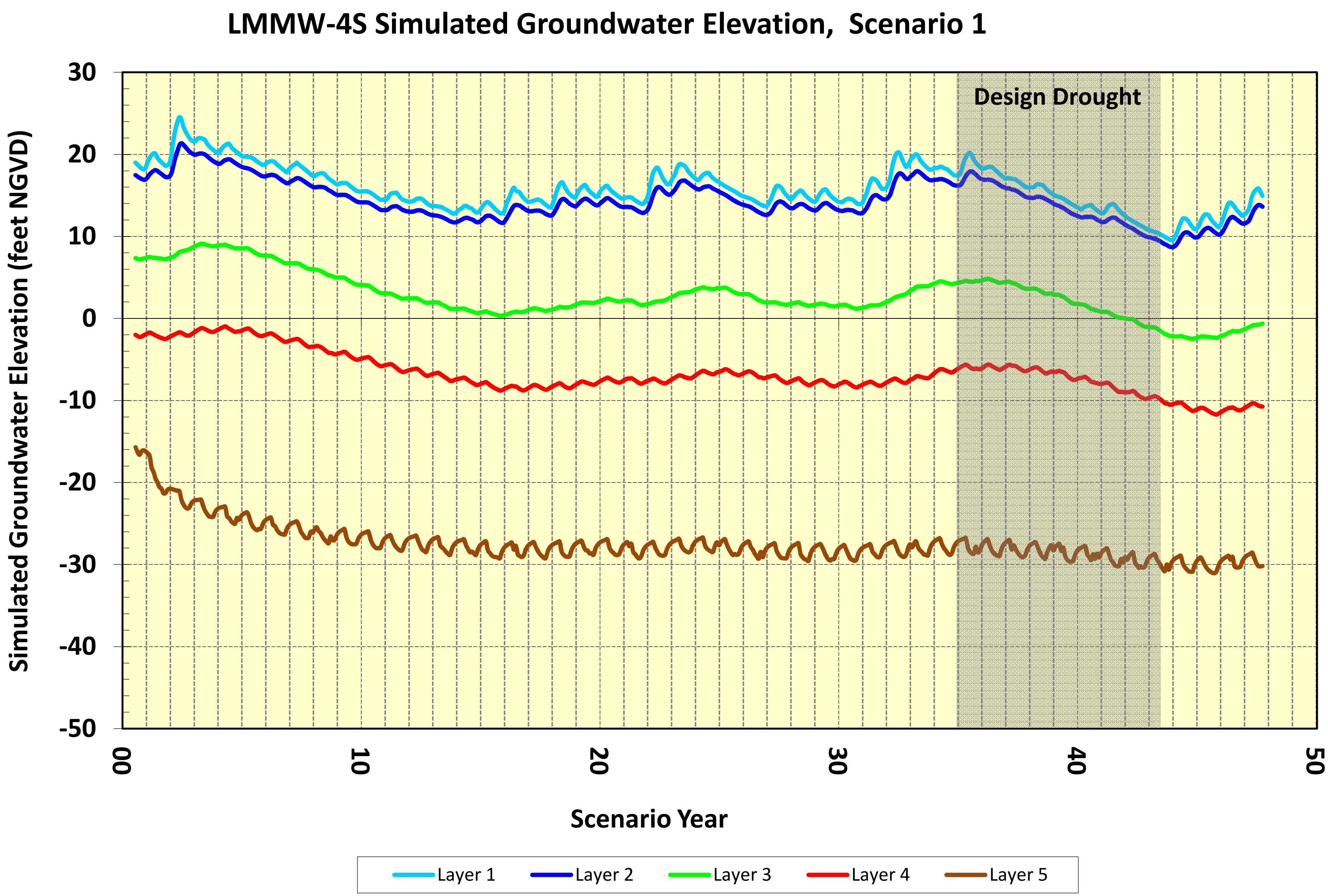
Note: At the location of SWM-GS-M, the model does not contain Model Layer 5.



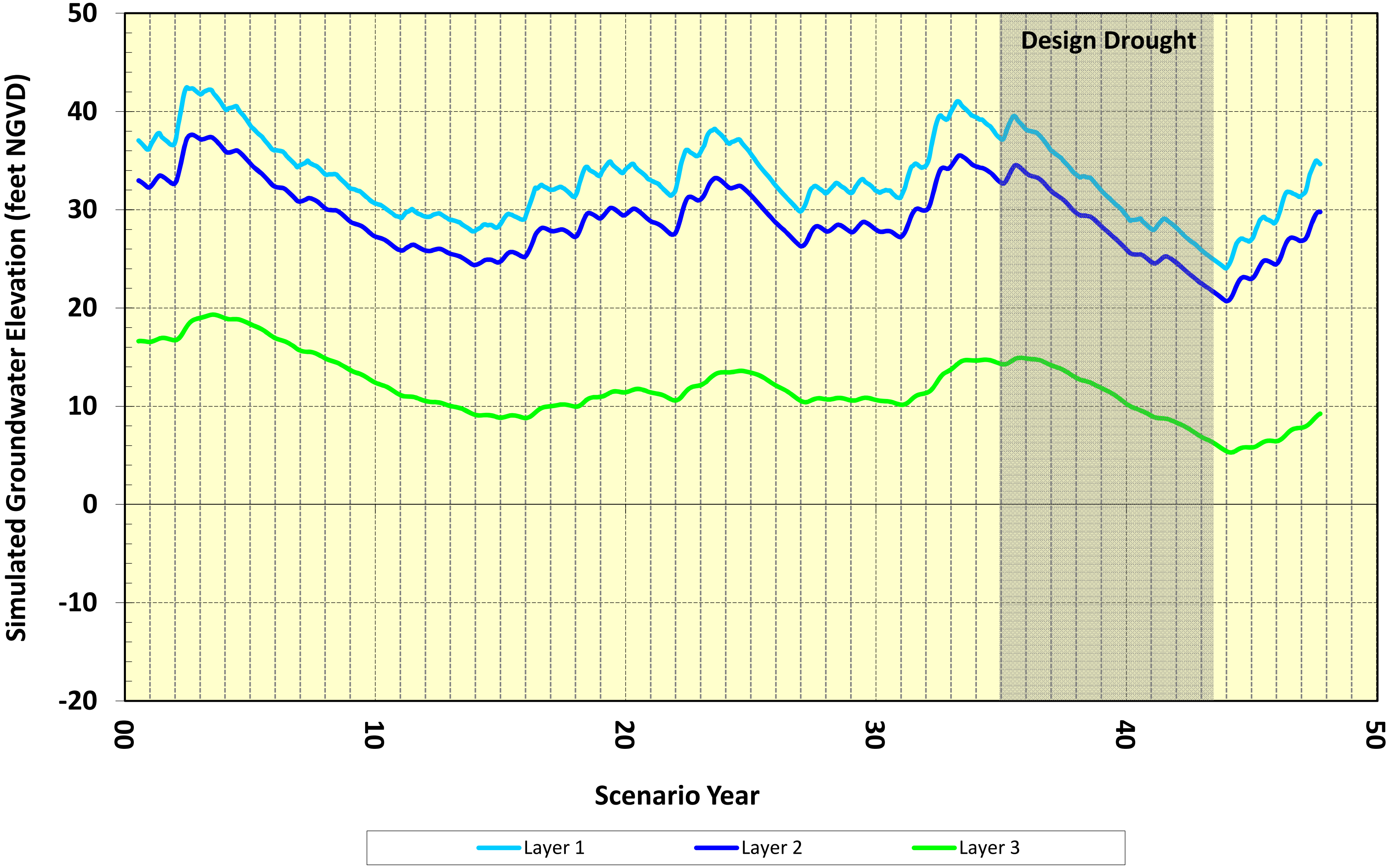
Ortega_MW Simulated Groundwater Elevation, Scenario 1
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
Design Drought
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



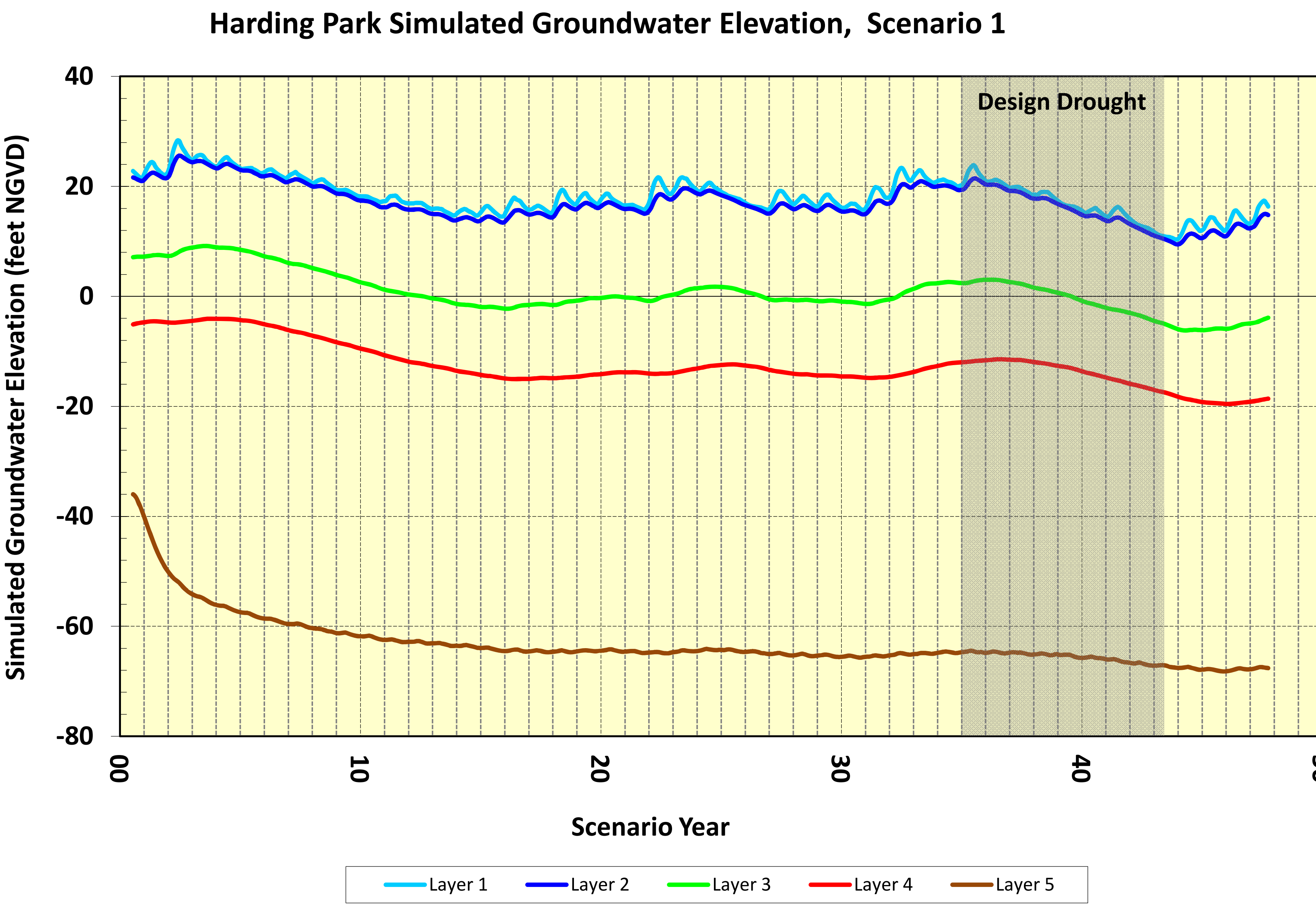
Santiago-S Simulated Groundwater Elevation, Scenario 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
-15
-20
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


LMMW-4S Simulated Groundwater Elevation, Scenario 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
30
20
10
0
-10
-20
-30
-40
-50
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

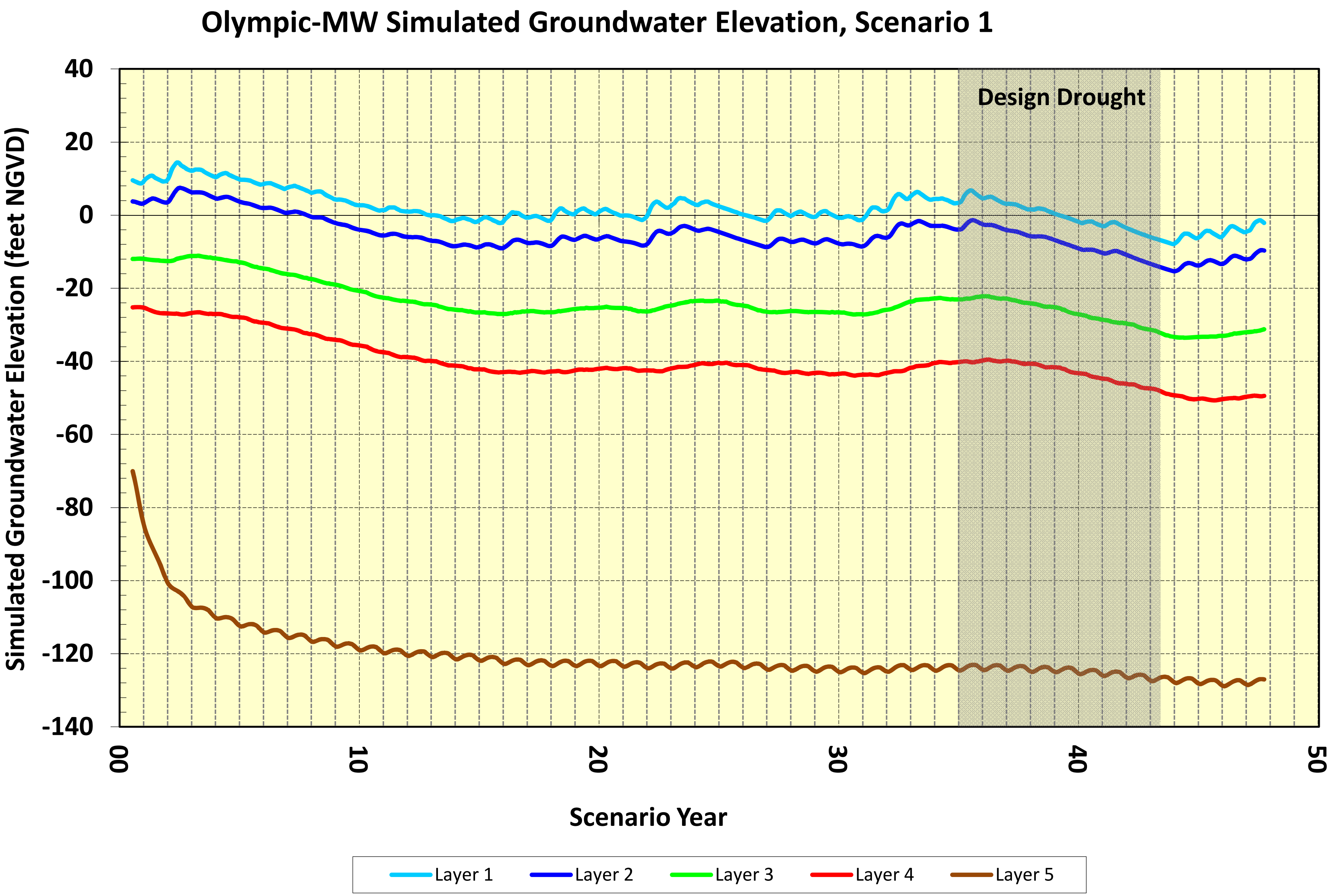
LMMW-5S Simulated Groundwater Elevation, Scenario 1



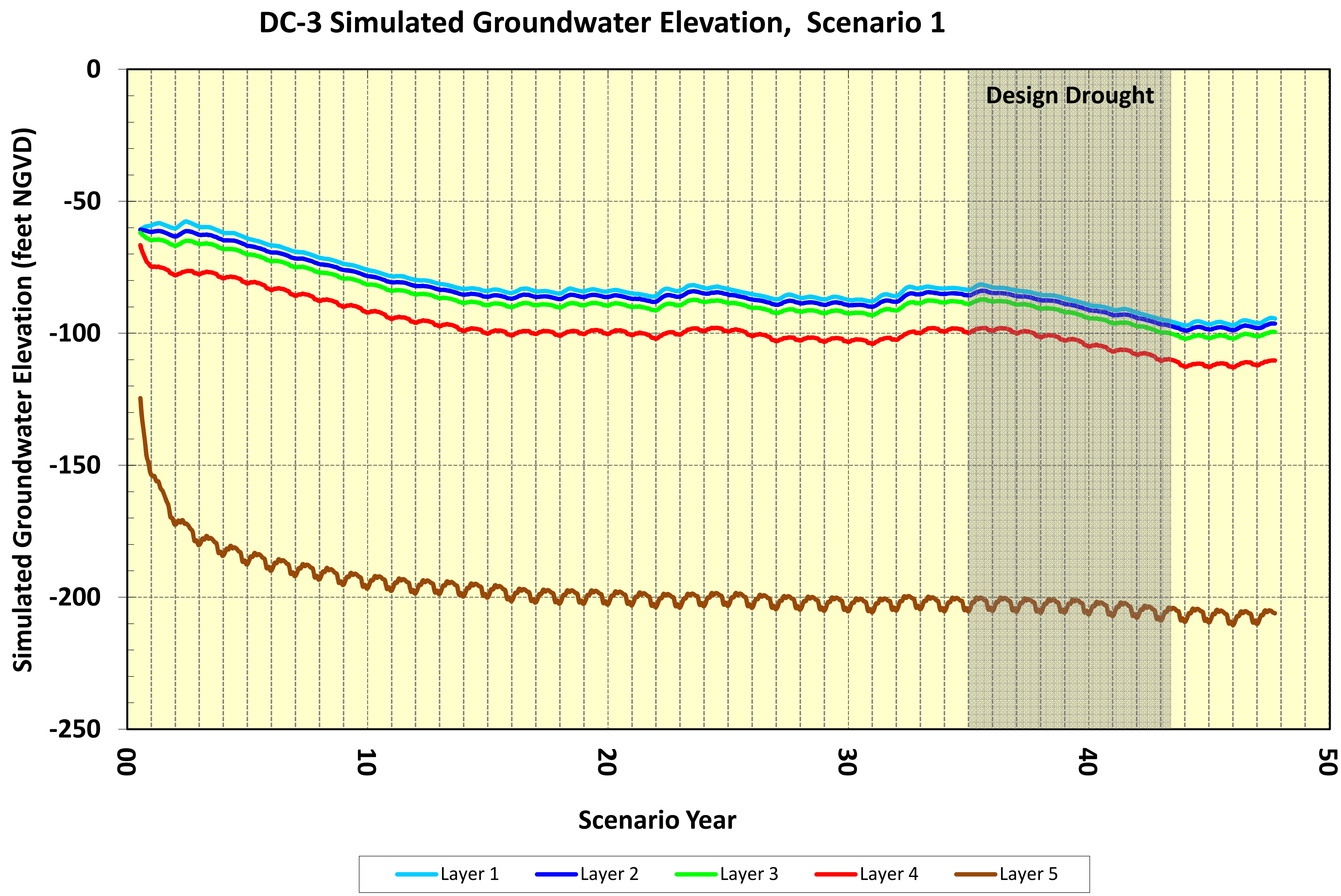
Note: At the location of LMMW-5S, the model does not contain Model Layers 4 and 5.



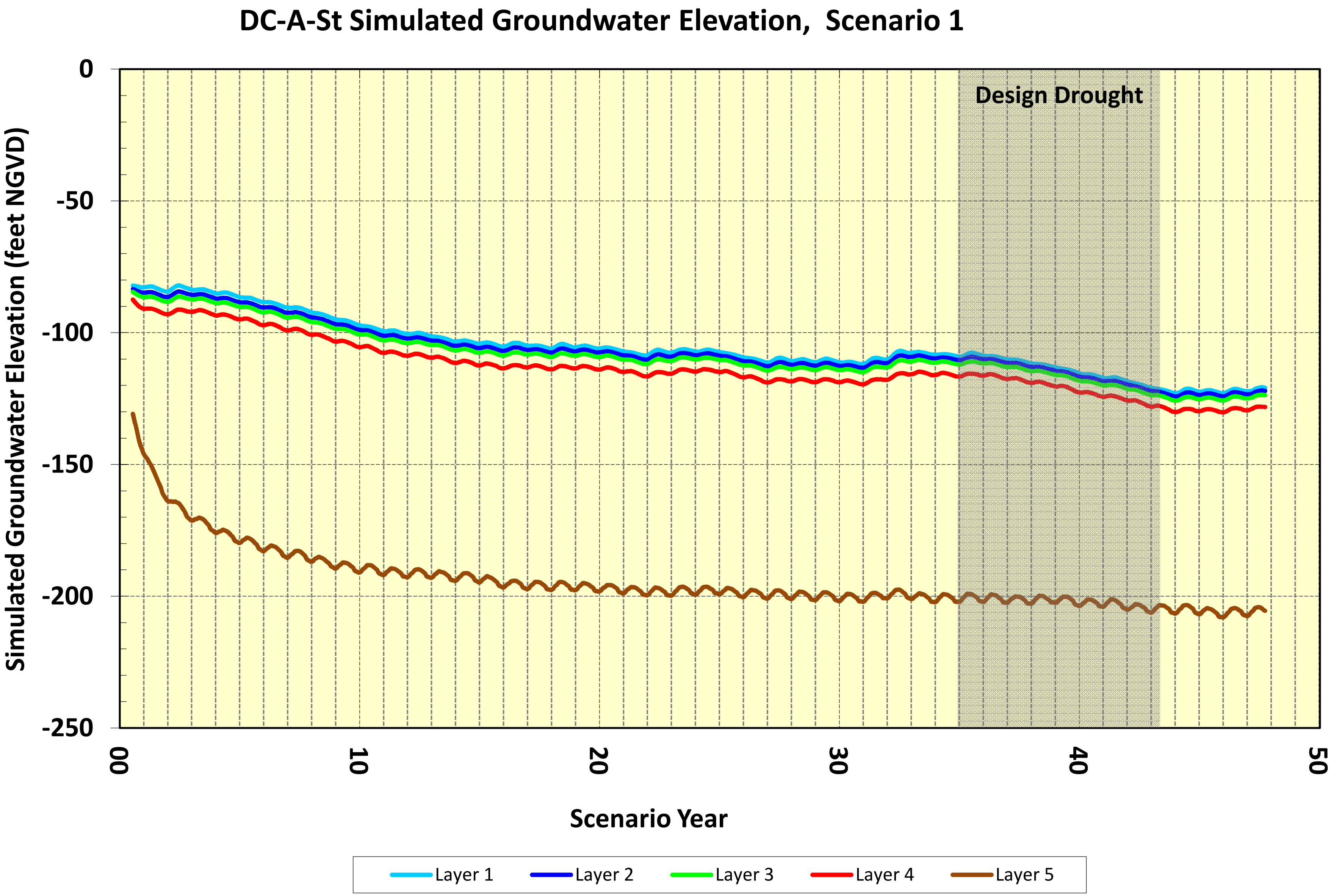
Harding Park Simulated Groundwater Elevation, Scenario 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

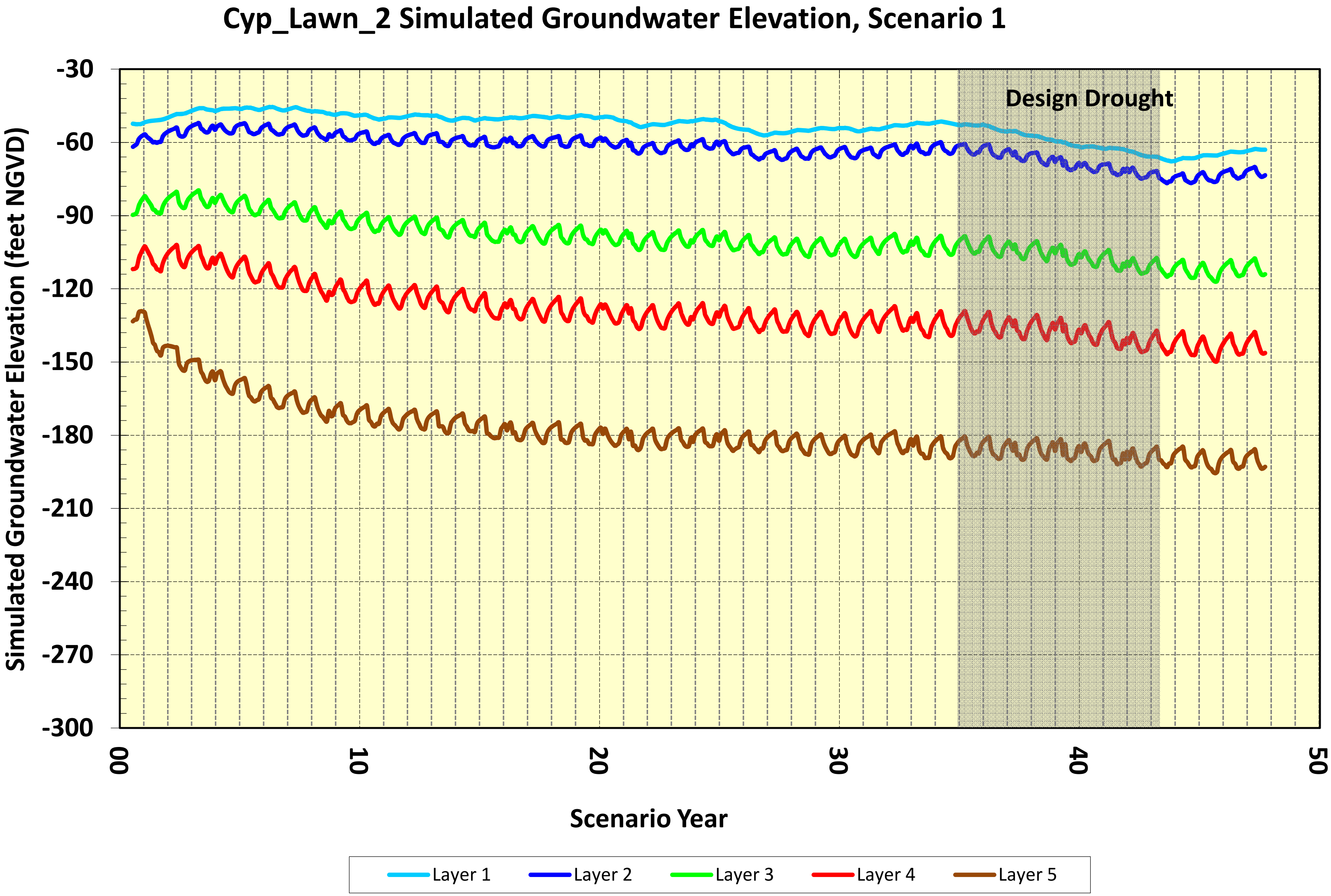


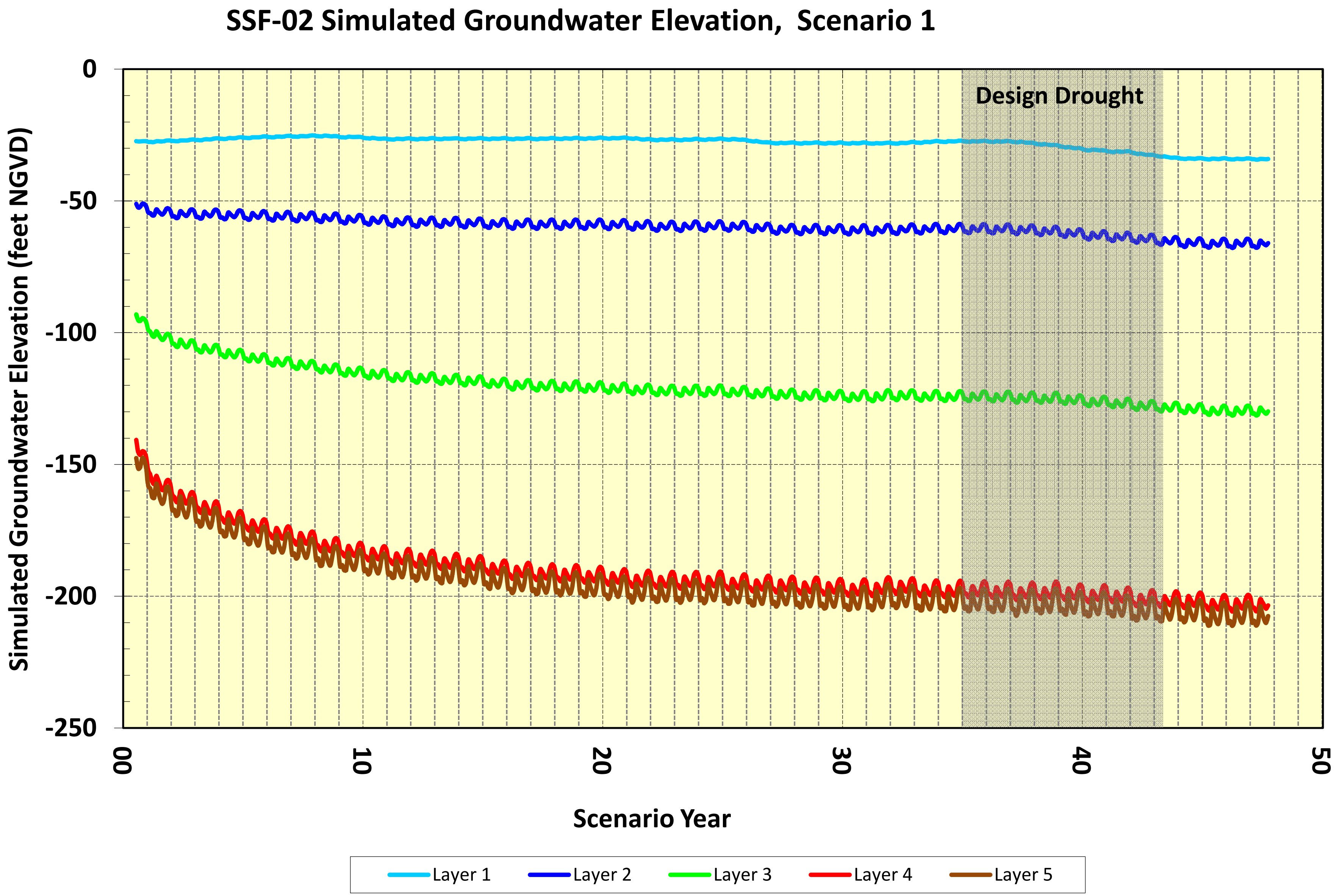
Olympic-MW Simulated Groundwater Elevation, Scenario 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
-100
-120
-140
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



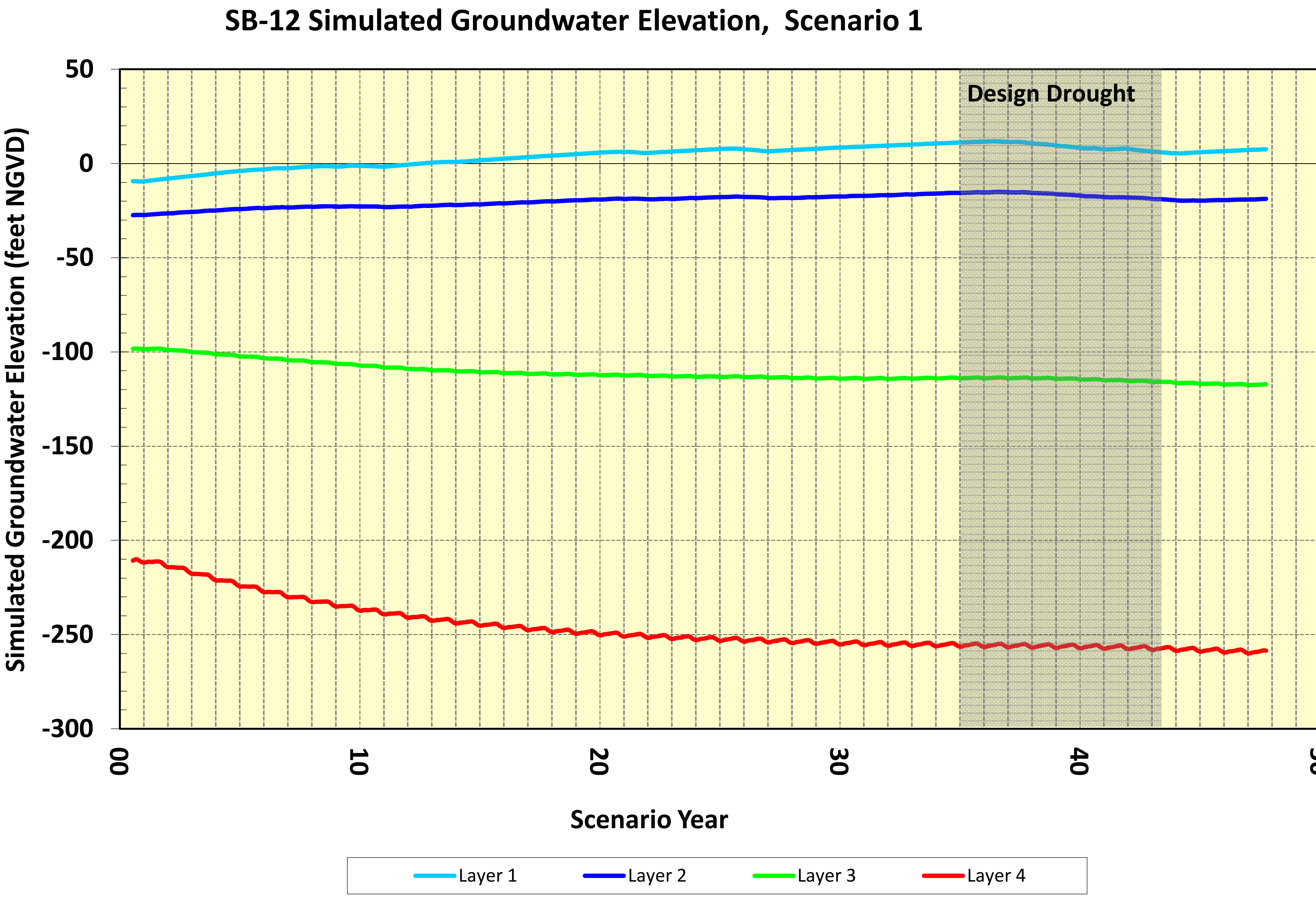
DC-3 Simulated Groundwater Elevation, Scenario 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


DC-A-St Simulated Groundwater Elevation, Scenario 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

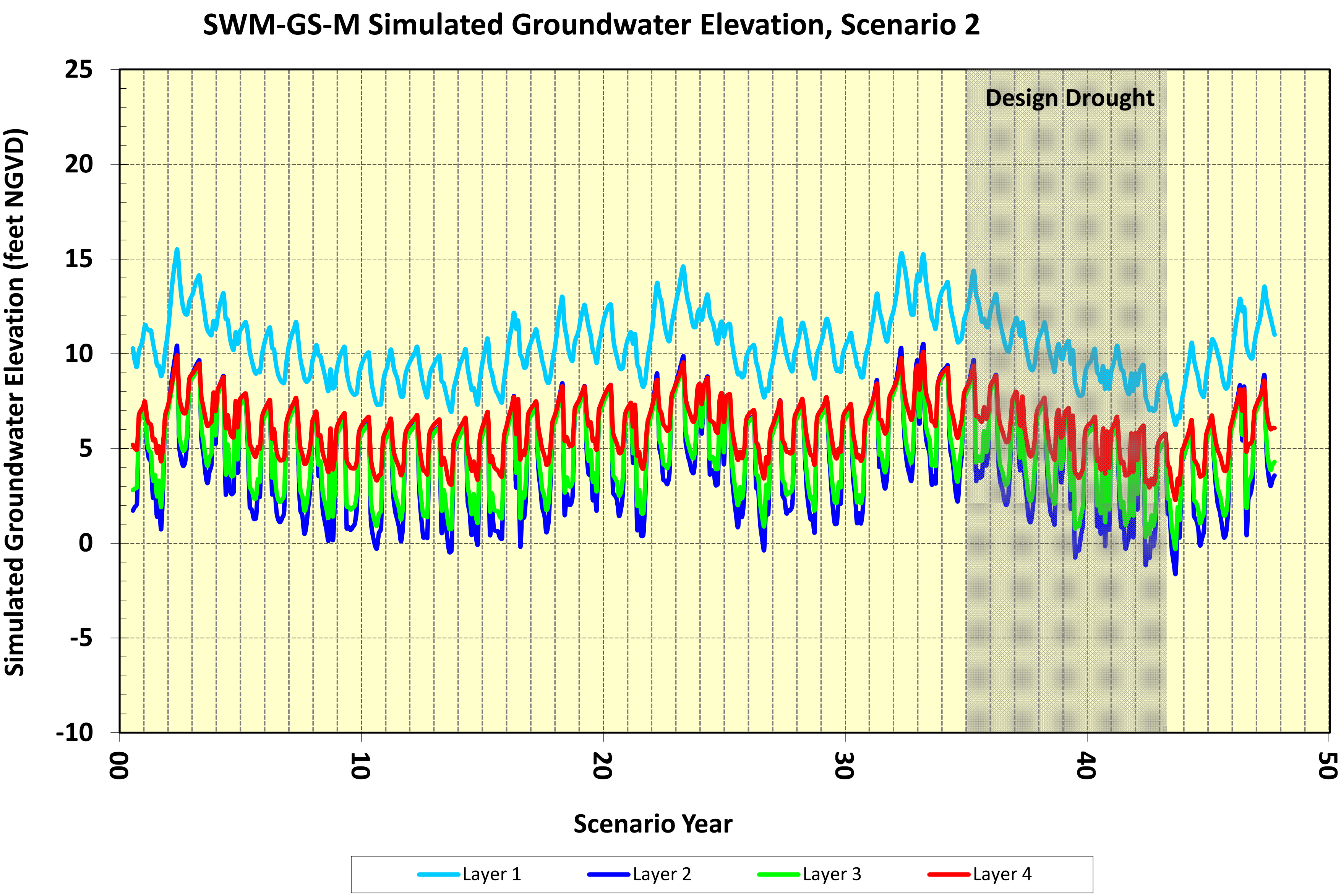

Cyp_Lawn_2 Simulated Groundwater Elevation, Scenario 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
-30
-60
-90
-120
-150
-180
-210
-240
-270
-300
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



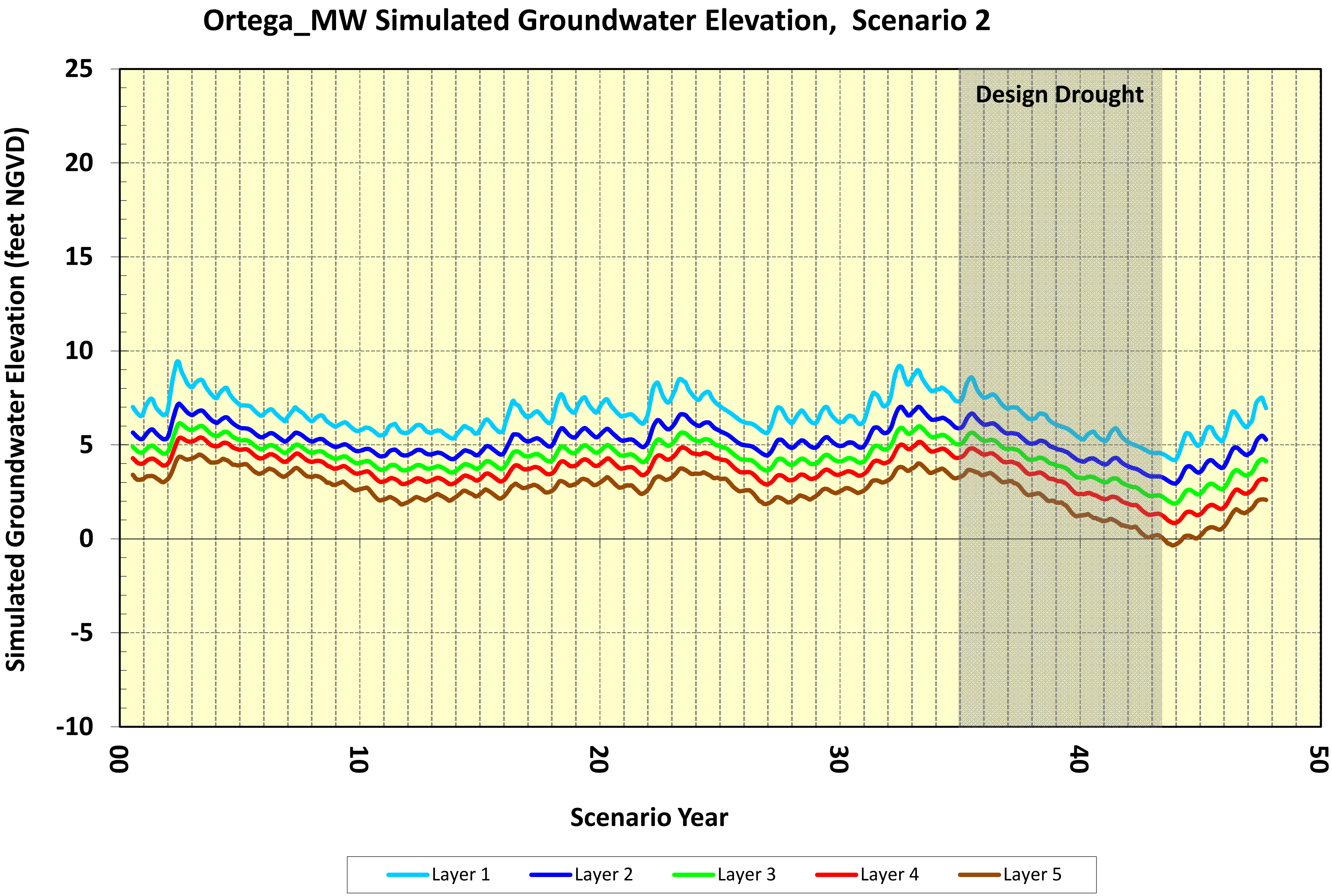
SSF-02 Simulated Groundwater Elevation, Scenario 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



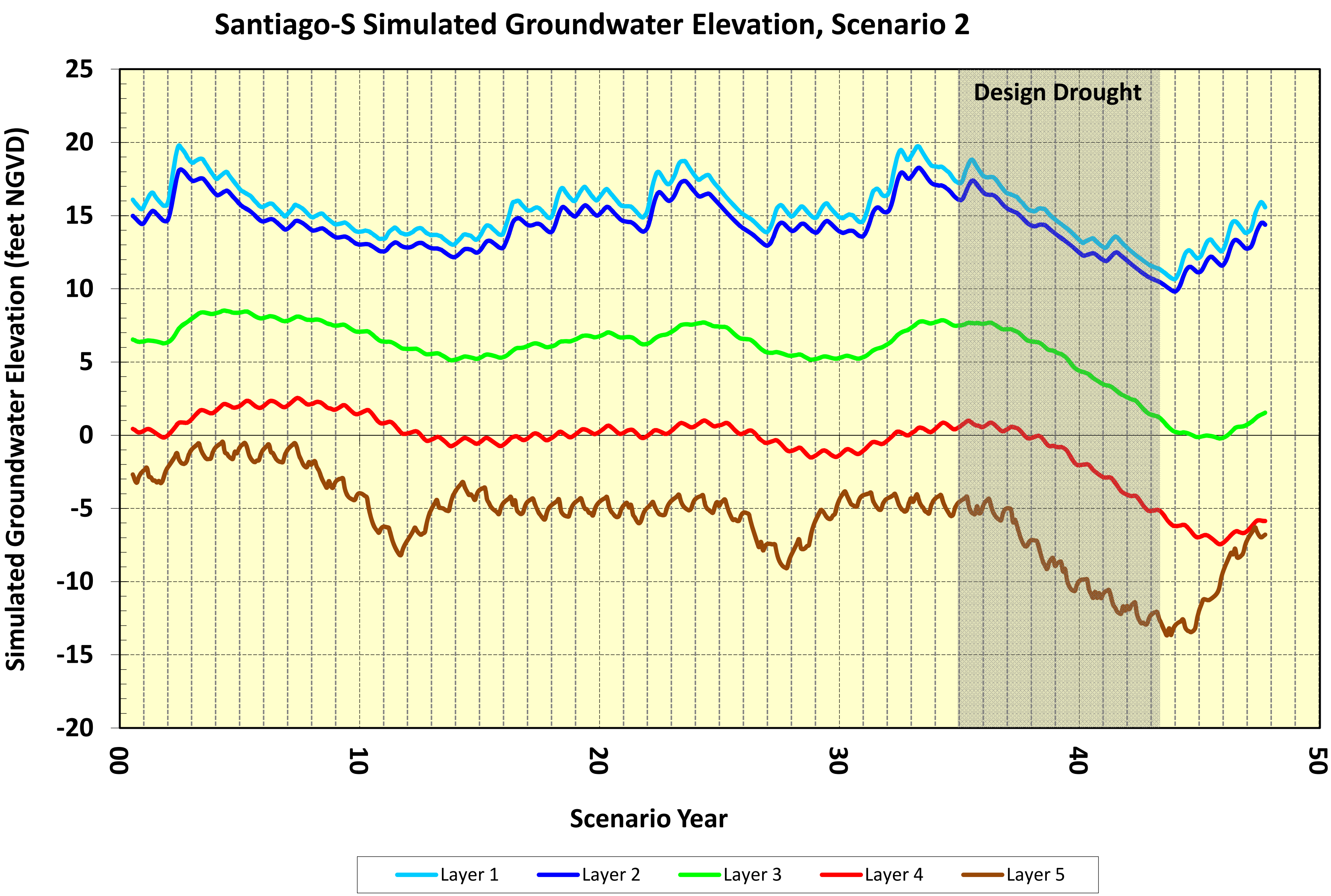
Note: At the location of SB-12, the model does not contain Model Layer 5.

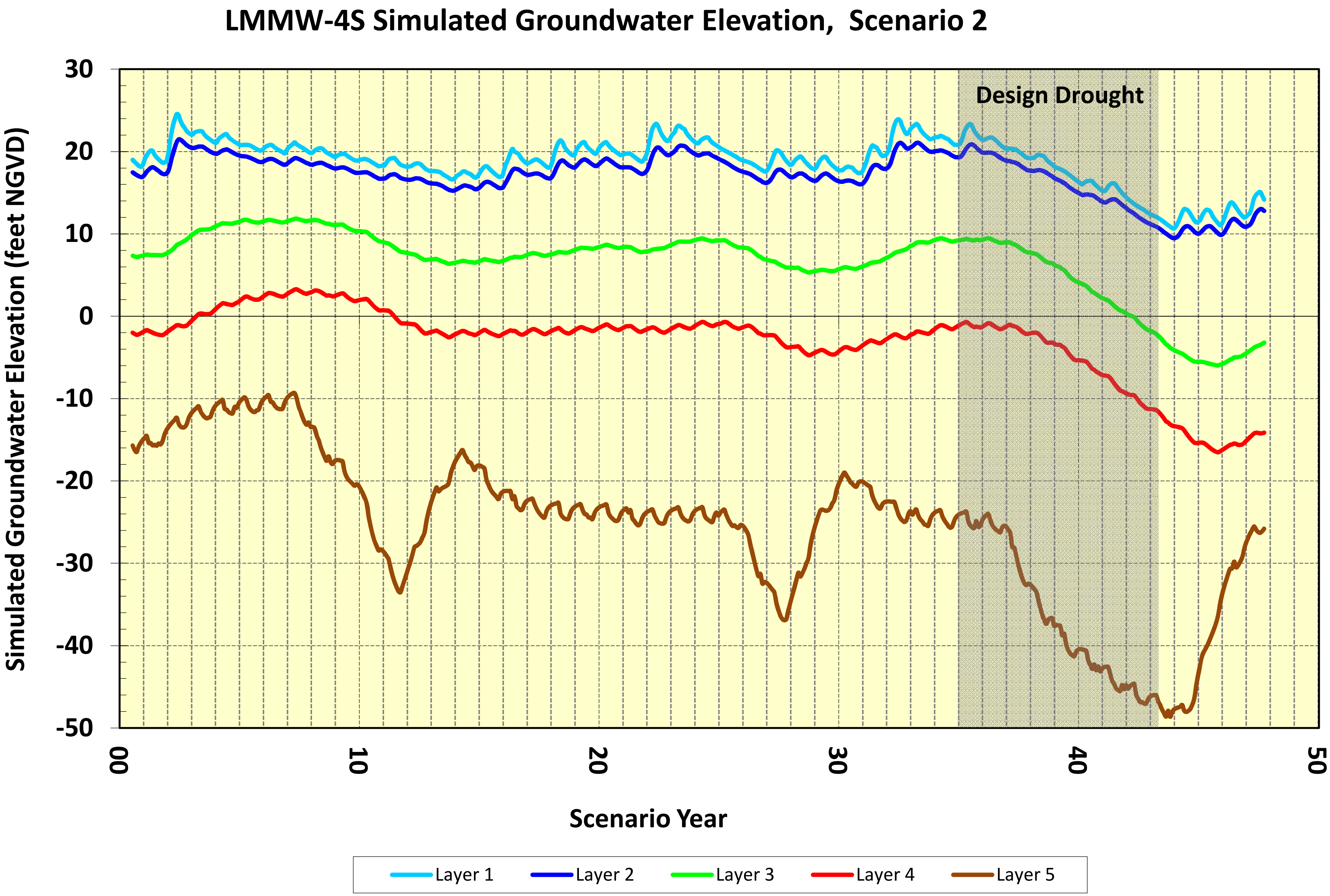


Note: At the location of SWM-GS-M, the model does not contain Model Layer 5.

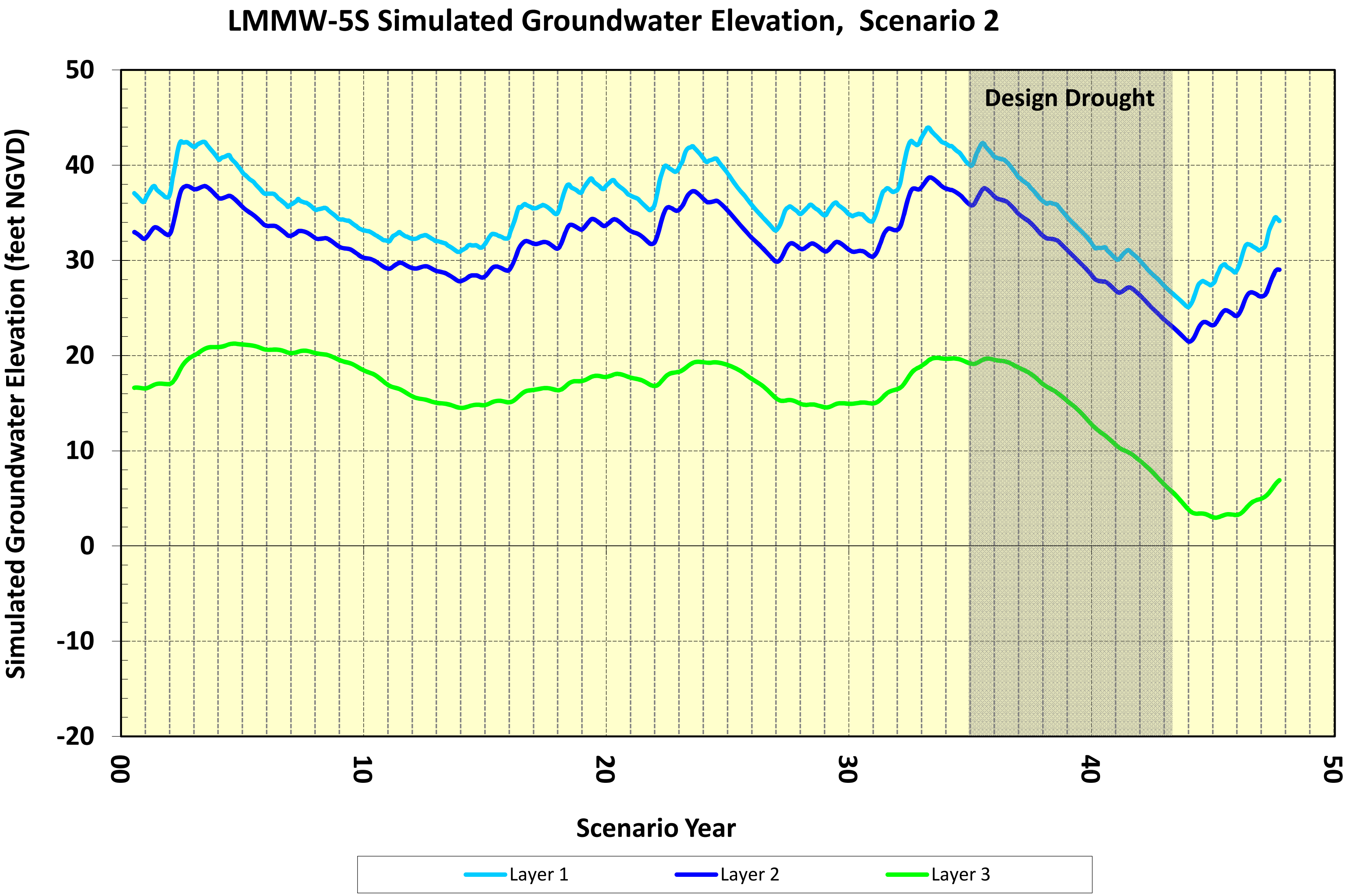


Ortega_MW Simulated Groundwater Elevation, Scenario 2
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

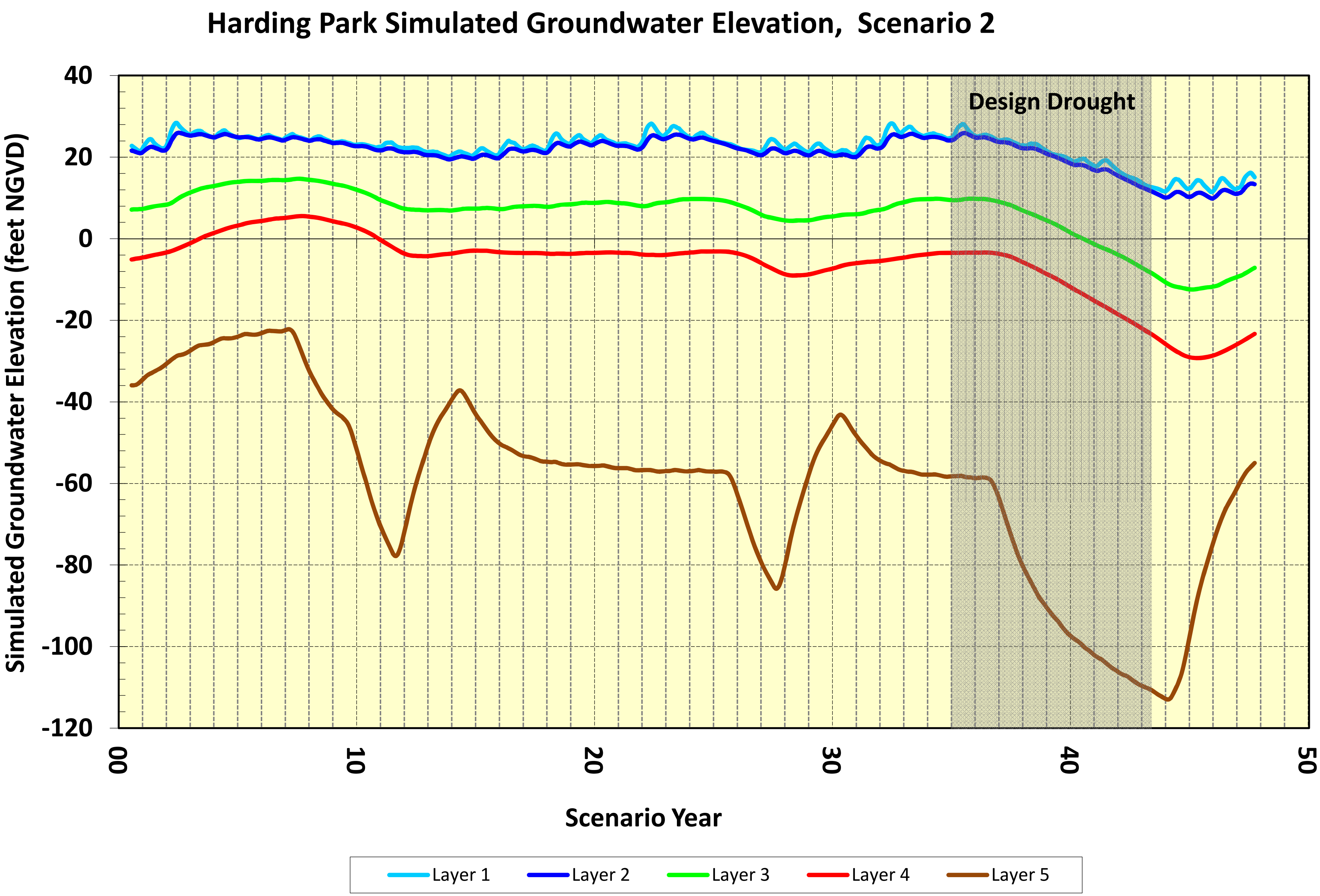

Santiago-S Simulated Groundwater Elevation, Scenario 2
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
-15
-20
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



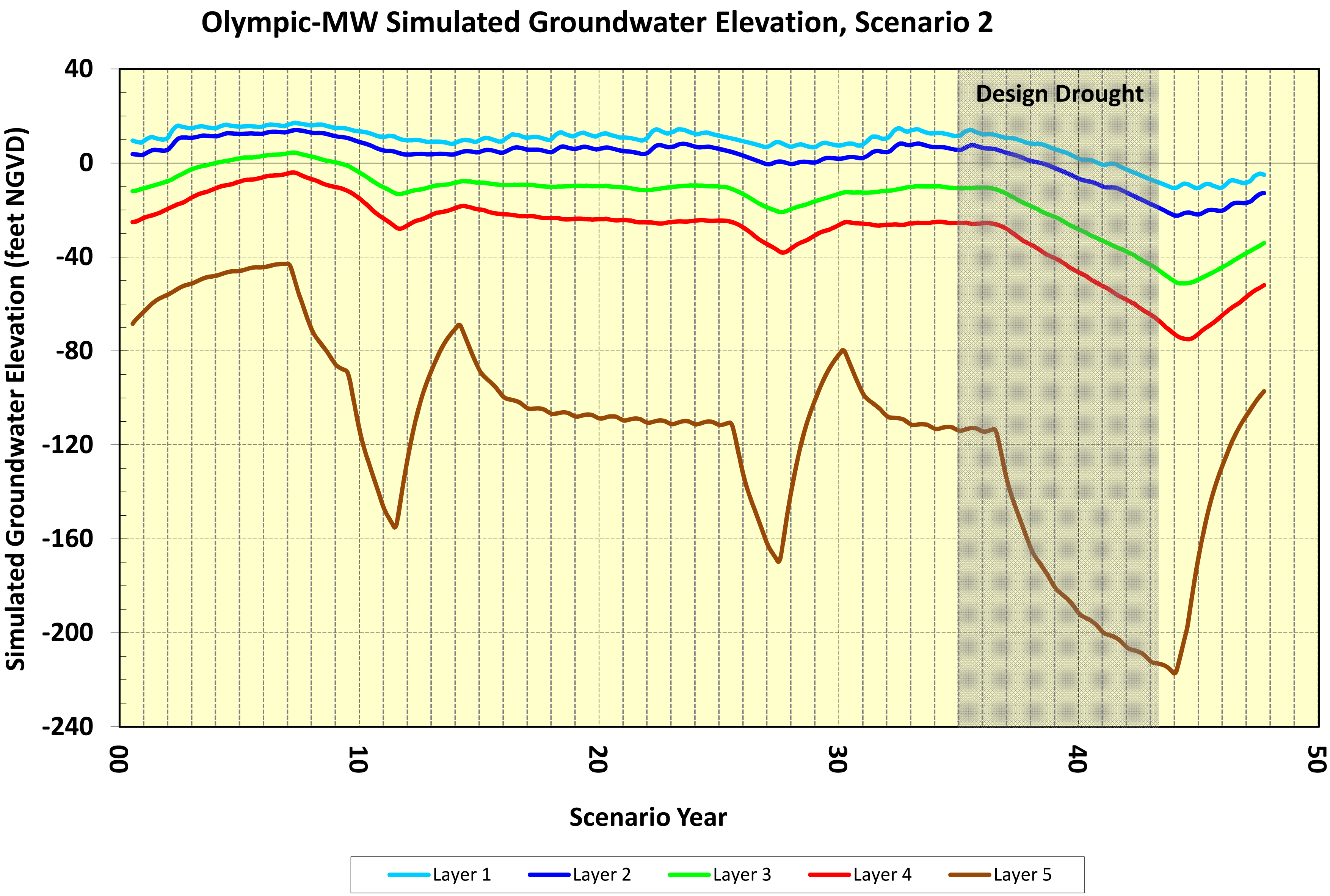
LMMW-4S Simulated Groundwater Elevation, Scenario 2
Design Drought
Simulated Groundwater Elevation (feet NGVD)
30
20
10
0
-10
-20
-30
-40
-50
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



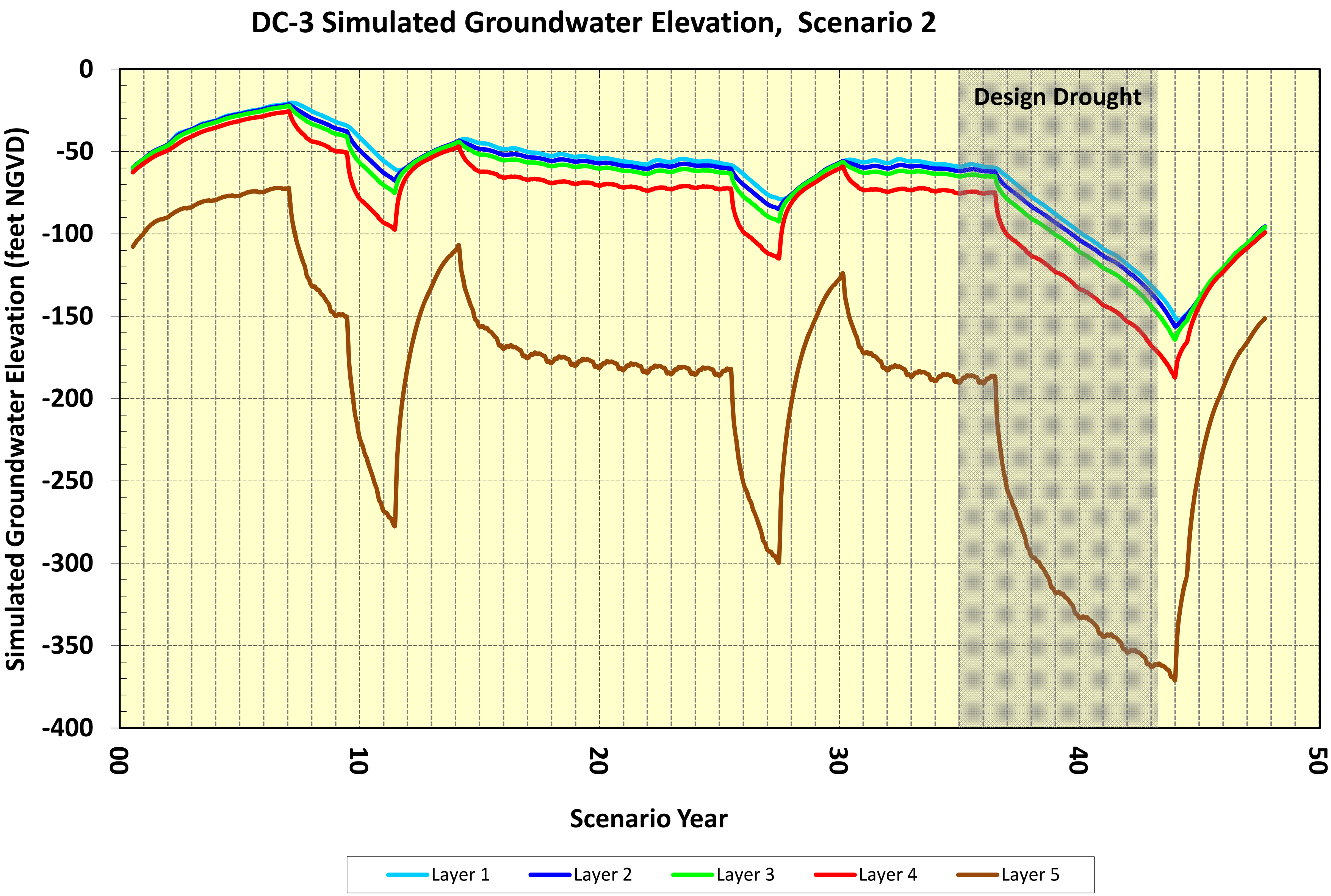
Note: At the location of LMMW-5S, the model does not contain Model Layers 4 and 5.



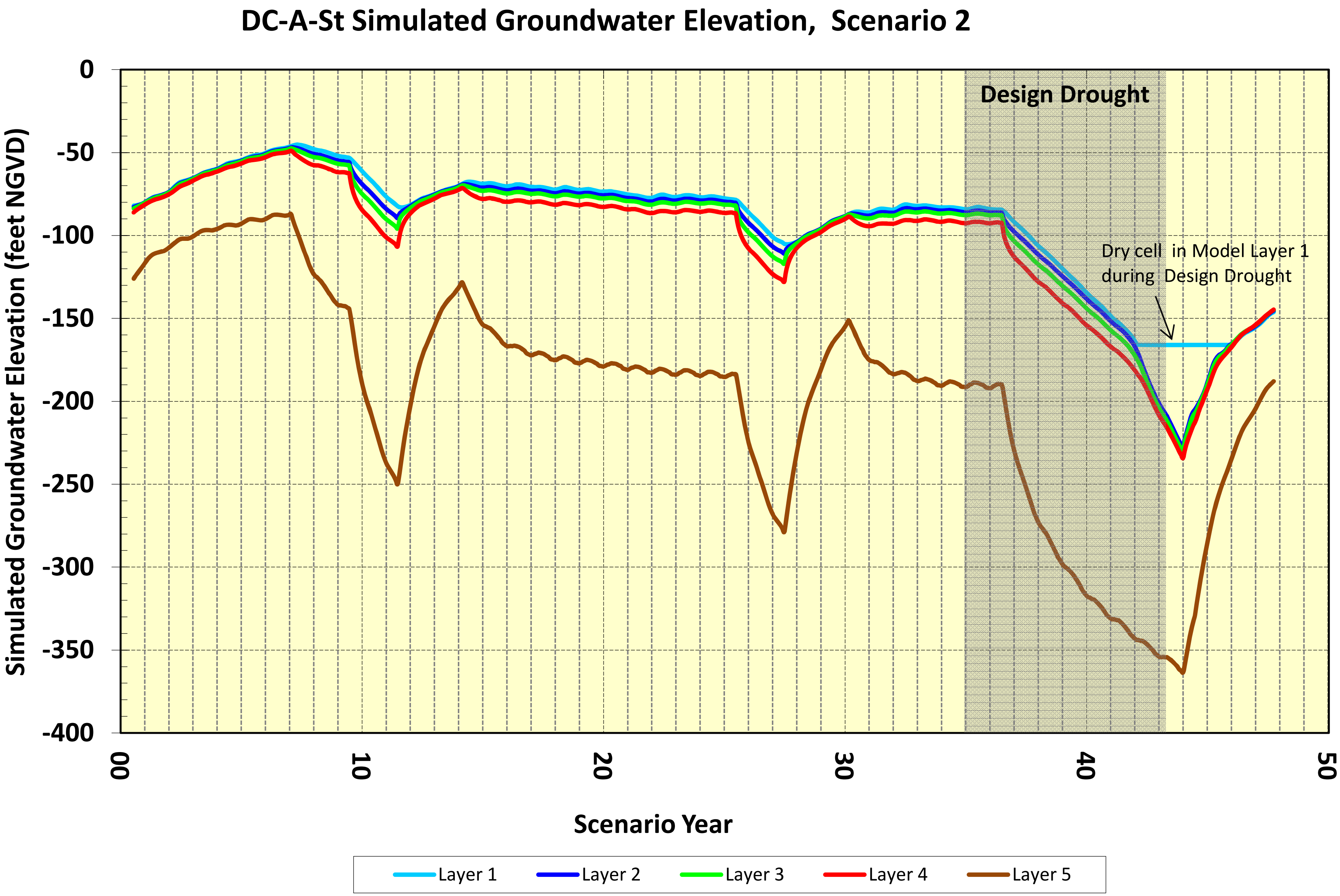
Harding Park Simulated Groundwater Elevation, Scenario 2
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
-100
-120
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

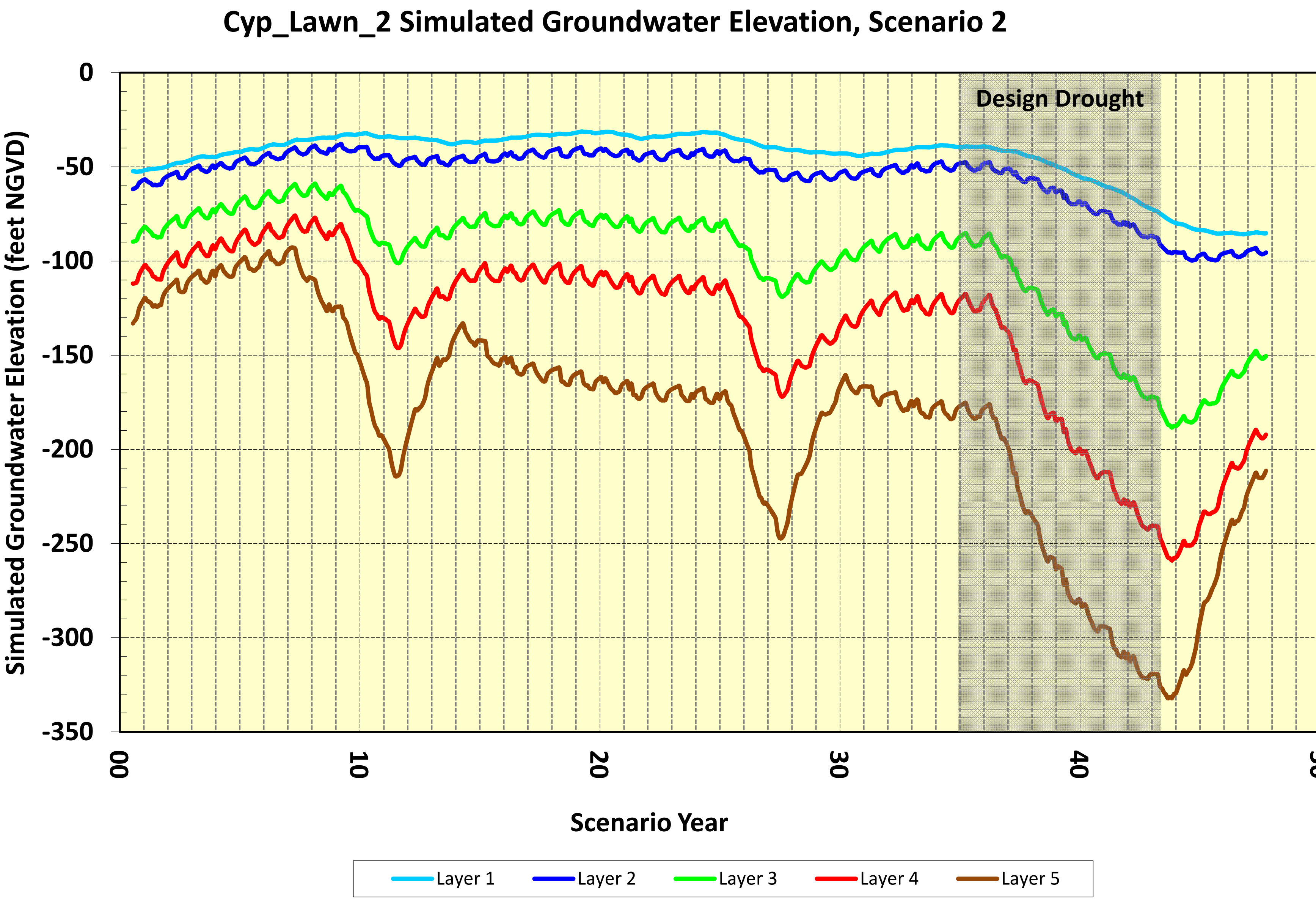


Olympic-MW Simulated Groundwater Elevation, Scenario 2
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
0
-40
-80
-120
-160
-200
-240
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

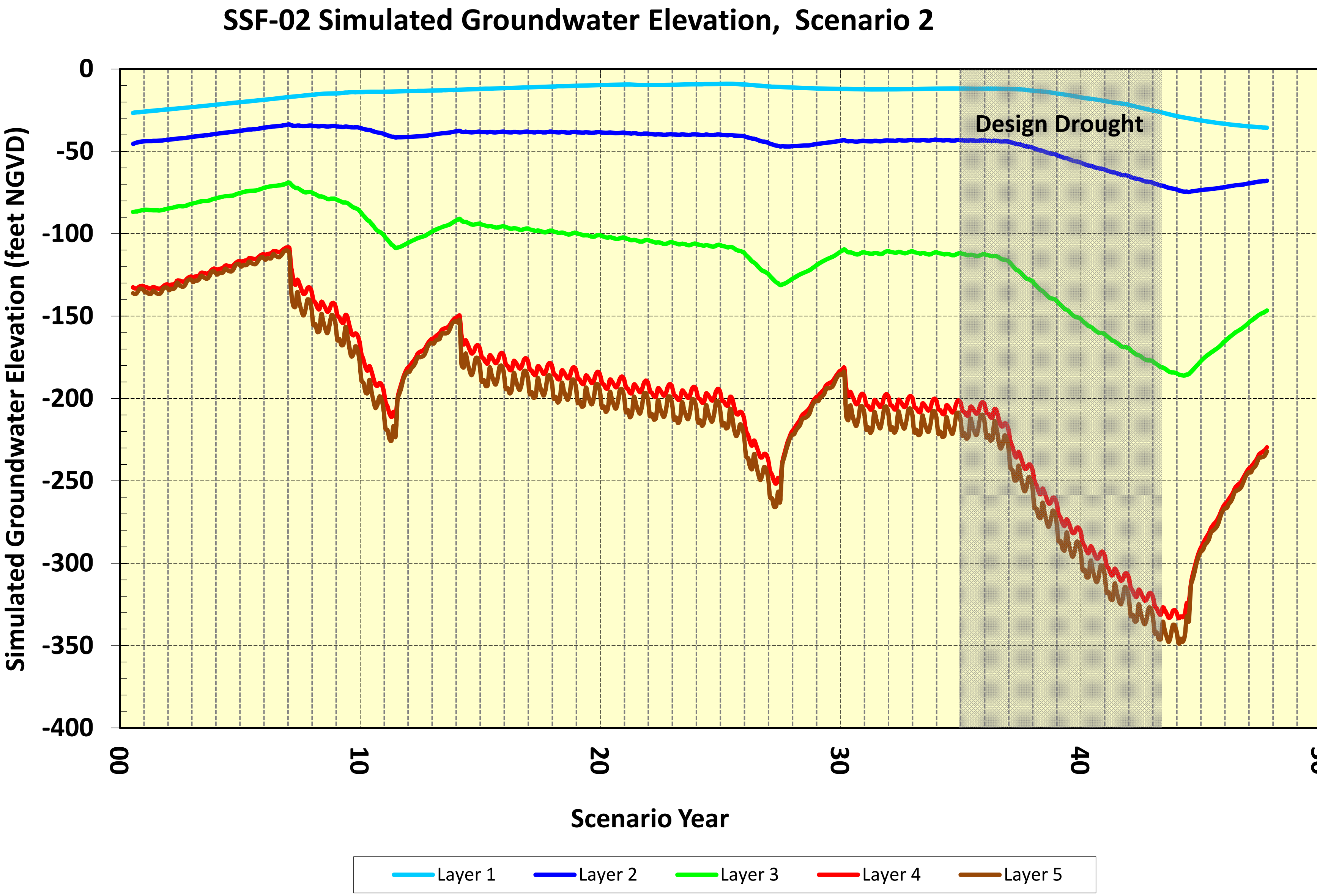


DC-3 Simulated Groundwater Elevation, Scenario 2
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

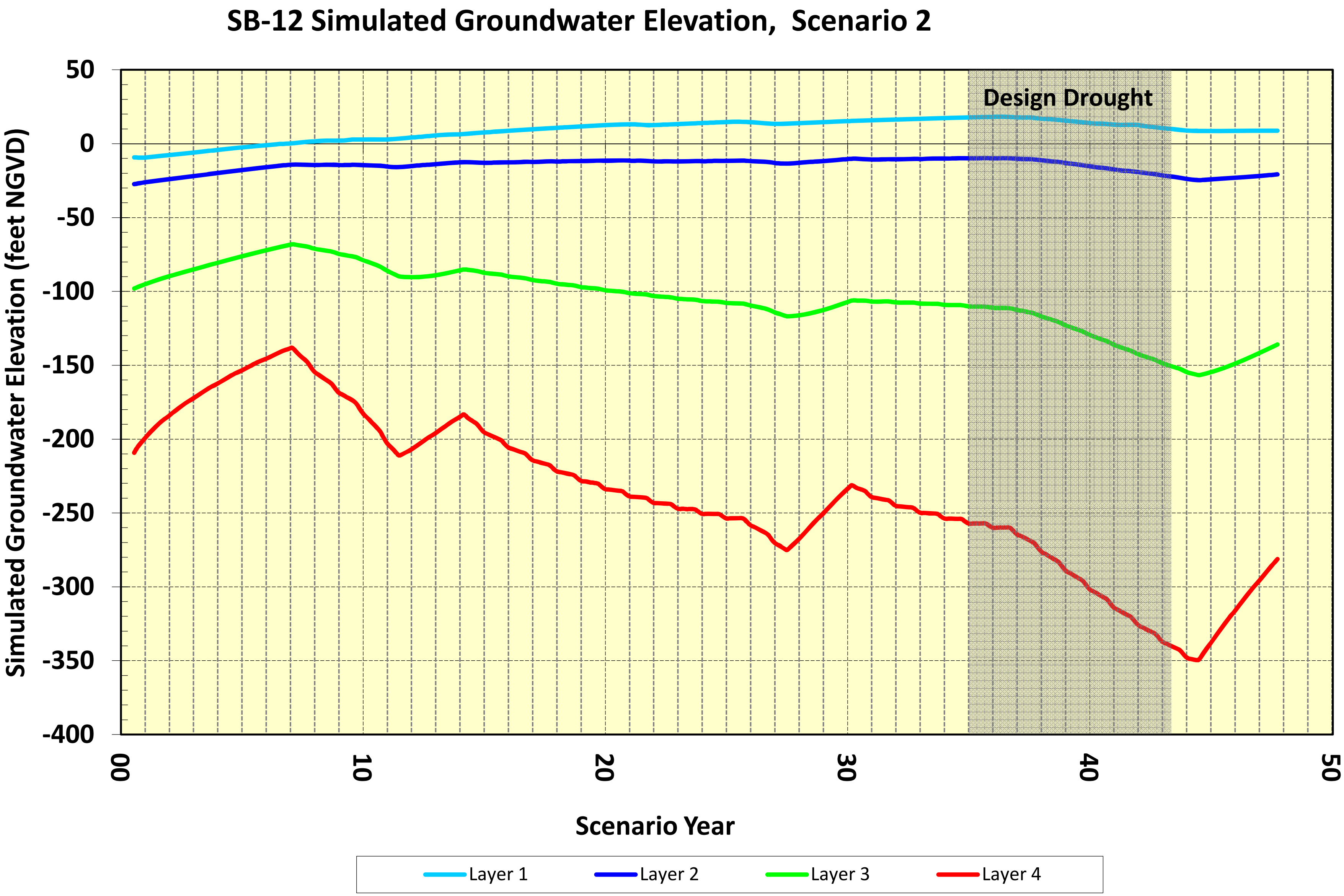

DC-A-St Simulated Groundwater Elevation, Scenario 2
Design Drought
Dry cell in Model Layer 1
during Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



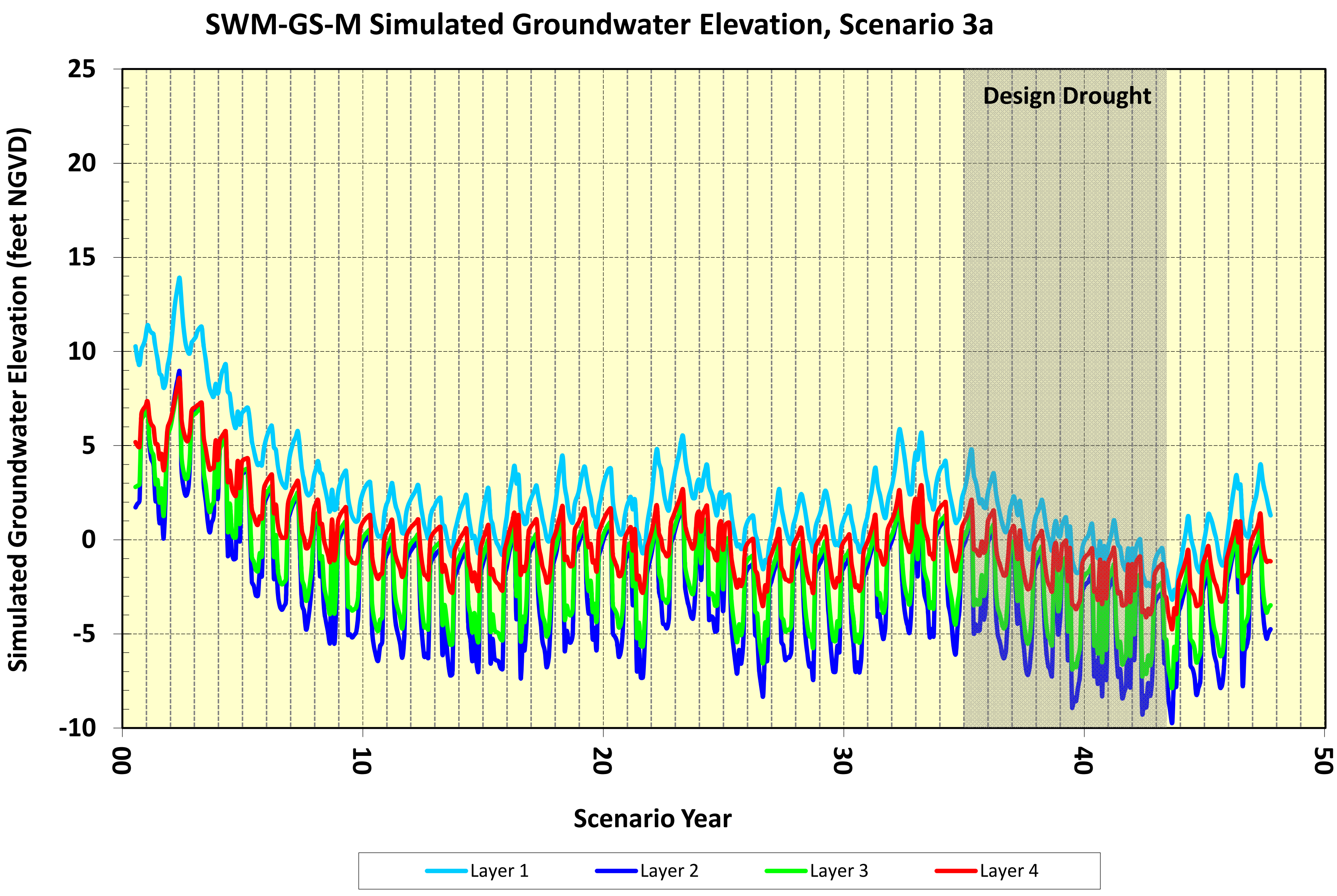
Cyp_Lawn_2 Simulated Groundwater Elevation, Scenario 2
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



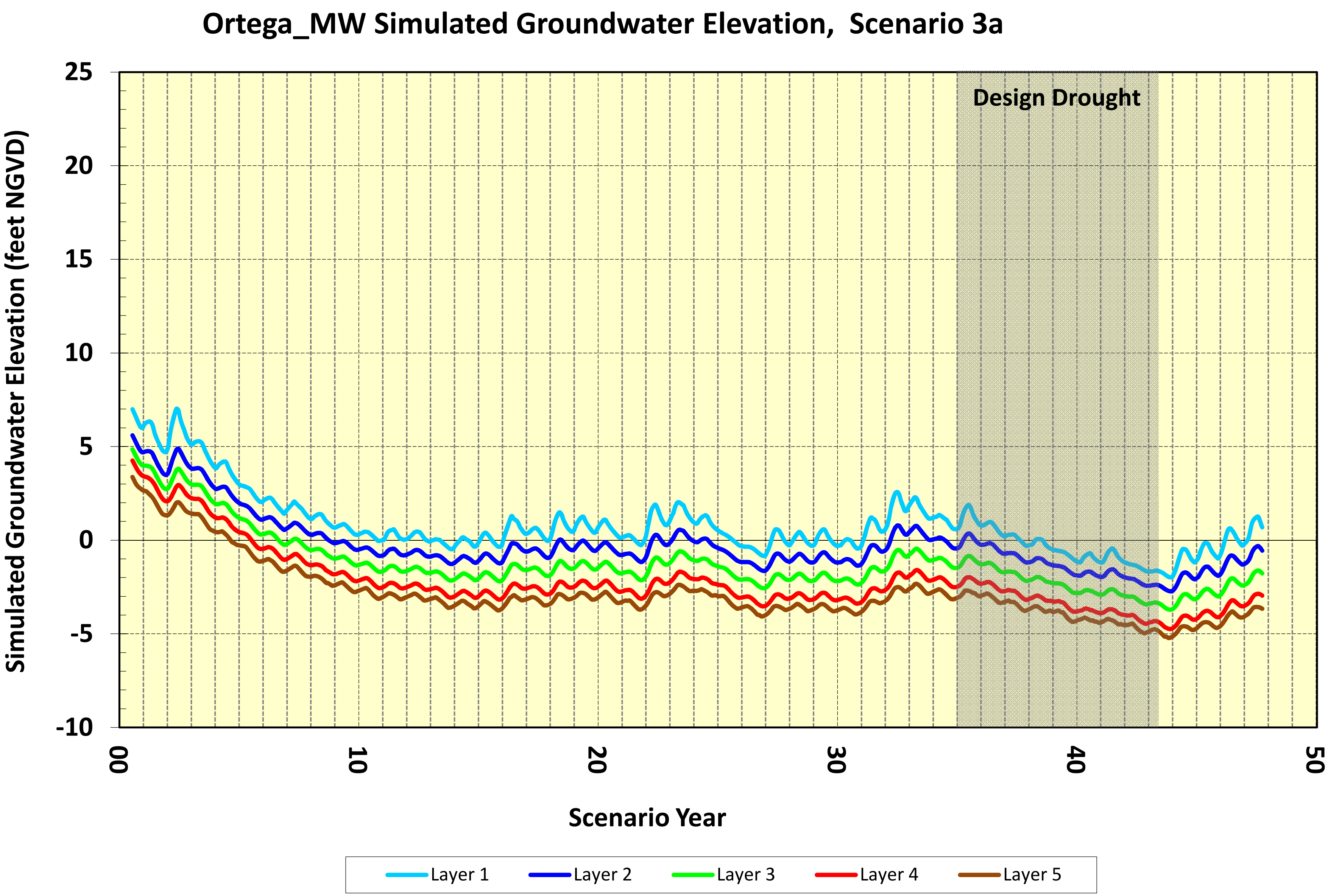
SSF-02 Simulated Groundwater Elevation, Scenario 2
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

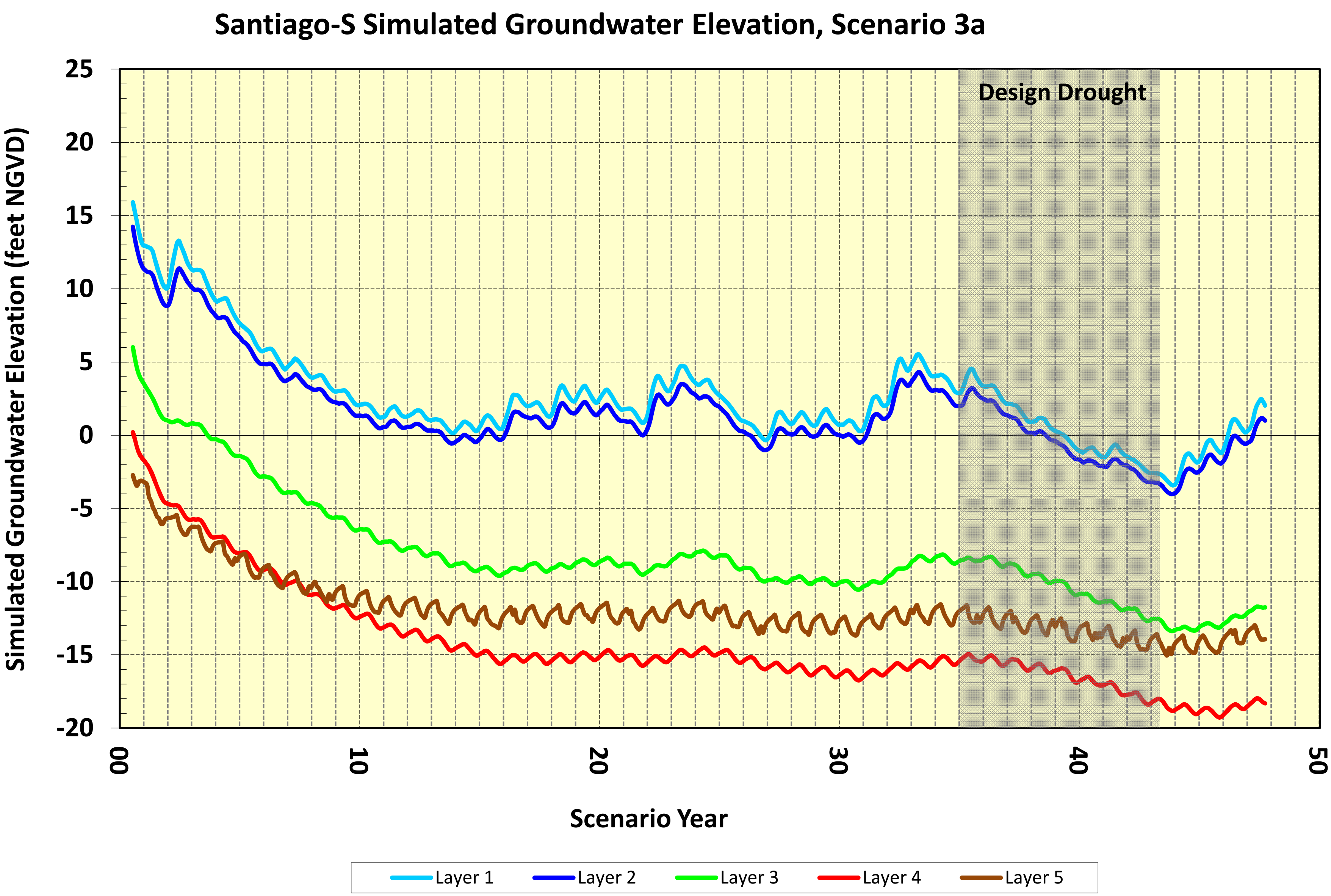


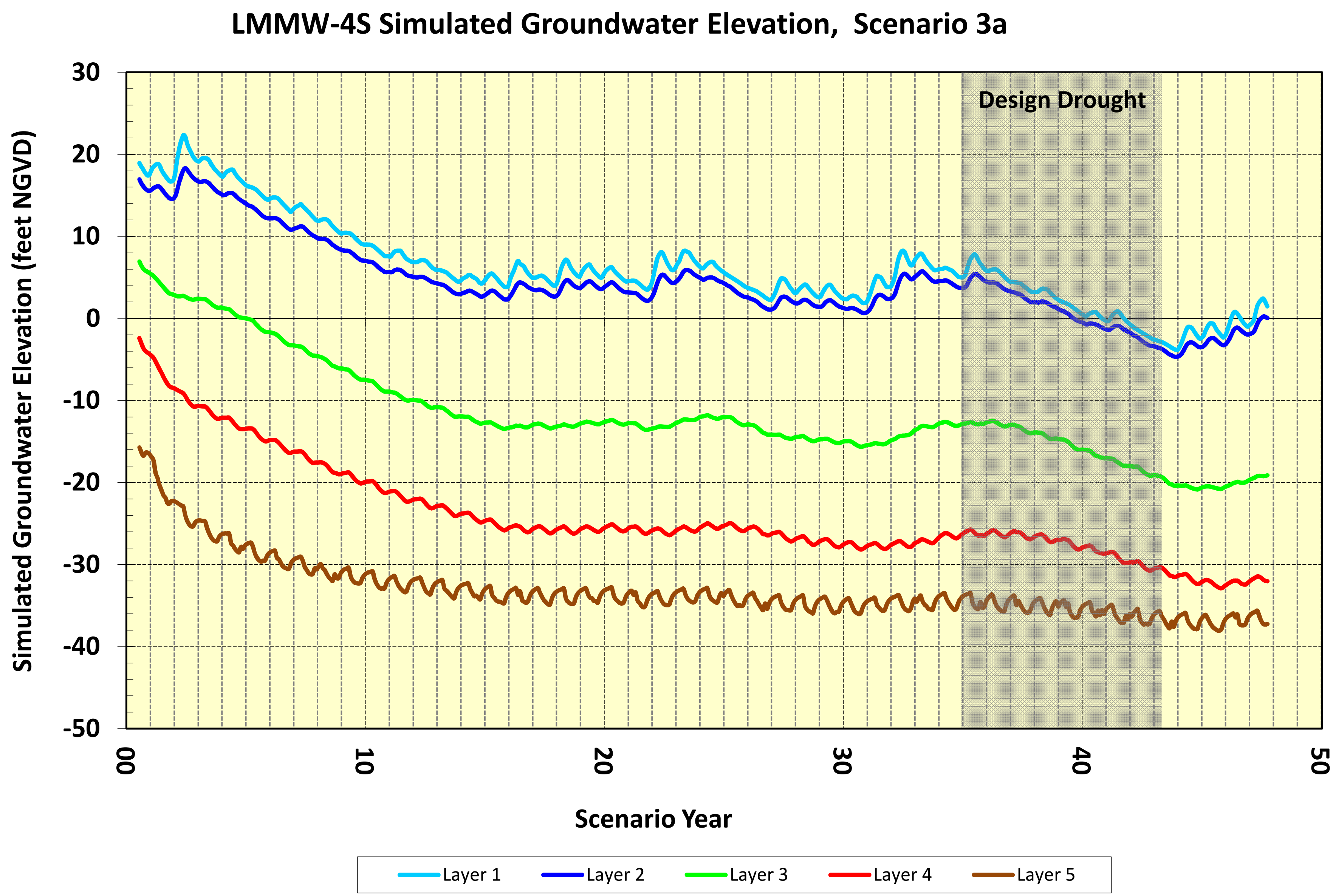
Note: At the location of SB-12, the model does not contain Model Layer 5.

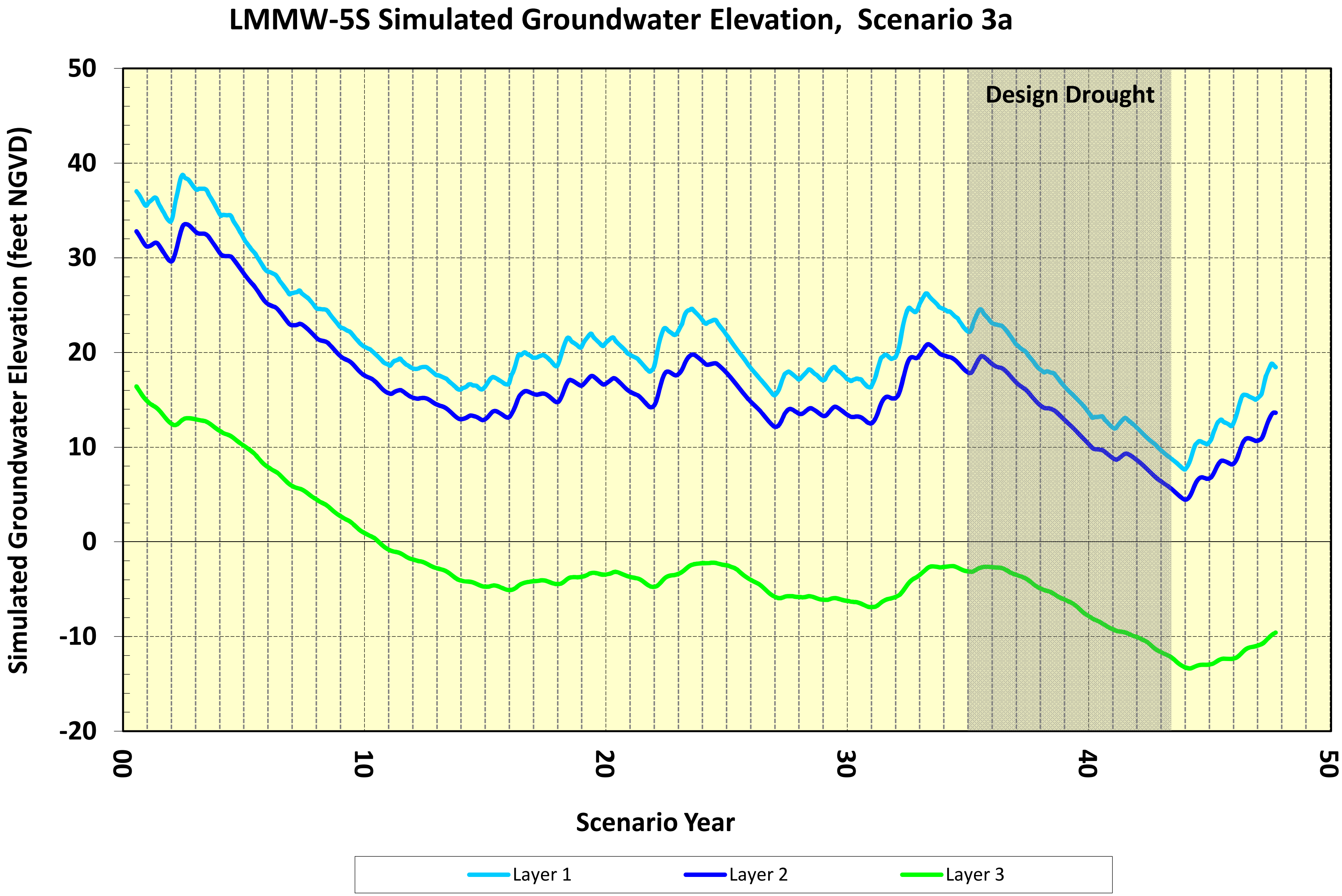


Note: At the location of SWM-GS-M, the model does not contain Model Layer 5.

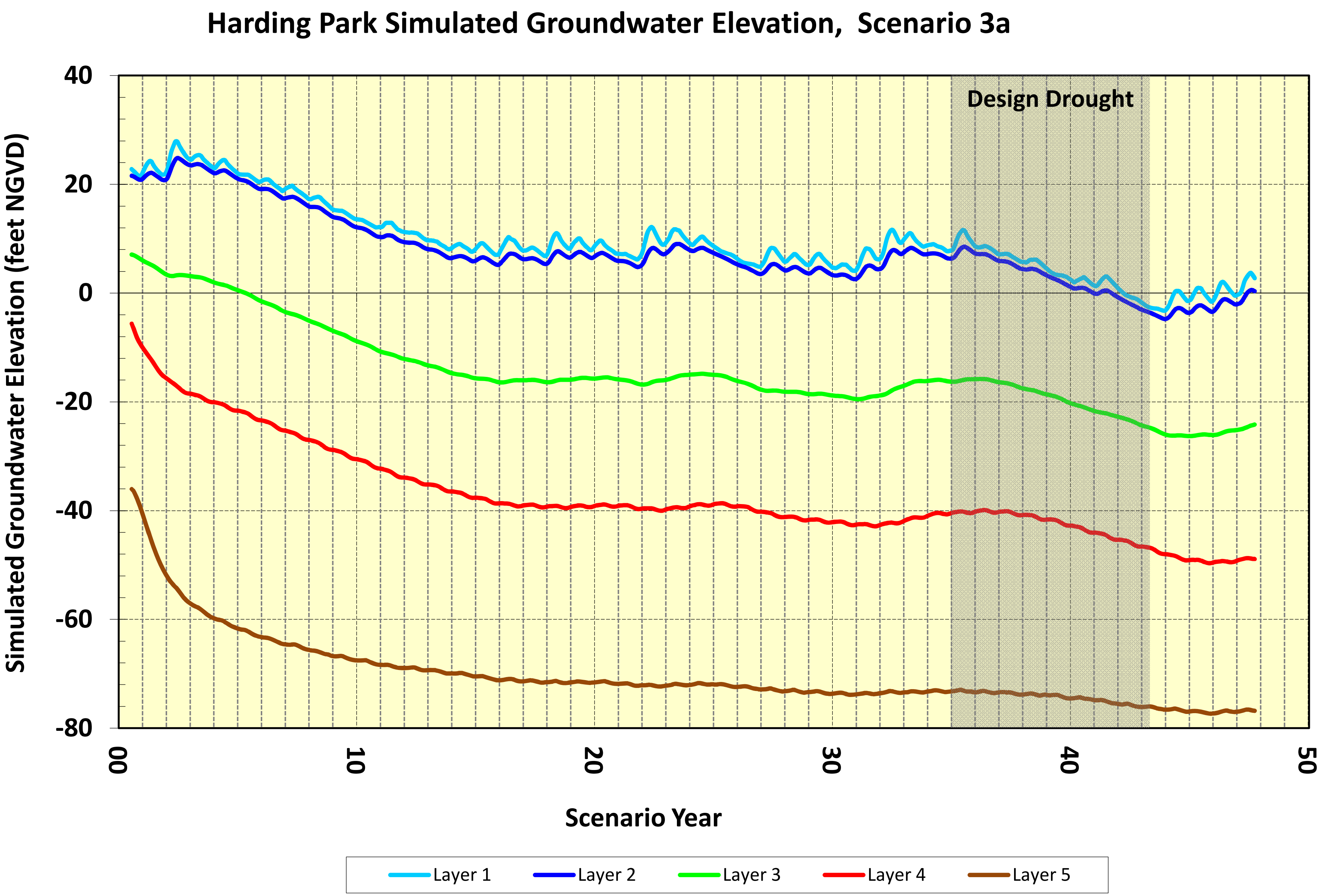

Ortega_MW Simulated Groundwater Elevation, Scenario 3a
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
Design Drought
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


Santiago-S Simulated Groundwater Elevation, Scenario 3a
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
-15
-20
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

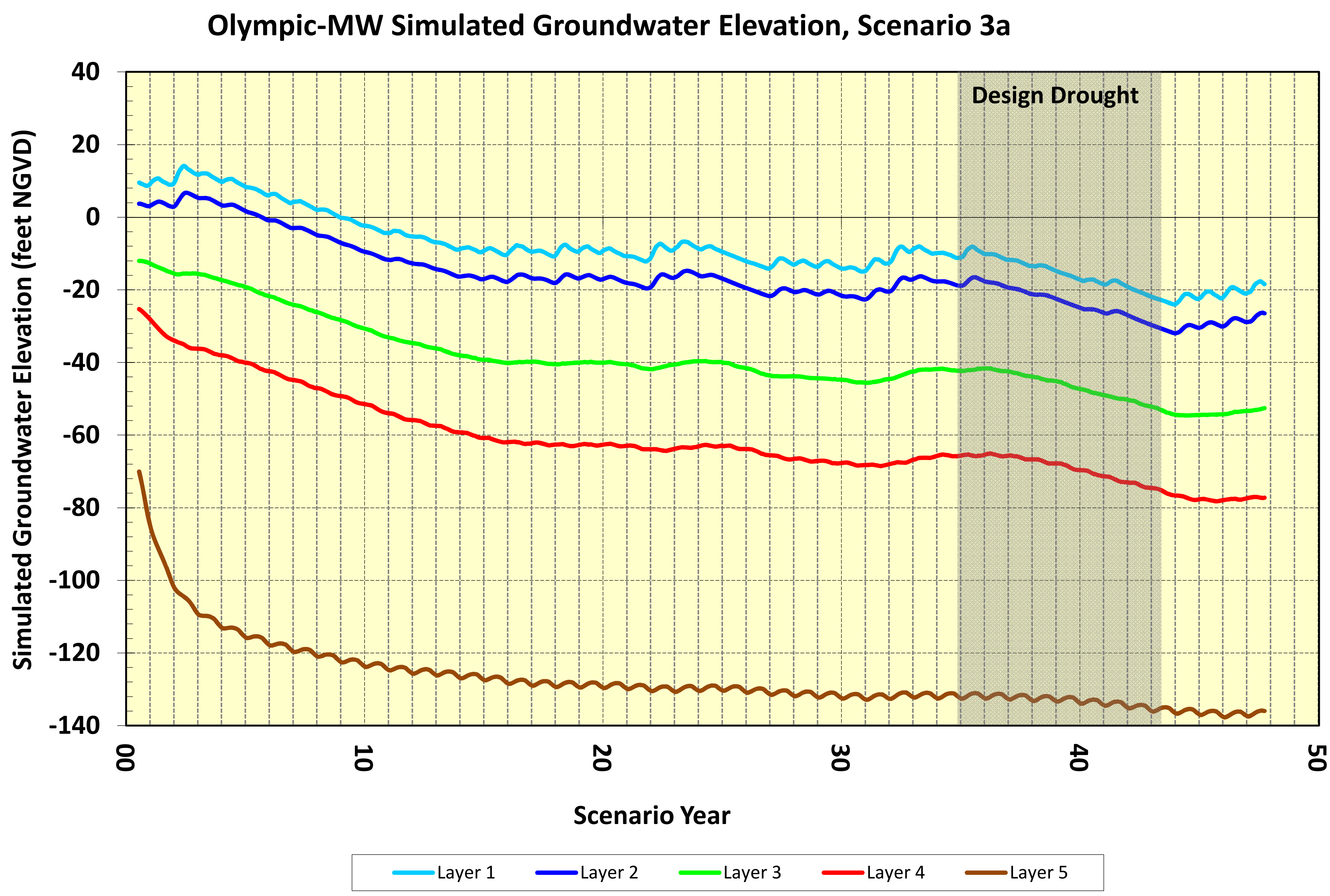

LMMW-4S Simulated Groundwater Elevation, Scenario 3a
Design Drought
Simulated Groundwater Elevation (feet NGVD)
30
20
10
0
-10
-20
-30
-40
-50
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



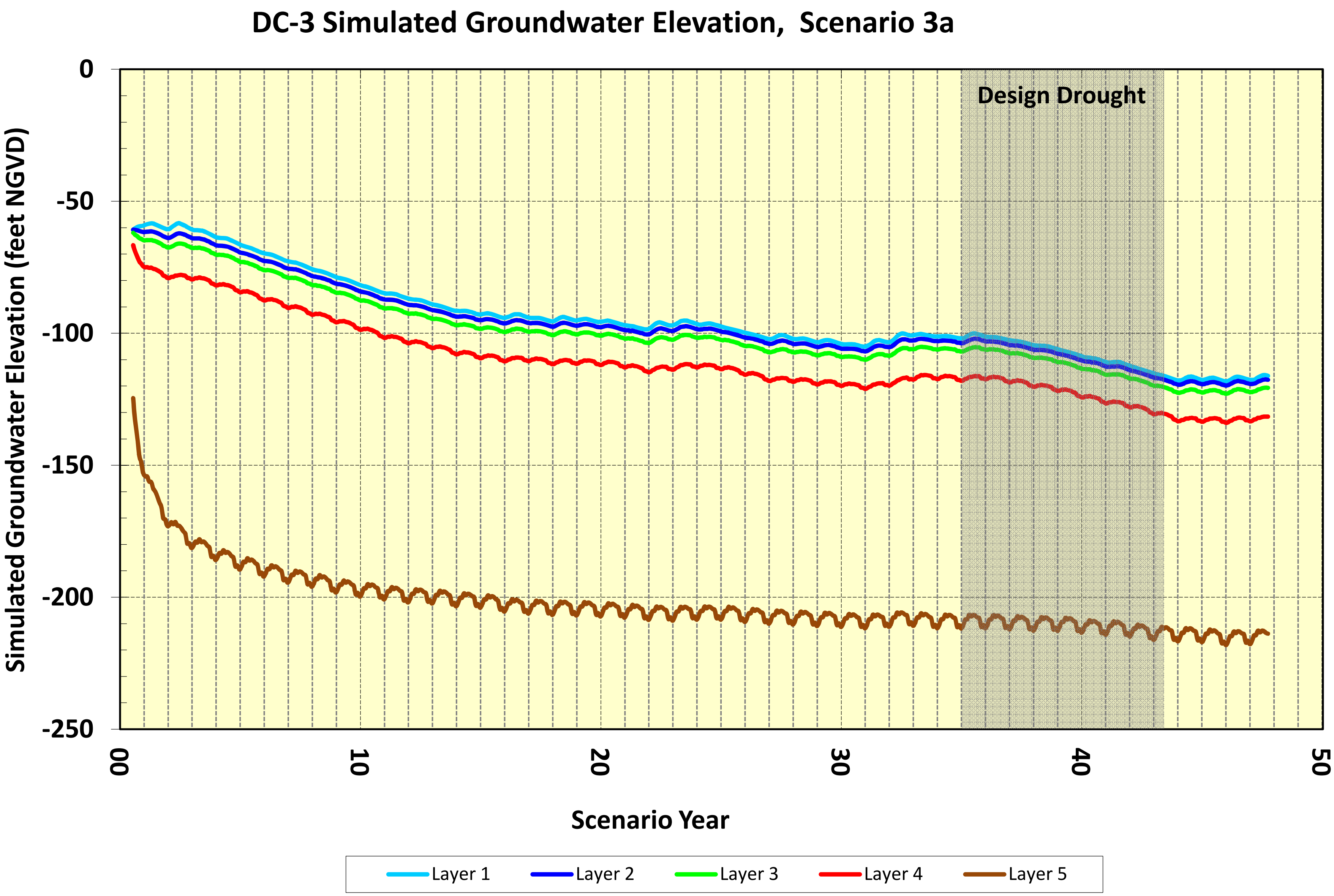
Note: At the location of LMMW-5S, the model does not contain Model Layers 4 and 5.

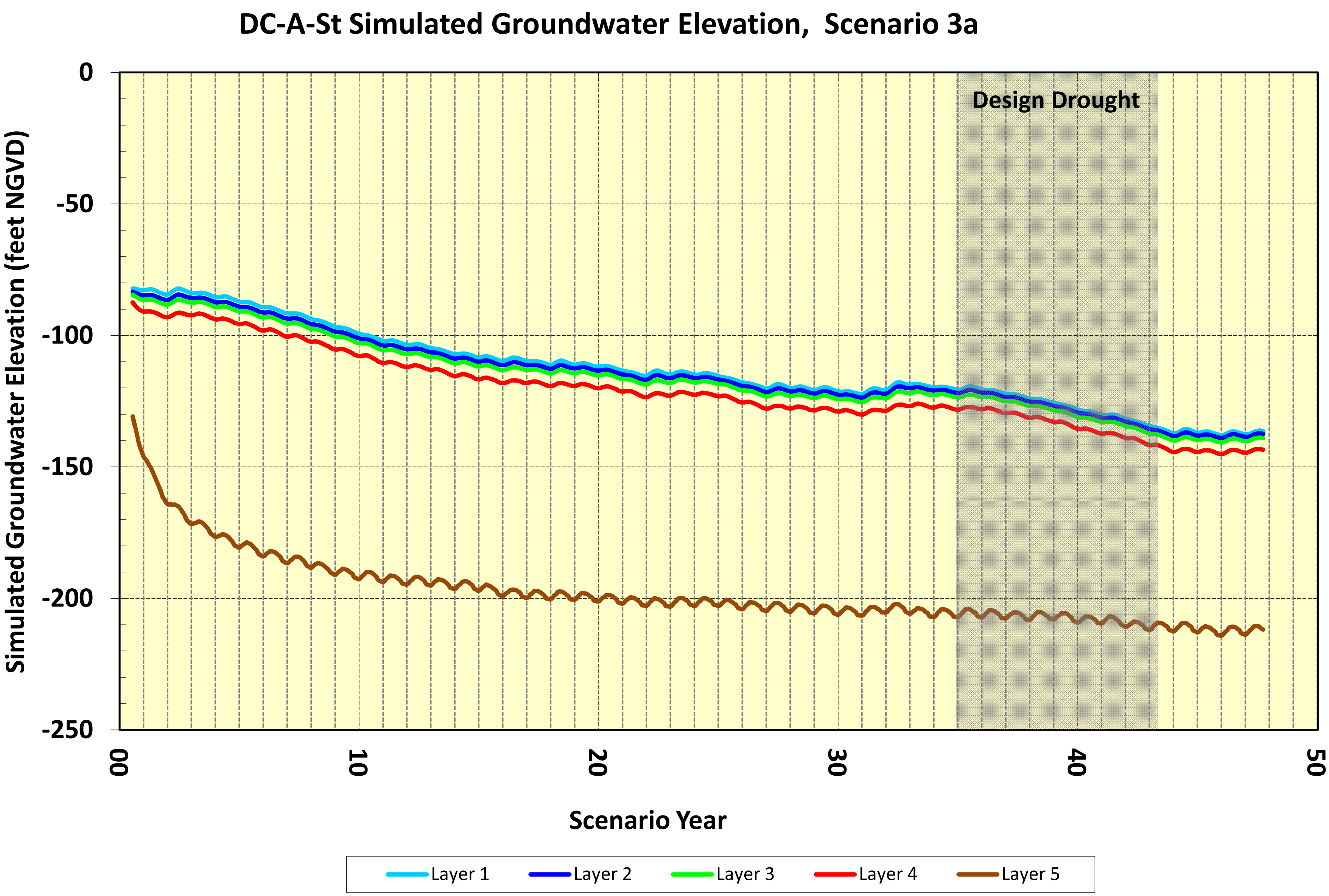


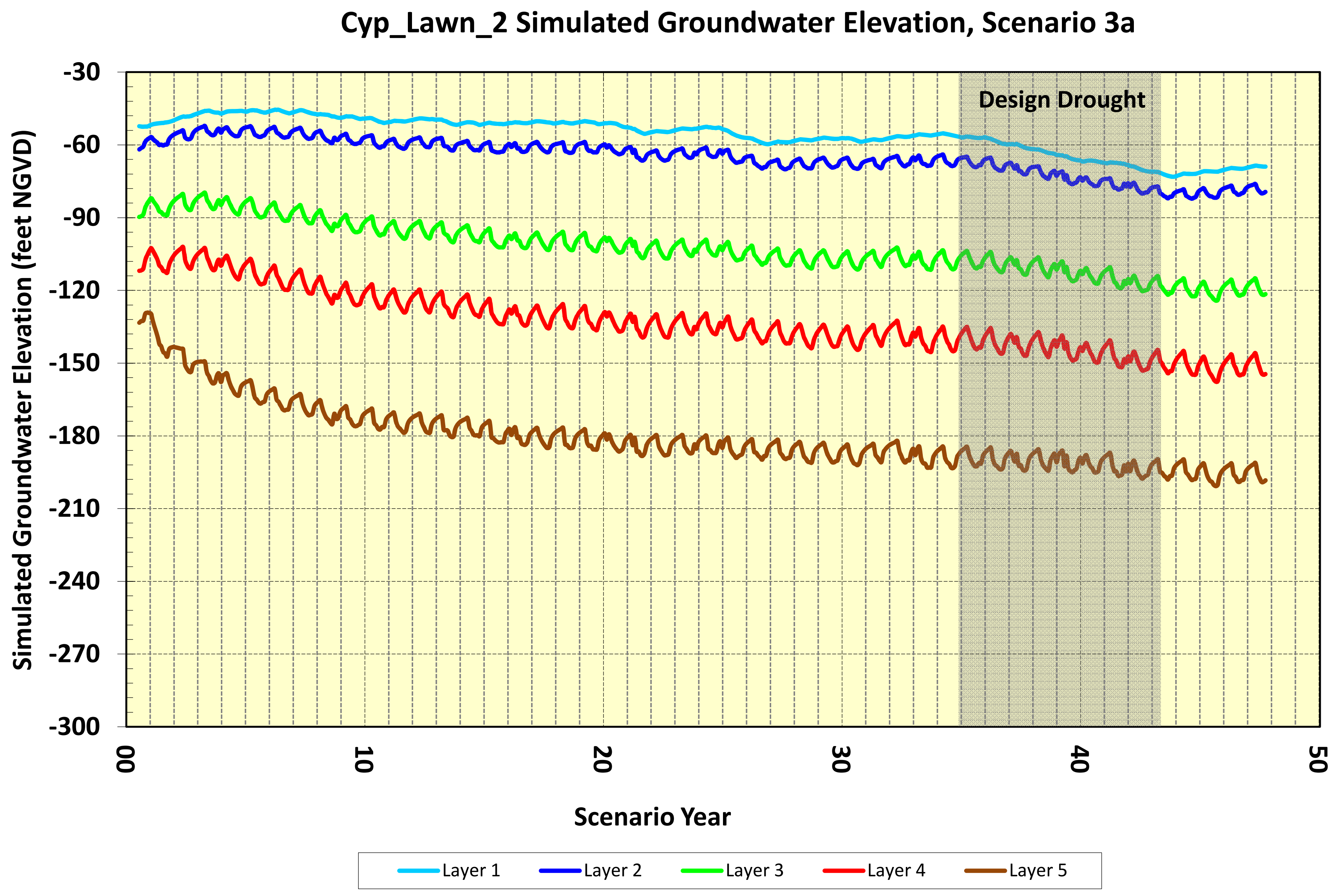
Harding Park Simulated Groundwater Elevation, Scenario 3a
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



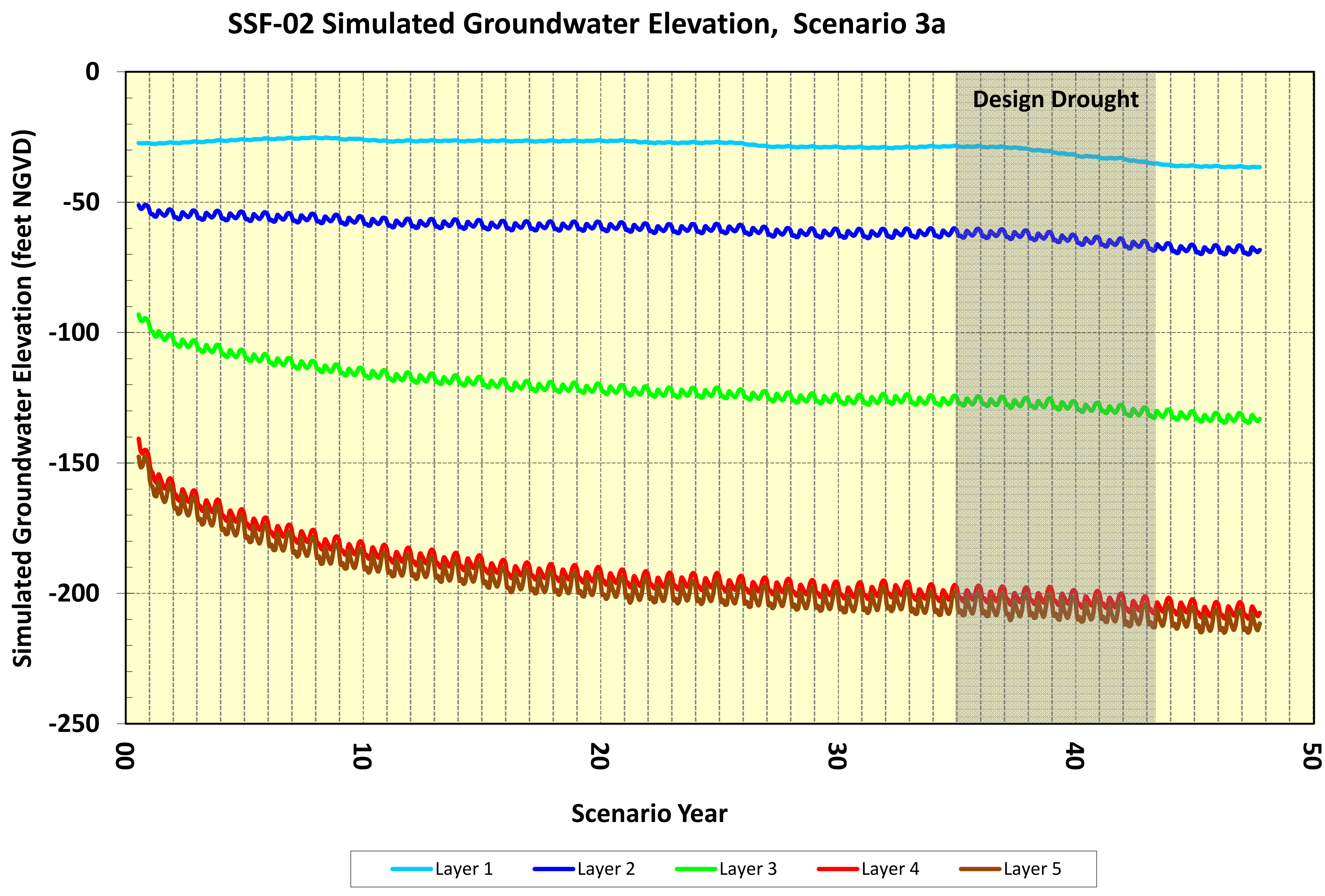
Olympic-MW Simulated Groundwater Elevation, Scenario 3a
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
-100
-120
-140
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


DC-3 Simulated Groundwater Elevation, Scenario 3a
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

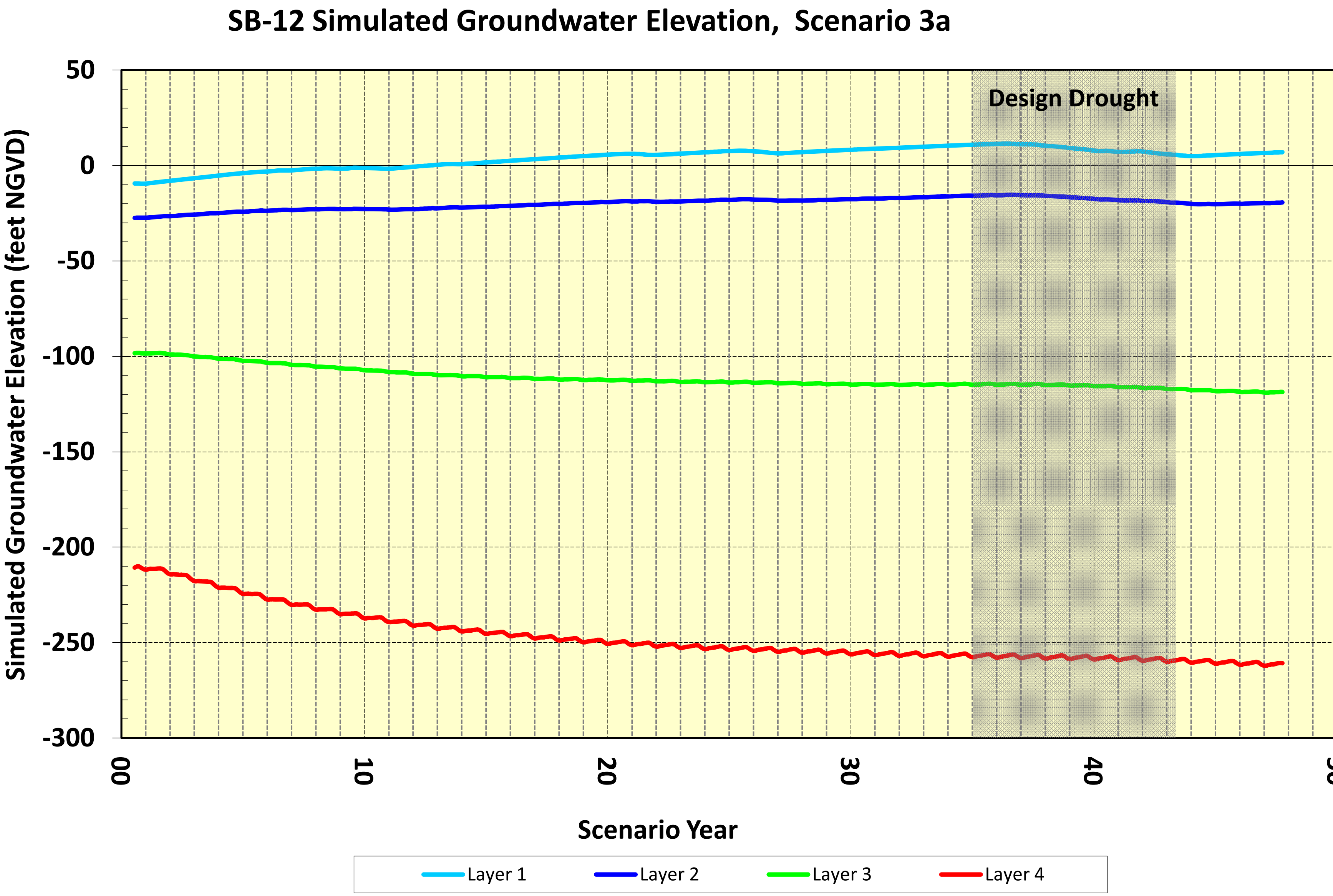

DC-A-St Simulated Groundwater Elevation, Scenario 3a
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



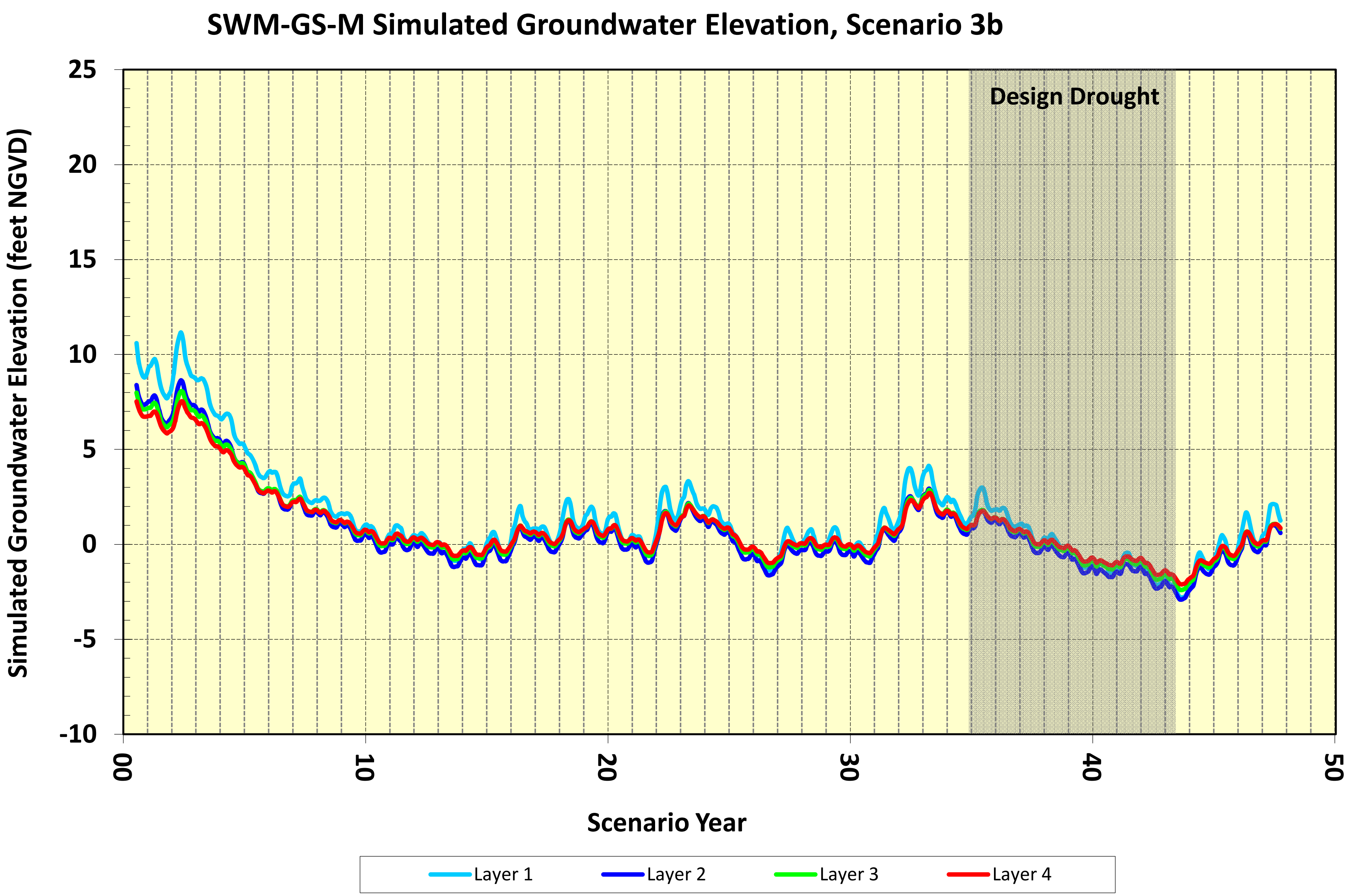
Cyp_Lawn_2 Simulated Groundwater Elevation, Scenario 3a
Design Drought
Simulated Groundwater Elevation (feet NGVD)
-30
-60
-90
-120
-150
-180
-210
-240
-270
-300
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



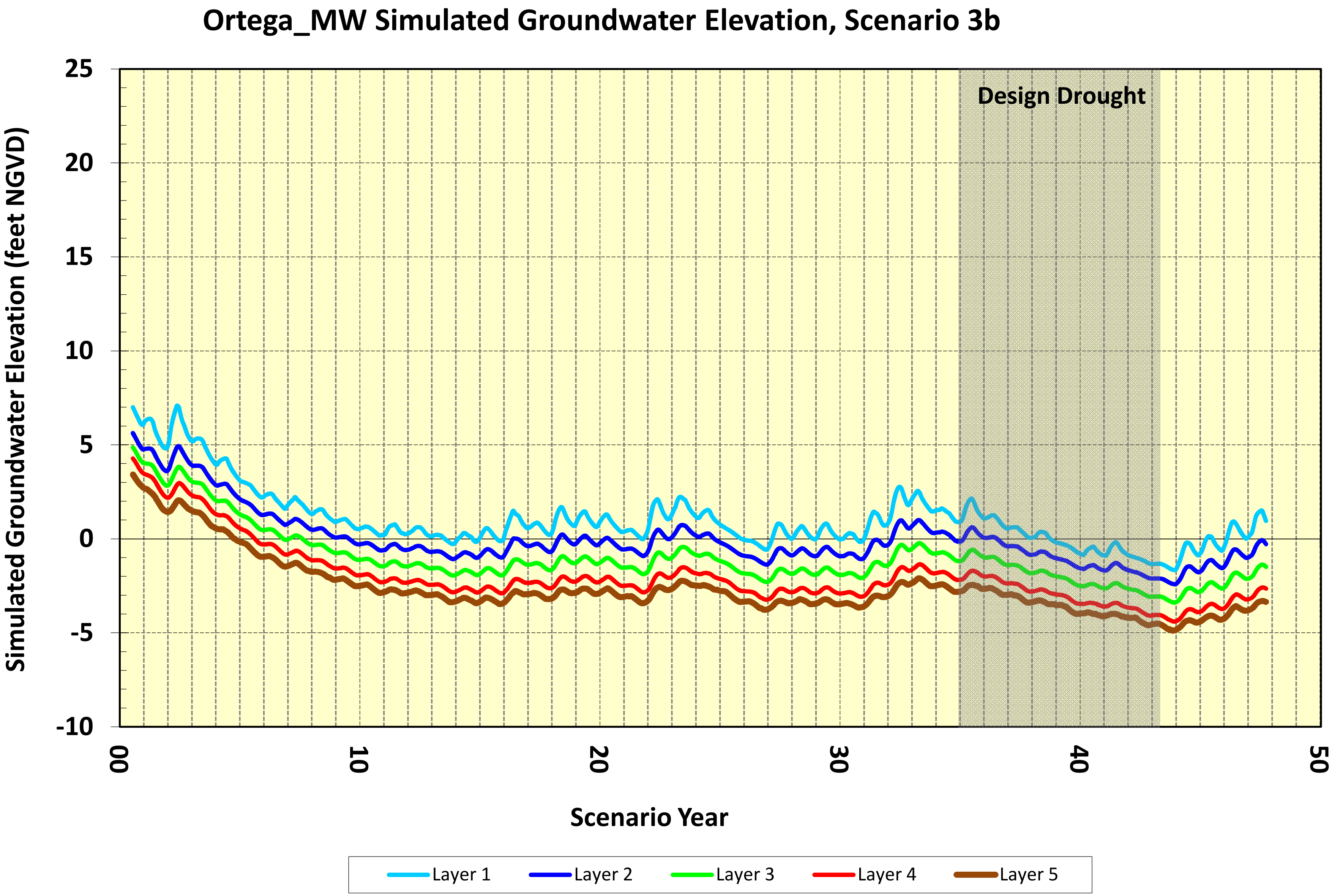
SSF-02 Simulated Groundwater Elevation, Scenario 3a
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

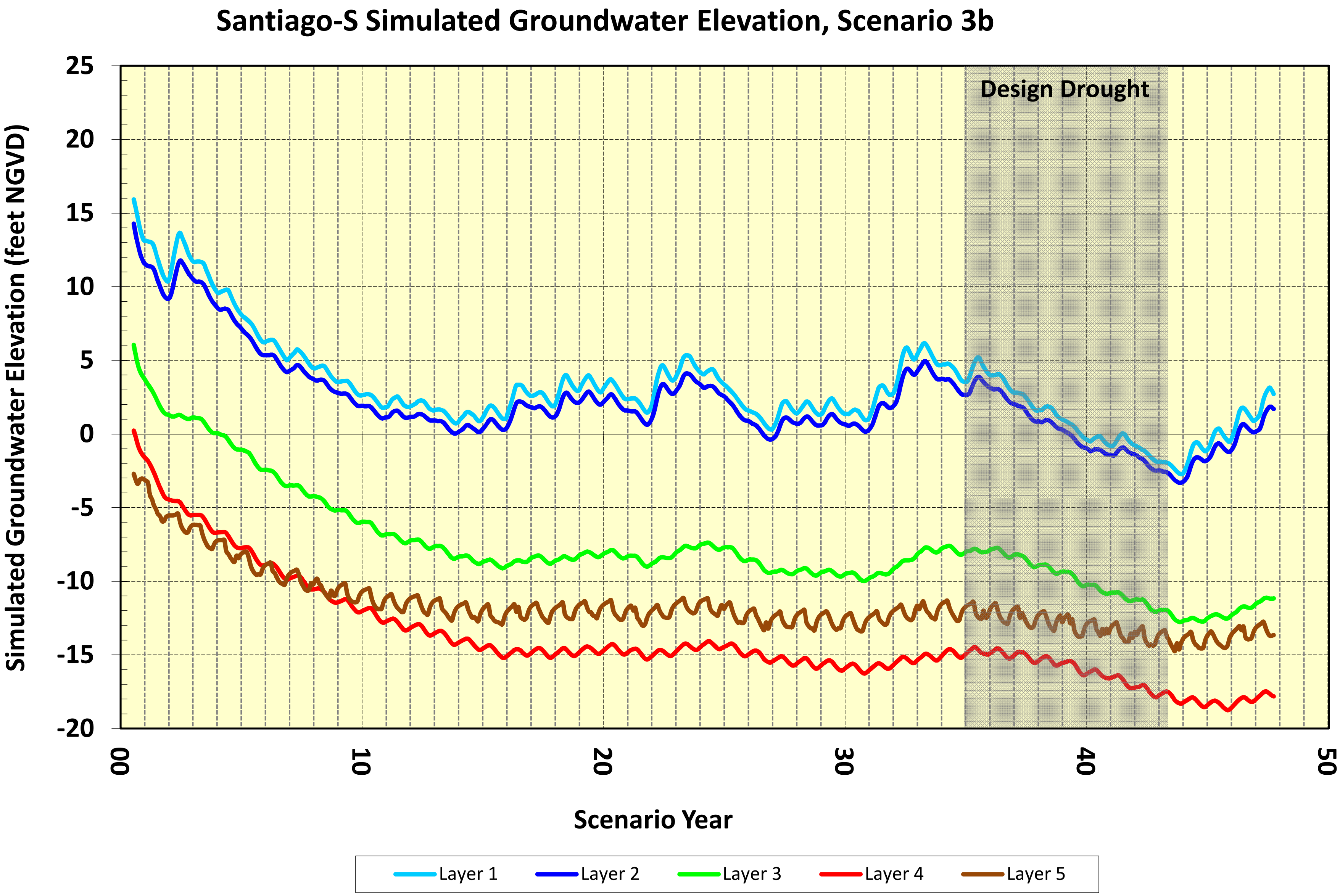


Note: At the location of SB-12, the model does not contain Model Layer 5.

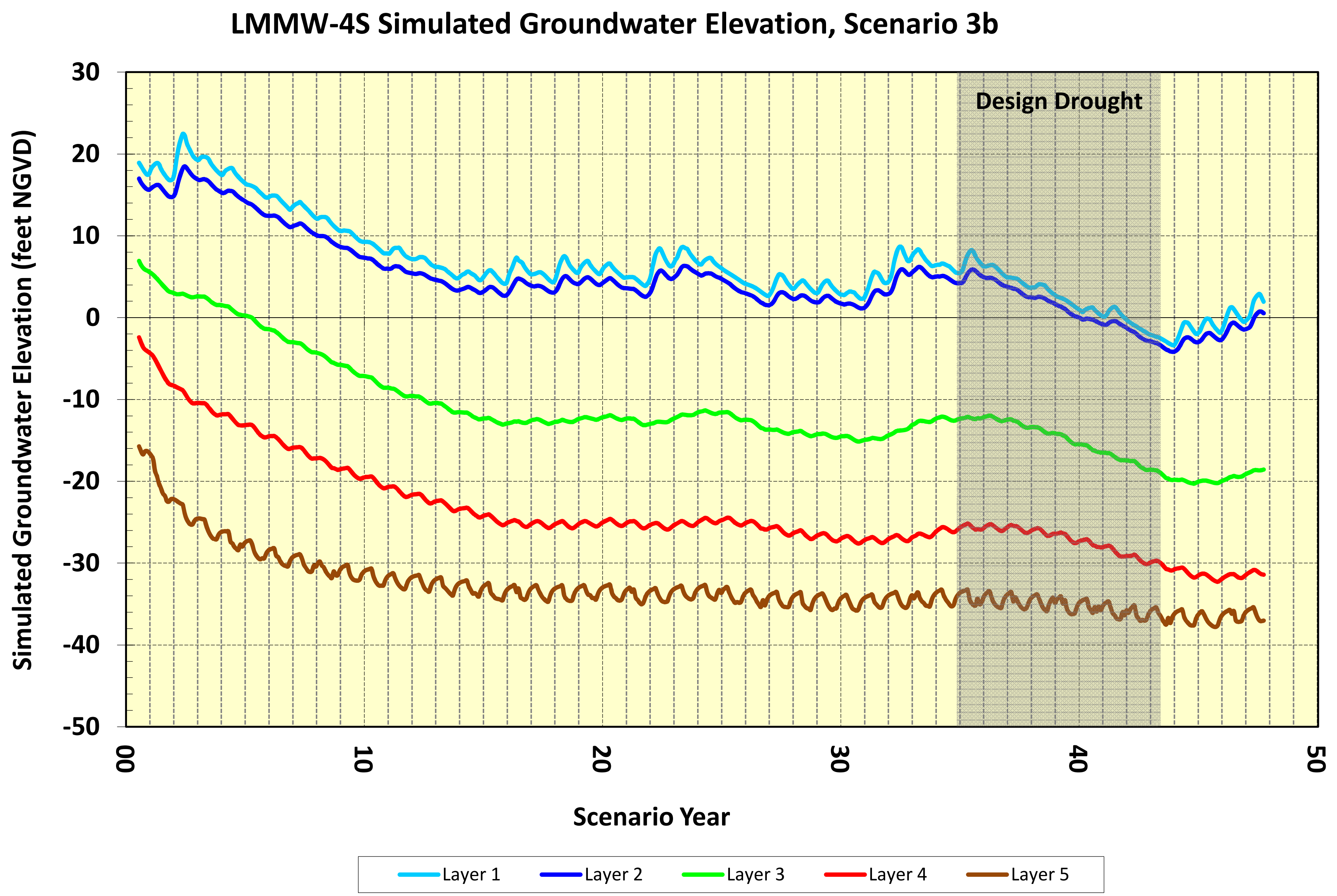


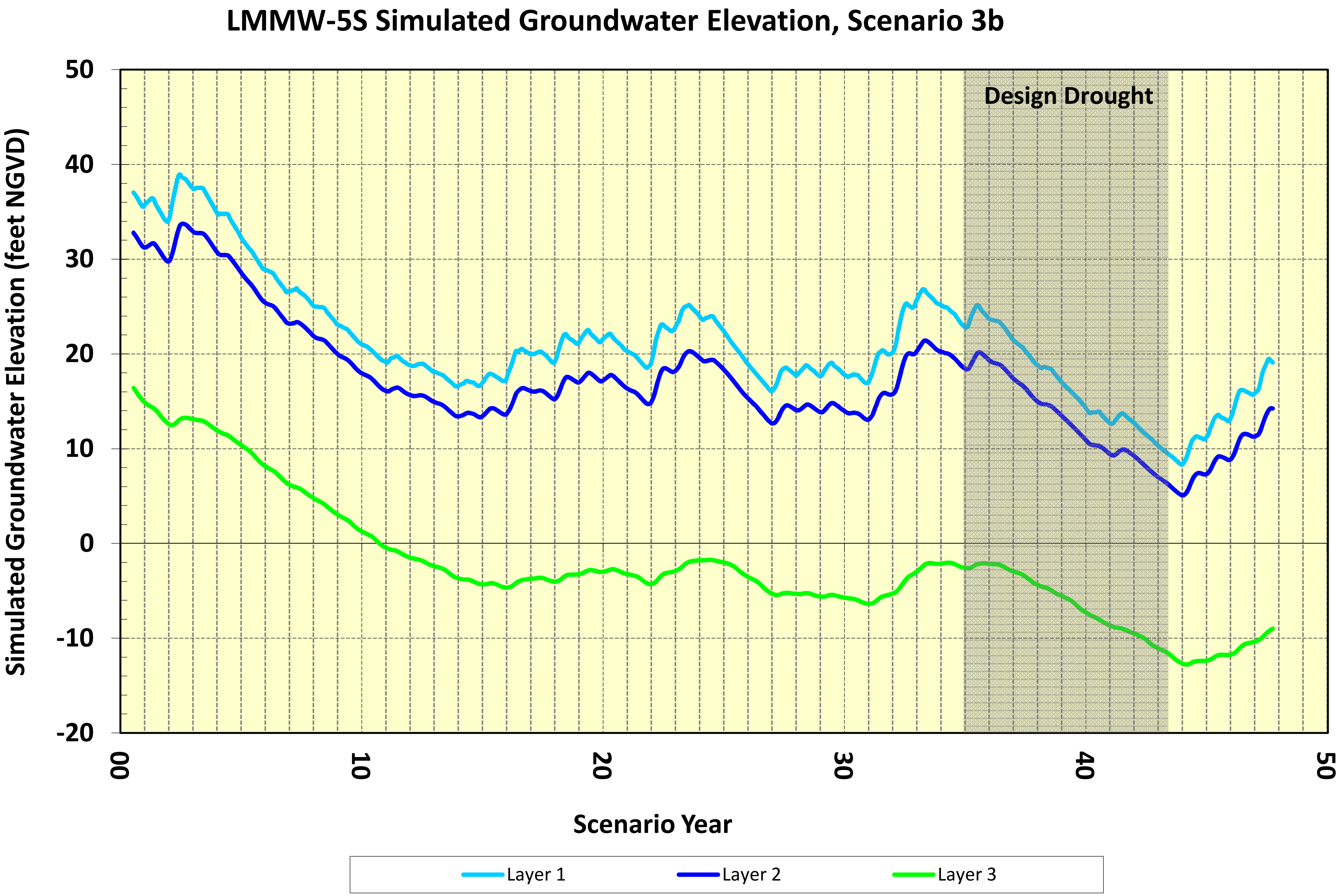
Note: At the location of SWM-GS-M, the model does not contain Model Layer 5.


Ortega_MW Simulated Groundwater Elevation, Scenario 3b
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
Design Drought
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

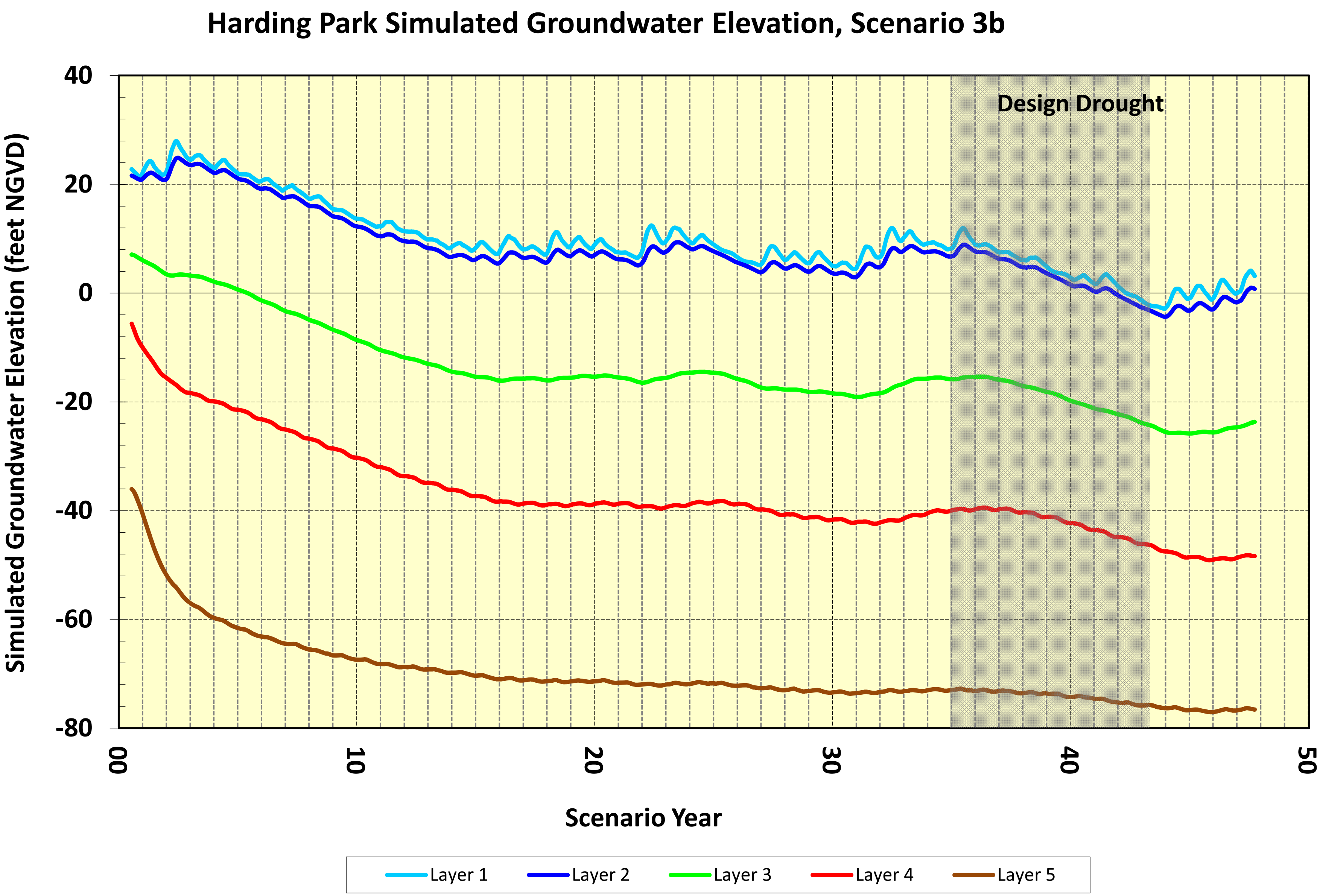


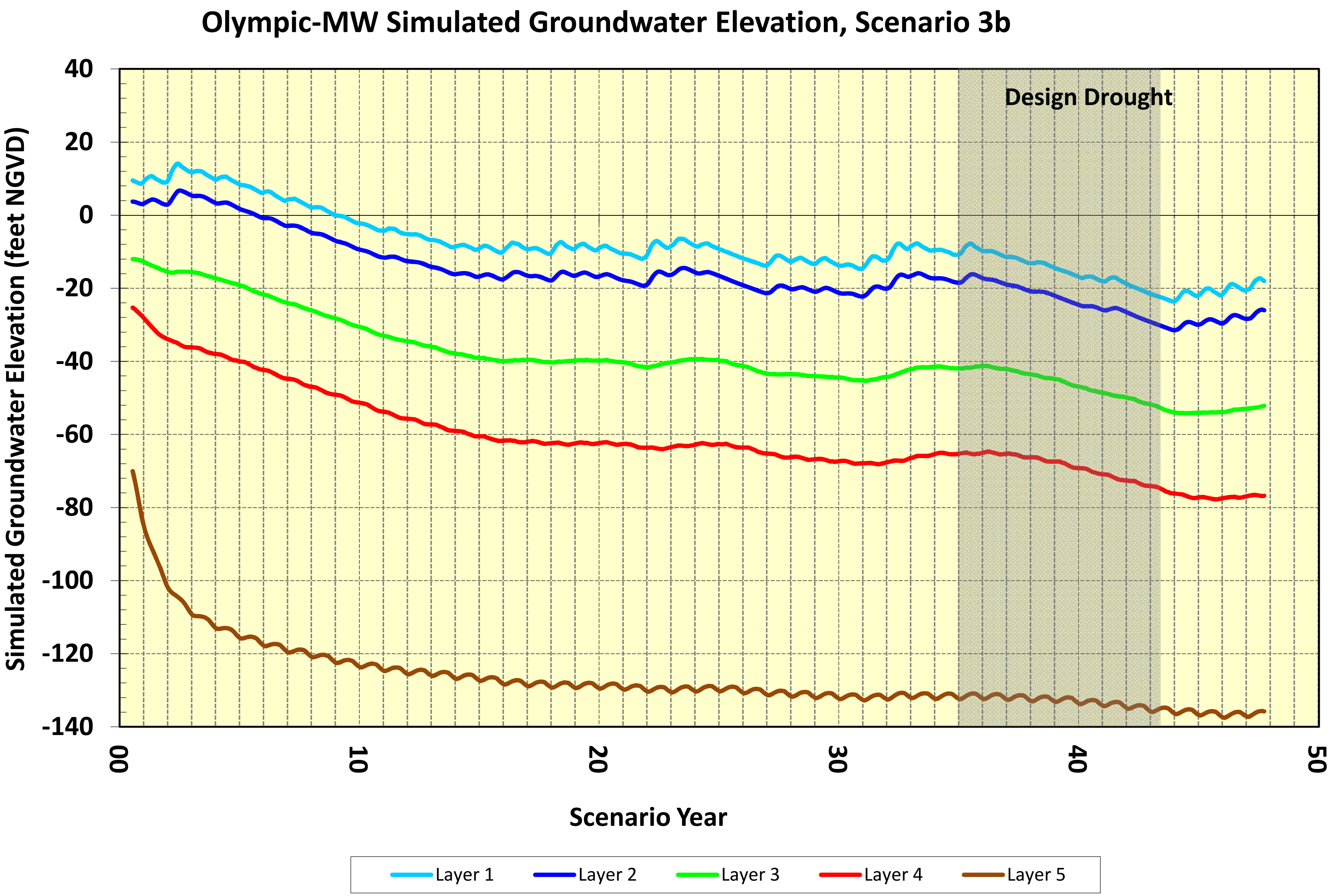
Santiago-S Simulated Groundwater Elevation, Scenario 3b
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
-15
-20
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


LMMW-4S Simulated Groundwater Elevation, Scenario 3b
Design Drought
Simulated Groundwater Elevation (feet NGVD)
30
20
10
0
-10
-20
-30
-40
-50
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

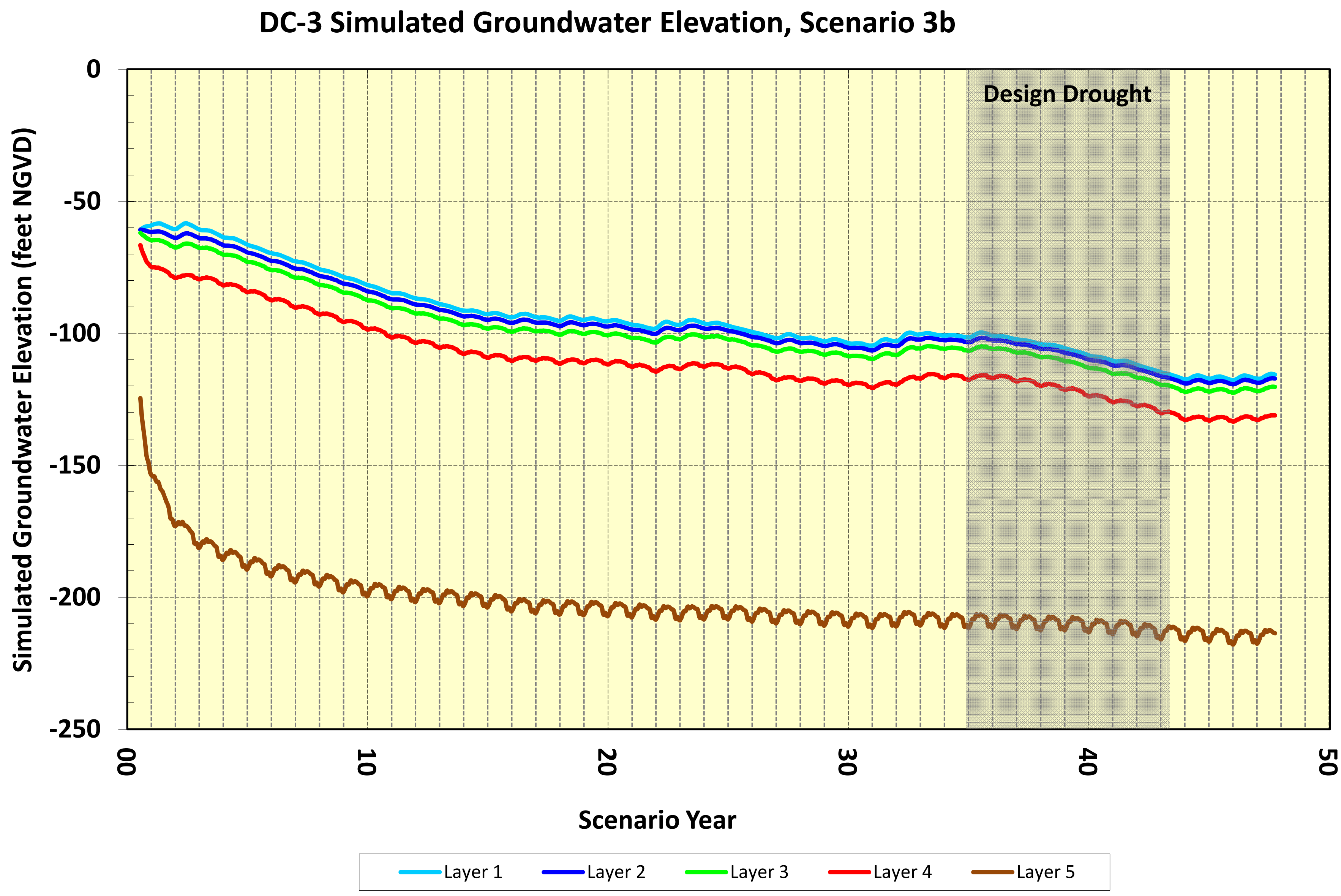


Note: At the location of LMMW-5S, the model does not contain Model Layers 4 and 5.

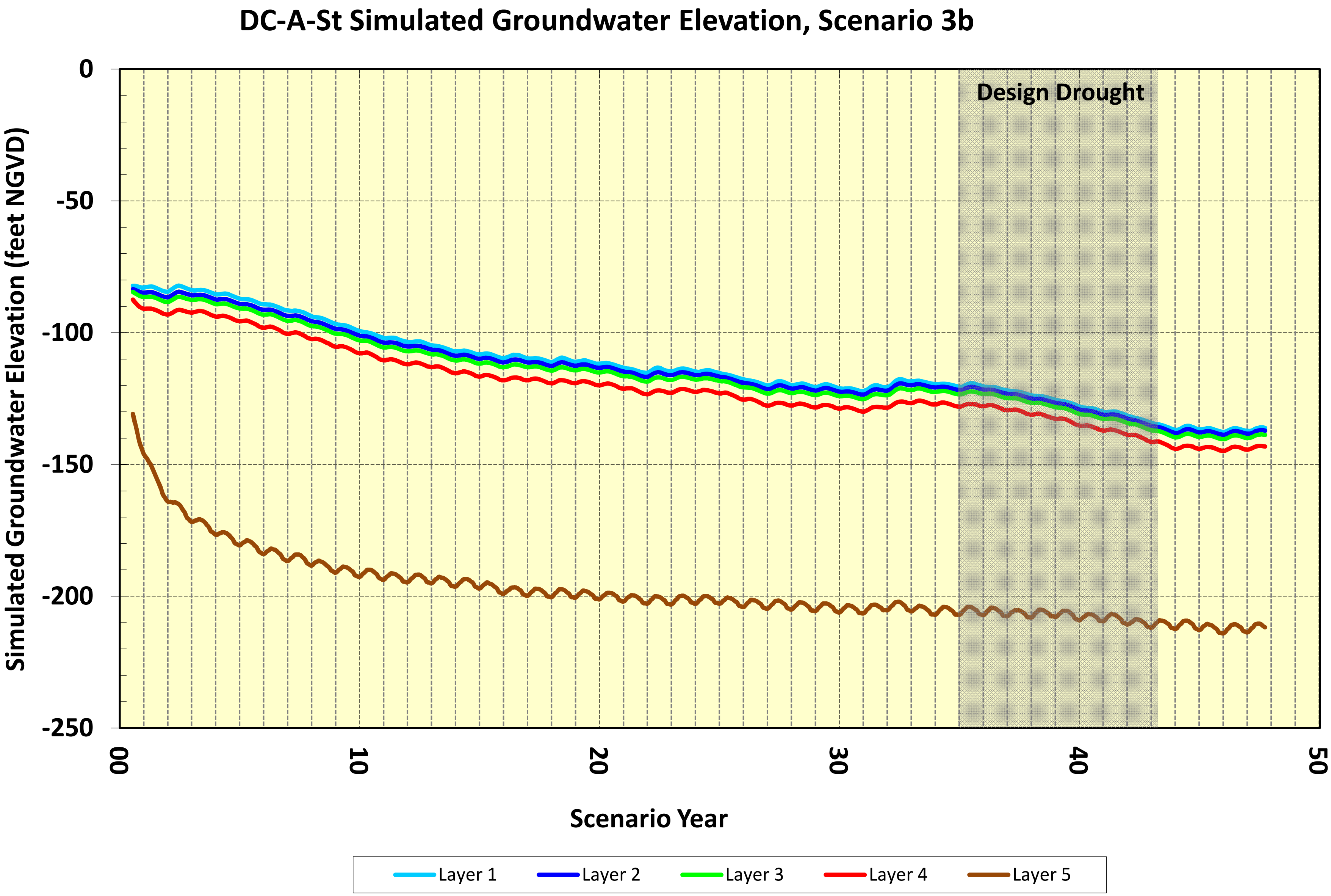

Harding Park Simulated Groundwater Elevation, Scenario 3b
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



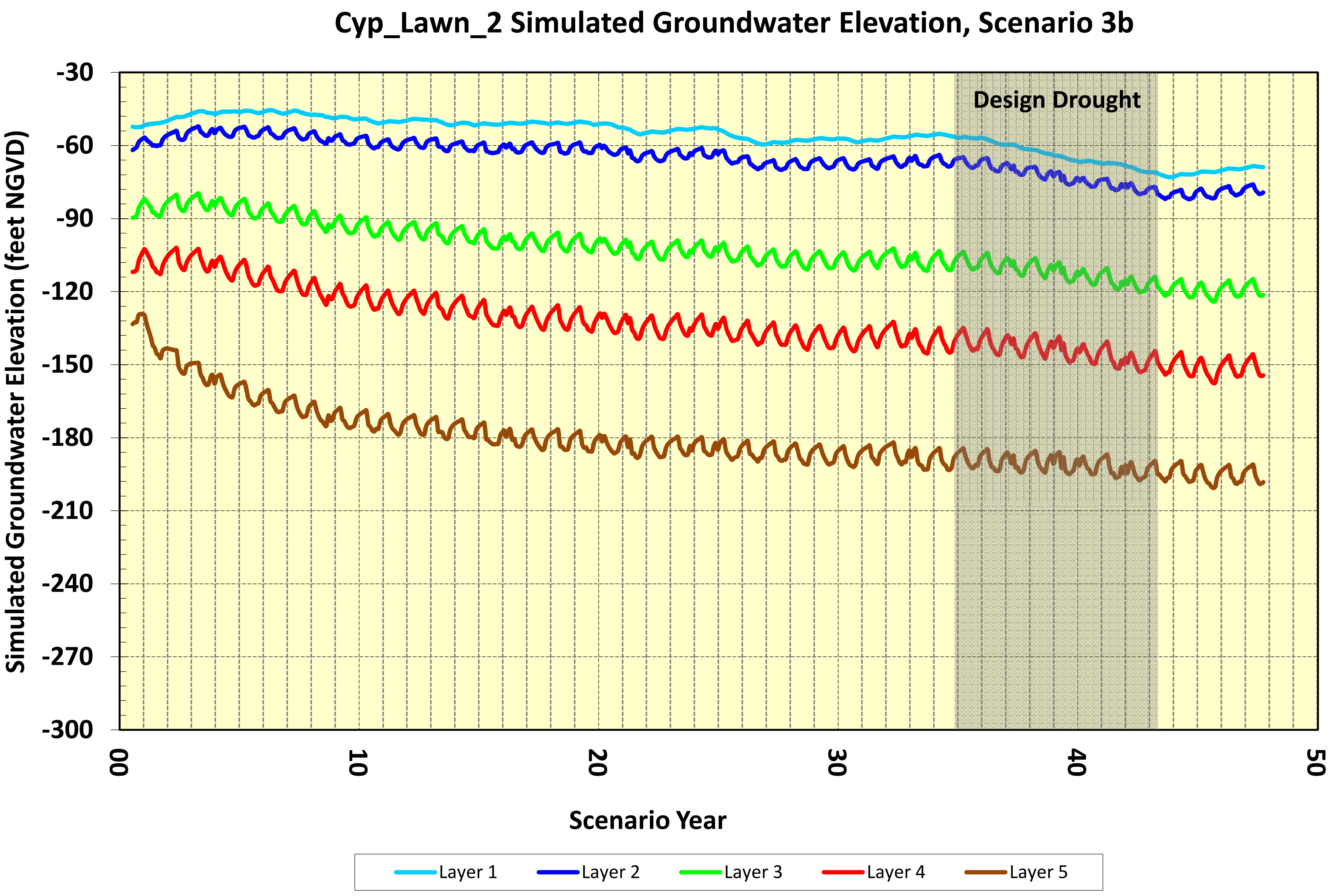
Olympic-MW Simulated Groundwater Elevation, Scenario 3b
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
-100
-120
-140
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

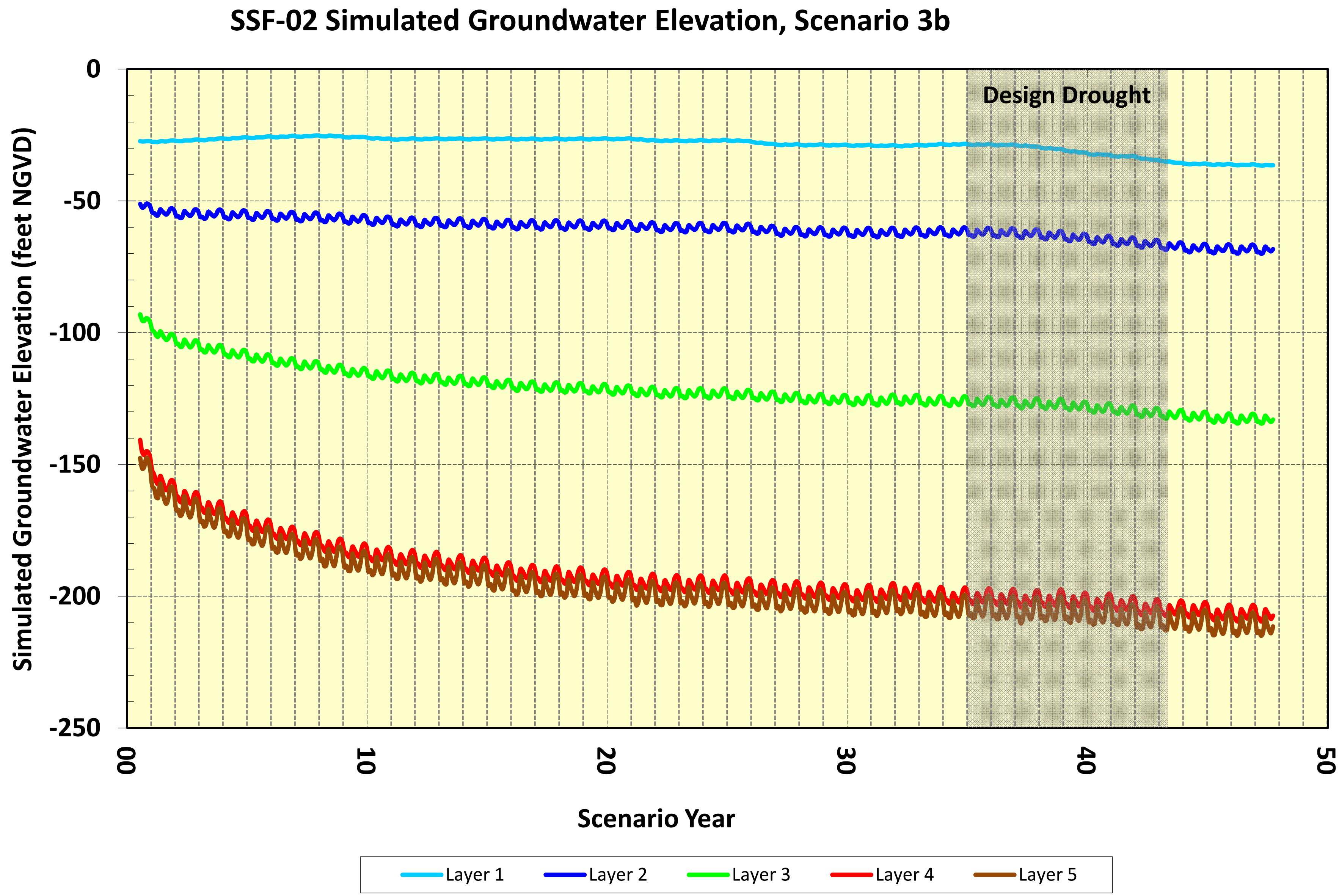


DC-3 Simulated Groundwater Elevation, Scenario 3b
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

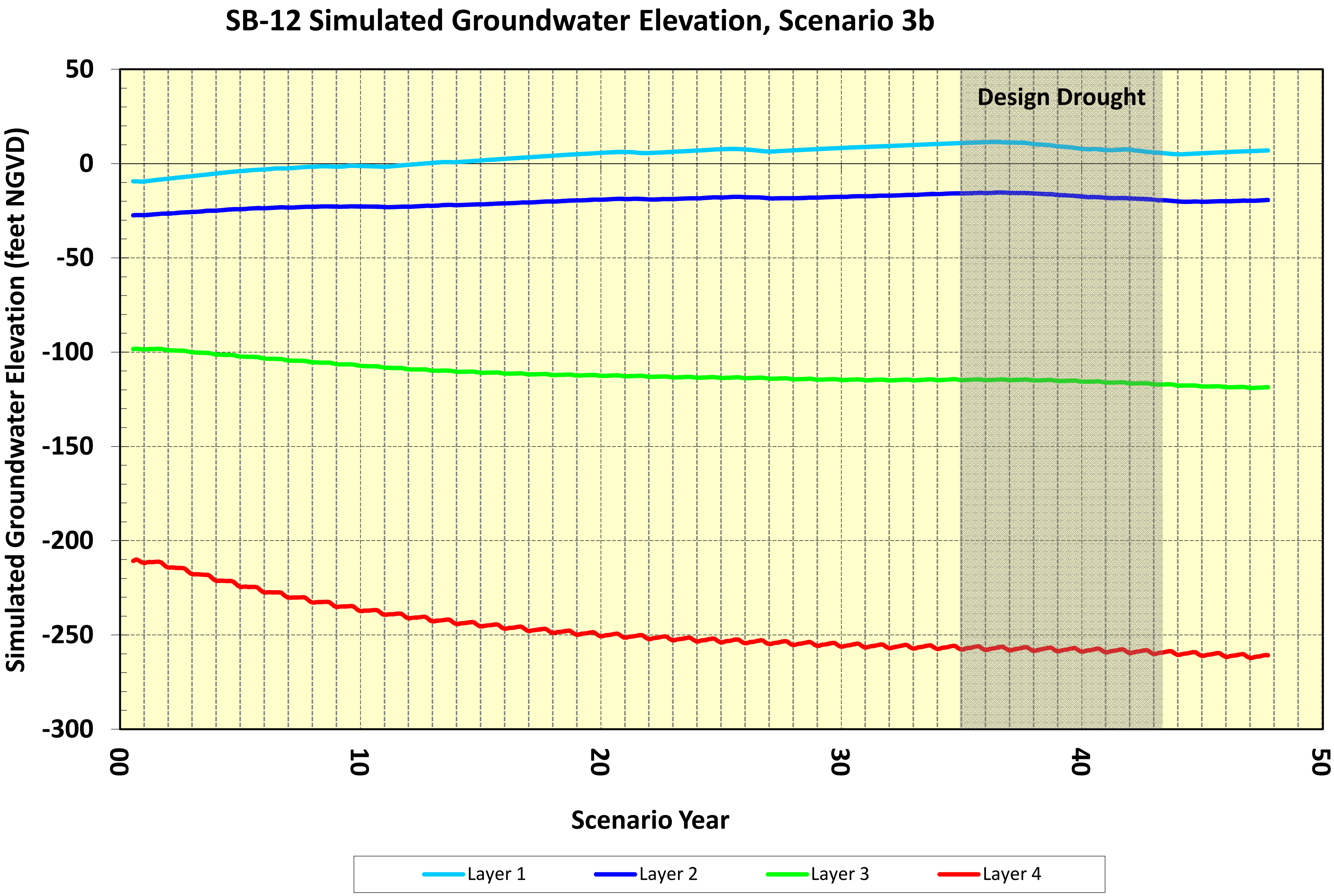


DC-A-St Simulated Groundwater Elevation, Scenario 3b
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

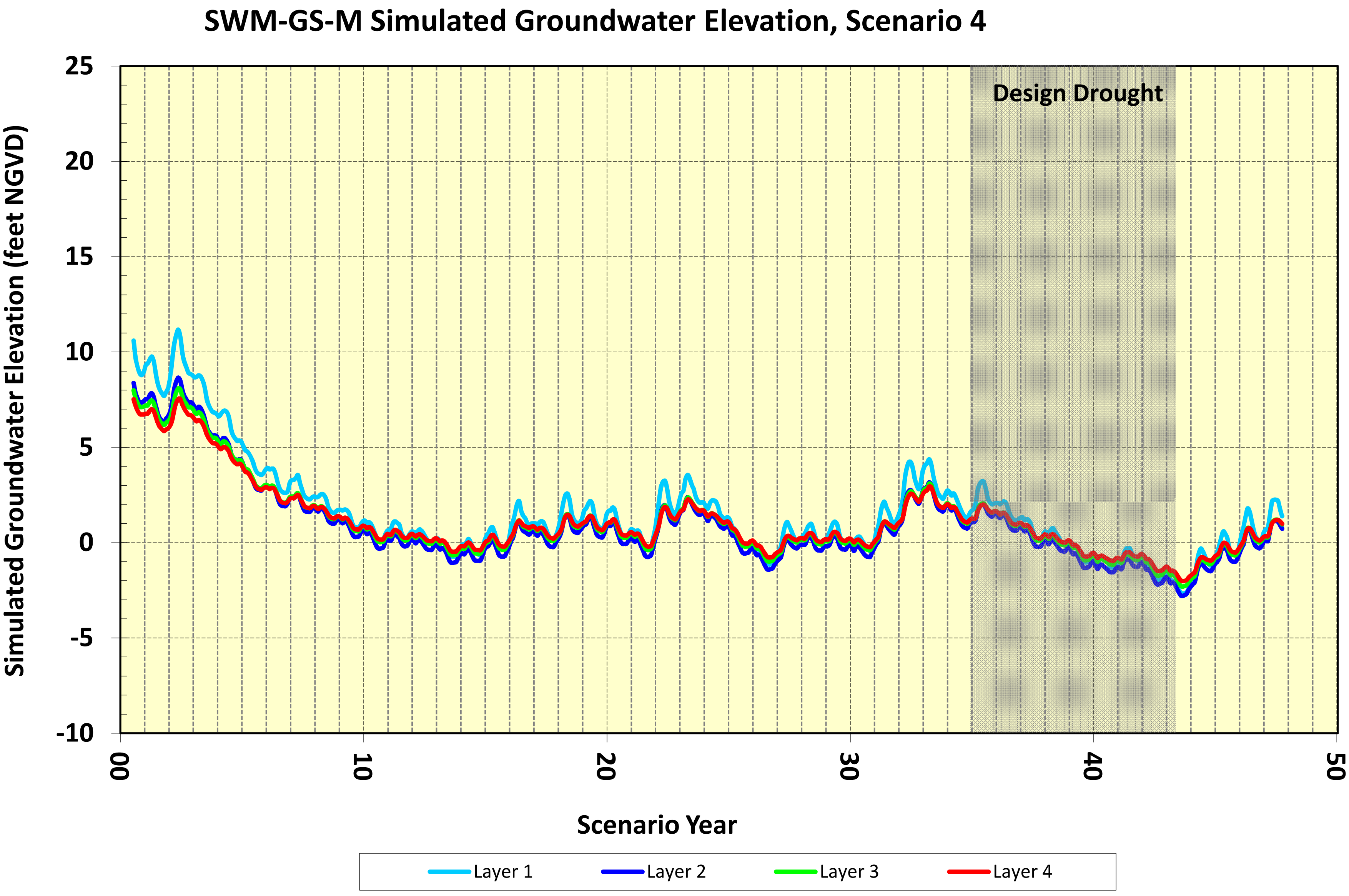

Cyp_Lawn_2 Simulated Groundwater Elevation, Scenario 3b
Design Drought
Simulated Groundwater Elevation (feet NGVD)
-30
-60
-90
-120
-150
-180
-210
-240
-270
-300
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



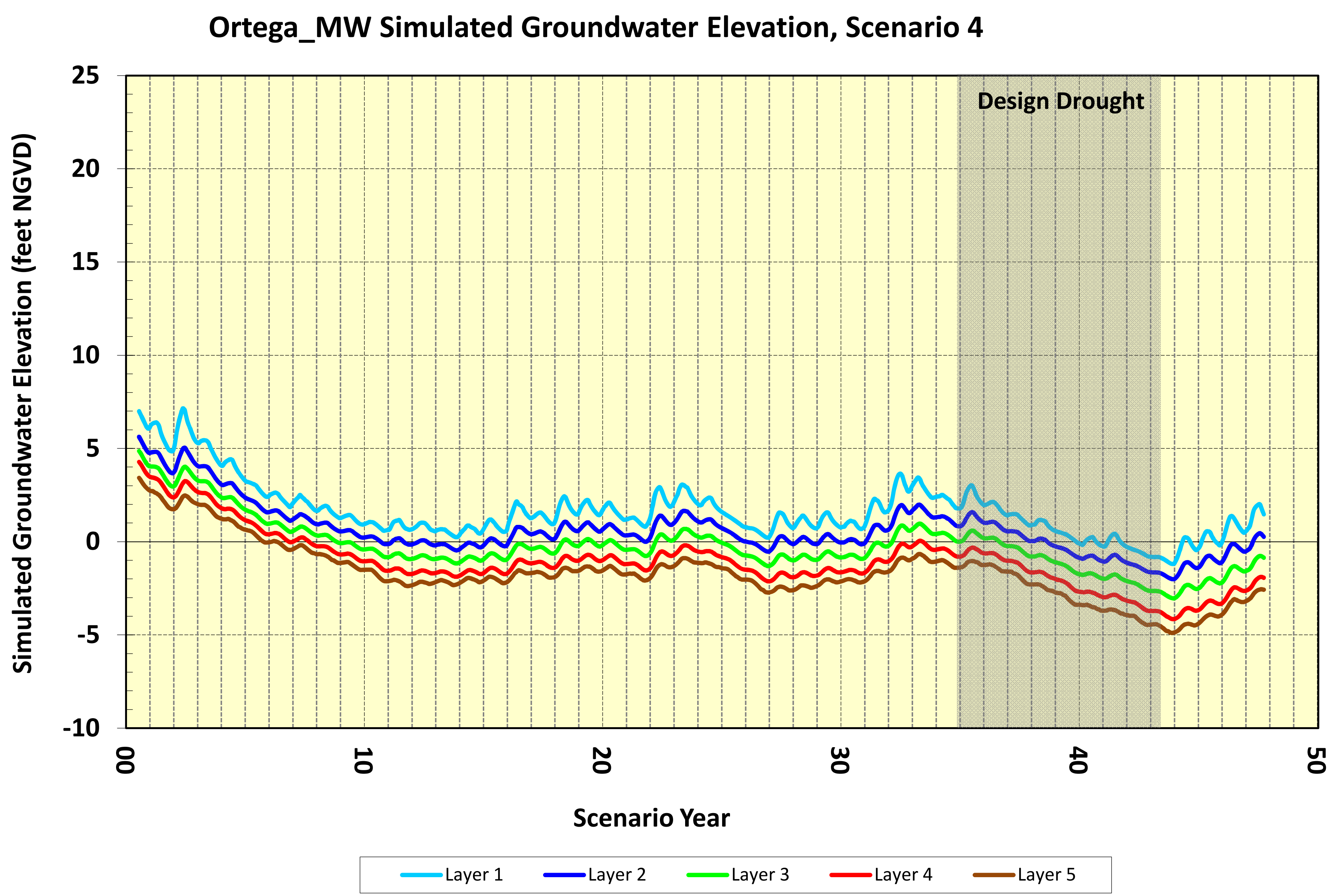
SSF-02 Simulated Groundwater Elevation, Scenario 3b
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



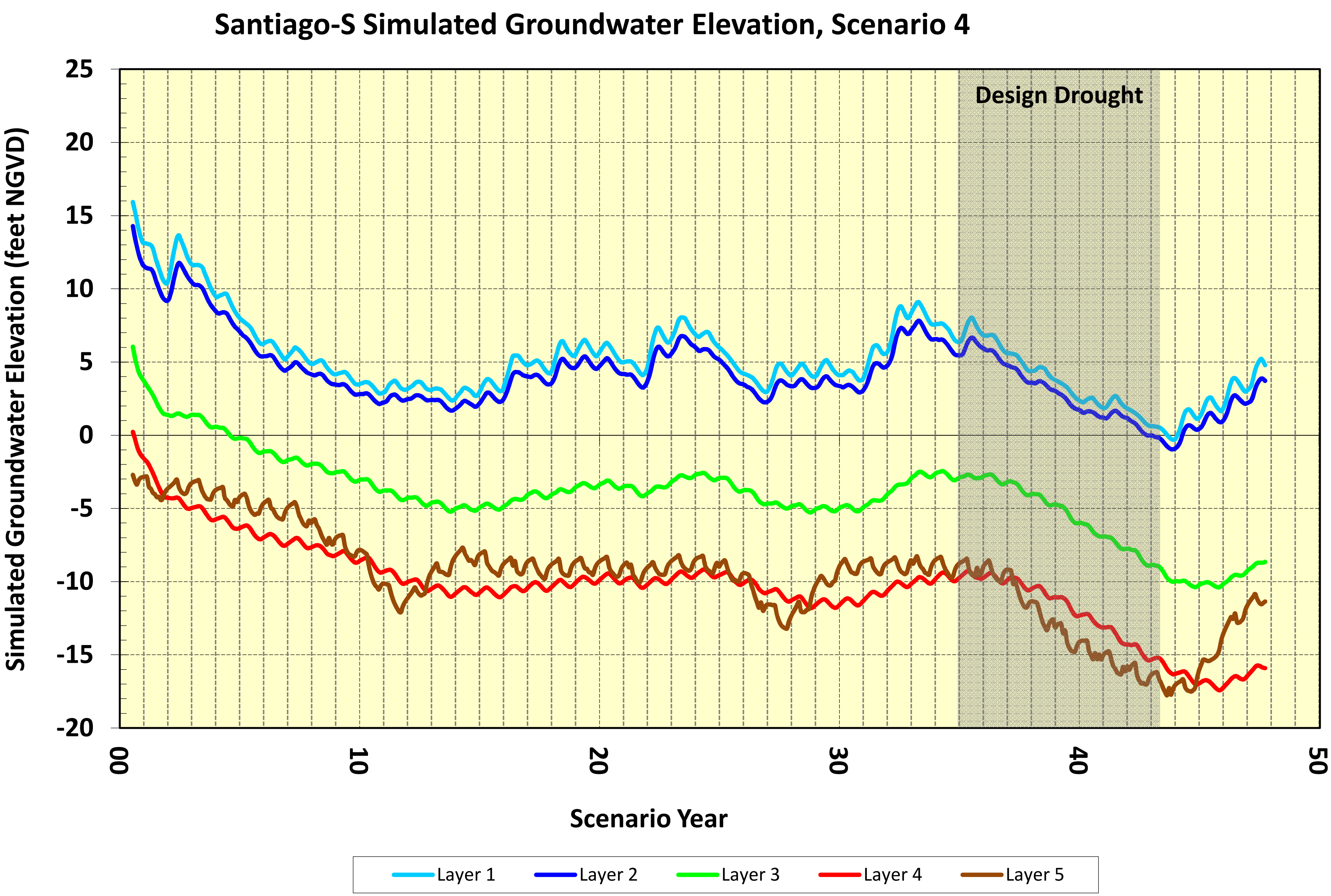
Note: At the location of SB-12, the model does not contain Model Layer 5.



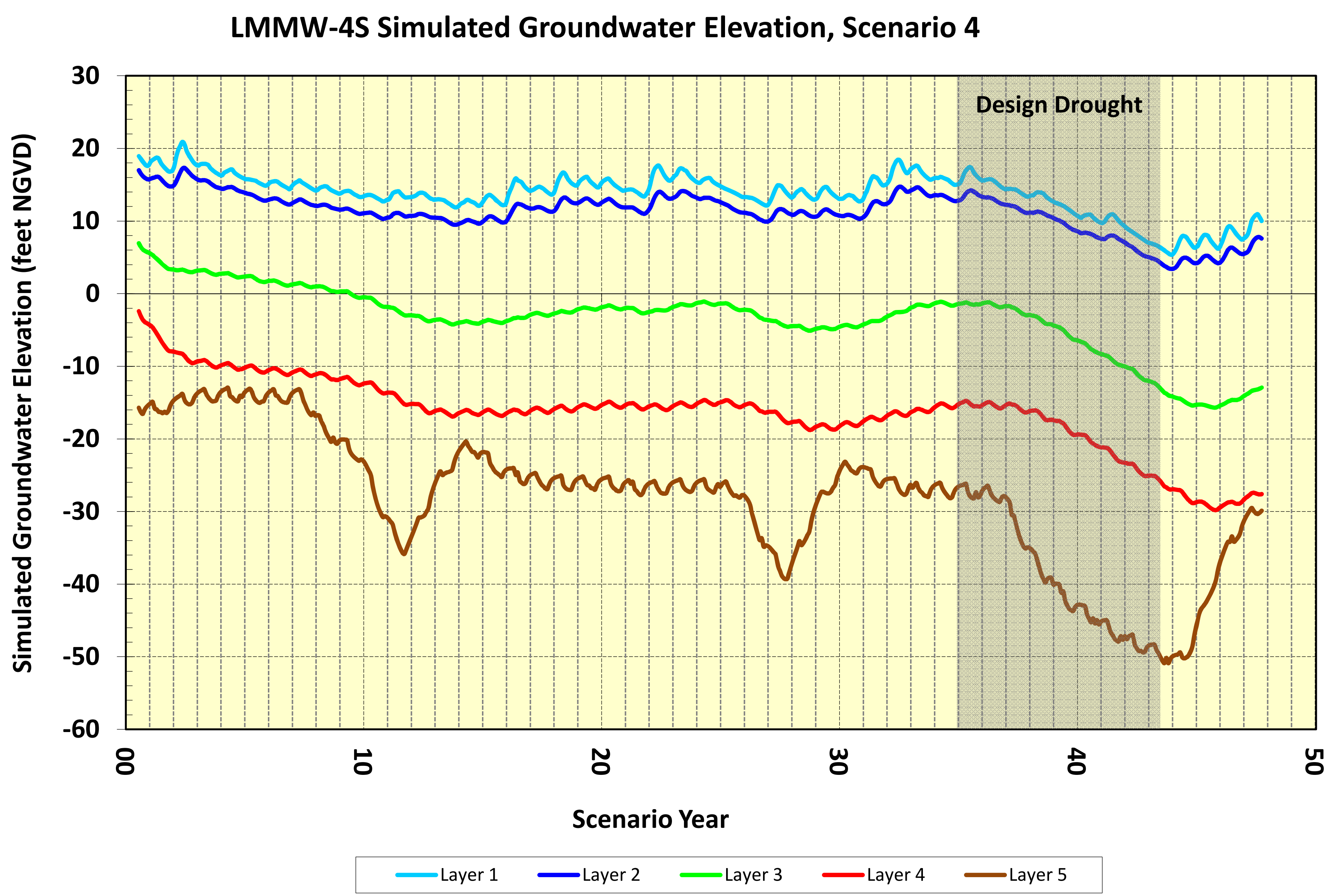
Note: At the location of SWM-GS-M, the model does not contain Model Layer 5.



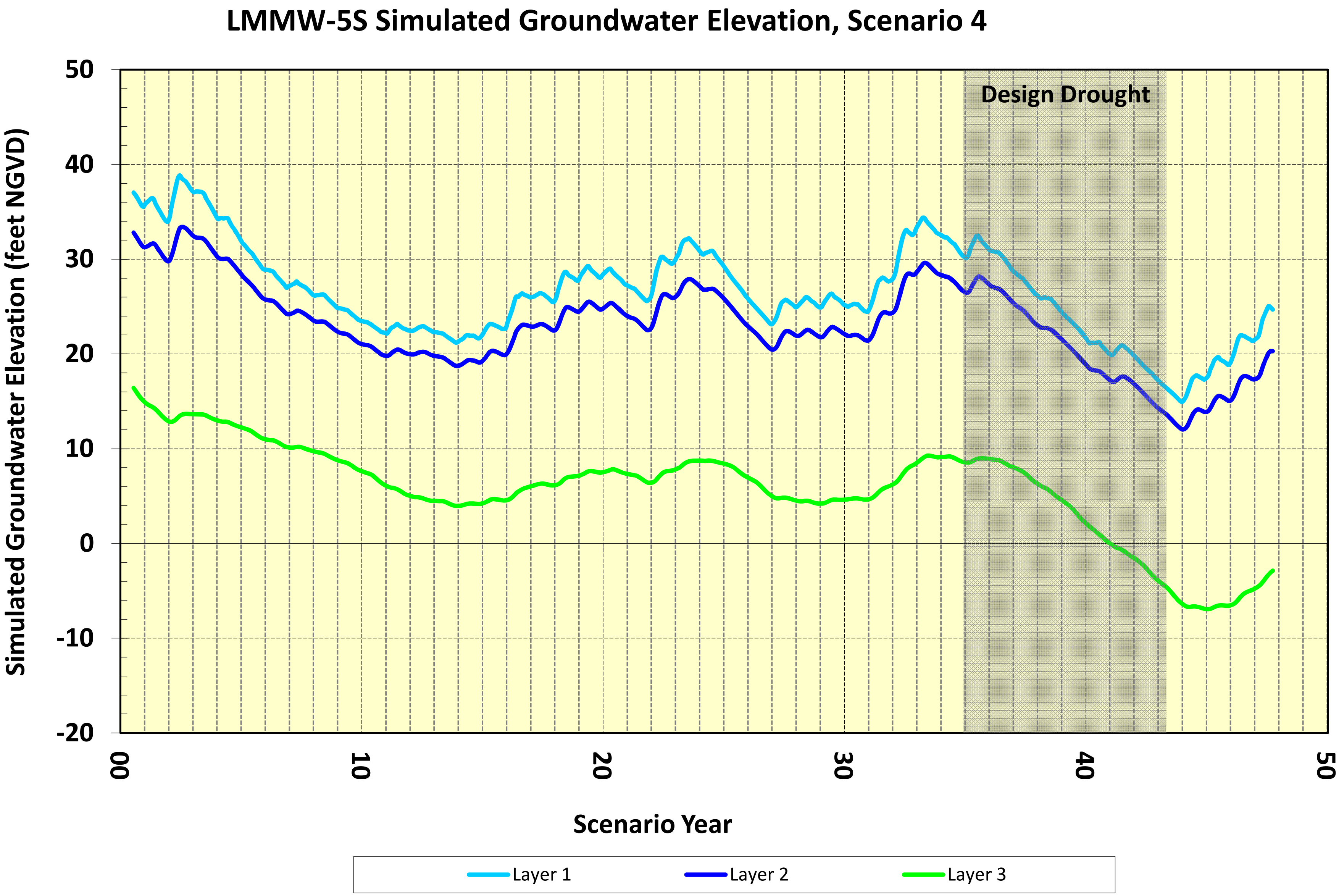
Ortega_MW Simulated Groundwater Elevation, Scenario 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



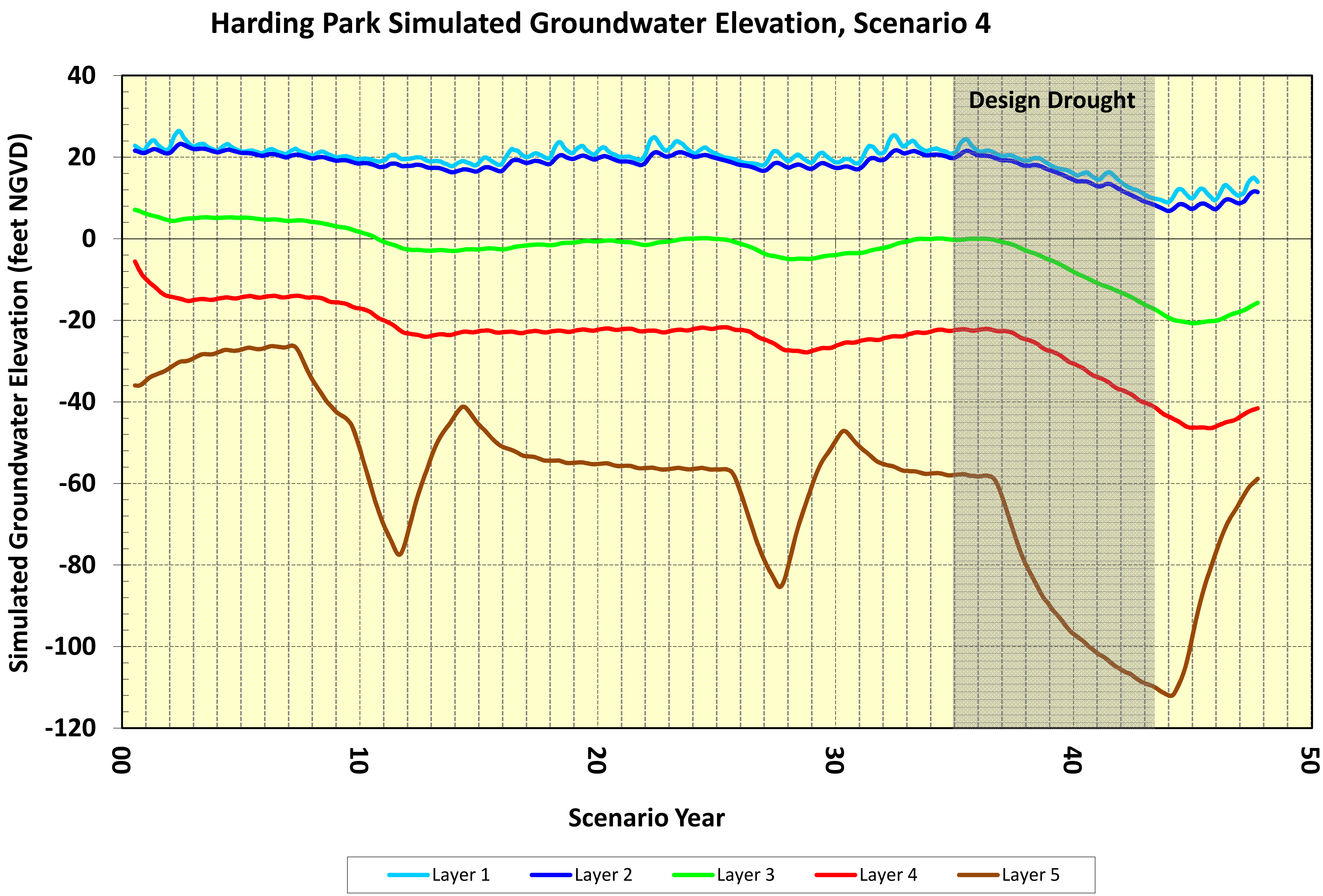
Santiago-S Simulated Groundwater Elevation, Scenario 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
-15
-20
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



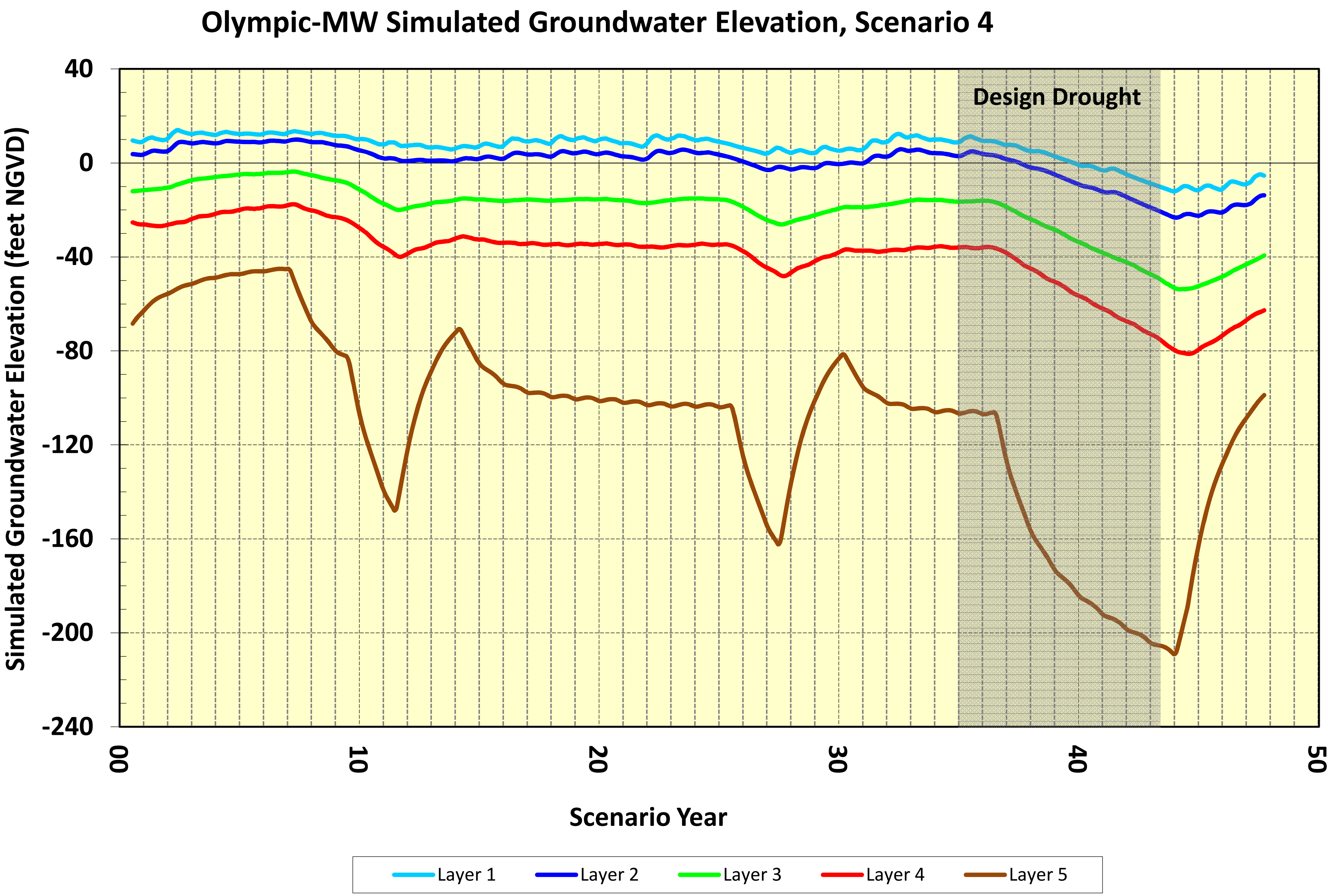
LMMW-4S Simulated Groundwater Elevation, Scenario 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
30
20
10
0
-10
-20
-30
-40
-50
-60
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



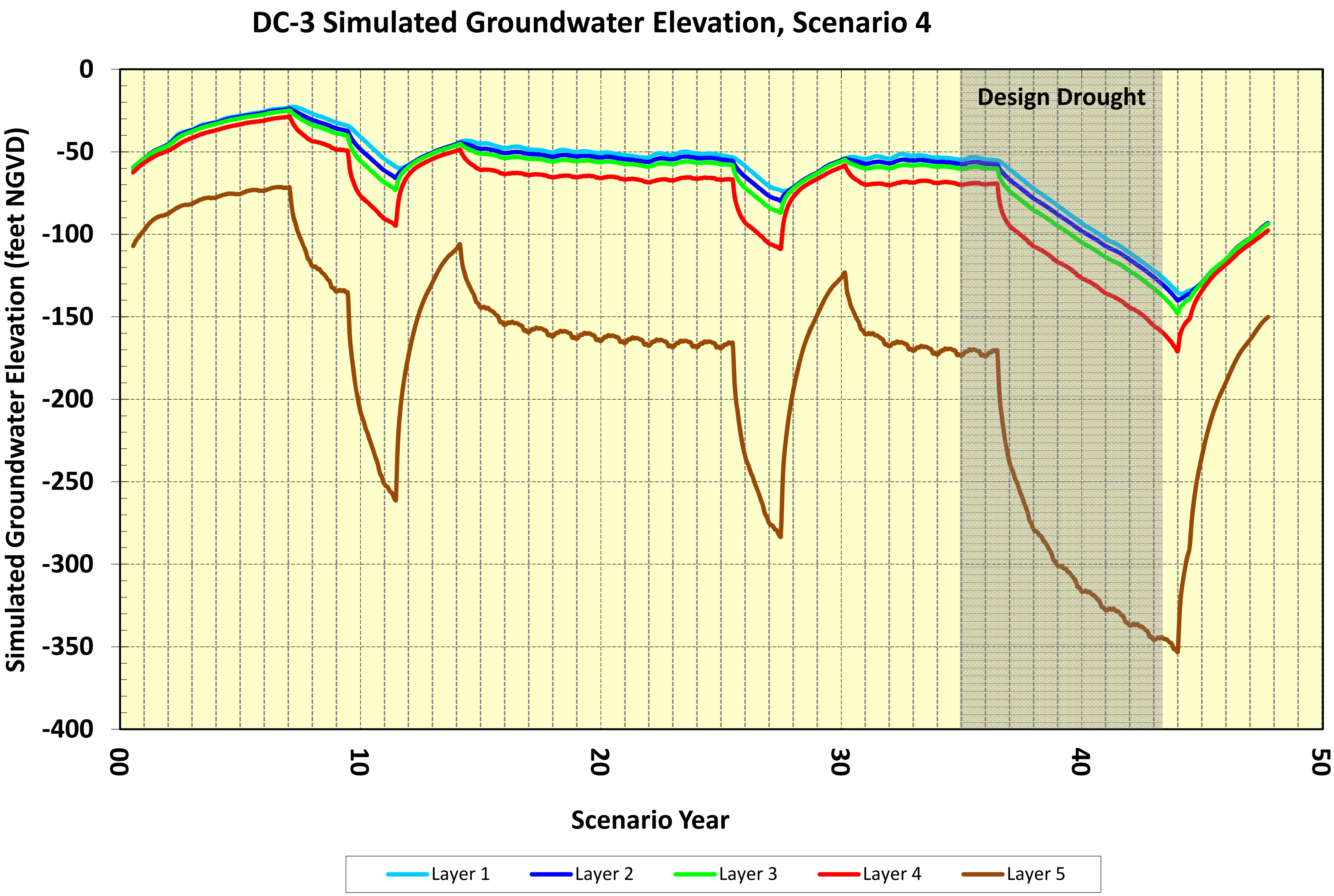
Note: At the location of LMMW-5S, the model does not contain Model Layers 4 and 5.



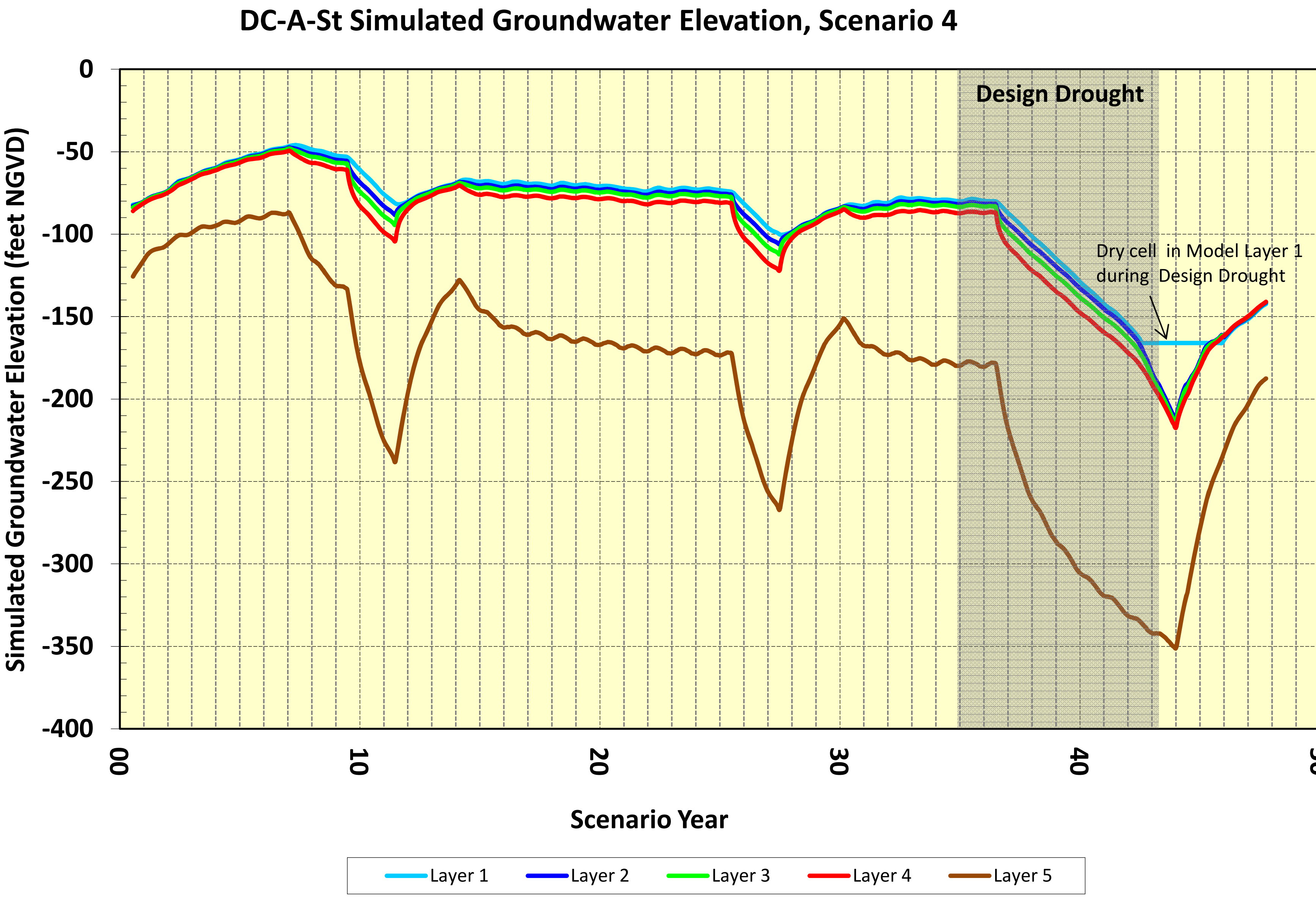
Harding Park Simulated Groundwater Elevation, Scenario 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
-100
-120
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



Olympic-MW Simulated Groundwater Elevation, Scenario 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
0
-40
-80
-120
-160
-200
-240
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

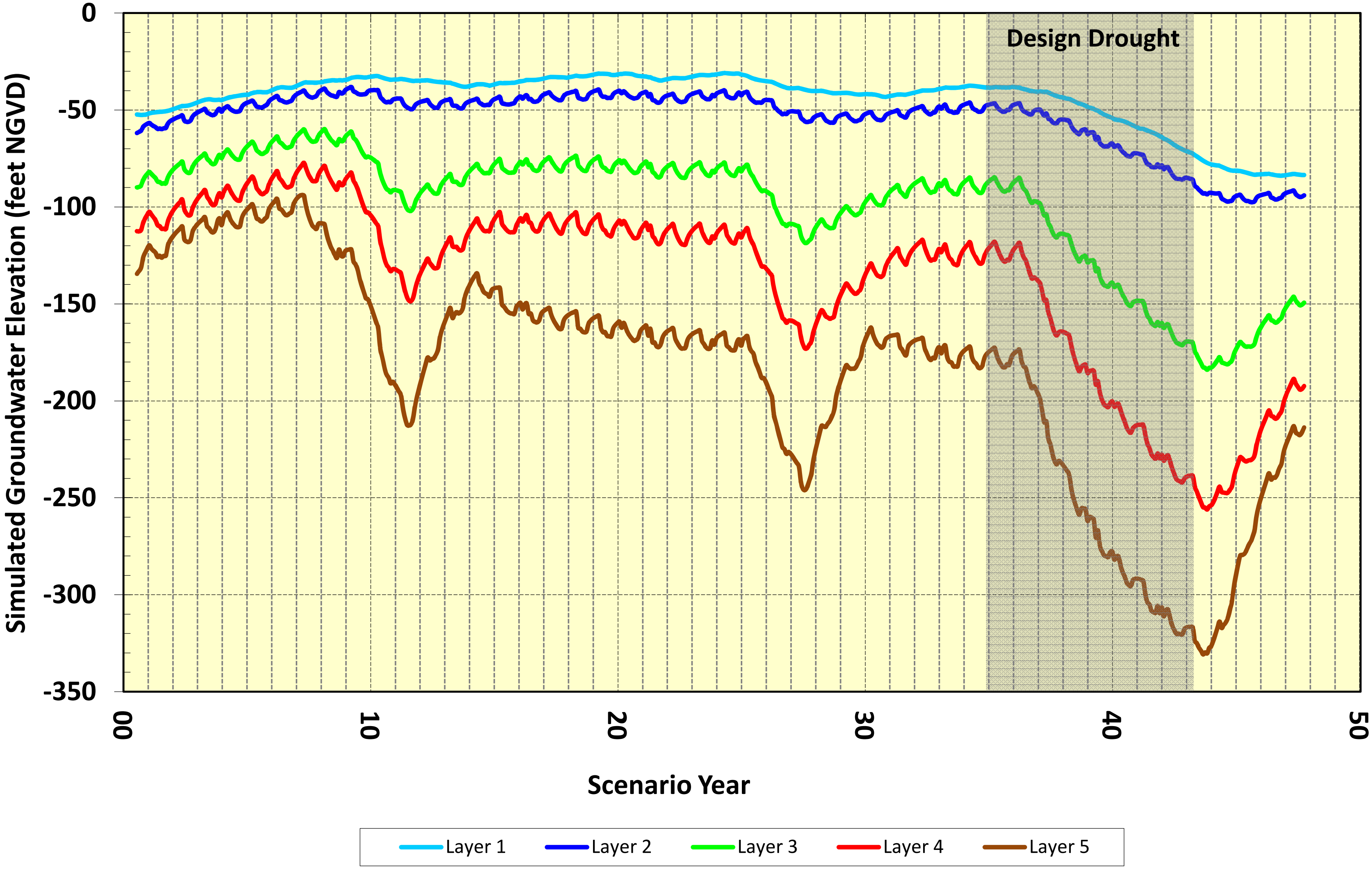


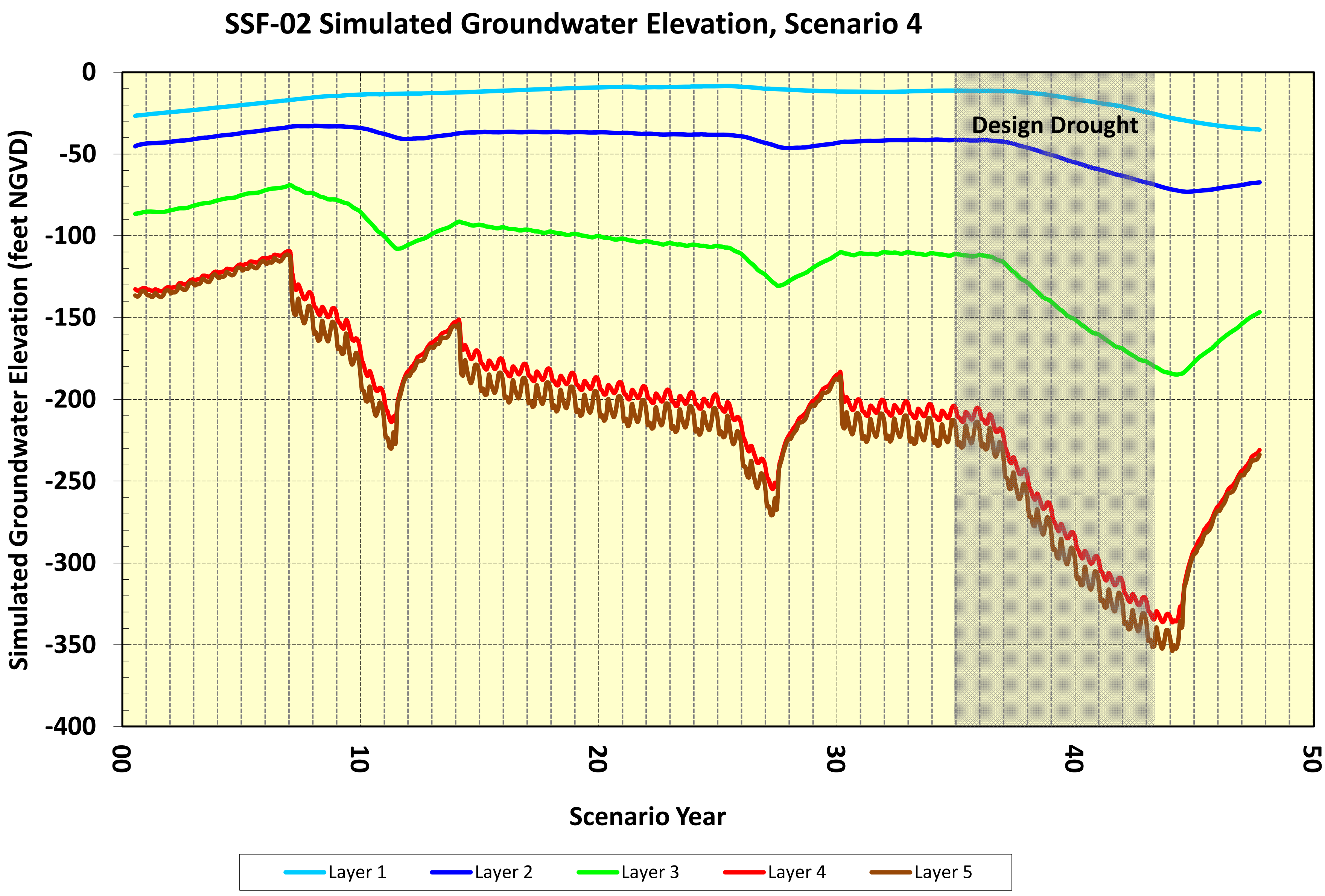
DC-3 Simulated Groundwater Elevation, Scenario 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

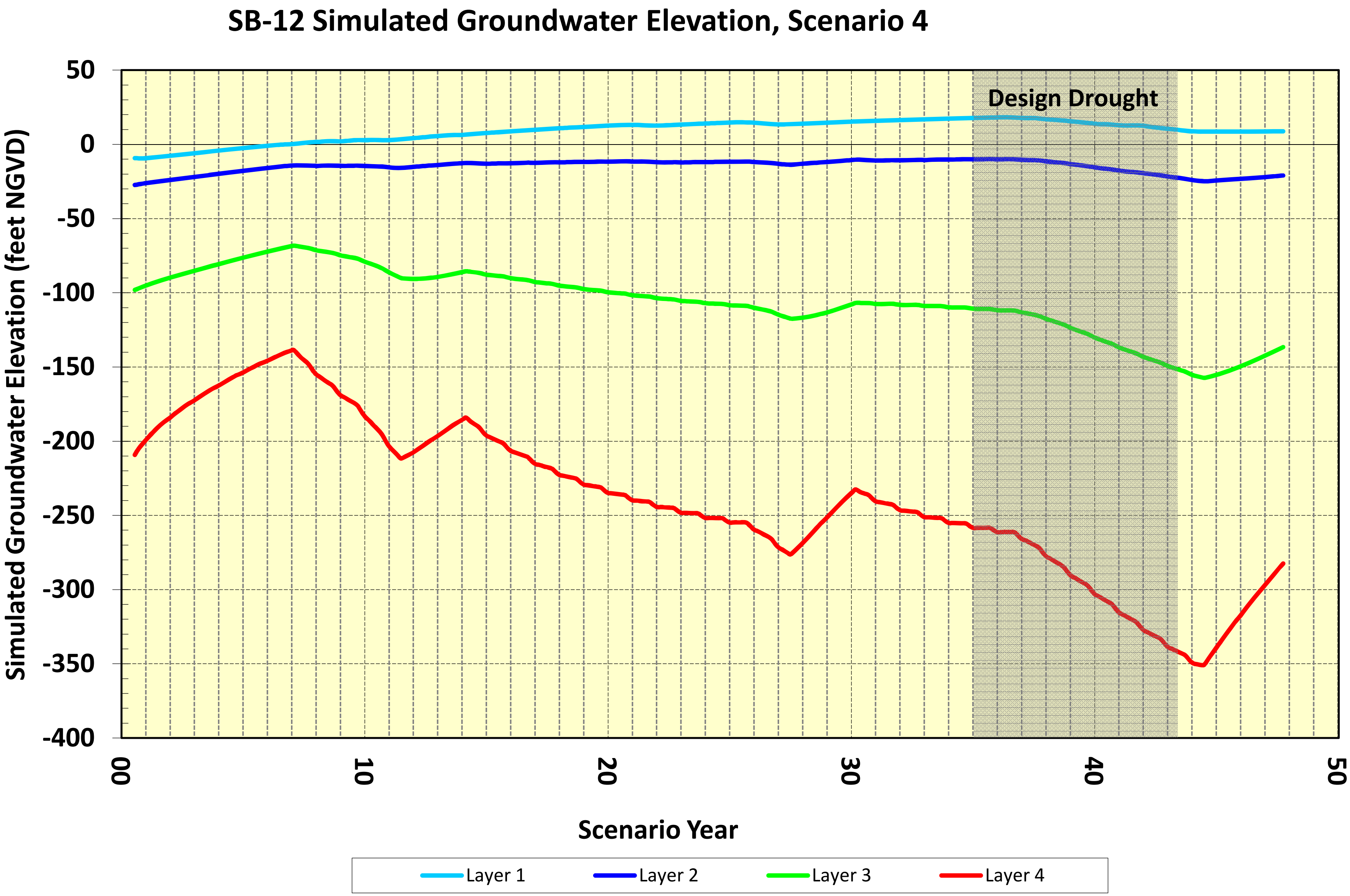


DC-A-St Simulated Groundwater Elevation, Scenario 4
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Design Drought
Dry cell in Model Layer 1 during Design Drought
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

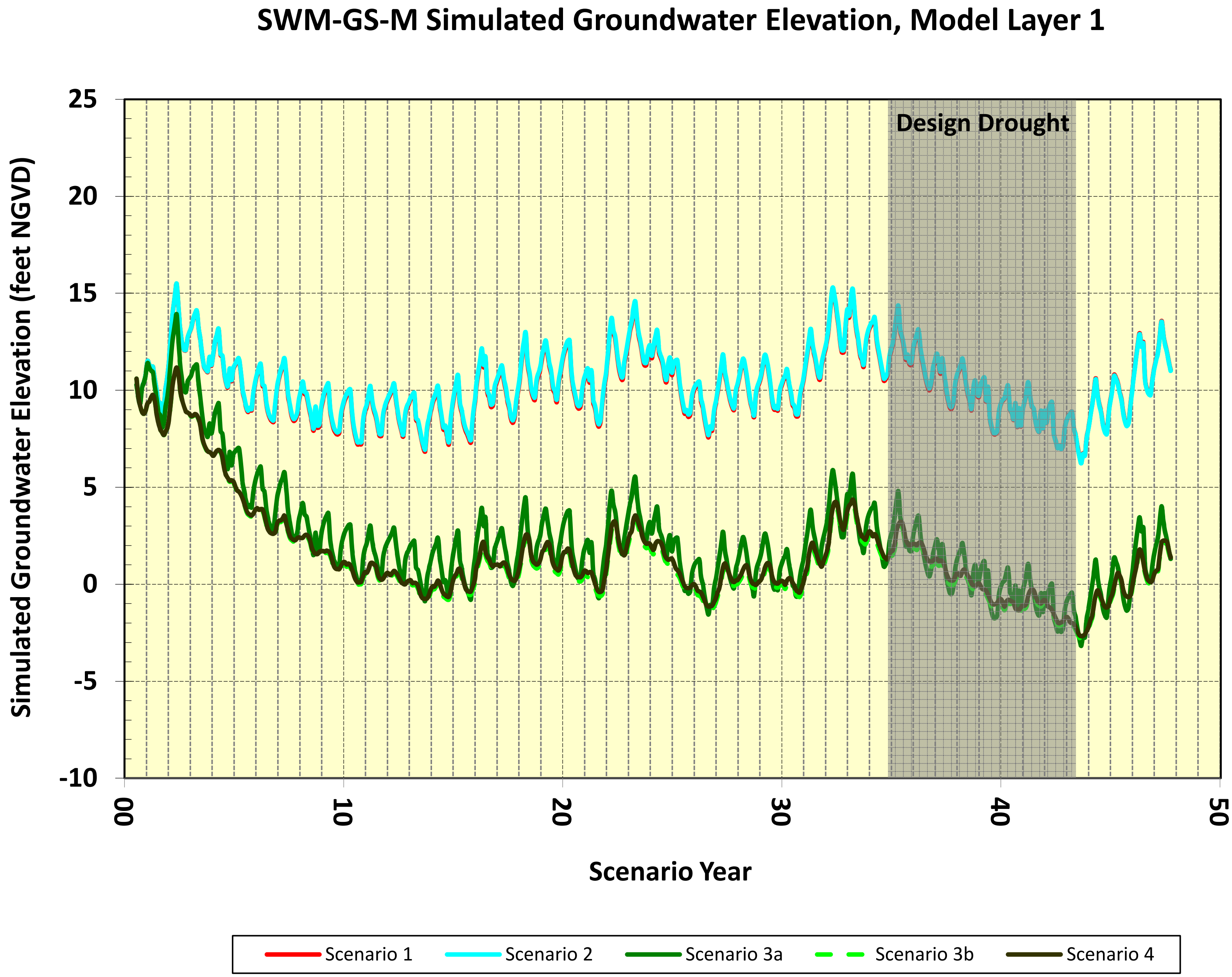
Cyp_Lawn_2 Simulated Groundwater Elevation, Scenario 4

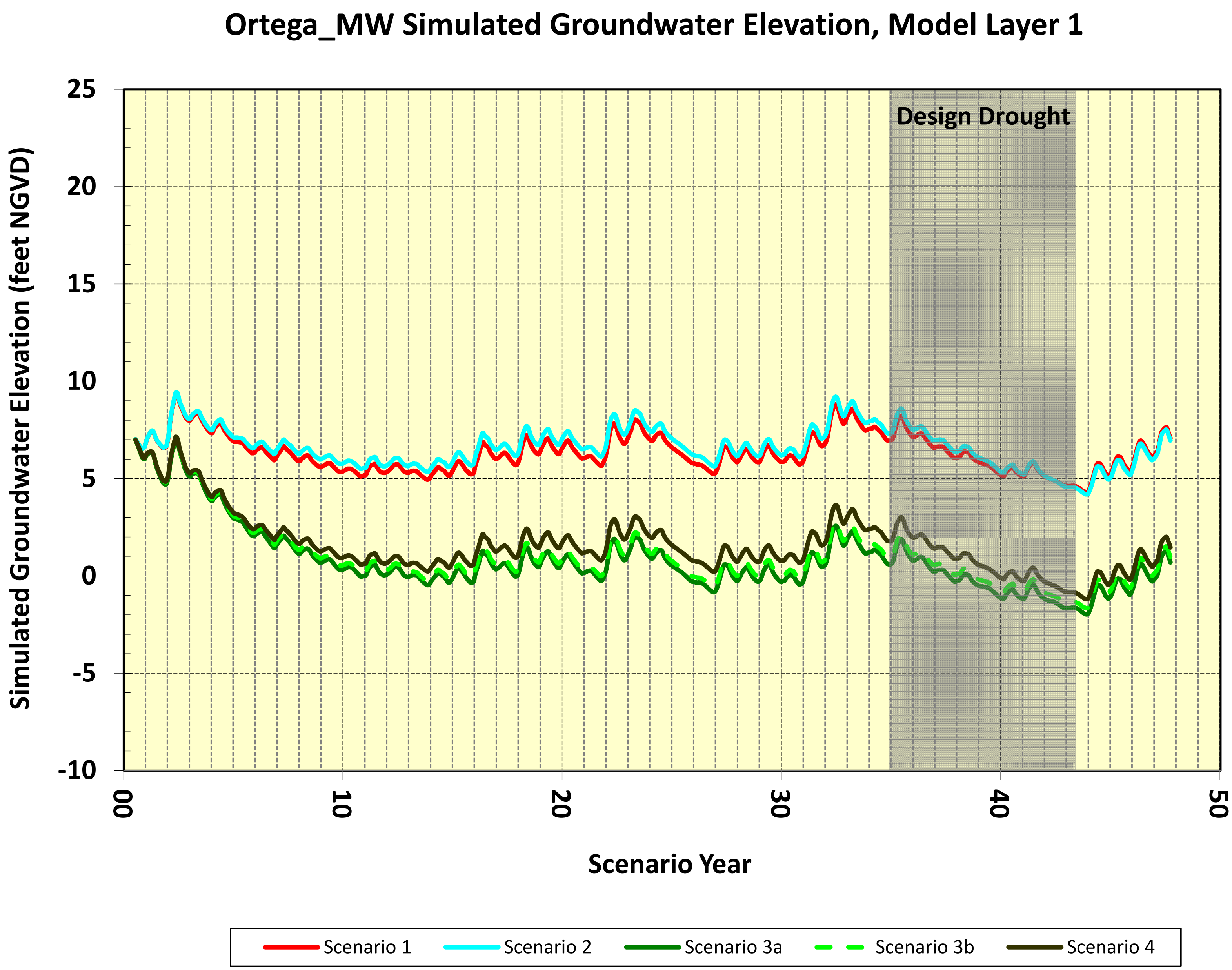



SSF-02 Simulated Groundwater Elevation, Scenario 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

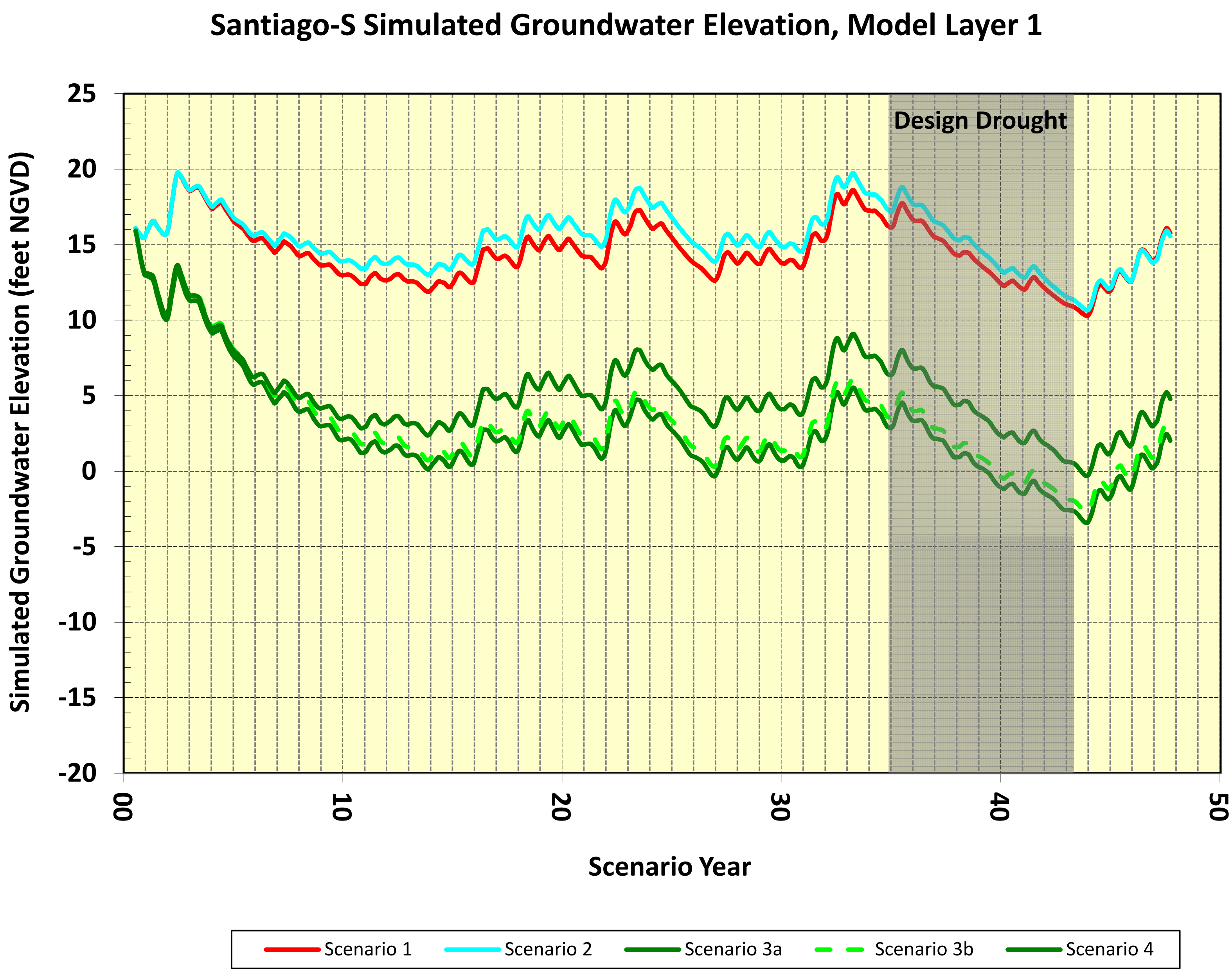


Note: At the location of LMMW-5S, the model does not contain Model Layers 4 and 5.

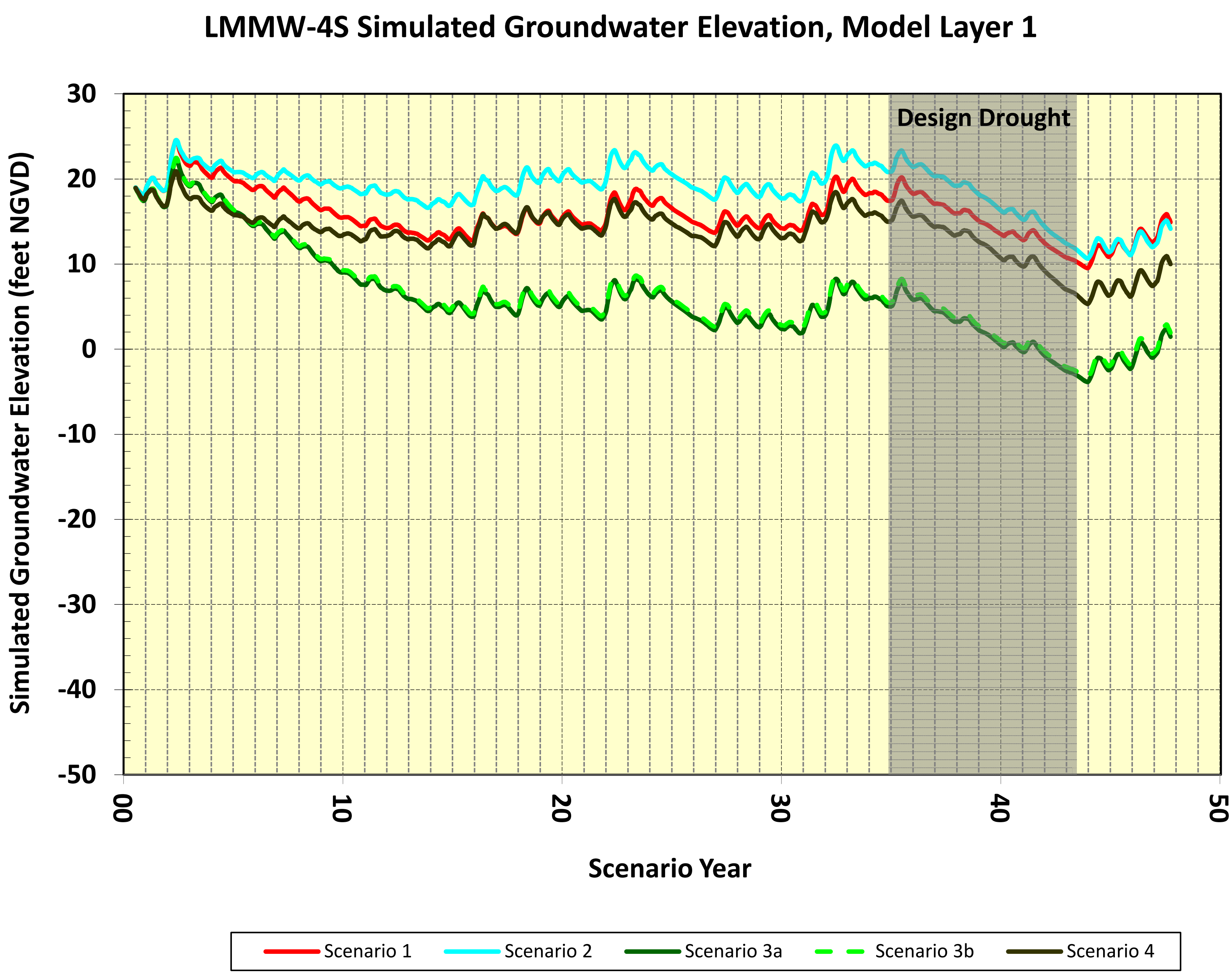

SWM-GS-M Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



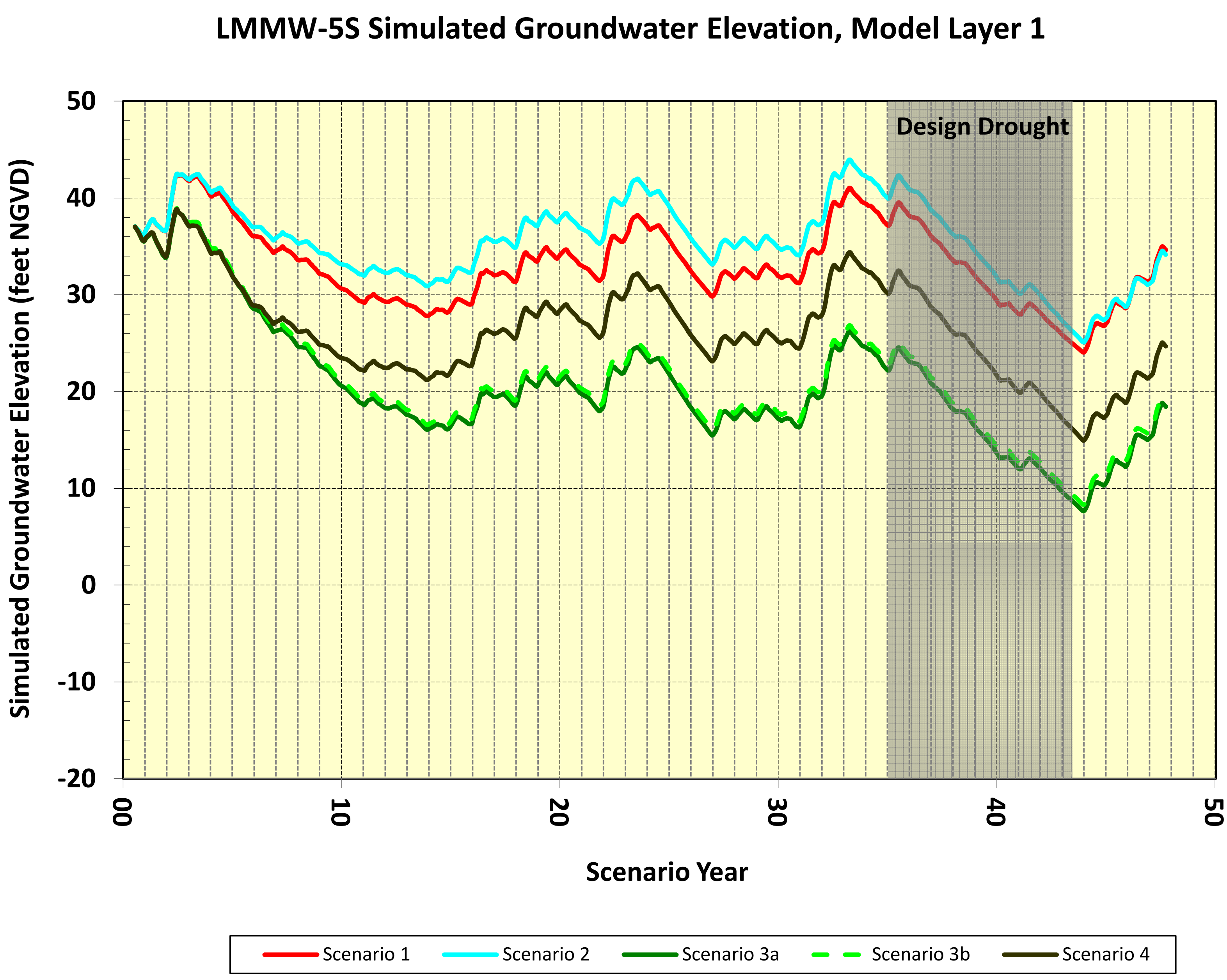
Ortega_MW Simulated Groundwater Elevation, Model Layer 1
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
00
10
20
30
40
50
Scenario Year
Design Drought
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



Santiago-S Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
-15
-20
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

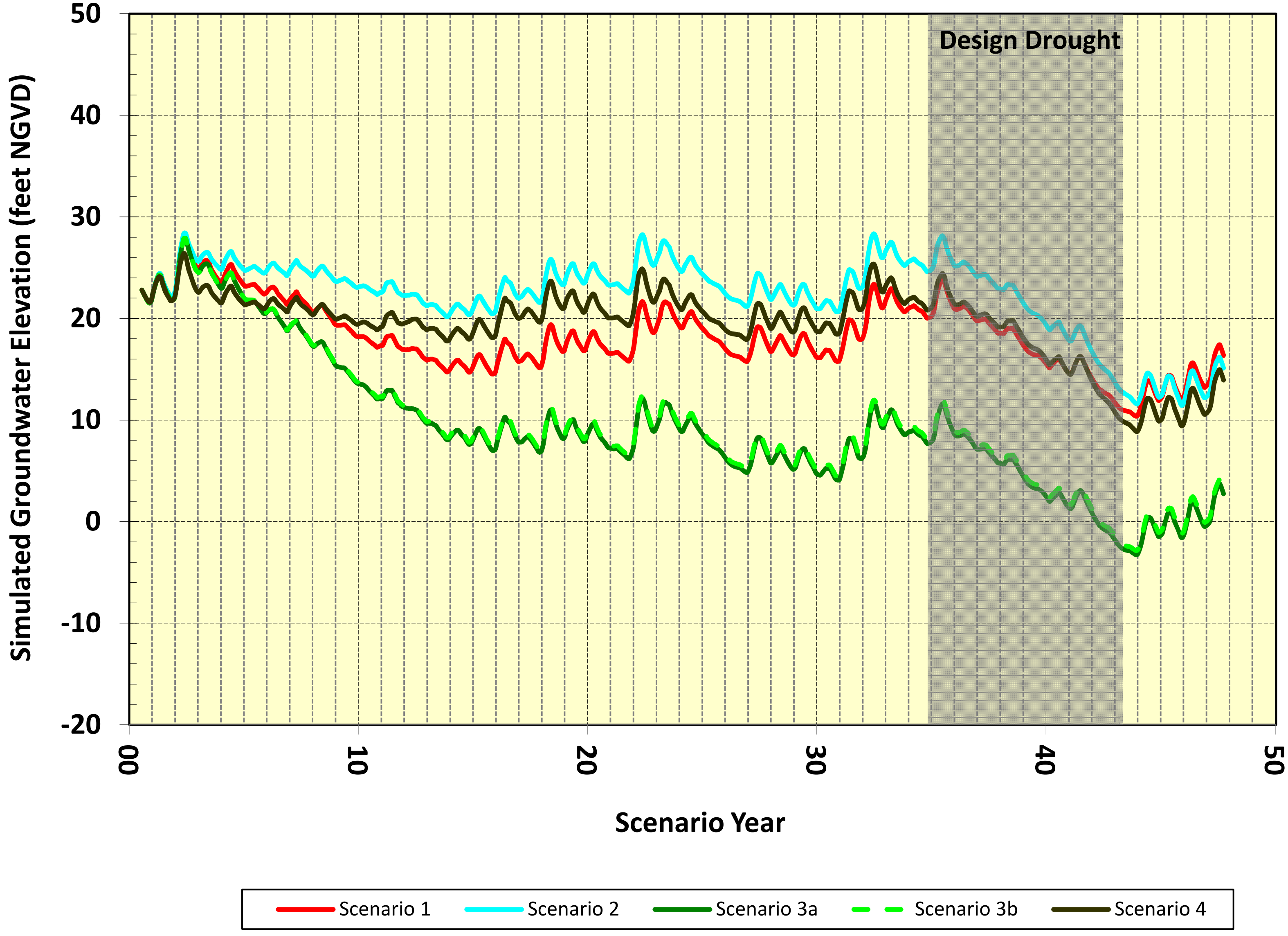


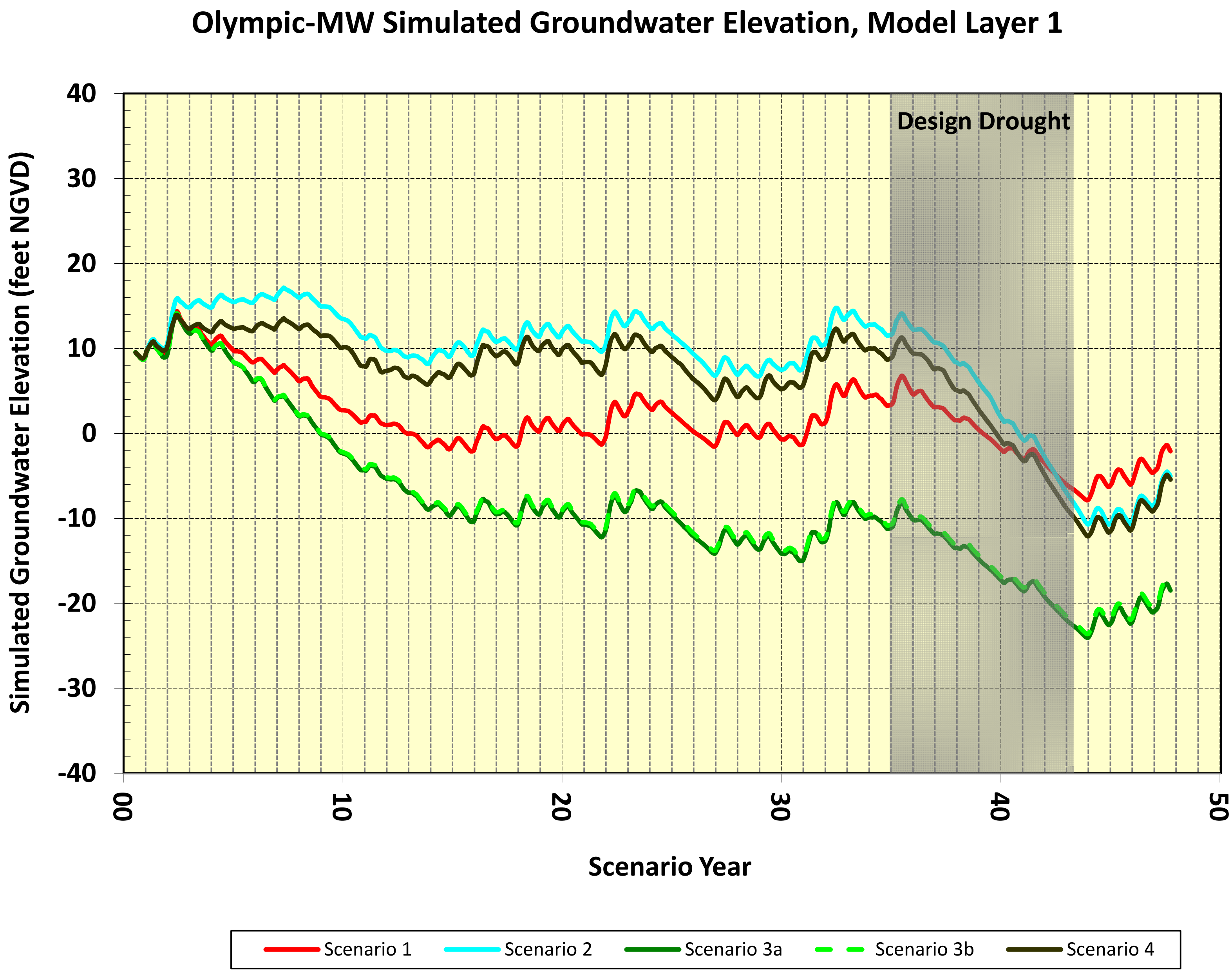
LMMW-4S Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
30
20
10
0
-10
-20
-30
-40
-50
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



LMMW-5S Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
50
40
30
20
10
0
-10
-20
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

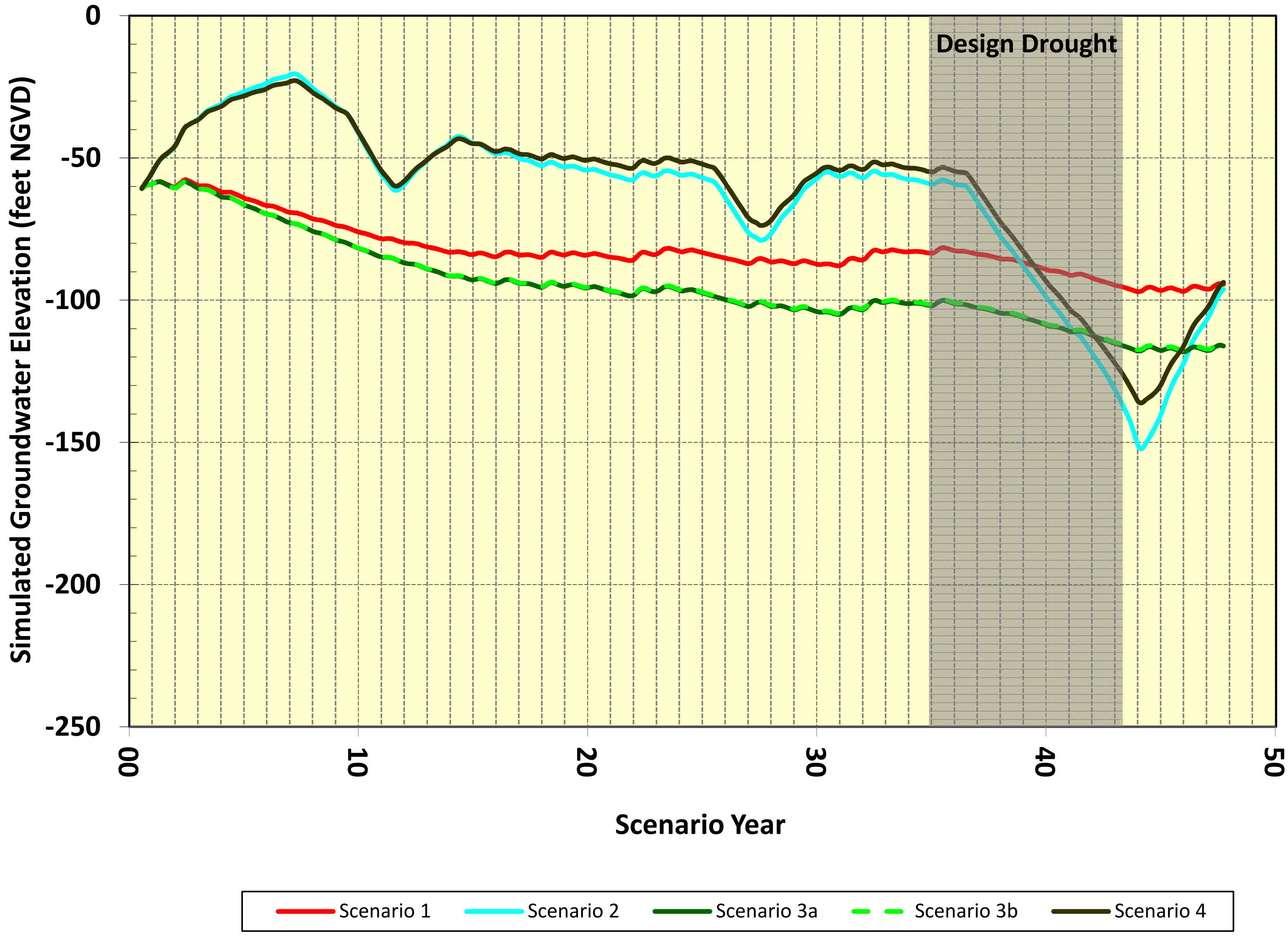
Harding Park Simulated Groundwater Elevation, Model Layer 1

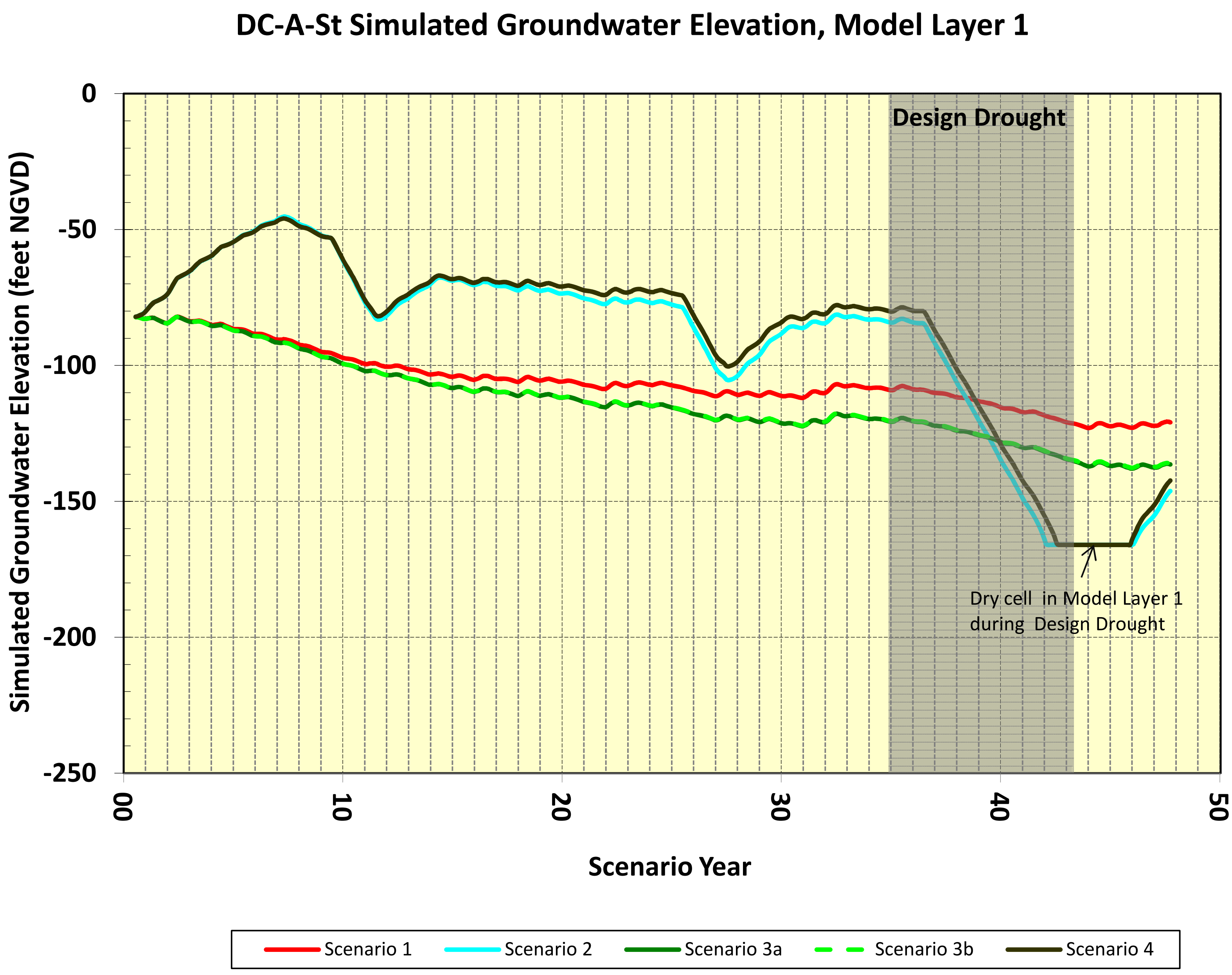




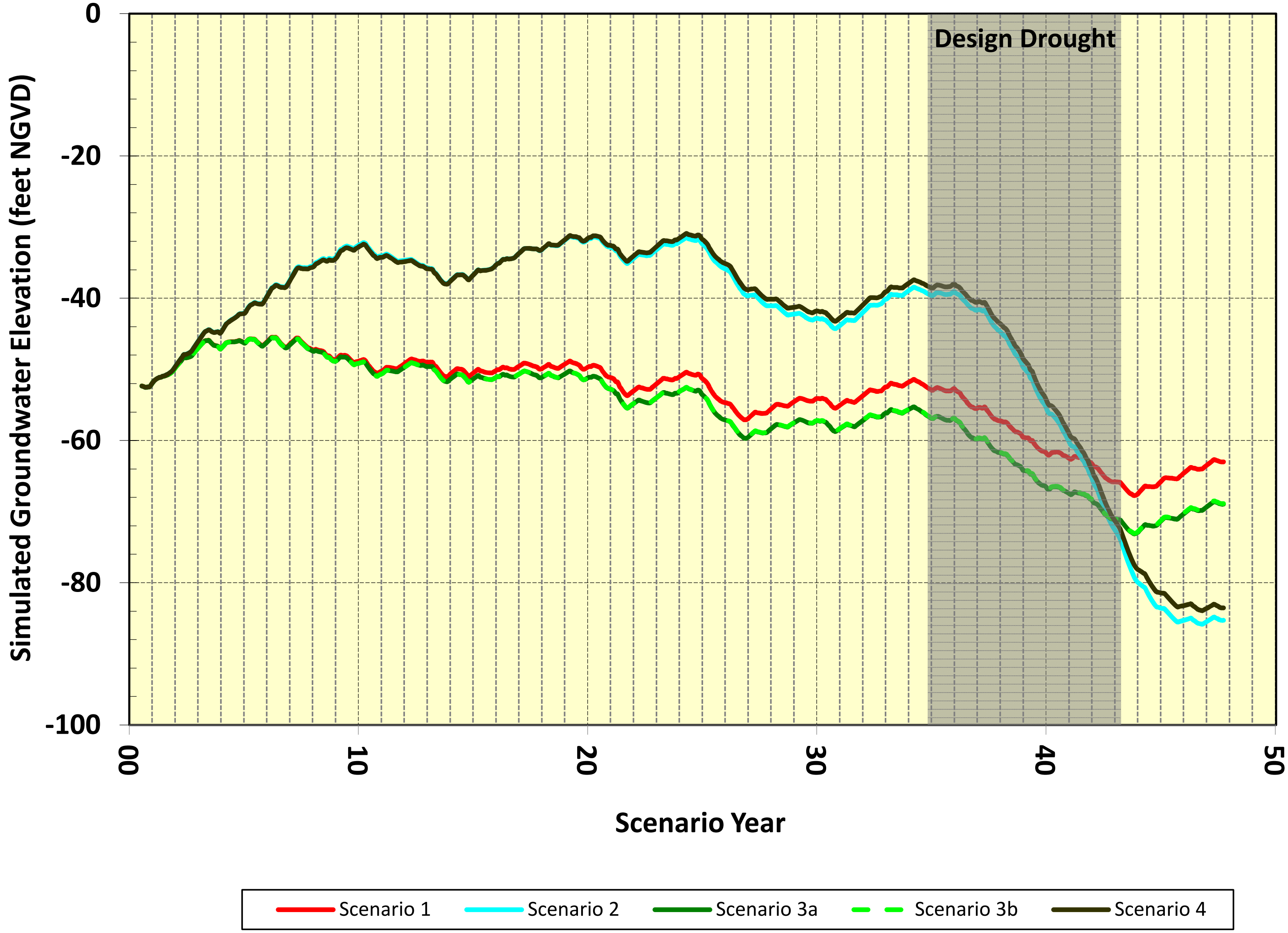
Olympic-MW Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
30
20
10
0
-10
-20
-30
-40
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

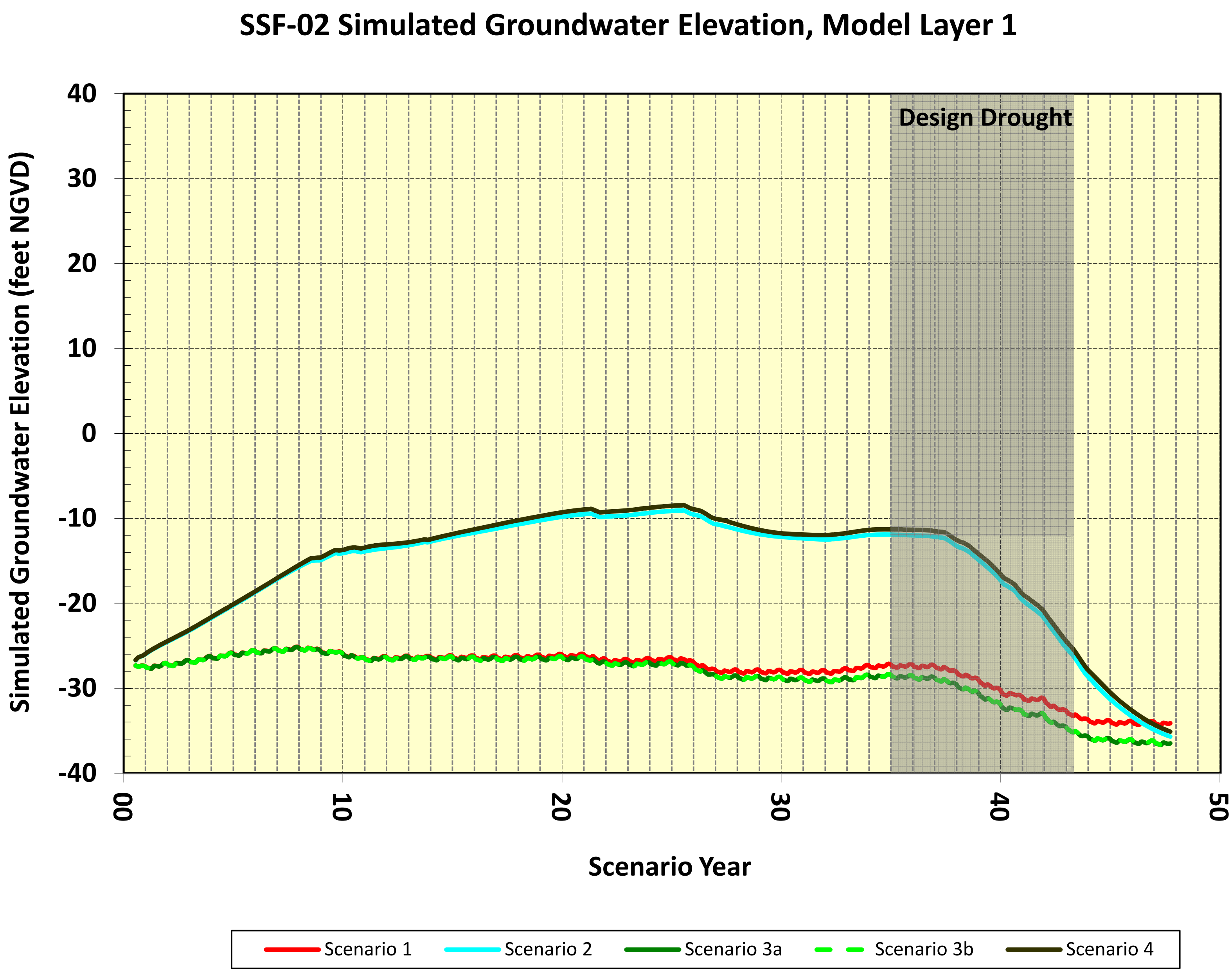
DC-3 Simulated Groundwater Elevation, Model Layer 1



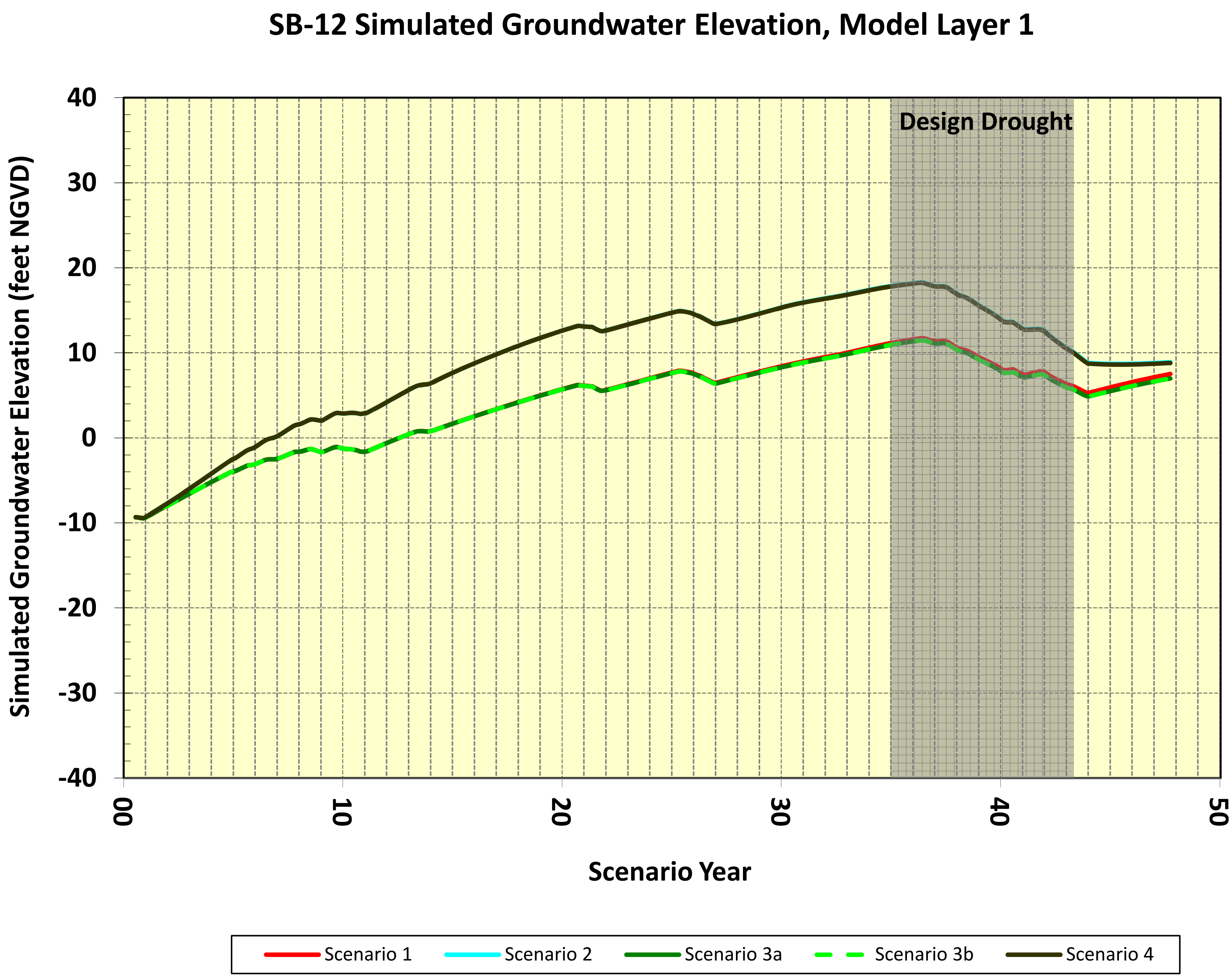

DC-A-St Simulated Groundwater Elevation, Model Layer 1
Design Drought
Dry cell in Model Layer 1
during Design Drought
0
-50
-100
-150
-200
-250
Simulated Groundwater Elevation (feet NGVD)
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

Cyp_Lawn_2 Simulated Groundwater Elevation, Model Layer 1

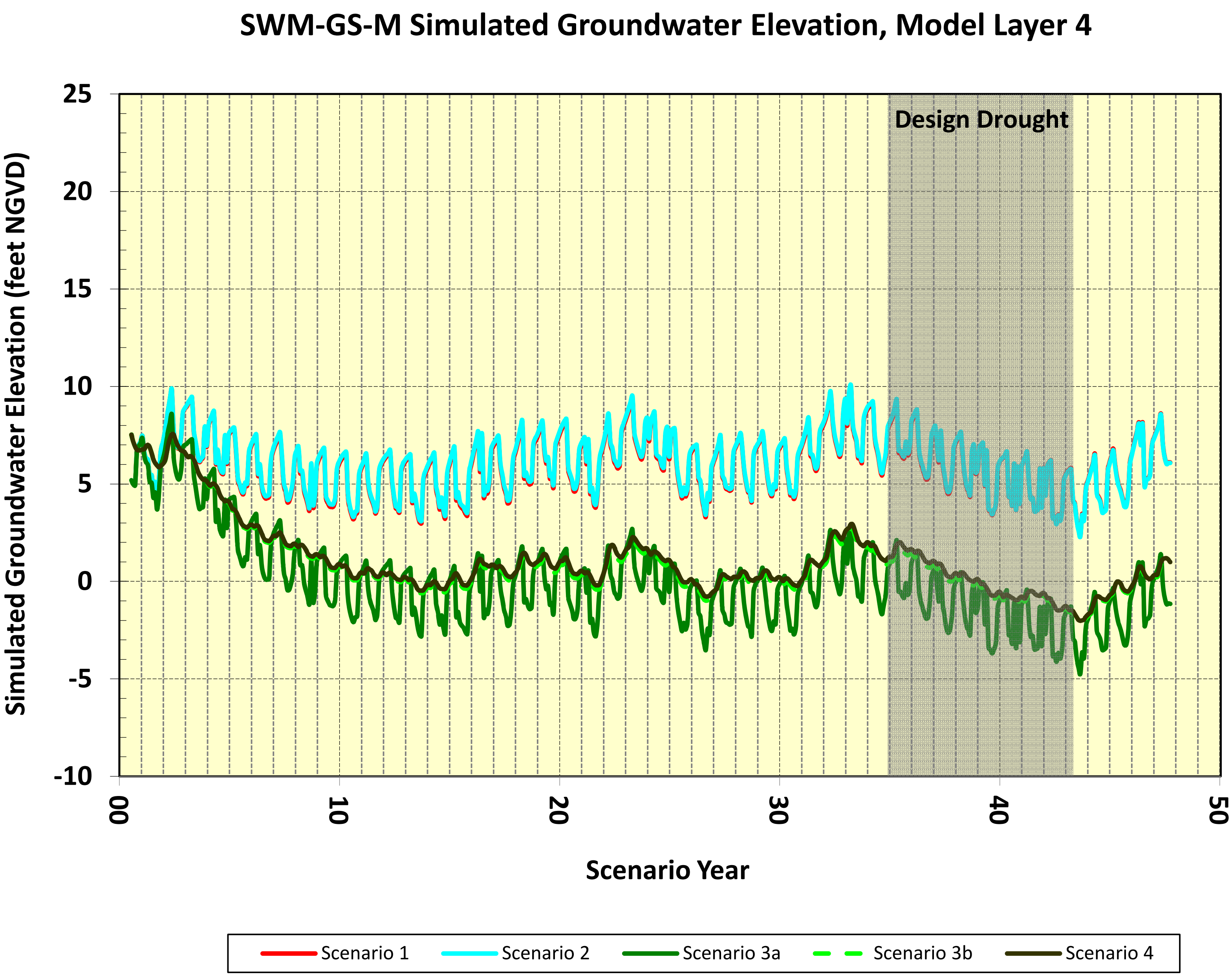




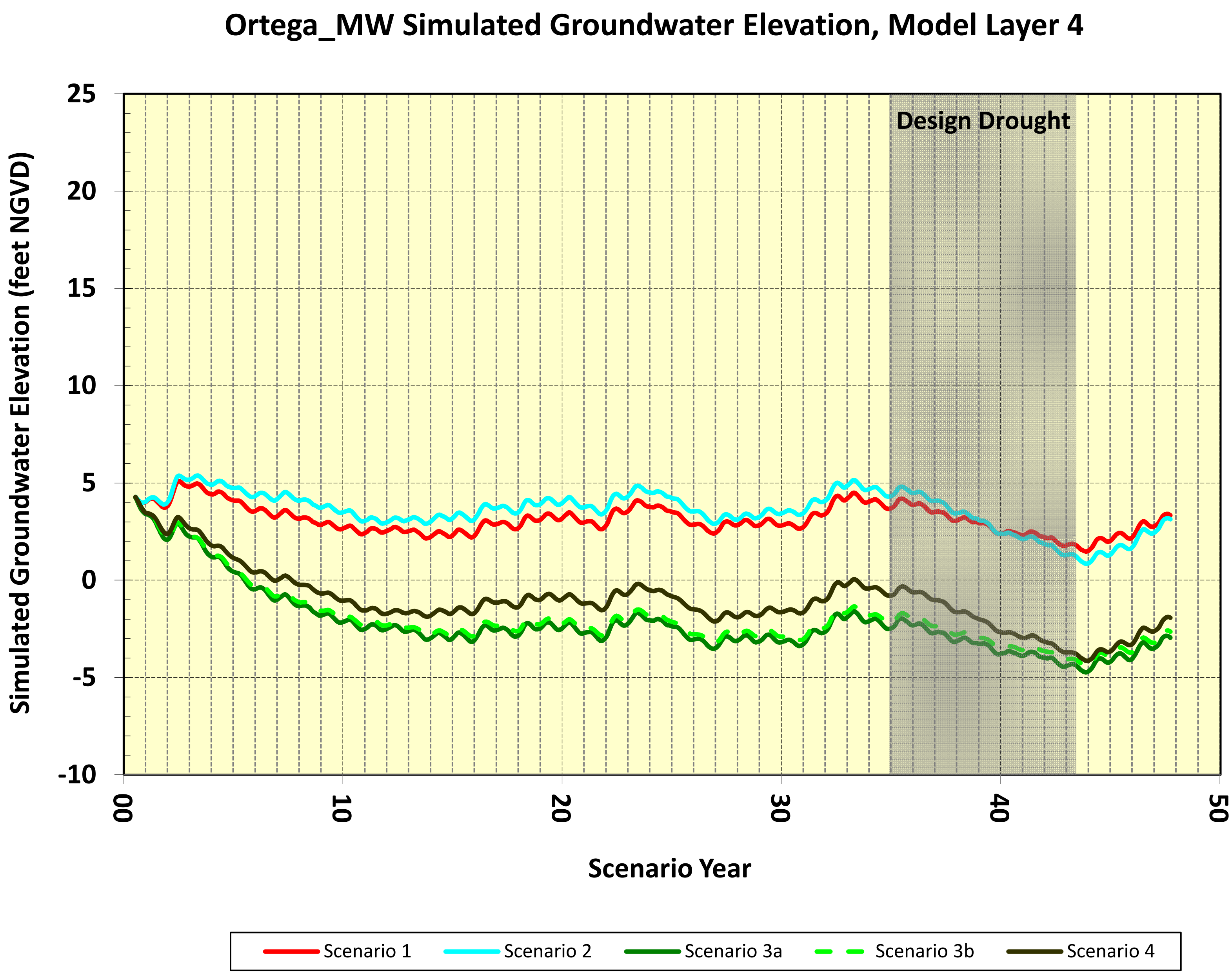
SSF-02 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
30
20
10
0
-10
-20
-30
-40
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



SB-12 Simulated Groundwater Elevation, Model Layer 1
Simulated Groundwater Elevation (feet NGVD)
40
30
20
10
0
-10
-20
-30
-40
00
10
20
30
40
50
Scenario Year
Design Drought
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

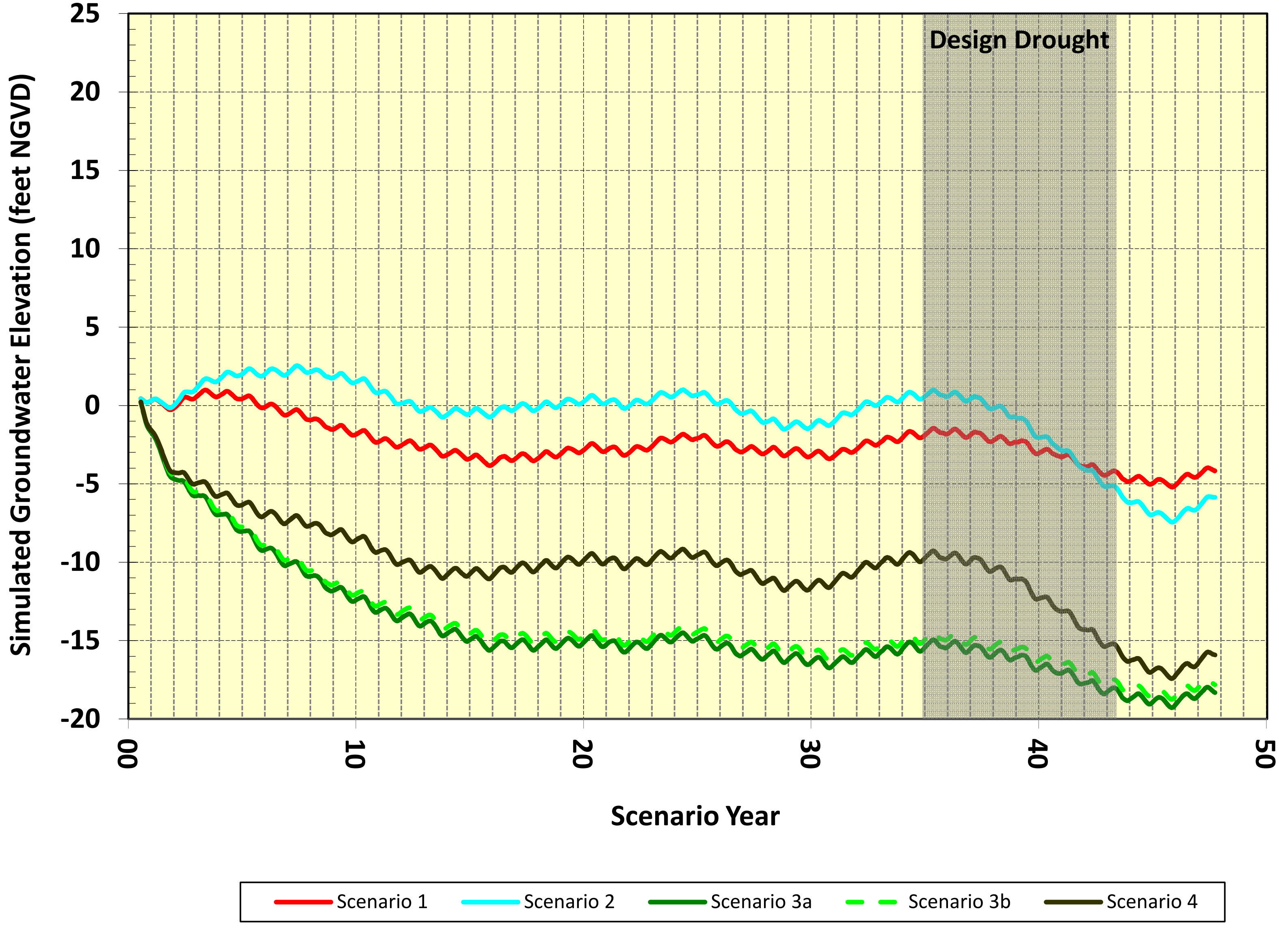


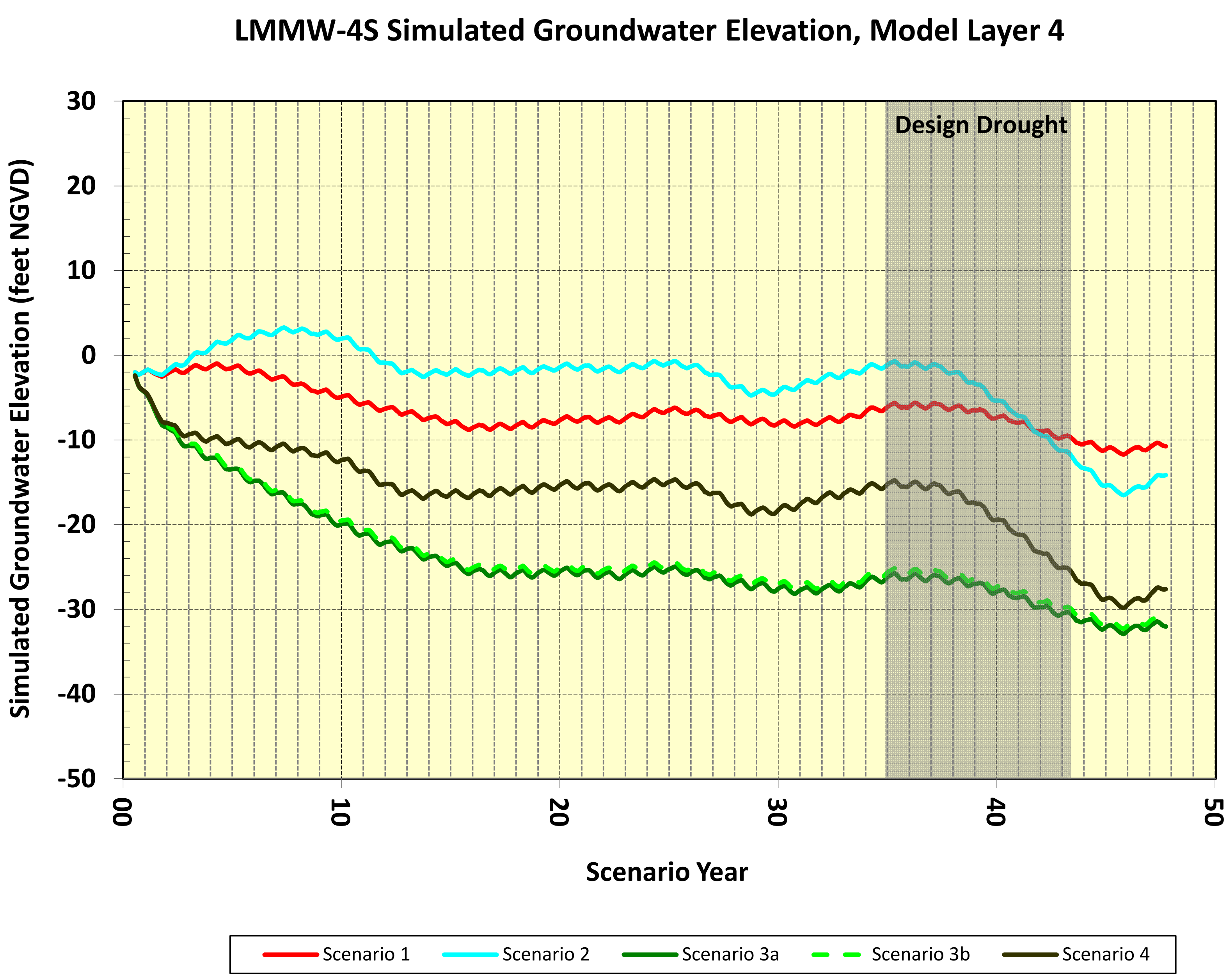
SWM-GS-M Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



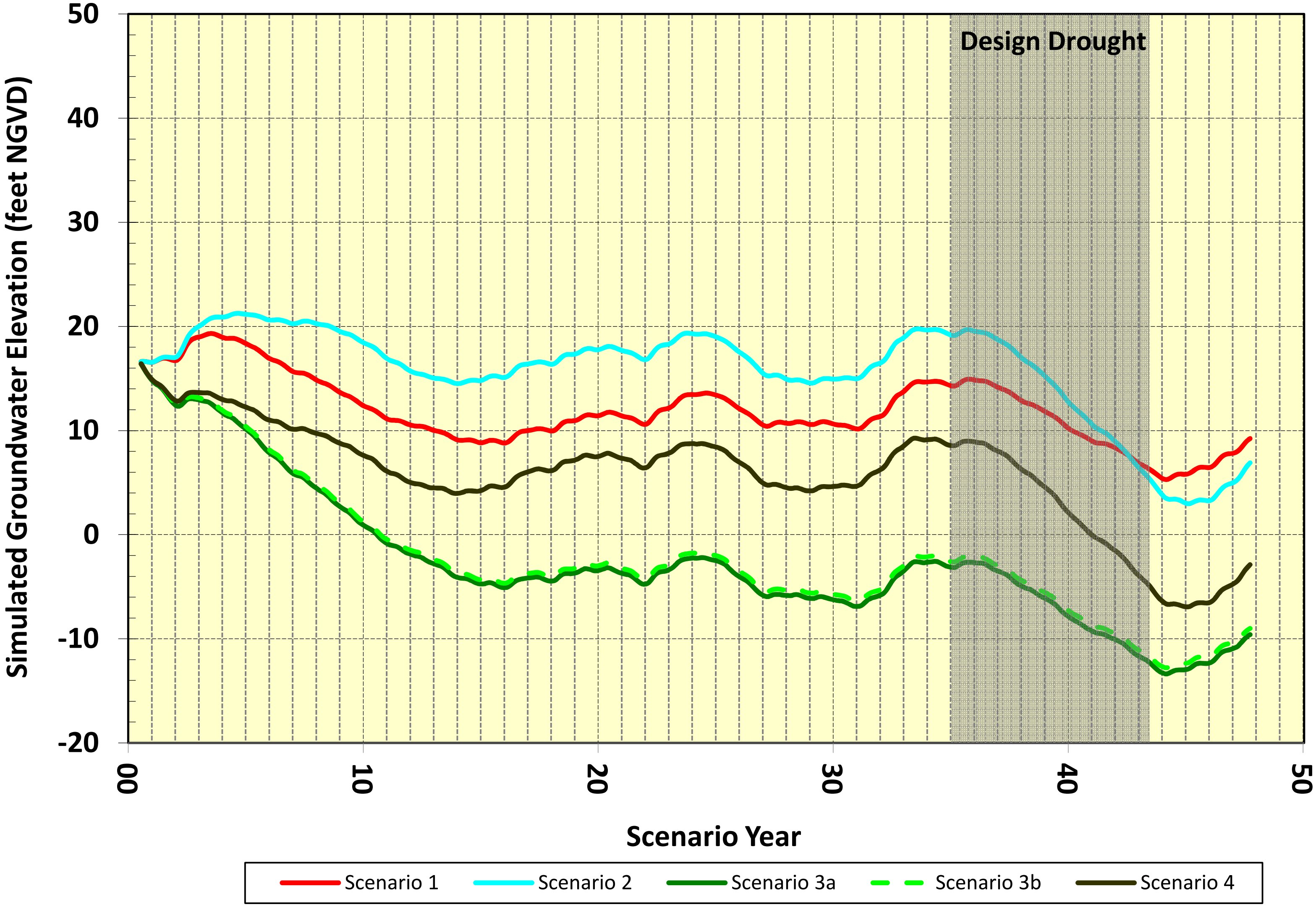
Ortega_MW Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
25
20
15
10
5
0
-5
-10
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

Santiago-S Simulated Groundwater Elevation, Model Layer 4

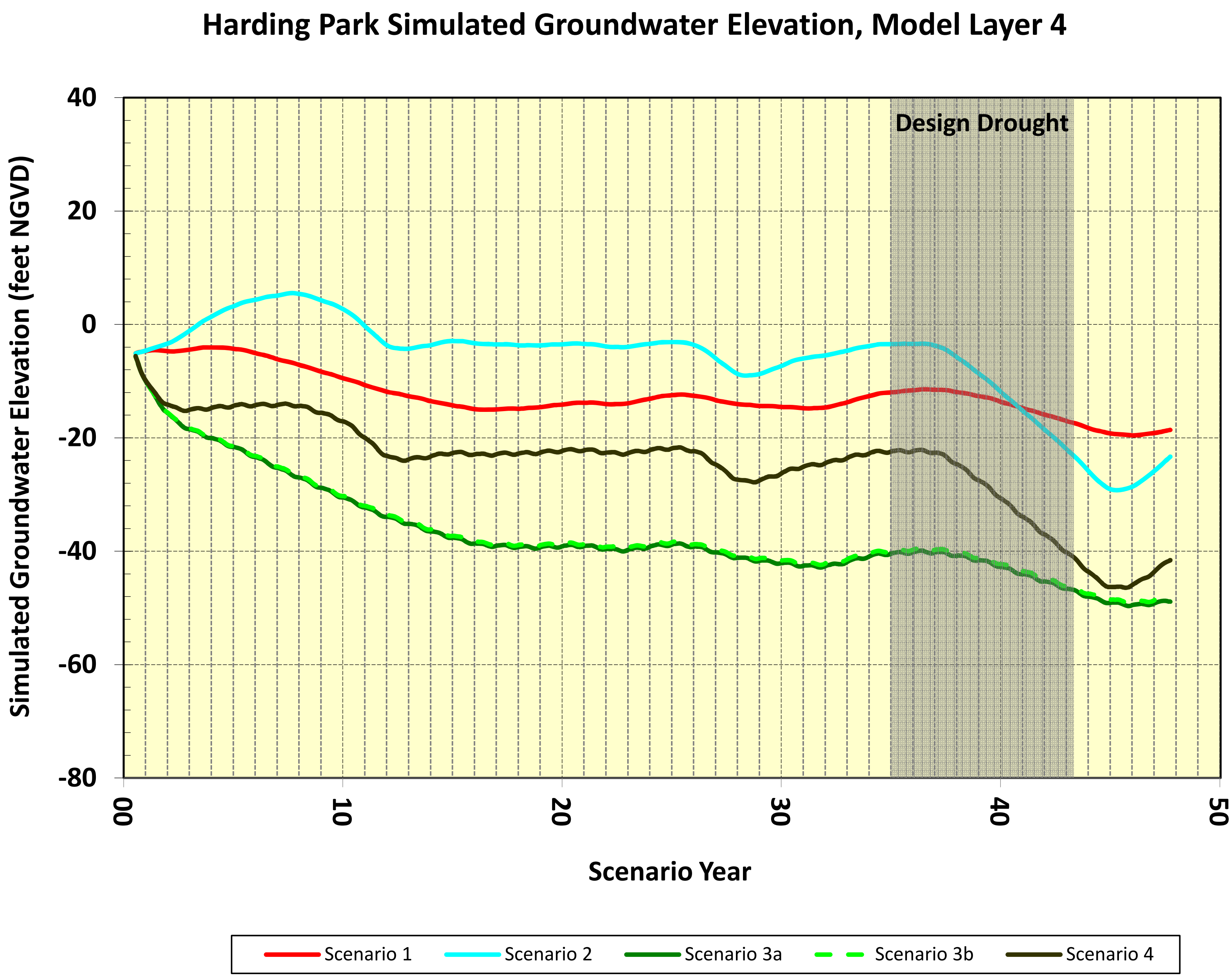


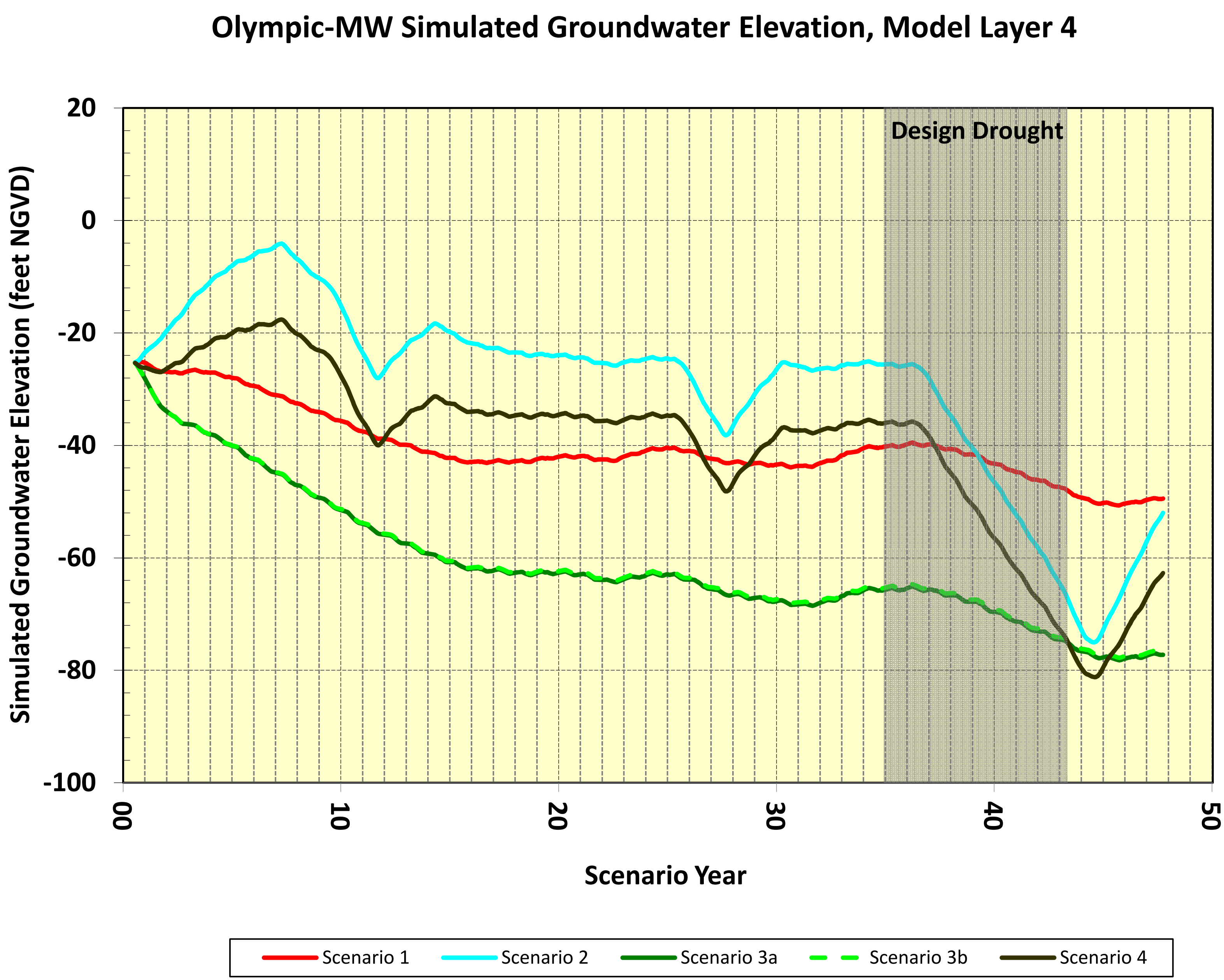

LMMW-4S Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
30
20
10
0
-10
-20
-30
-40
-50
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

LMMW-5S Simulated Groundwater Elevation, Model Layer 3



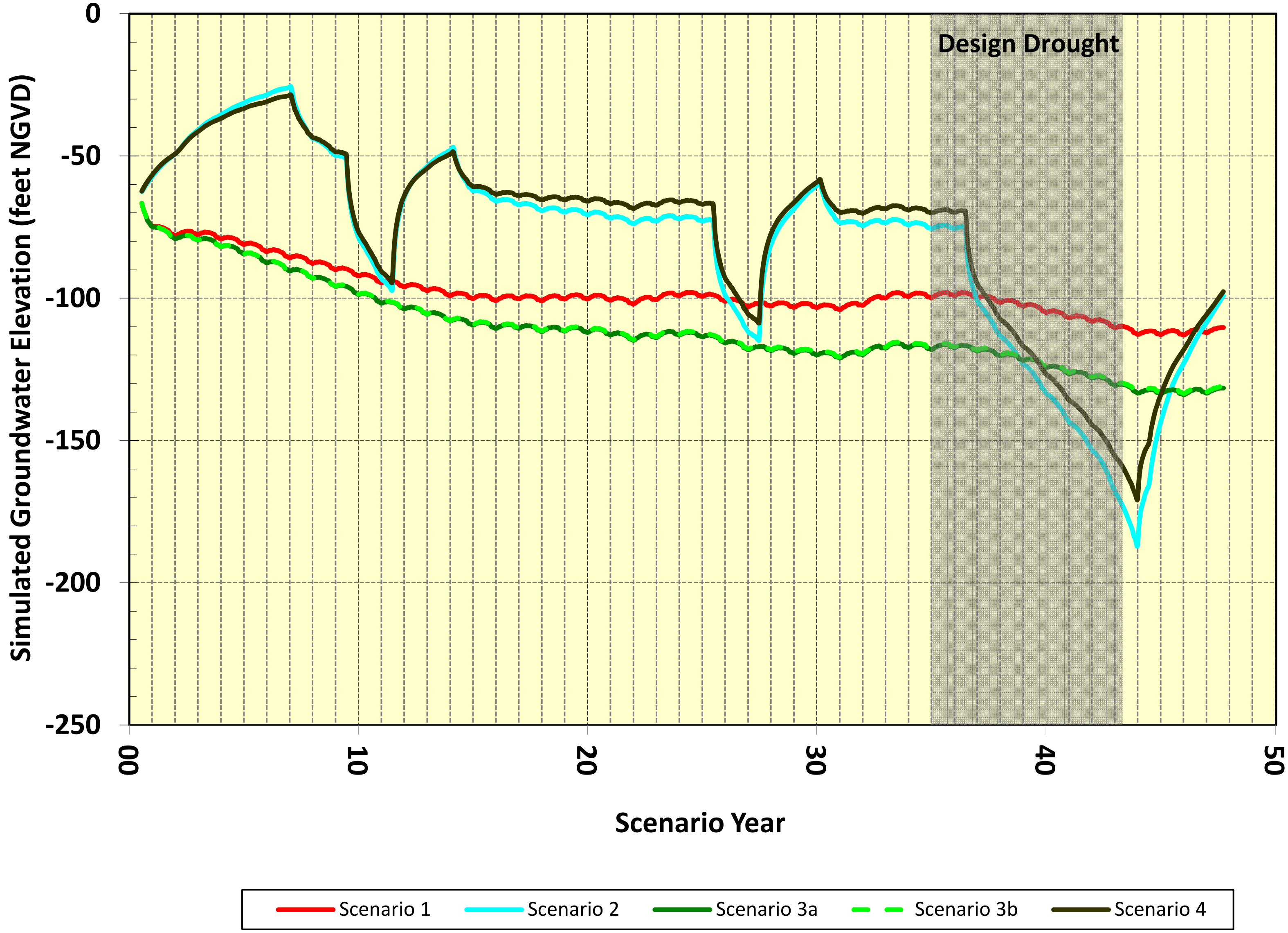
Note: At the location of LMMW-5S, the model does not contain layer 4. Layer 3 is presented in order to show the deepest layer response.

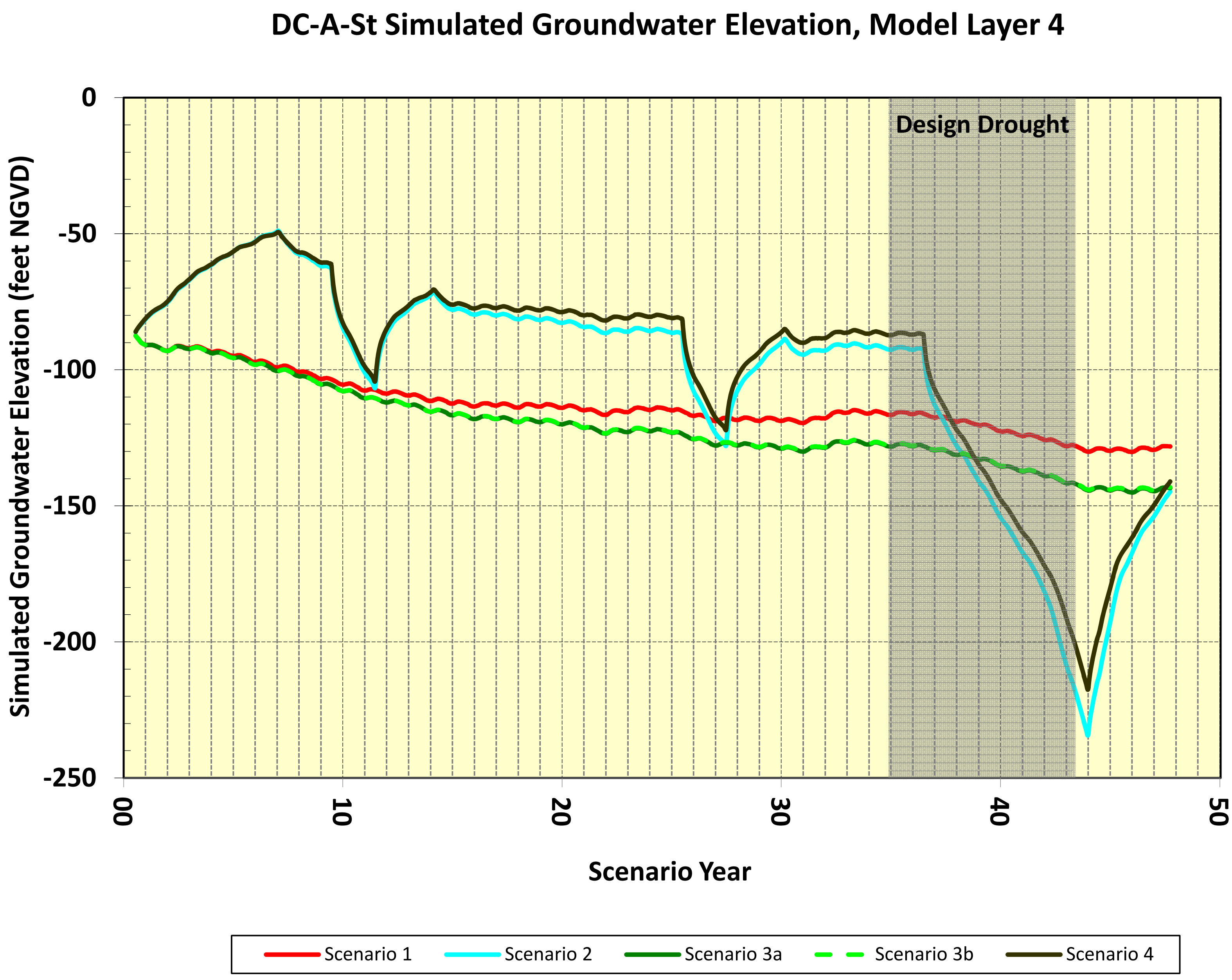

Harding Park Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
20
0
-20
-40
-60
-80
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



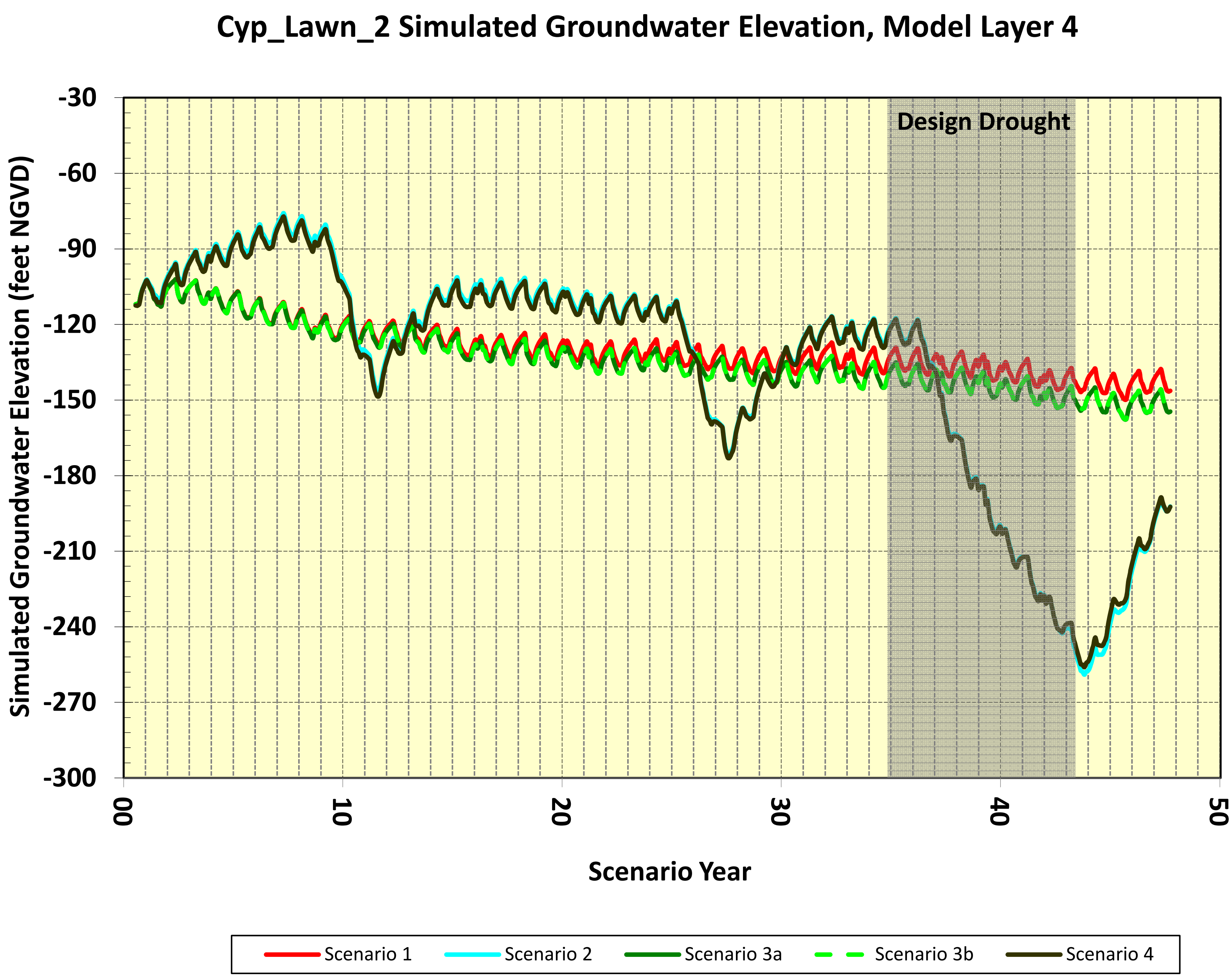
Olympic-MW Simulated Groundwater Elevation, Model Layer 4
Simulated Groundwater Elevation (feet NGVD)
20
0
-20
-40
-60
-80
-100
00
10
20
30
40
50
Scenario Year
Design Drought
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

DC-3 Simulated Groundwater Elevation, Model Layer 4

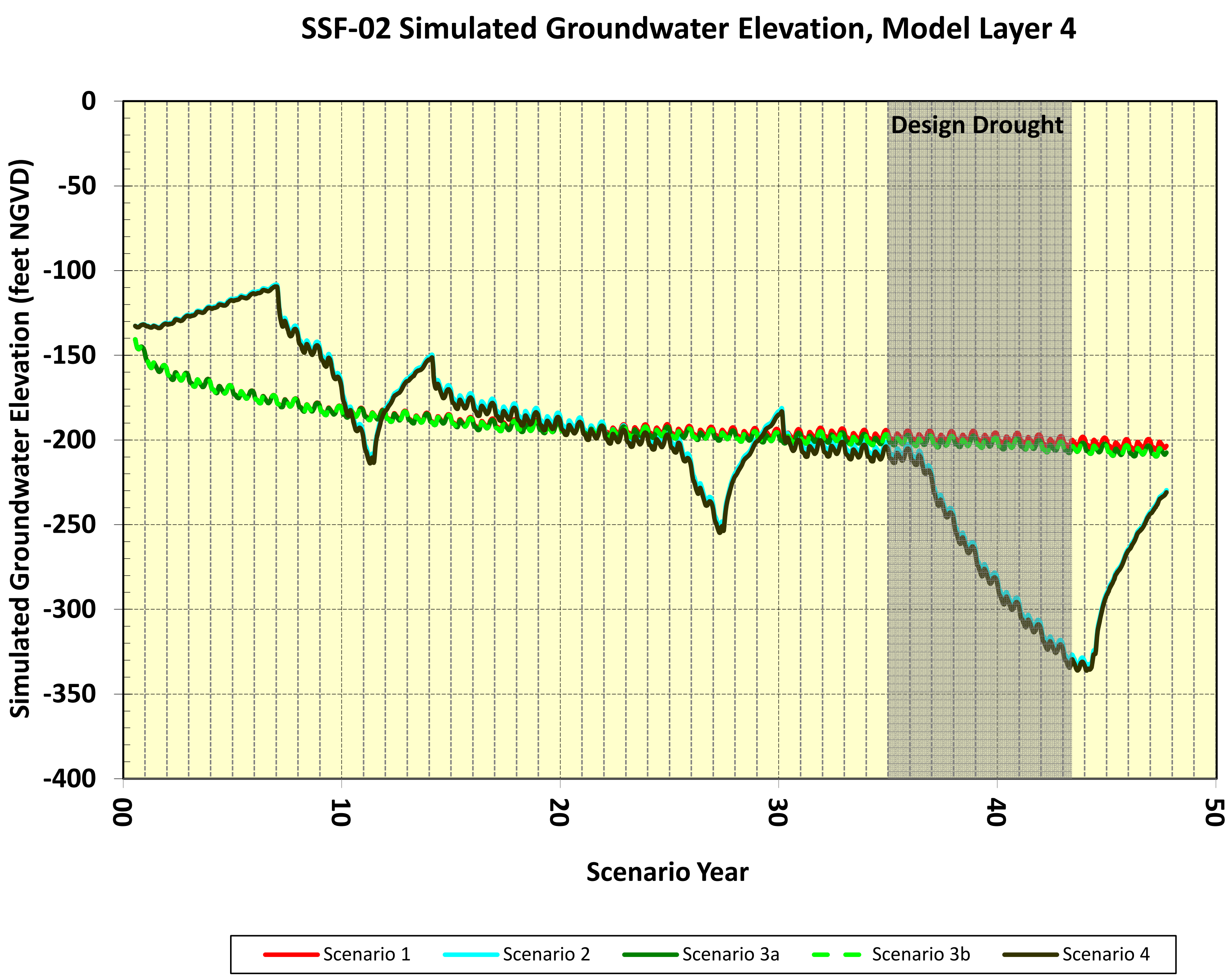


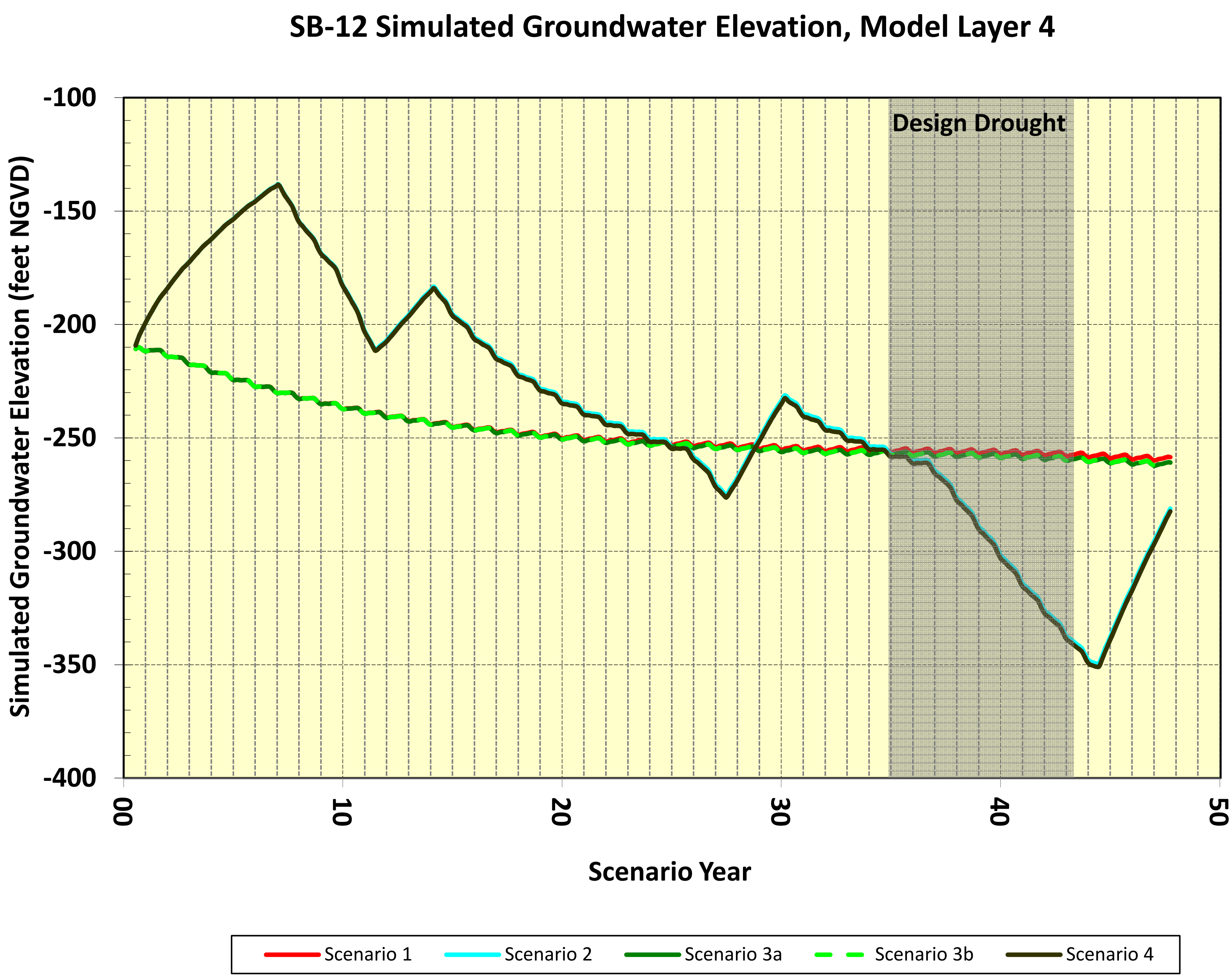


DC-A-St Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



Cyp_Lawn_2 Simulated Groundwater Elevation, Model Layer 4
Simulated Groundwater Elevation (feet NGVD)
-30
-60
-90
-120
-150
-180
-210
-240
-270
-300
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4


SSF-02 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4


SB-12 Simulated Groundwater Elevation, Model Layer 4
Simulated Groundwater Elevation (feet NGVD)
-100
-150
-200
-250
-300
-350
-400
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

Attachment 10.1-C

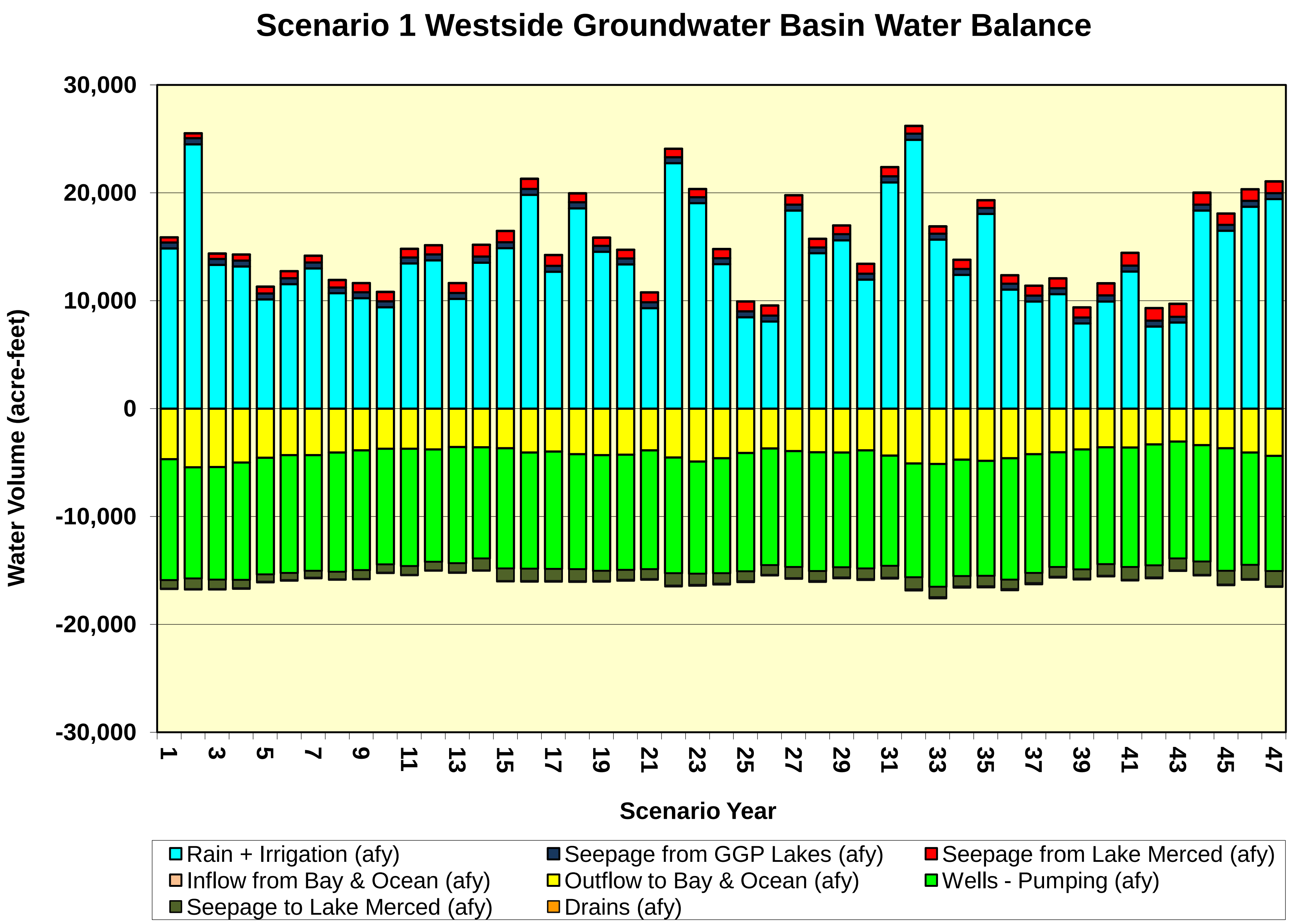
Model Scenario Water Balance Results – Westside Basin

Scenario 1 Westside Groundwater Basin Water Balance Summary

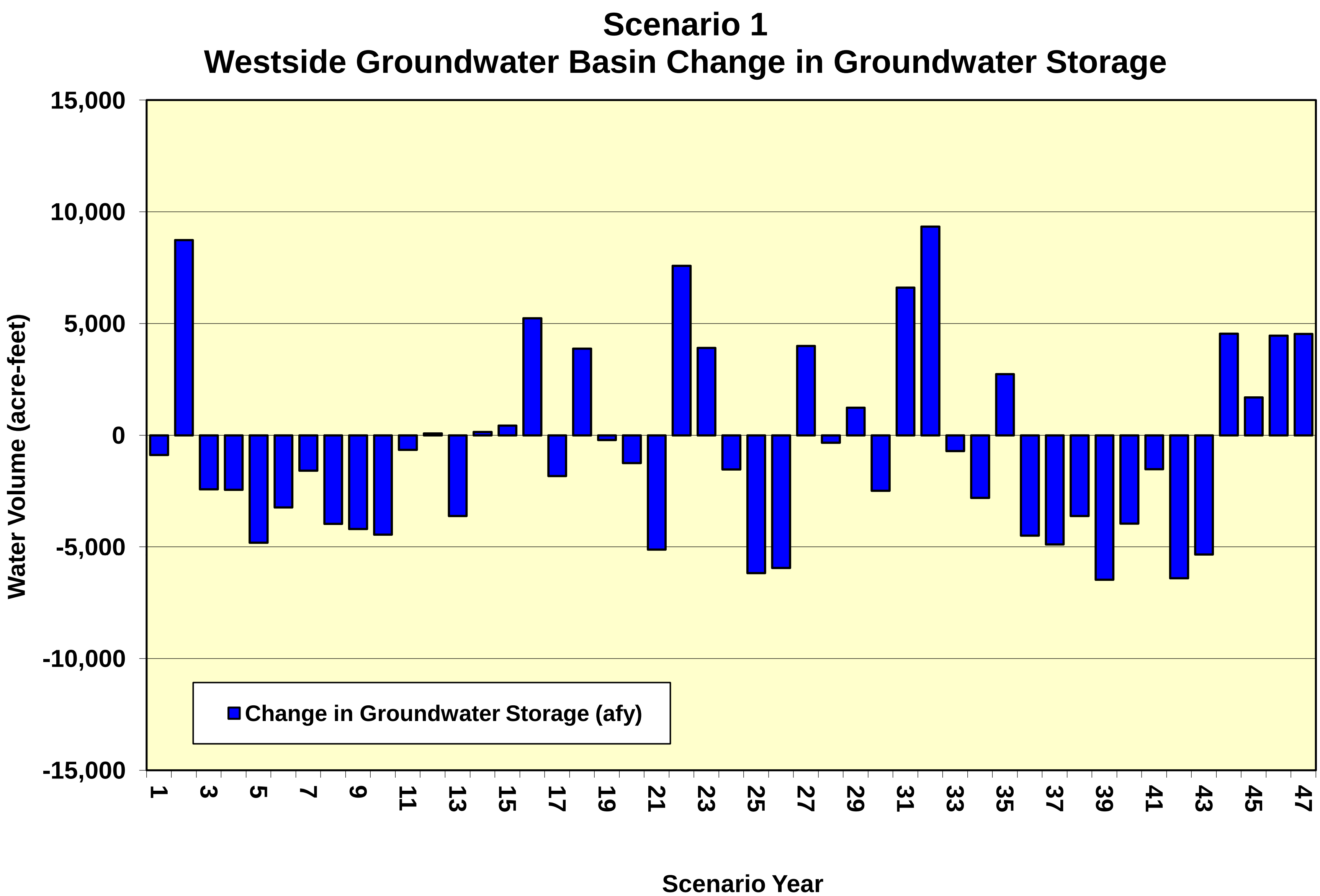
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	5	546	14,845	464	-4,684	-11,229	-753	-71	-877
2	5	558	24,505	456	-5,439	-10,299	-974	-72	8,739
3	5	552	13,329	475	-5,406	-10,445	-858	-73	-2,420
4	5	549	13,169	547	-4,988	-10,889	-758	-74	-2,440
5	5	549	10,129	623	-4,561	-10,804	-679	-74	-4,814
6	5	551	11,546	624	-4,317	-10,917	-653	-73	-3,234
7	5	552	12,988	614	-4,317	-10,717	-634	-72	-1,580
8	5	545	10,691	671	-4,064	-11,064	-680	-72	-3,968
9	6	549	10,235	853	-3,868	-11,113	-788	-70	-4,198
10	6	554	9,386	875	-3,717	-10,720	-767	-68	-4,451
11	7	549	13,455	807	-3,710	-10,879	-807	-68	-647
12	8	556	13,751	820	-3,780	-10,420	-772	-74	89
13	9	553	10,162	915	-3,568	-10,761	-841	-76	-3,609
14	10	558	13,533	1,086	-3,585	-10,315	-1,067	-75	145
15	11	549	14,876	1,040	-3,666	-11,154	-1,139	-81	437
16	12	556	19,804	925	-4,070	-10,766	-1,142	-84	5,234
17	10	549	12,678	995	-3,989	-10,883	-1,095	-88	-1,823
18	10	554	18,568	828	-4,225	-10,663	-1,102	-92	3,879
19	9	553	14,531	755	-4,322	-10,710	-932	-96	-212
20	9	556	13,363	791	-4,272	-10,673	-920	-100	-1,245
21	9	548	9,310	896	-3,869	-11,010	-912	-93	-5,120
22	10	554	22,751	765	-4,542	-10,729	-1,125	-94	7,591
23	9	556	19,036	745	-4,914	-10,402	-1,014	-101	3,915
24	9	549	13,397	837	-4,599	-10,670	-949	-105	-1,530
25	9	549	8,479	893	-4,123	-10,963	-904	-107	-6,167
26	11	550	8,071	921	-3,694	-10,827	-871	-96	-5,935
27	12	552	18,354	870	-3,946	-10,732	-1,017	-96	3,997
28	12	549	14,398	788	-4,057	-11,007	-911	-104	-331
29	12	553	15,609	801	-4,065	-10,650	-921	-109	1,231
30	13	550	11,960	905	-3,871	-10,961	-964	-112	-2,479
31	13	556	20,974	840	-4,352	-10,230	-1,076	-115	6,611
32	12	556	24,922	717	-5,079	-10,564	-1,106	-118	9,340
33	12	545	15,668	661	-5,124	-11,398	-951	-121	-709
34	11	554	12,389	855	-4,732	-10,800	-955	-124	-2,802
35	11	553	18,045	708	-4,839	-10,663	-951	-128	2,737
36	11	545	11,034	780	-4,601	-11,255	-871	-129	-4,486
37	11	545	9,932	915	-4,215	-11,035	-919	-121	-4,886
38	11	554	10,605	904	-4,058	-10,620	-900	-114	-3,618
39	12	549	7,905	926	-3,789	-11,119	-846	-106	-6,468
40	15	556	9,935	1,119	-3,588	-10,839	-1,052	-100	-3,953
41	17	549	12,714	1,156	-3,608	-11,081	-1,163	-100	-1,516
42	22	550	7,618	1,146	-3,322	-11,202	-1,120	-96	-6,403
43	28	549	7,975	1,171	-3,057	-10,827	-1,087	-87	-5,335
44	31	552	18,357	1,090	-3,379	-10,805	-1,216	-87	4,544
45	29	545	16,490	1,030	-3,669	-11,371	-1,263	-95	1,697
46	27	556	18,714	1,050	-4,069	-10,412	-1,305	-98	4,464
47	23	545	19,422	1,095	-4,385	-10,681	-1,383	-101	4,535
Average (afy)	**12**	**551**	**14,034**	**846**	**-4,172**	**-10,814**	**-960**	**-94**	**-597**
Maximum (afy)	**31**	**558**	**24,922**	**1,171**	**-3,057**	**-10,230**	**-634**	**-68**	**9,340**
Minimum (afy)	**5**	**545**	**7,618**	**456**	**-5,439**	**-11,398**	**-1,383**	**-129**	**-6,468**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

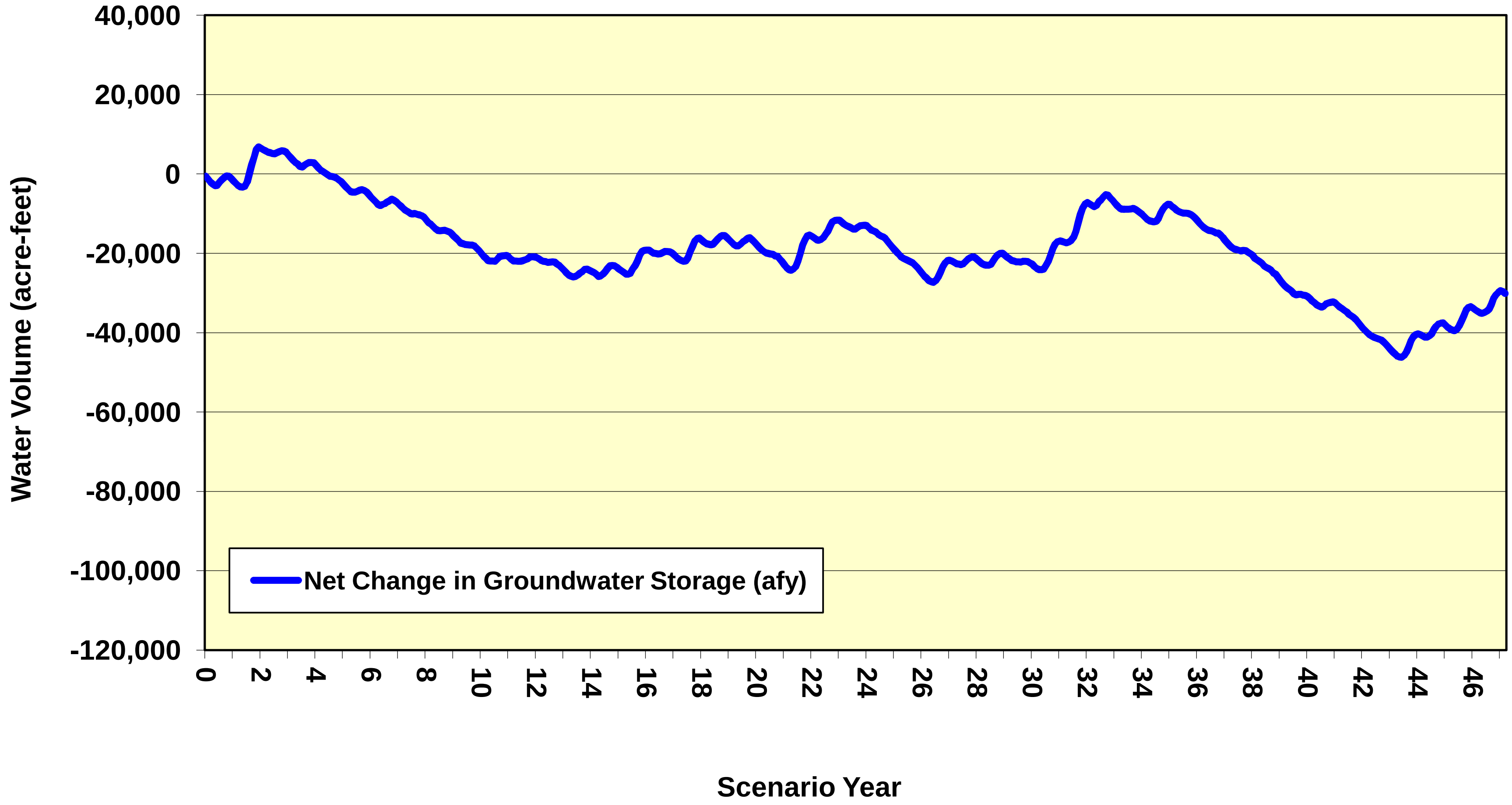
Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Note: Volume of some water balance components may be too small to be visible.


Scenario 1
Westside Groundwater Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
Change in Groundwater Storage (afy)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year

Scenario 1
Westside Groundwater Basin Net Change in Groundwater Storage

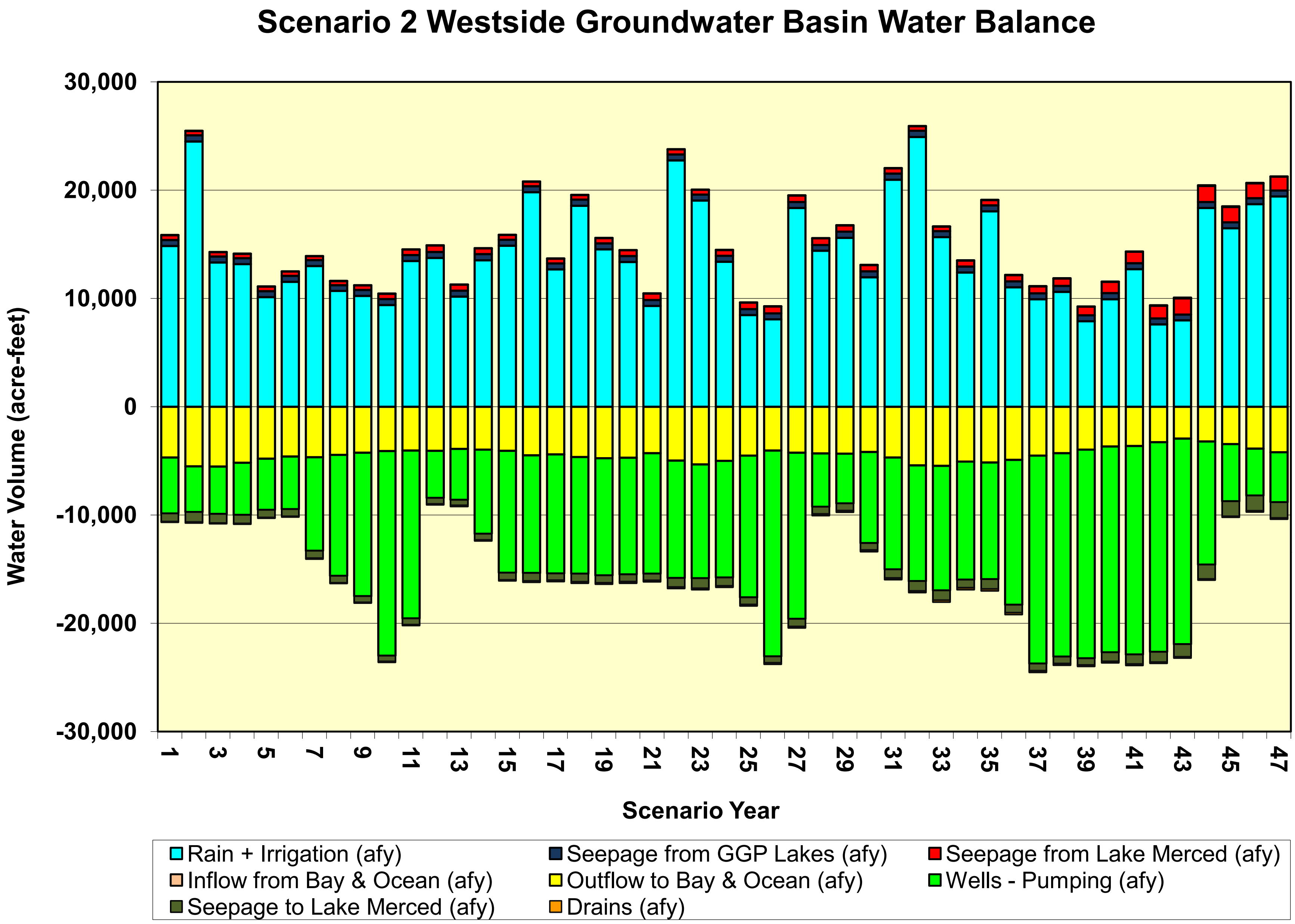


Scenario 2 Westside Groundwater Basin Water Balance Summary

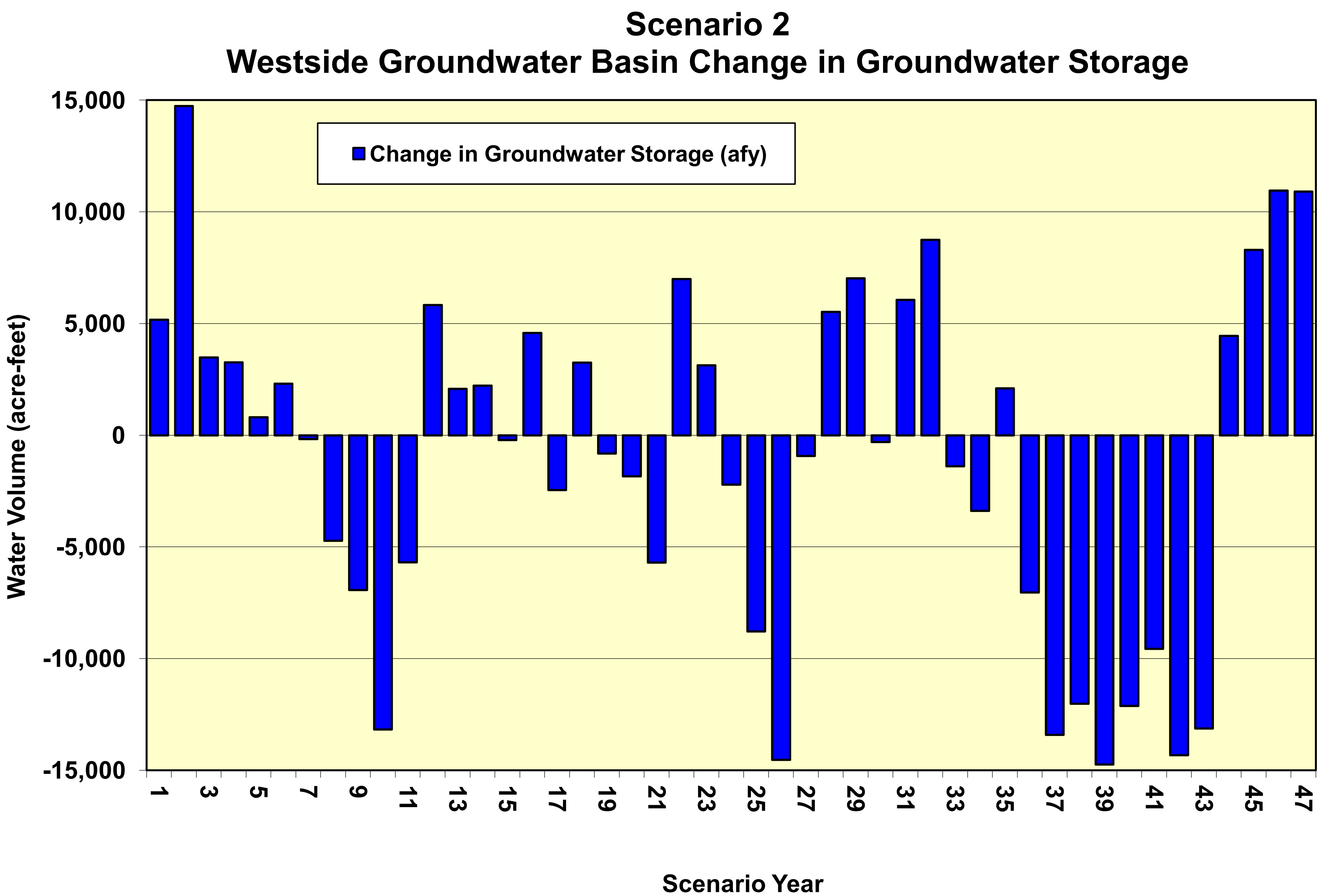
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	5	546	14,845	452	-4,698	-5,157	-754	-71	5,168
2	5	558	24,505	405	-5,499	-4,227	-931	-72	14,744
3	5	552	13,329	402	-5,526	-4,373	-835	-74	3,480
4	5	549	13,169	395	-5,165	-4,817	-798	-75	3,262
5	5	549	10,129	418	-4,789	-4,732	-698	-77	805
6	4	551	11,546	394	-4,601	-4,845	-667	-77	2,305
7	4	552	12,988	351	-4,657	-8,647	-680	-78	-166
8	4	545	10,691	365	-4,435	-11,173	-640	-81	-4,723
9	4	549	10,235	425	-4,252	-13,237	-569	-84	-6,929
10	4	554	9,386	492	-4,097	-18,889	-529	-85	-13,164
11	4	549	13,455	512	-4,044	-15,498	-574	-87	-5,683
12	5	556	13,751	575	-4,081	-4,348	-533	-94	5,832
13	4	553	10,162	567	-3,900	-4,689	-522	-98	2,077
14	4	558	13,533	526	-3,963	-7,759	-583	-99	2,218
15	4	549	14,876	448	-4,070	-11,262	-647	-109	-213
16	4	556	19,804	419	-4,482	-10,874	-728	-117	4,582
17	4	549	12,678	461	-4,406	-10,991	-624	-124	-2,453
18	4	554	18,568	427	-4,647	-10,771	-752	-130	3,253
19	4	553	14,531	486	-4,749	-10,818	-690	-136	-819
20	4	556	13,363	530	-4,702	-10,781	-671	-141	-1,841
21	4	548	9,310	595	-4,296	-11,119	-611	-134	-5,702
22	4	554	22,751	471	-4,969	-10,837	-840	-135	6,999
23	4	556	19,036	442	-5,333	-10,510	-920	-144	3,132
24	4	549	13,397	517	-4,993	-10,778	-762	-149	-2,214
25	4	549	8,479	595	-4,504	-13,087	-662	-151	-8,778
26	5	550	8,071	644	-4,053	-18,996	-605	-139	-14,523
27	6	552	18,354	598	-4,245	-15,350	-706	-137	-927
28	7	549	14,398	617	-4,310	-4,935	-663	-145	5,519
29	6	553	15,609	589	-4,340	-4,578	-668	-149	7,022
30	6	550	11,960	567	-4,184	-8,404	-641	-153	-299
31	6	556	20,974	489	-4,688	-10,338	-777	-157	6,065
32	6	556	24,922	424	-5,418	-10,673	-908	-161	8,748
33	6	545	15,668	430	-5,453	-11,506	-912	-166	-1,389
34	6	554	12,389	558	-5,053	-10,908	-757	-171	-3,382
35	6	553	18,045	500	-5,154	-10,771	-902	-175	2,100
36	6	545	11,034	573	-4,907	-13,378	-736	-176	-7,040
37	6	545	9,932	648	-4,503	-19,204	-670	-163	-13,409
38	7	554	10,605	689	-4,289	-18,789	-645	-152	-12,020
39	9	549	7,905	790	-3,949	-19,288	-614	-140	-14,738
40	15	556	9,935	1,038	-3,678	-19,008	-842	-131	-12,113
41	23	549	12,714	1,048	-3,631	-19,250	-882	-128	-9,557
42	36	550	7,618	1,170	-3,278	-19,363	-934	-121	-14,321
43	53	549	7,975	1,498	-2,948	-18,976	-1,172	-108	-13,129
44	65	552	18,357	1,481	-3,201	-11,372	-1,330	-103	4,449
45	61	545	16,490	1,422	-3,452	-5,271	-1,384	-107	8,303
46	47	556	18,714	1,356	-3,864	-4,335	-1,408	-107	10,960
47	34	545	19,422	1,281	-4,207	-4,607	-1,453	-107	10,906
Average (afy)	**11**	**551**	**14,034**	**640**	**-4,418**	**-10,926**	**-784**	**-122**	**-1,013**
Maximum (afy)	**65**	**558**	**24,922**	**1,498**	**-2,948**	**-4,227**	**-522**	**-71**	**14,744**
Minimum (afy)	**4**	**545**	**7,618**	**351**	**-5,526**	**-19,363**	**-1,453**	**-176**	**-14,738**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

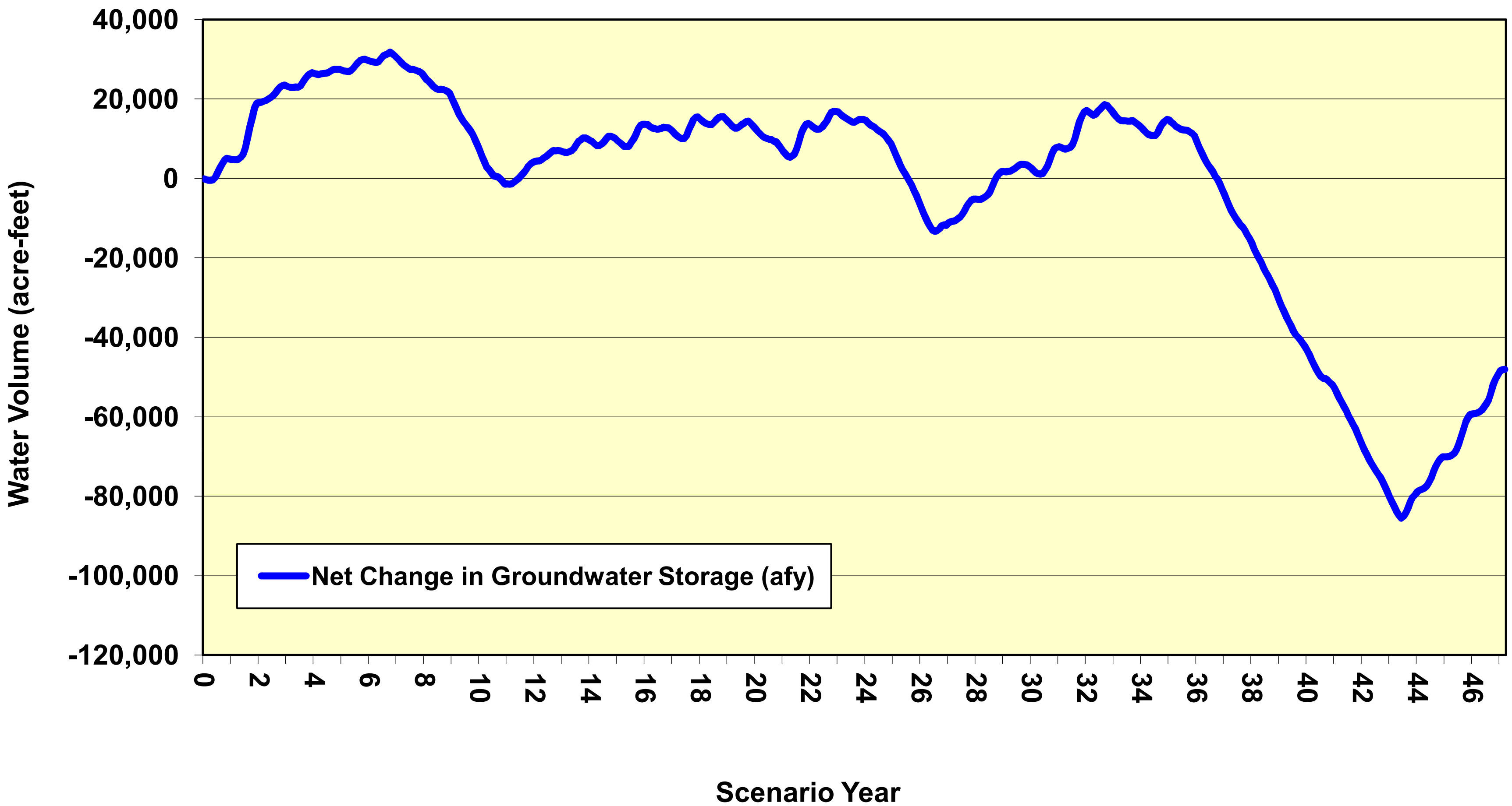
Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Note: Volume of some water balance components may be too small to be visible.


Scenario 2
Westside Groundwater Basin Change in Groundwater Storage
Change in Groundwater Storage (afy)
Water Volume (acre-feet)
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year

Scenario 2
Westside Groundwater Basin Net Change in Groundwater Storage

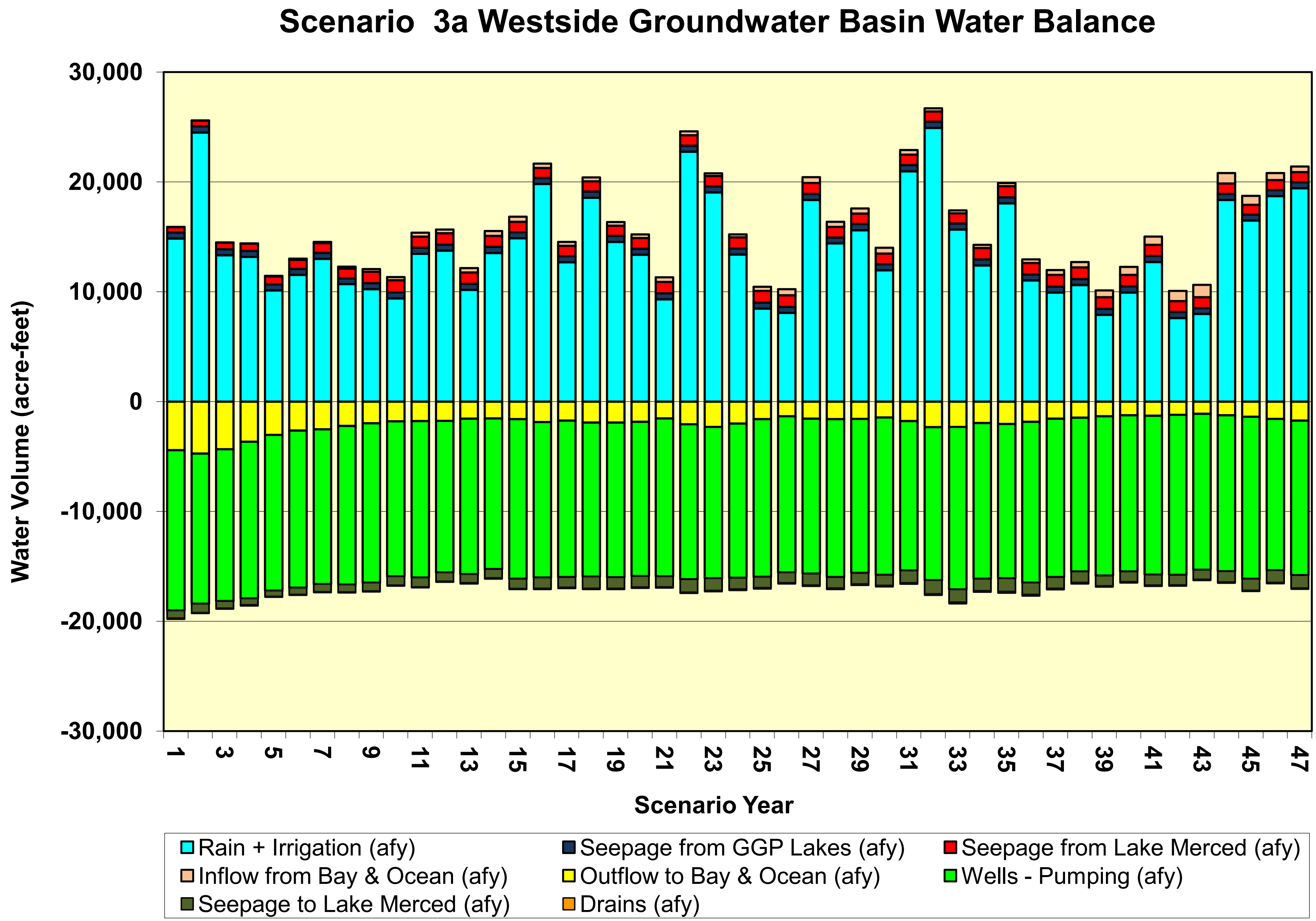


Scenario 3a Westside Groundwater Basin Water Balance Summary

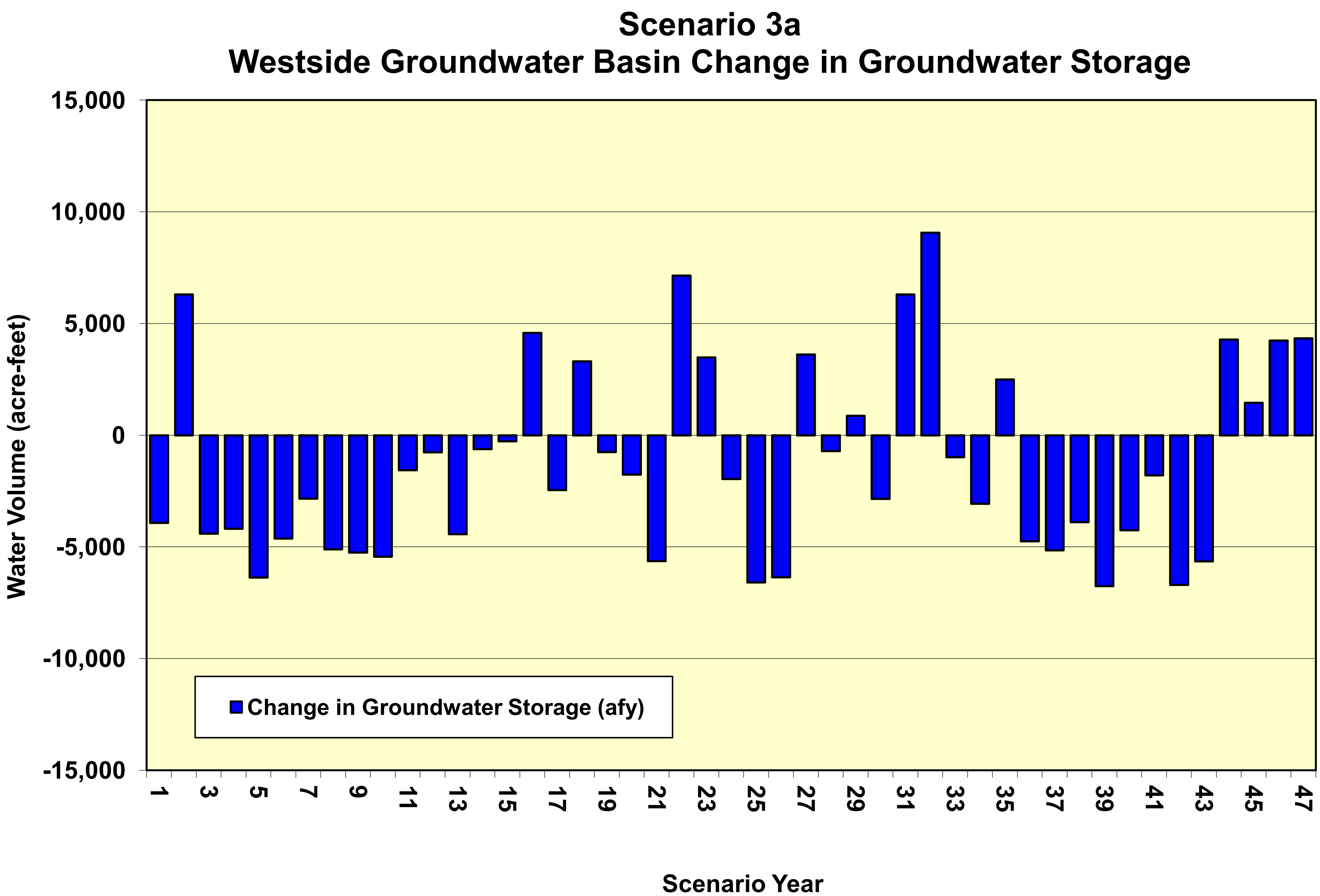
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	5	546	14,845	485	-4,415	-14,603	-712	-71	-3,919
2	7	558	24,505	517	-4,731	-13,674	-806	-72	6,303
3	11	552	13,329	601	-4,339	-13,820	-661	-73	-4,399
4	26	549	13,169	660	-3,649	-14,264	-605	-74	-4,188
5	53	549	10,129	718	-3,023	-14,179	-534	-74	-6,362
6	93	551	11,546	818	-2,639	-14,292	-628	-73	-4,624
7	127	552	12,988	881	-2,526	-14,091	-692	-72	-2,833
8	183	545	10,691	874	-2,213	-14,439	-678	-72	-5,109
9	243	549	10,235	1,035	-1,978	-14,488	-772	-70	-5,247
10	301	554	9,386	1,105	-1,802	-14,095	-814	-68	-5,432
11	349	549	13,455	1,031	-1,765	-14,254	-854	-68	-1,558
12	335	556	13,751	1,029	-1,752	-13,795	-818	-74	-766
13	409	553	10,162	1,035	-1,558	-14,136	-810	-76	-4,421
14	431	558	13,533	1,002	-1,539	-13,690	-835	-75	-616
15	463	549	14,876	941	-1,594	-14,528	-896	-81	-272
16	397	556	19,804	922	-1,872	-14,141	-999	-84	4,585
17	370	549	12,678	951	-1,721	-14,257	-930	-87	-2,447
18	361	554	18,568	928	-1,896	-14,037	-1,072	-92	3,313
19	314	553	14,531	943	-1,905	-14,084	-1,011	-96	-755
20	327	556	13,363	979	-1,836	-14,047	-1,006	-99	-1,763
21	432	548	9,310	1,031	-1,520	-14,385	-957	-93	-5,634
22	346	554	22,751	945	-2,056	-14,103	-1,193	-94	7,150
23	253	556	19,036	945	-2,299	-13,777	-1,125	-101	3,489
24	273	549	13,397	1,010	-1,985	-14,045	-1,047	-105	-1,952
25	380	549	8,479	1,057	-1,608	-14,338	-1,000	-107	-6,589
26	544	550	8,071	1,071	-1,343	-14,201	-955	-96	-6,359
27	522	552	18,354	997	-1,550	-14,106	-1,060	-96	3,614
28	469	549	14,398	961	-1,589	-14,381	-1,014	-104	-710
29	463	553	15,609	964	-1,574	-14,025	-1,014	-108	869
30	529	550	11,960	980	-1,435	-14,335	-979	-112	-2,841
31	425	556	20,974	959	-1,778	-13,604	-1,117	-115	6,301
32	291	556	24,922	933	-2,327	-13,939	-1,246	-117	9,072
33	258	545	15,668	938	-2,315	-14,773	-1,183	-120	-982
34	293	554	12,389	1,038	-1,949	-14,175	-1,097	-124	-3,068
35	302	553	18,045	1,014	-2,046	-14,037	-1,207	-127	2,496
36	337	545	11,034	1,035	-1,844	-14,629	-1,094	-128	-4,745
37	426	545	9,932	1,067	-1,557	-14,409	-1,035	-120	-5,151
38	495	554	10,605	1,058	-1,474	-13,994	-1,017	-113	-3,885
39	613	549	7,905	1,058	-1,333	-14,494	-948	-105	-6,755
40	729	556	9,935	1,037	-1,255	-14,213	-936	-99	-4,245
41	757	549	12,714	1,001	-1,297	-14,456	-963	-98	-1,793
42	949	550	7,618	974	-1,204	-14,576	-915	-95	-6,699
43	1,123	549	7,975	988	-1,115	-14,201	-872	-86	-5,640
44	957	552	18,357	943	-1,250	-14,180	-1,006	-85	4,287
45	806	545	16,490	891	-1,369	-14,746	-1,069	-93	1,457
46	637	556	18,714	904	-1,572	-13,786	-1,113	-96	4,243
47	508	545	19,422	938	-1,734	-14,055	-1,184	-99	4,340
Average (afy)	**403**	**551**	**14,034**	**940**	**-1,982**	**-14,189**	**-946**	**-93**	**-1,282**
Maximum (afy)	**1,123**	**558**	**24,922**	**1,105**	**-1,115**	**-13,604**	**-534**	**-68**	**9,072**
Minimum (afy)	**5**	**545**	**7,618**	**485**	**-4,731**	**-14,773**	**-1,246**	**-128**	**-6,755**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.

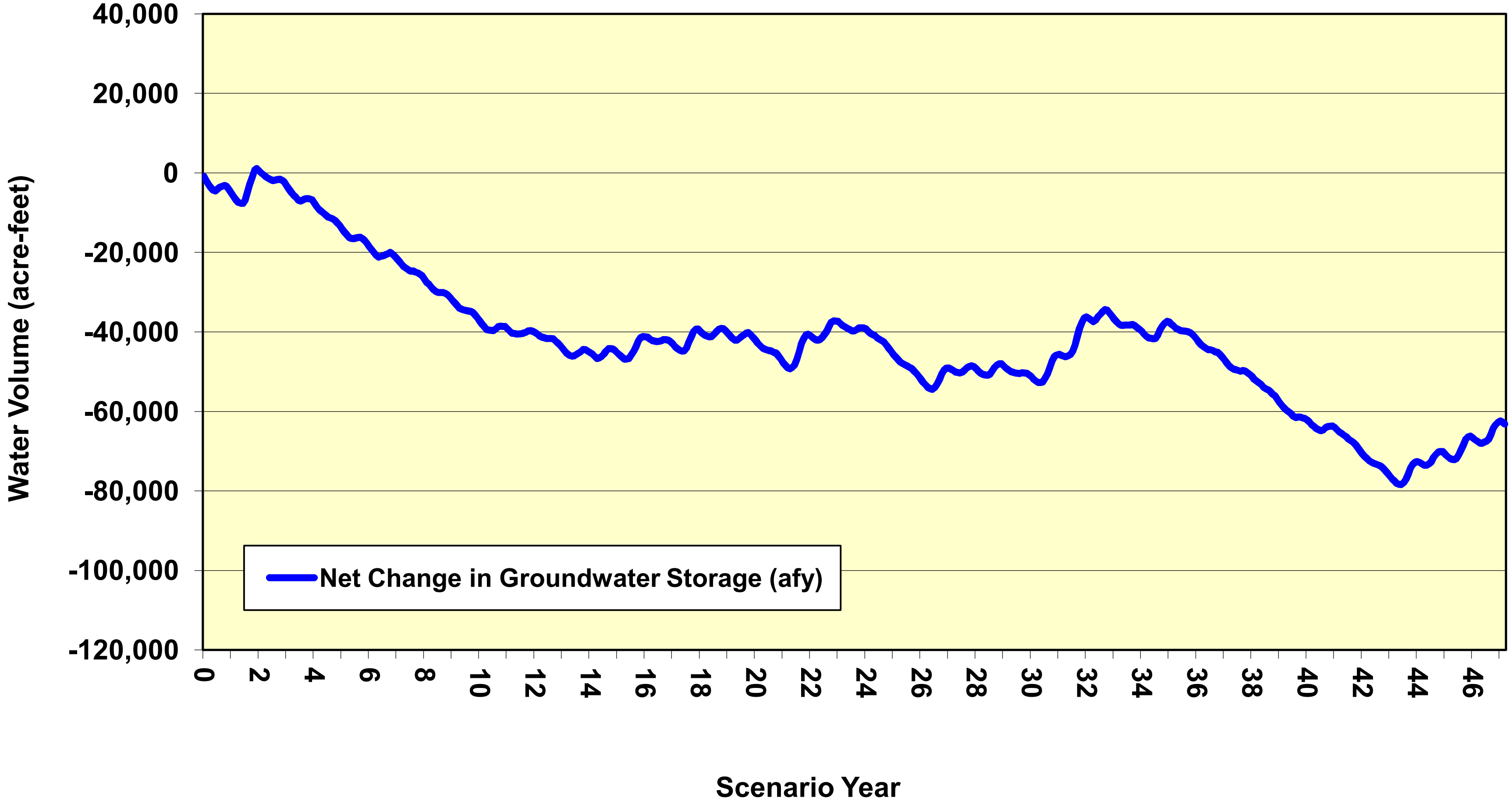


Note: Volume of some water balance components may be too small to be visible.



Scenario 3a
Westside Groundwater Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
Change in Groundwater Storage (afy)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year

Scenario 3a
Westside Groundwater Basin Net Change in Groundwater Storage

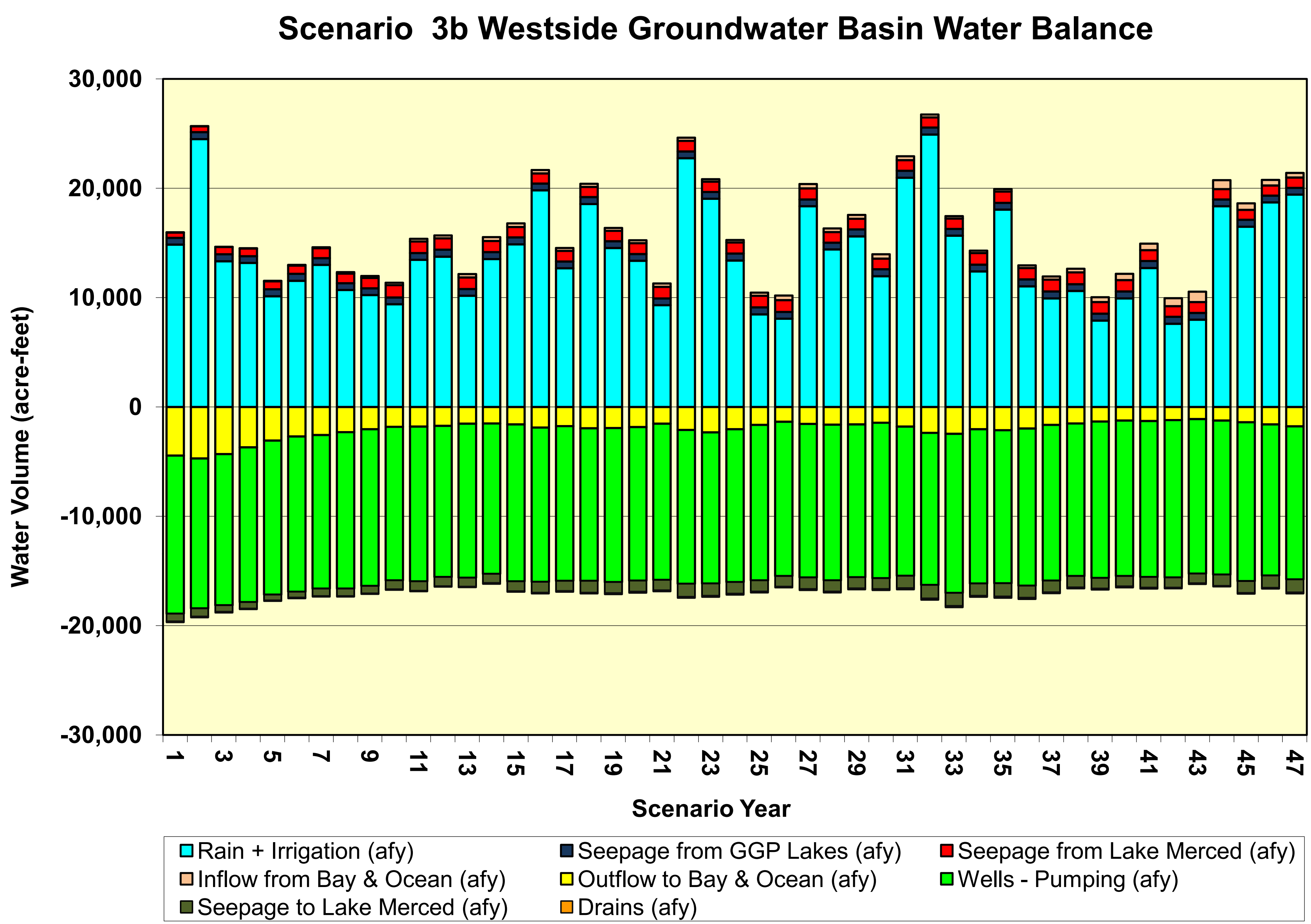


Scenario 3b Westside Groundwater Basin Water Balance Summary

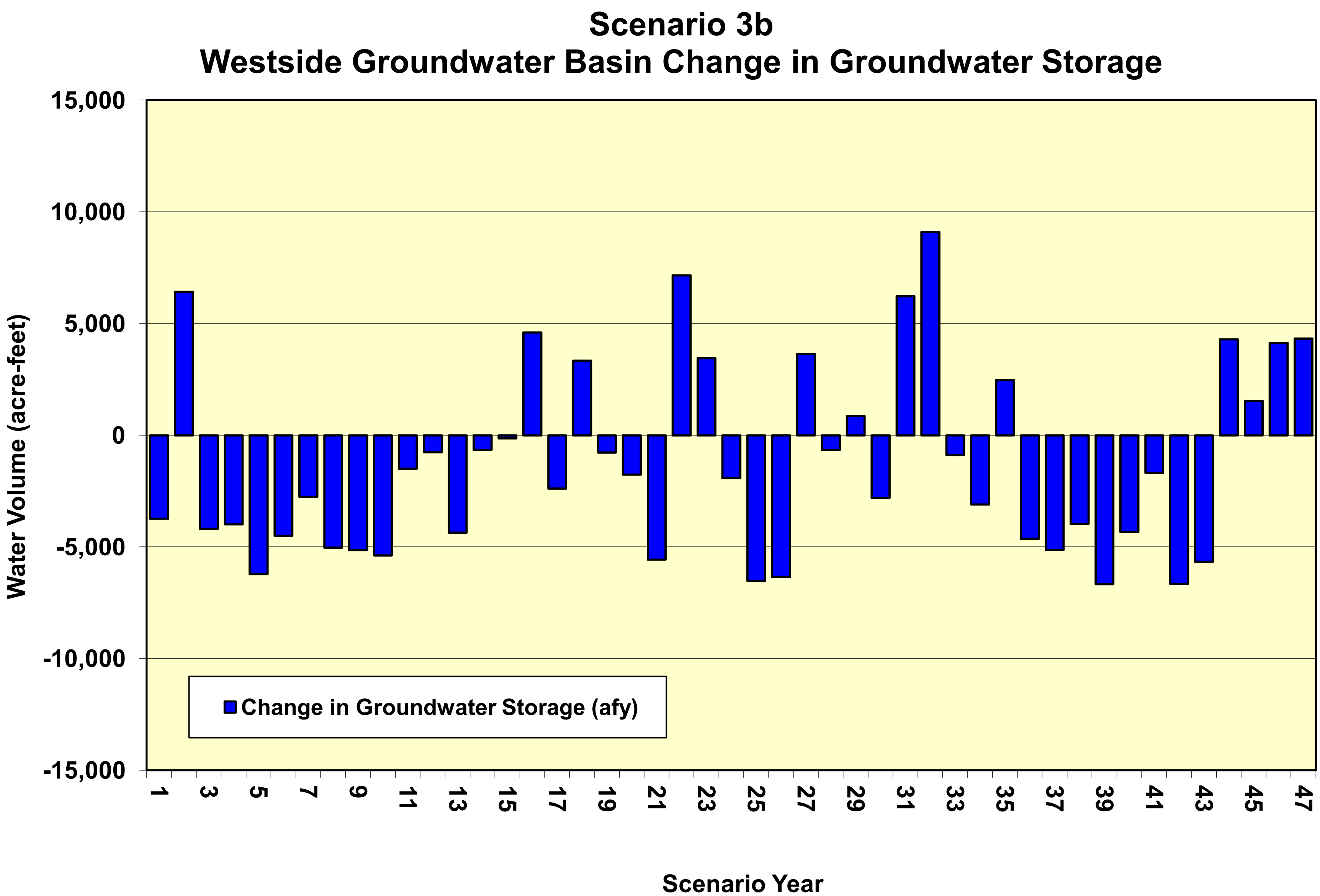
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	5	626	14,845	485	-4,455	-14,452	-713	-71	-3,730
2	6	628	24,505	532	-4,703	-13,711	-761	-72	6,423
3	9	626	13,329	664	-4,316	-13,809	-609	-73	-4,179
4	22	626	13,169	705	-3,687	-14,160	-591	-74	-3,990
5	44	626	10,129	747	-3,082	-14,074	-531	-74	-6,216
6	74	628	11,546	757	-2,702	-14,191	-541	-73	-4,502
7	101	626	12,988	896	-2,569	-14,034	-694	-72	-2,758
8	133	626	10,691	890	-2,312	-14,298	-684	-72	-5,025
9	175	626	10,235	951	-2,040	-14,332	-681	-70	-5,136
10	221	628	9,386	1,116	-1,817	-14,032	-818	-68	-5,385
11	255	626	13,455	1,045	-1,791	-14,149	-863	-68	-1,491
12	266	626	13,751	1,043	-1,737	-13,815	-827	-74	-766
13	314	626	10,162	1,048	-1,540	-14,073	-820	-76	-4,359
14	357	628	13,533	1,015	-1,509	-13,752	-846	-75	-649
15	342	626	14,876	953	-1,601	-14,340	-906	-81	-132
16	309	626	19,804	933	-1,893	-14,088	-1,008	-84	4,600
17	278	626	12,678	964	-1,756	-14,143	-940	-88	-2,380
18	278	628	18,568	939	-1,940	-13,957	-1,082	-92	3,342
19	253	626	14,531	955	-1,937	-14,078	-1,022	-96	-767
20	261	626	13,363	992	-1,840	-14,048	-1,017	-99	-1,763
21	315	626	9,310	1,044	-1,538	-14,266	-968	-93	-5,571
22	284	628	22,751	955	-2,099	-14,063	-1,203	-94	7,158
23	217	626	19,036	955	-2,329	-13,813	-1,135	-101	3,456
24	219	626	13,397	1,022	-2,045	-13,972	-1,058	-105	-1,915
25	277	626	8,479	1,069	-1,639	-14,218	-1,011	-107	-6,524
26	405	628	8,071	1,083	-1,350	-14,119	-966	-96	-6,345
27	409	626	18,354	1,008	-1,560	-14,032	-1,071	-96	3,638
28	342	626	14,398	971	-1,615	-14,241	-1,024	-104	-647
29	349	626	15,609	975	-1,590	-13,978	-1,024	-108	858
30	384	628	11,960	991	-1,453	-14,214	-990	-112	-2,806
31	350	626	20,974	969	-1,791	-13,655	-1,128	-115	6,231
32	252	626	24,922	943	-2,362	-13,905	-1,257	-117	9,102
33	200	626	15,668	949	-2,462	-14,544	-1,194	-120	-877
34	224	628	12,389	1,051	-2,035	-14,120	-1,108	-124	-3,095
35	238	626	18,045	1,025	-2,132	-13,984	-1,218	-127	2,473
36	240	626	11,034	1,047	-1,962	-14,388	-1,106	-128	-4,636
37	292	626	9,932	1,079	-1,641	-14,249	-1,047	-120	-5,127
38	347	628	10,605	1,069	-1,514	-13,955	-1,028	-113	-3,960
39	446	626	7,905	1,070	-1,341	-14,307	-960	-105	-6,666
40	572	626	9,935	1,048	-1,253	-14,212	-947	-99	-4,329
41	582	626	12,714	1,011	-1,298	-14,251	-974	-98	-1,688
42	723	628	7,618	984	-1,207	-14,383	-926	-95	-6,657
43	937	626	7,975	1,000	-1,114	-14,119	-883	-86	-5,665
44	803	626	18,357	954	-1,247	-14,091	-1,019	-86	4,297
45	610	626	16,490	901	-1,391	-14,525	-1,080	-93	1,539
46	508	626	18,714	914	-1,587	-13,825	-1,125	-96	4,130
47	416	618	19,422	949	-1,765	-14,011	-1,196	-99	4,333
Average (afy)	**312**	**626**	**14,034**	**950**	**-2,012**	**-14,106**	**-949**	**-93**	**-1,237**
Maximum (afy)	**937**	**628**	**24,922**	**1,116**	**-1,114**	**-13,655**	**-531**	**-68**	**9,102**
Minimum (afy)	**5**	**618**	**7,618**	**485**	**-4,703**	**-14,544**	**-1,257**	**-128**	**-6,666**

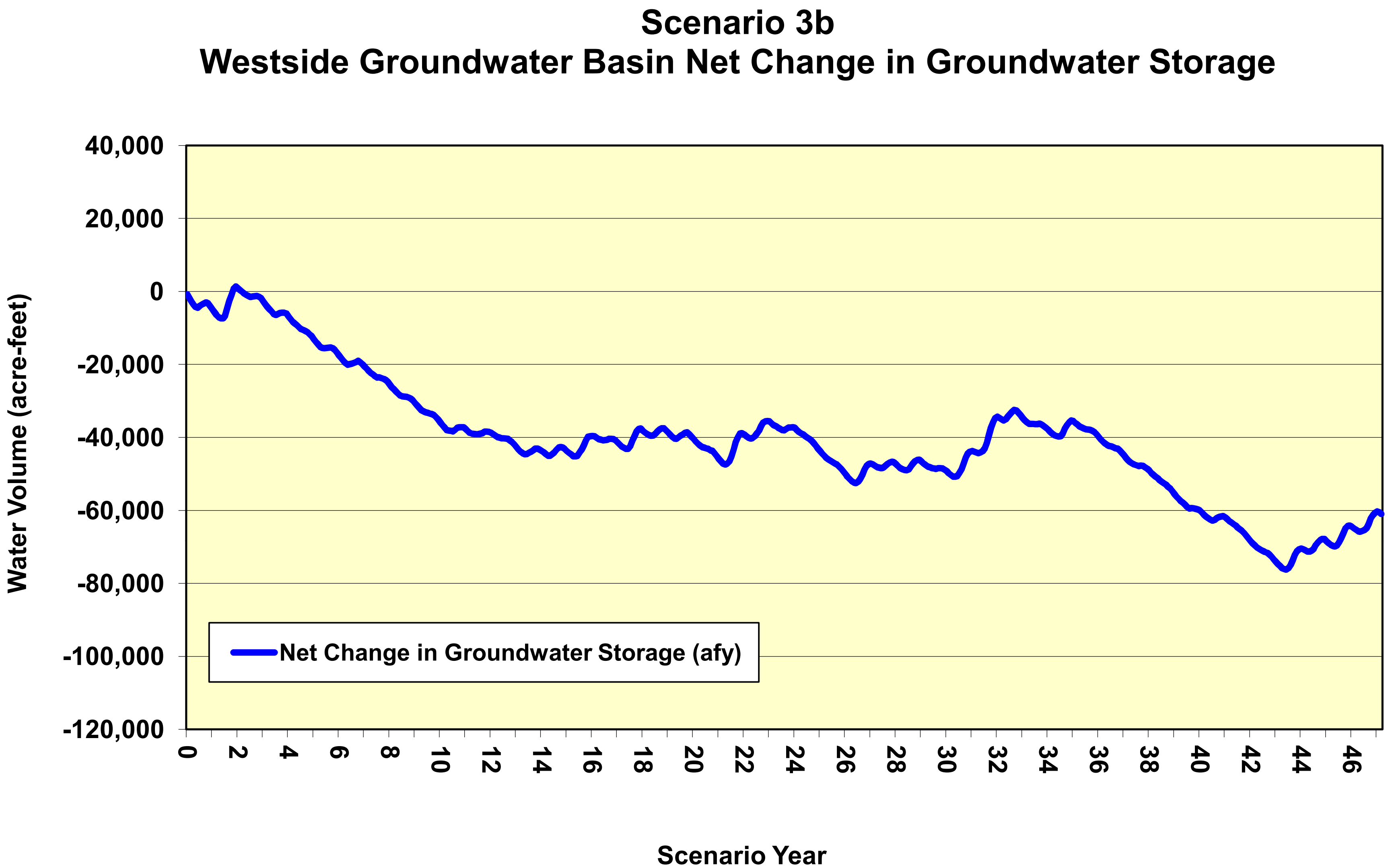
Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Note: Volume of some water balance components may be too small to be visible.


Scenario 3b
Westside Groundwater Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
Change in Groundwater Storage (afy)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year



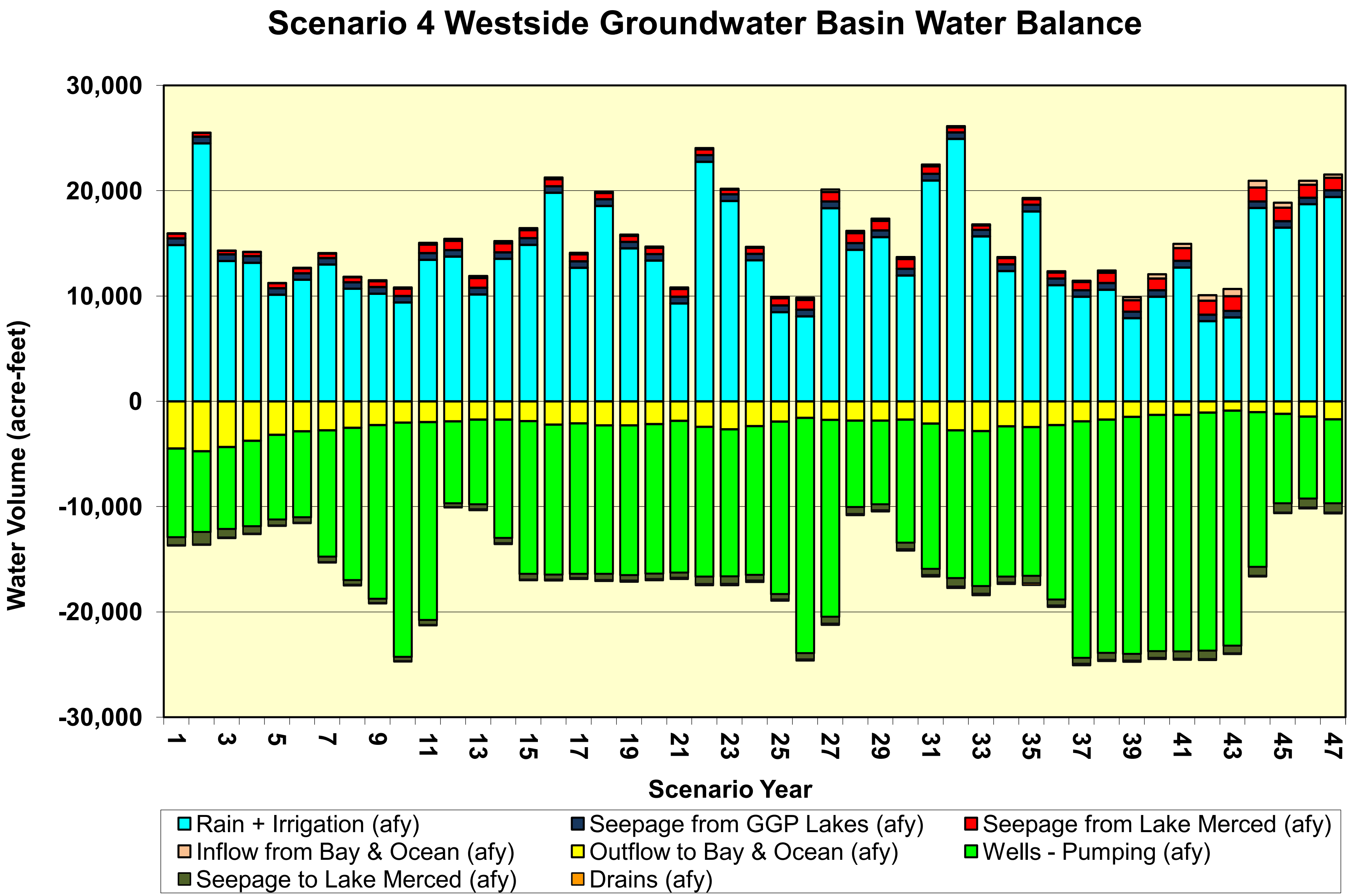
Scenario 3b
Westside Groundwater Basin Net Change in Groundwater Storage
40,000
20,000
0
-20,000
-40,000
-60,000
-80,000
-100,000
-120,000
Water Volume (acre-feet)
Net Change in Groundwater Storage (afy)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
Scenario Year

Scenario 4 Westside Groundwater Basin Water Balance Summary

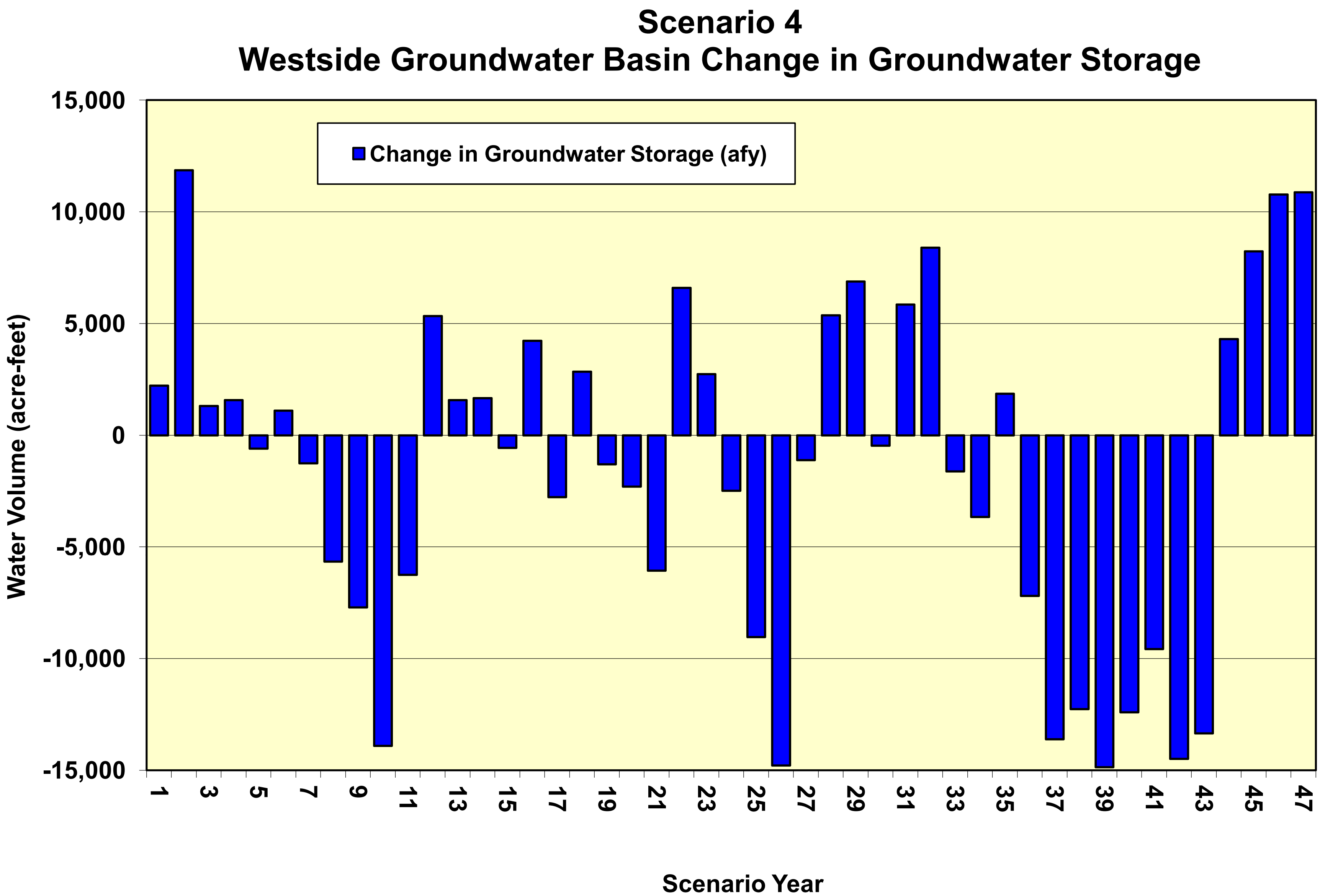
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	5	626	14,845	460	-4,466	-8,435	-737	-71	2,226
2	5	628	24,505	363	-4,735	-7,671	-1,156	-72	11,867
3	5	626	13,329	336	-4,339	-7,771	-803	-74	1,309
4	9	626	13,169	394	-3,732	-8,135	-676	-75	1,579
5	17	626	10,129	460	-3,166	-8,046	-543	-77	-600
6	31	628	11,546	471	-2,834	-8,167	-495	-77	1,103
7	41	626	12,988	422	-2,750	-12,007	-492	-78	-1,250
8	57	626	10,691	465	-2,513	-14,458	-440	-81	-5,653
9	85	626	10,235	558	-2,243	-16,509	-374	-84	-7,707
10	122	628	9,386	687	-2,009	-22,245	-384	-85	-13,901
11	170	626	13,455	797	-1,957	-18,815	-433	-87	-6,245
12	191	626	13,751	870	-1,899	-7,778	-325	-94	5,341
13	204	626	10,162	921	-1,728	-8,045	-462	-98	1,579
14	213	628	13,533	846	-1,740	-11,230	-485	-99	1,666
15	190	626	14,876	752	-1,878	-14,502	-517	-110	-565
16	166	626	19,804	665	-2,203	-14,243	-468	-117	4,230
17	139	626	12,678	666	-2,085	-14,299	-375	-125	-2,774
18	138	628	18,568	584	-2,278	-14,107	-559	-131	2,842
19	117	626	14,531	567	-2,274	-14,232	-500	-137	-1,303
20	118	626	13,363	594	-2,166	-14,202	-488	-142	-2,297
21	151	626	9,310	731	-1,836	-14,427	-477	-135	-6,057
22	136	628	22,751	546	-2,417	-14,217	-693	-136	6,597
23	91	626	19,036	444	-2,653	-13,958	-703	-145	2,738
24	90	626	13,397	555	-2,345	-14,123	-537	-150	-2,486
25	124	626	8,479	686	-1,907	-16,392	-491	-152	-9,029
26	213	628	8,071	936	-1,563	-22,336	-584	-140	-14,778
27	247	626	18,354	900	-1,758	-18,694	-647	-138	-1,110
28	216	626	14,398	955	-1,819	-8,218	-646	-146	5,366
29	200	626	15,609	914	-1,823	-7,947	-543	-150	6,886
30	195	628	11,960	919	-1,719	-11,707	-589	-154	-467
31	170	626	20,974	721	-2,117	-13,794	-567	-158	5,854
32	111	626	24,922	475	-2,736	-14,052	-783	-162	8,400
33	79	626	15,668	428	-2,826	-14,713	-713	-167	-1,618
34	90	628	12,389	591	-2,365	-14,276	-547	-171	-3,661
35	99	626	18,045	537	-2,447	-14,135	-685	-176	1,864
36	100	626	11,034	588	-2,258	-16,566	-536	-177	-7,188
37	137	626	9,932	773	-1,898	-22,469	-541	-164	-13,603
38	197	628	10,605	988	-1,719	-22,165	-641	-153	-12,261
39	277	626	7,905	1,082	-1,457	-22,529	-614	-141	-14,852
40	386	626	9,935	1,119	-1,280	-22,433	-622	-131	-12,399
41	415	626	12,714	1,216	-1,278	-22,470	-669	-128	-9,573
42	511	628	7,618	1,320	-1,075	-22,607	-761	-121	-14,486
43	681	626	7,975	1,390	-866	-22,321	-718	-108	-13,342
44	629	626	18,357	1,334	-1,018	-14,704	-814	-103	4,307
45	479	626	16,490	1,277	-1,188	-8,494	-844	-107	8,239
46	384	626	18,714	1,228	-1,445	-7,789	-831	-107	10,780
47	300	618	19,422	1,190	-1,706	-7,982	-857	-107	10,878
Average (AFY)	**186**	**626**	**14,034**	**760**	**-2,181**	**-14,264**	**-603**	**-122**	**-1,565**
Maximum (AFY)	**681**	**628**	**24,922**	**1,390**	**-866**	**-7,671**	**-325**	**-71**	**11,867**
Minimum (AFY)	**5**	**618**	**7,618**	**336**	**-4,735**	**-22,607**	**-1,156**	**-177**	**-14,852**

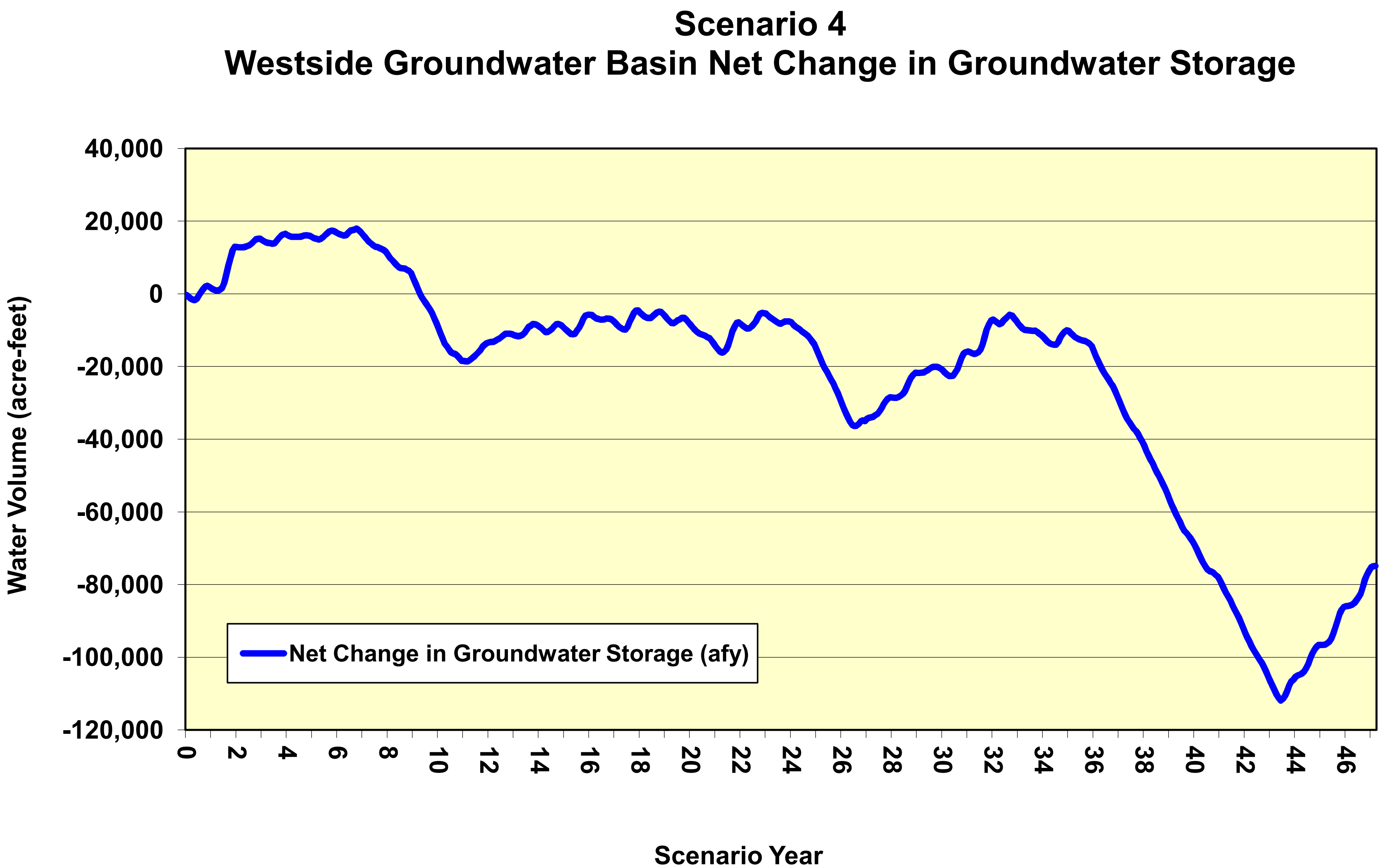
Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Note: Volume of some water balance components may be too small to be visible.


Scenario 4
Westside Groundwater Basin Change in Groundwater Storage
Change in Groundwater Storage (afy)
Water Volume (acre-feet)
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year


Scenario 4
Westside Groundwater Basin Net Change in Groundwater Storage
40,000
20,000
0
-20,000
-40,000
-60,000
-80,000
-100,000
-120,000
Water Volume (acre-feet)
Net Change in Groundwater Storage (afy)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
Scenario Year

Attachment 10.1-D

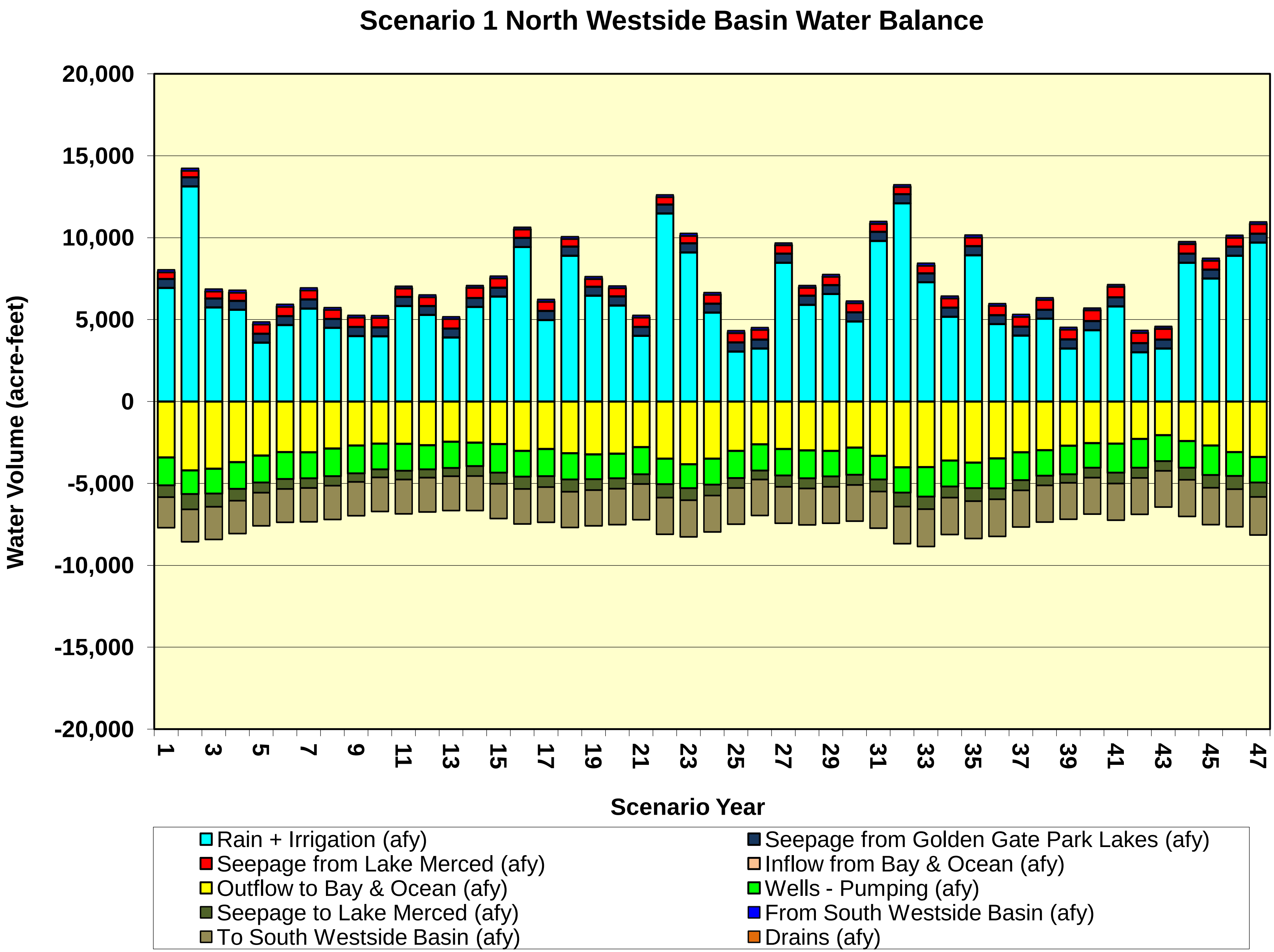
Model Scenario Water Balance Results – North and South Westside Basins

Scenario 1 North Westside Basin Water Balance Summary

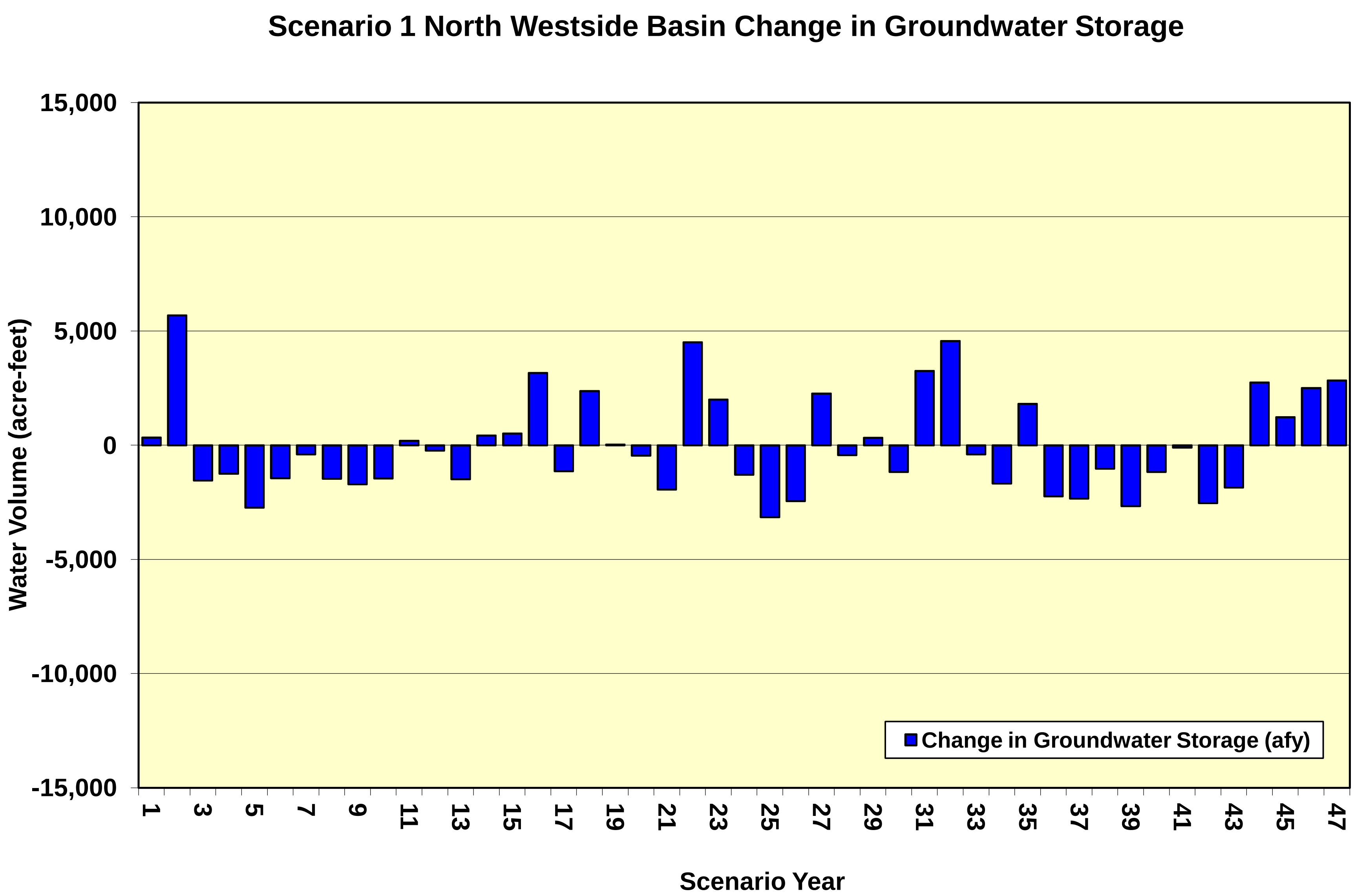
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From South to North Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From North to South Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	2	546	6,941	421	134	-3,406	-1,716	-711	-1,870	0	341
2	2	558	13,135	406	138	-4,193	-1,457	-933	-1,972	0	5,684
3	2	552	5,749	425	146	-4,100	-1,523	-800	-1,986	0	-1,535
4	2	549	5,610	499	142	-3,703	-1,635	-707	-2,004	0	-1,248
5	2	549	3,598	572	138	-3,291	-1,648	-625	-2,022	0	-2,726
6	2	551	4,673	572	134	-3,079	-1,649	-601	-2,041	0	-1,438
7	2	552	5,687	562	132	-3,103	-1,586	-582	-2,065	0	-401
8	3	545	4,503	557	131	-2,862	-1,703	-562	-2,071	0	-1,459
9	3	549	4,009	573	129	-2,682	-1,709	-509	-2,067	0	-1,703
10	3	554	3,982	587	126	-2,558	-1,590	-479	-2,075	0	-1,450
11	4	549	5,843	524	124	-2,580	-1,651	-527	-2,093	0	195
12	4	556	5,286	540	124	-2,661	-1,486	-492	-2,099	0	-228
13	5	553	3,915	580	124	-2,457	-1,597	-506	-2,095	0	-1,479
14	7	558	5,773	626	123	-2,505	-1,431	-608	-2,111	0	432
15	8	549	6,407	574	123	-2,587	-1,760	-675	-2,117	0	521
16	8	556	9,441	518	125	-3,009	-1,578	-739	-2,149	0	3,172
17	5	549	4,984	569	129	-2,893	-1,663	-666	-2,144	0	-1,131
18	5	554	8,904	478	127	-3,153	-1,604	-754	-2,178	0	2,380
19	4	553	6,466	472	130	-3,227	-1,522	-648	-2,190	0	38
20	4	556	5,871	501	130	-3,178	-1,513	-629	-2,194	0	-453
21	4	548	4,017	570	128	-2,779	-1,663	-584	-2,182	0	-1,940
22	4	554	11,482	454	126	-3,486	-1,564	-820	-2,237	0	4,513
23	3	556	9,106	464	133	-3,821	-1,465	-733	-2,244	0	2,000
24	3	549	5,433	540	135	-3,483	-1,595	-650	-2,225	0	-1,291
25	3	549	3,062	582	131	-3,010	-1,669	-590	-2,207	0	-3,149
26	4	550	3,238	600	126	-2,610	-1,603	-548	-2,197	0	-2,440
27	5	552	8,480	526	124	-2,899	-1,621	-681	-2,224	0	2,263
28	5	549	5,916	493	127	-2,986	-1,697	-615	-2,222	0	-429
29	5	553	6,566	505	128	-3,004	-1,571	-625	-2,227	0	330
30	5	550	4,895	557	128	-2,805	-1,671	-615	-2,212	0	-1,167
31	5	556	9,806	499	127	-3,311	-1,443	-739	-2,240	0	3,259
32	3	556	12,107	443	133	-4,011	-1,556	-836	-2,269	0	4,570
33	3	545	7,280	475	139	-3,996	-1,811	-761	-2,274	0	-400
34	3	554	5,178	572	138	-3,604	-1,582	-671	-2,255	0	-1,667
35	3	553	8,941	532	135	-3,733	-1,561	-779	-2,279	0	1,811
36	3	545	4,727	575	136	-3,463	-1,838	-662	-2,260	0	-2,236
37	3	545	4,032	604	132	-3,095	-1,711	-606	-2,242	0	-2,337
38	3	554	5,061	591	128	-2,967	-1,564	-586	-2,241	0	-1,022
39	4	549	3,248	605	126	-2,695	-1,744	-525	-2,225	0	-2,656
40	6	556	4,359	666	122	-2,529	-1,513	-599	-2,229	0	-1,160
41	8	549	5,814	652	122	-2,563	-1,779	-663	-2,234	0	-95
42	12	550	3,017	643	121	-2,280	-1,762	-615	-2,217	0	-2,531
43	17	549	3,238	665	118	-2,045	-1,603	-580	-2,210	0	-1,850
44	19	552	8,481	593	117	-2,403	-1,640	-726	-2,243	0	2,750
45	16	545	7,522	541	122	-2,677	-1,804	-774	-2,261	0	1,230
46	13	556	8,902	557	125	-3,081	-1,459	-812	-2,290	0	2,512
47	8	545	9,712	582	129	-3,384	-1,565	-875	-2,313	0	2,840
Average (afy)	**5**	**551**	**6,264**	**546**	**129**	**-3,063**	**-1,619**	**-660**	**-2,170**	**0**	**-17**
Maximum (afy)	**19**	**558**	**13,135**	**666**	**146**	**-2,045**	**-1,431**	**-479**	**-1,870**	**0**	**5,684**
Minimum (afy)	**2**	**545**	**3,017**	**406**	**117**	**-4,193**	**-1,838**	**-933**	**-2,313**	**0**	**-3,149**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Scenario 1 North Westside Basin Water Balance
Water Volume (acre-feet)
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Rain + Irrigation (afy)
Seepage from Golden Gate Park Lakes (afy)
Seepage from Lake Merced (afy)
Inflow from Bay & Ocean (afy)
Outflow to Bay & Ocean (afy)
Wells - Pumping (afy)
Seepage to Lake Merced (afy)
From South Westside Basin (afy)
To South Westside Basin (afy)
Drains (afy)



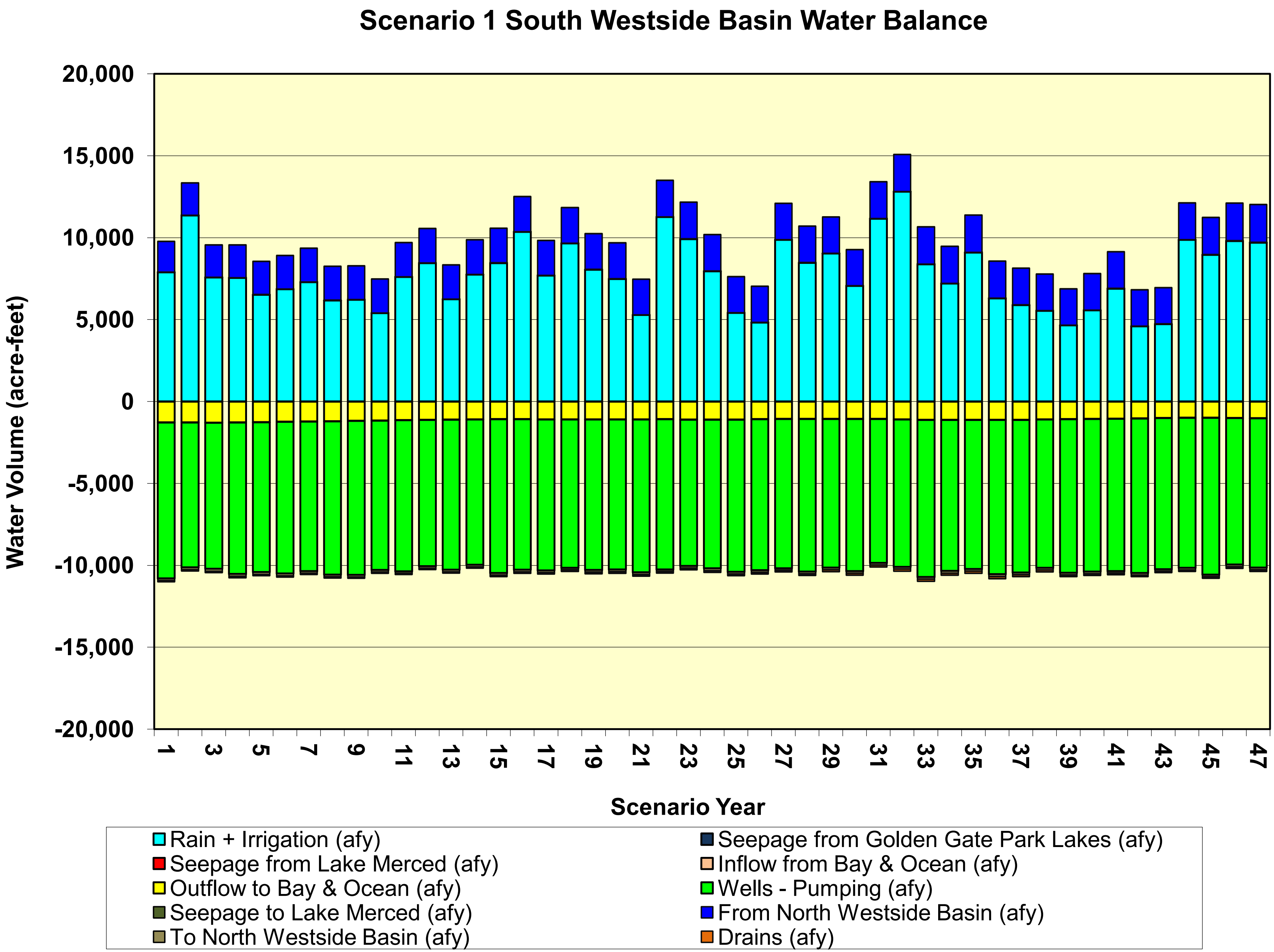
Scenario 1 North Westside Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Change in Groundwater Storage (afy)

Scenario 1 South Westside Basin Water Balance Summary

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From North to South Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From South to North Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	3	0	7,904	0	1,870	-1,276	-9,513	0	-134	-71	-1,217
2	3	0	11,370	0	1,972	-1,278	-8,842	0	-138	-72	3,014
3	3	0	7,580	0	1,986	-1,291	-8,922	0	-146	-73	-862
4	3	0	7,559	0	2,004	-1,277	-9,252	0	-142	-74	-1,180
5	3	0	6,531	0	2,022	-1,257	-9,157	0	-138	-74	-2,071
6	3	0	6,873	0	2,041	-1,233	-9,268	0	-134	-73	-1,791
7	3	0	7,302	0	2,065	-1,215	-9,131	0	-132	-72	-1,180
8	3	0	6,188	0	2,071	-1,199	-9,362	0	-131	-71	-2,502
9	3	0	6,225	0	2,067	-1,178	-9,405	0	-129	-70	-2,486
10	3	0	5,405	0	2,075	-1,154	-9,130	0	-126	-68	-2,996
11	3	0	7,611	0	2,093	-1,133	-9,228	0	-124	-68	-847
12	3	0	8,465	0	2,099	-1,118	-8,934	0	-124	-74	317
13	3	0	6,247	0	2,095	-1,103	-9,164	0	-124	-76	-2,121
14	4	0	7,760	0	2,111	-1,086	-8,884	0	-123	-75	-294
15	4	0	8,469	0	2,117	-1,078	-9,394	0	-123	-81	-86
16	4	0	10,364	0	2,149	-1,079	-9,188	0	-125	-84	2,041
17	4	0	7,695	0	2,144	-1,085	-9,220	0	-129	-88	-679
18	5	0	9,663	0	2,178	-1,084	-9,059	0	-127	-92	1,483
19	5	0	8,066	0	2,190	-1,092	-9,188	0	-130	-96	-246
20	5	0	7,492	0	2,194	-1,091	-9,159	0	-130	-100	-789
21	5	0	5,293	0	2,182	-1,081	-9,348	0	-128	-93	-3,169
22	6	0	11,269	0	2,237	-1,080	-9,165	0	-126	-94	3,047
23	6	0	9,930	0	2,244	-1,100	-8,937	0	-133	-101	1,908
24	6	0	7,964	0	2,225	-1,107	-9,075	0	-135	-106	-228
25	6	0	5,416	0	2,207	-1,096	-9,294	0	-131	-107	-2,998
26	7	0	4,834	0	2,197	-1,076	-9,224	0	-126	-96	-3,484
27	7	0	9,875	0	2,224	-1,062	-9,111	0	-124	-96	1,713
28	8	0	8,482	0	2,222	-1,066	-9,310	0	-127	-105	104
29	8	0	9,043	0	2,227	-1,064	-9,078	0	-128	-109	898
30	8	0	7,065	0	2,212	-1,060	-9,290	0	-128	-112	-1,306
31	8	0	11,168	0	2,240	-1,060	-8,786	0	-127	-115	3,327
32	8	0	12,815	0	2,269	-1,086	-9,008	0	-133	-118	4,747
33	8	0	8,388	0	2,274	-1,119	-9,587	0	-139	-121	-296
34	8	0	7,212	0	2,255	-1,121	-9,218	0	-138	-125	-1,126
35	8	0	9,104	0	2,279	-1,118	-9,102	0	-135	-128	910
36	8	0	6,306	0	2,260	-1,122	-9,417	0	-136	-129	-2,230
37	8	0	5,900	0	2,242	-1,110	-9,324	0	-132	-121	-2,537
38	8	0	5,544	0	2,241	-1,094	-9,056	0	-128	-114	-2,598
39	8	0	4,657	0	2,225	-1,079	-9,375	0	-126	-106	-3,796
40	9	0	5,576	0	2,229	-1,059	-9,327	0	-122	-100	-2,794
41	9	0	6,900	0	2,234	-1,044	-9,302	0	-122	-100	-1,424
42	10	0	4,601	0	2,217	-1,030	-9,440	0	-121	-96	-3,859
43	11	0	4,737	0	2,210	-1,007	-9,224	0	-118	-87	-3,478
44	12	0	9,876	0	2,243	-990	-9,166	0	-117	-87	1,772
45	13	0	8,968	0	2,261	-994	-9,567	0	-122	-95	465
46	14	0	9,812	0	2,290	-1,002	-8,953	0	-125	-98	1,938
47	15	0	9,710	0	2,313	-1,013	-9,116	0	-129	-101	1,678
Average (afy)	**6**	**0**	**7,770**	**0**	**2,170**	**-1,110**	**-9,196**	**0**	**-129**	**-94**	**-581**
Maximum (afy)	**15**	**0**	**12,815**	**0**	**2,313**	**-990**	**-8,786**	**0**	**-117**	**-68**	**4,747**
Minimum (afy)	**3**	**0**	**4,601**	**0**	**1,870**	**-1,291**	**-9,587**	**0**	**-146**	**-129**	**-3,859**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.


Scenario 1 South Westside Basin Water Balance
Water Volume (acre-feet)
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
1
3
5
7
9
11
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23
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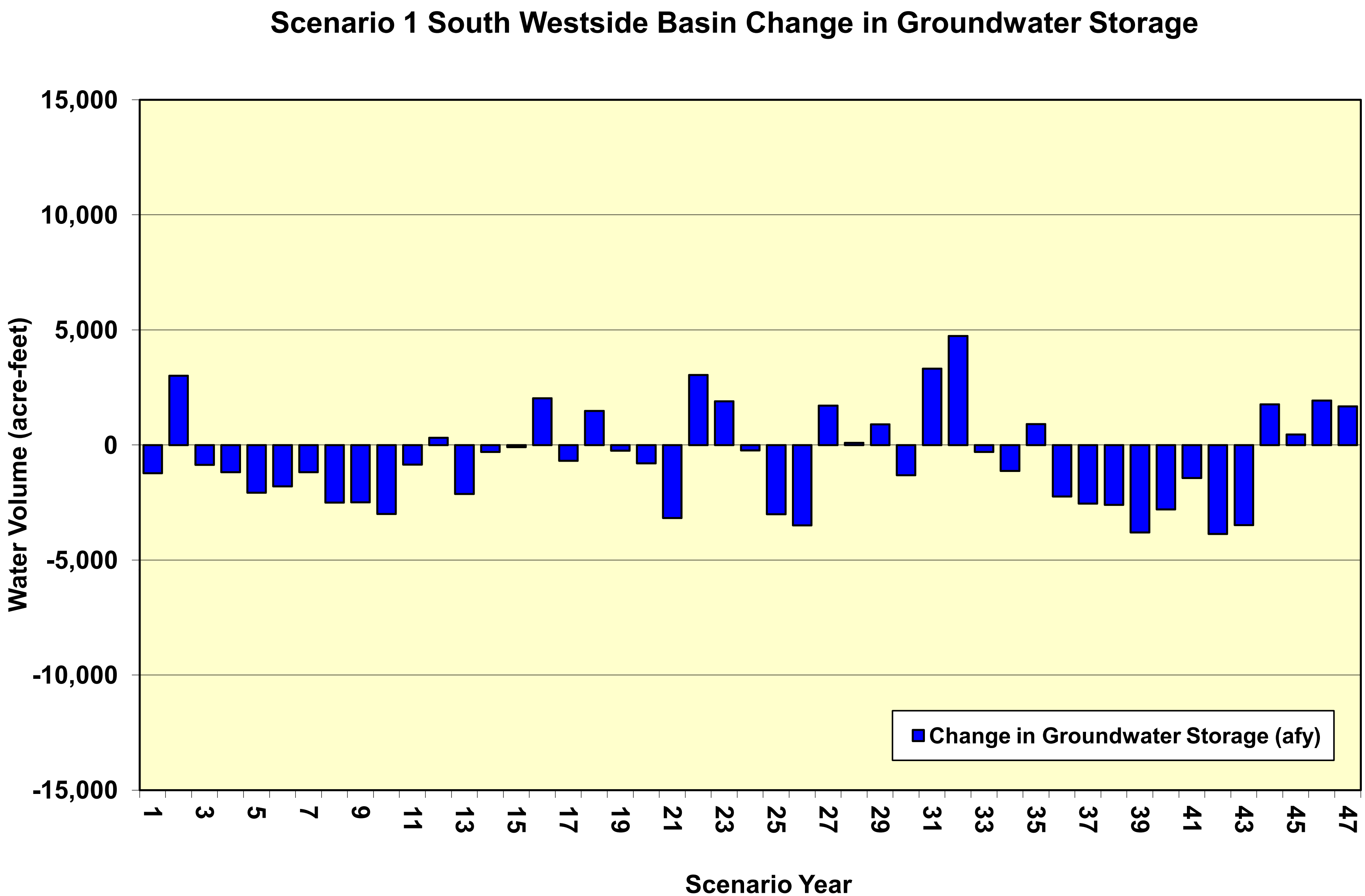
45
47
Scenario Year
Rain + Irrigation (afy)
Seepage from Golden Gate Park Lakes (afy)
Seepage from Lake Merced (afy)
Inflow from Bay & Ocean (afy)
Outflow to Bay & Ocean (afy)
Wells - Pumping (afy)
Seepage to Lake Merced (afy)
From North Westside Basin (afy)
To North Westside Basin (afy)
Drains (afy)



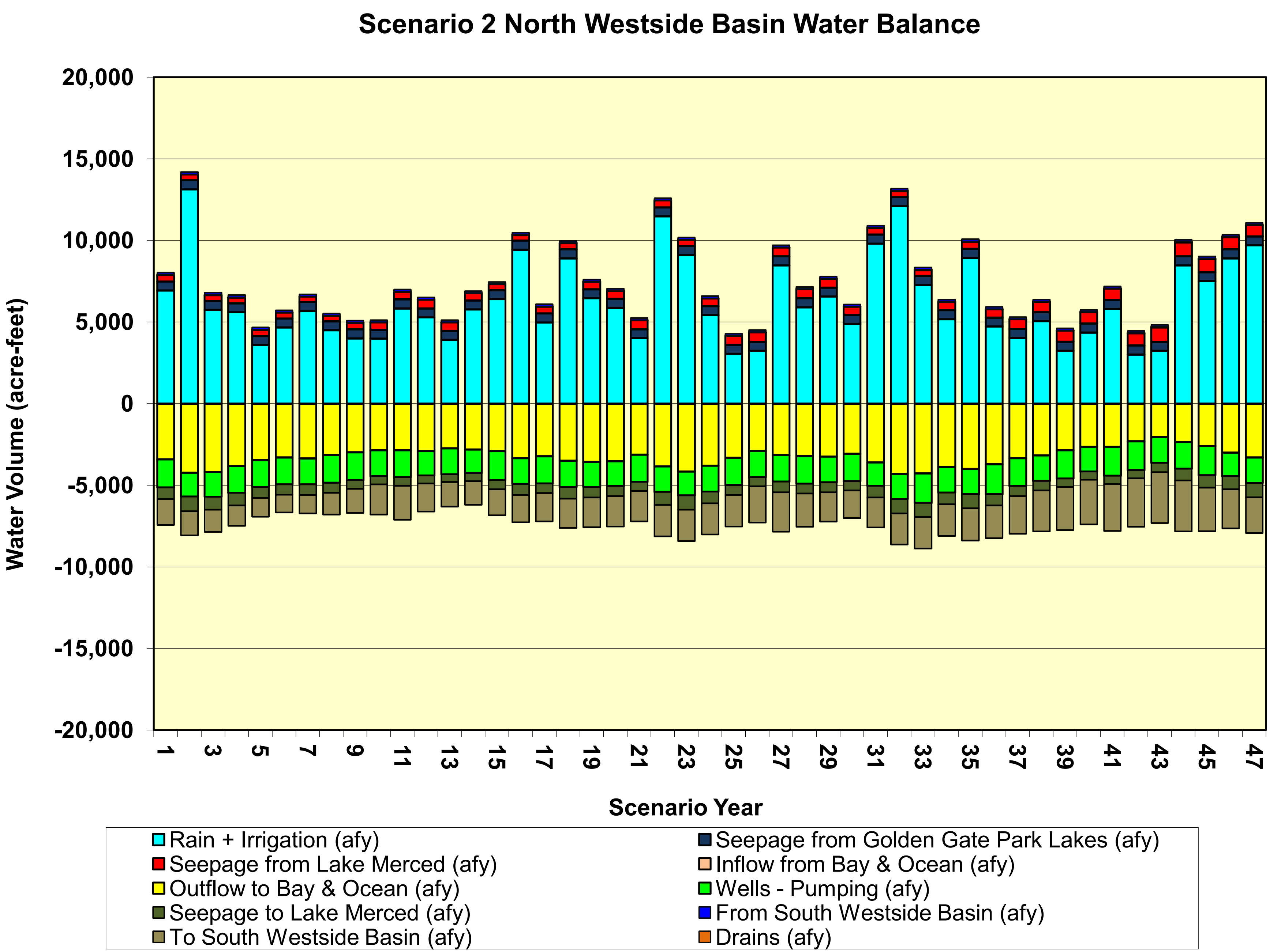
Scenario 1 South Westside Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Change in Groundwater Storage (afy)

Scenario 2 North Westside Basin Water Balance Summary

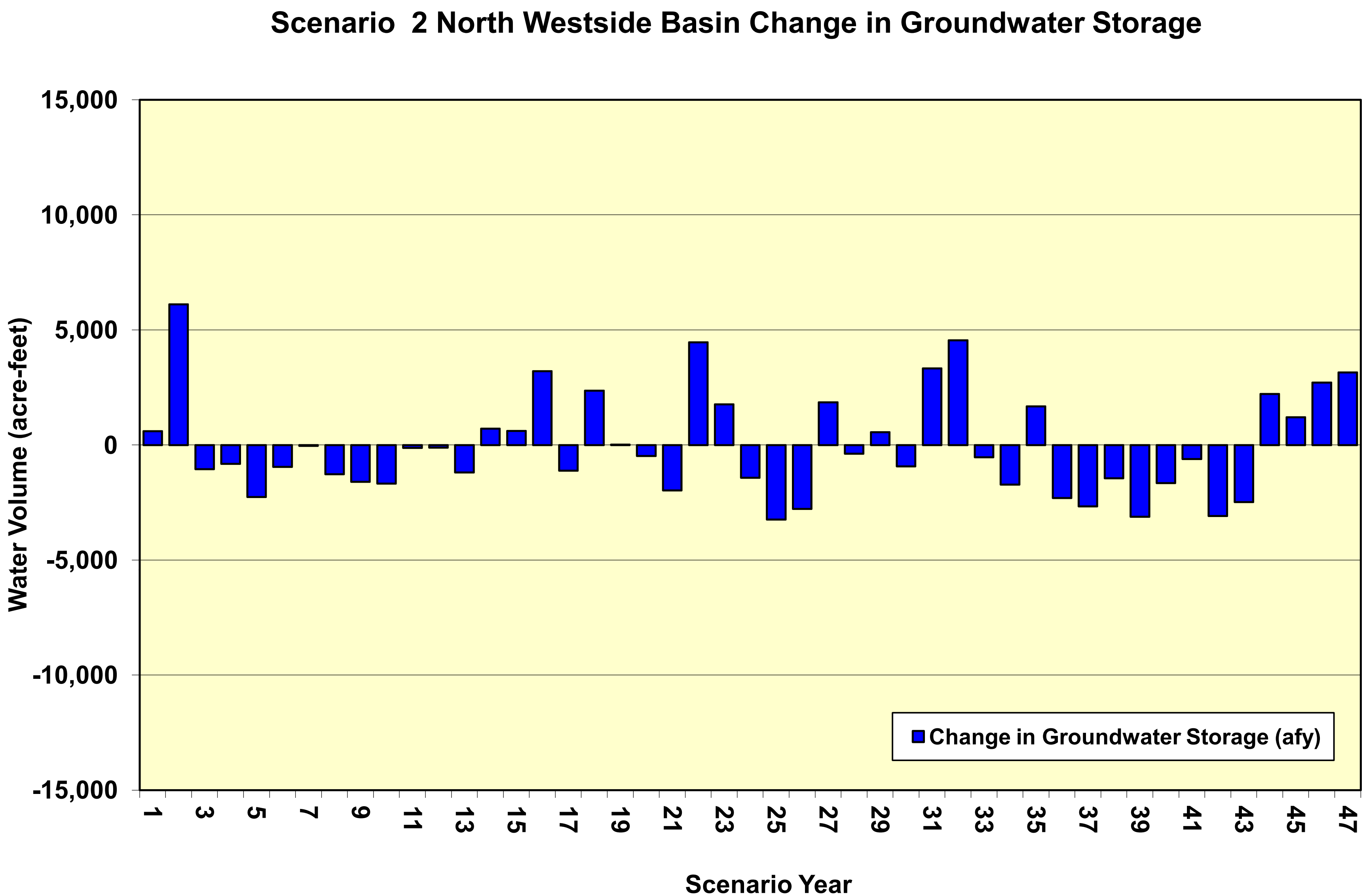
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From South to North Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From North to South Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	2	546	6,941	409	134	-3,414	-1,716	-713	-1,587	0	601
2	2	558	13,135	363	139	-4,234	-1,457	-897	-1,487	0	6,122
3	2	552	5,749	360	146	-4,188	-1,523	-789	-1,354	0	-1,044
4	2	549	5,610	358	143	-3,834	-1,635	-762	-1,248	0	-817
5	2	549	3,598	389	140	-3,458	-1,648	-666	-1,160	0	-2,253
6	2	551	4,673	368	136	-3,289	-1,649	-641	-1,093	0	-943
7	2	552	5,687	325	134	-3,356	-1,586	-655	-1,130	0	-28
8	2	545	4,503	344	134	-3,142	-1,703	-616	-1,329	0	-1,261
9	2	549	4,009	399	131	-2,974	-1,709	-542	-1,464	0	-1,598
10	2	554	3,982	461	129	-2,854	-1,590	-496	-1,856	0	-1,668
11	3	549	5,843	474	127	-2,850	-1,651	-536	-2,077	0	-118
12	3	556	5,286	534	126	-2,910	-1,486	-491	-1,723	0	-104
13	2	553	3,915	519	126	-2,730	-1,597	-474	-1,502	0	-1,189
14	2	558	5,773	448	124	-2,811	-1,431	-506	-1,445	0	713
15	2	549	6,407	371	125	-2,913	-1,760	-573	-1,587	0	620
16	2	556	9,441	352	127	-3,341	-1,578	-665	-1,683	0	3,211
17	2	549	4,984	425	131	-3,231	-1,663	-584	-1,725	0	-1,113
18	2	554	8,904	389	129	-3,496	-1,604	-717	-1,793	0	2,371
19	2	553	6,466	447	133	-3,575	-1,522	-649	-1,828	0	27
20	2	556	5,871	487	132	-3,527	-1,513	-627	-1,853	0	-472
21	2	548	4,017	549	130	-3,126	-1,663	-563	-1,859	0	-1,964
22	2	554	11,482	427	128	-3,834	-1,564	-803	-1,925	0	4,468
23	2	556	9,106	388	136	-4,160	-1,465	-869	-1,926	0	1,769
24	2	549	5,433	471	138	-3,798	-1,595	-712	-1,907	0	-1,419
25	2	549	3,062	547	133	-3,314	-1,669	-611	-1,928	0	-3,229
26	3	550	3,238	594	128	-2,900	-1,603	-553	-2,234	0	-2,776
27	4	552	8,480	544	125	-3,148	-1,621	-658	-2,415	0	1,864
28	4	549	5,916	564	129	-3,205	-1,697	-608	-2,028	0	-374
29	3	553	6,566	538	129	-3,239	-1,571	-618	-1,796	0	565
30	2	550	4,895	507	129	-3,067	-1,671	-583	-1,691	0	-928
31	2	556	9,806	426	128	-3,590	-1,443	-717	-1,836	0	3,331
32	2	556	12,107	383	134	-4,294	-1,556	-872	-1,910	0	4,550
33	2	545	7,280	380	140	-4,269	-1,811	-857	-1,935	0	-524
34	2	554	5,178	510	139	-3,869	-1,582	-706	-1,946	0	-1,720
35	2	553	8,941	447	136	-3,993	-1,561	-854	-1,982	0	1,689
36	2	545	4,727	525	137	-3,714	-1,838	-684	-2,002	0	-2,300
37	2	545	4,032	597	134	-3,334	-1,711	-617	-2,306	0	-2,657
38	4	554	5,061	635	129	-3,168	-1,564	-588	-2,501	0	-1,439
39	5	549	3,248	693	126	-2,849	-1,744	-517	-2,626	0	-3,113
40	10	556	4,359	700	122	-2,640	-1,513	-502	-2,744	0	-1,650
41	17	549	5,814	689	121	-2,631	-1,779	-526	-2,863	0	-609
42	29	550	3,017	748	120	-2,306	-1,762	-508	-2,969	0	-3,082
43	44	549	3,238	893	116	-2,030	-1,603	-565	-3,118	0	-2,477
44	53	552	8,481	853	114	-2,345	-1,640	-709	-3,136	0	2,223
45	46	545	7,522	794	118	-2,587	-1,804	-757	-2,663	0	1,214
46	30	556	8,902	750	121	-2,989	-1,459	-803	-2,390	0	2,718
47	15	545	9,712	693	125	-3,301	-1,565	-872	-2,191	0	3,161
Average (afy)	**7**	**551**	**6,264**	**512**	**130**	**-3,273**	**-1,619**	**-656**	**-1,952**	**0**	**-35**
Maximum (afy)	**53**	**558**	**13,135**	**893**	**146**	**-2,030**	**-1,431**	**-474**	**-1,093**	**0**	**6,122**
Minimum (afy)	**2**	**545**	**3,017**	**325**	**114**	**-4,294**	**-1,838**	**-897**	**-3,136**	**0**	**-3,229**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Scenario 2 North Westside Basin Water Balance
Water Volume (acre-feet)
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Rain + Irrigation (afy)
Seepage from Golden Gate Park Lakes (afy)
Seepage from Lake Merced (afy)
Inflow from Bay & Ocean (afy)
Outflow to Bay & Ocean (afy)
Wells - Pumping (afy)
Seepage to Lake Merced (afy)
From South Westside Basin (afy)
To South Westside Basin (afy)
Drains (afy)



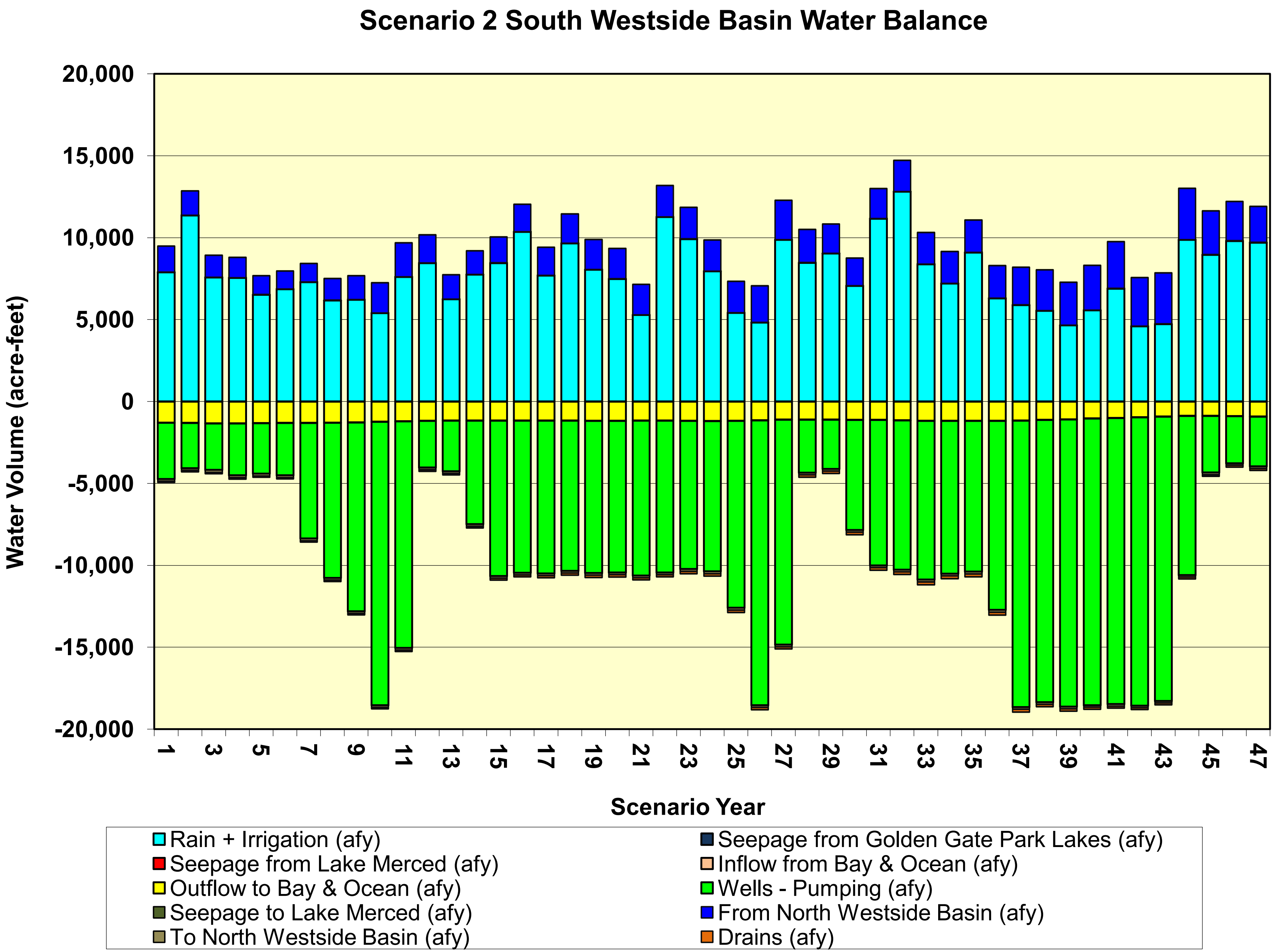
Scenario 2 North Westside Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Change in Groundwater Storage (afy)

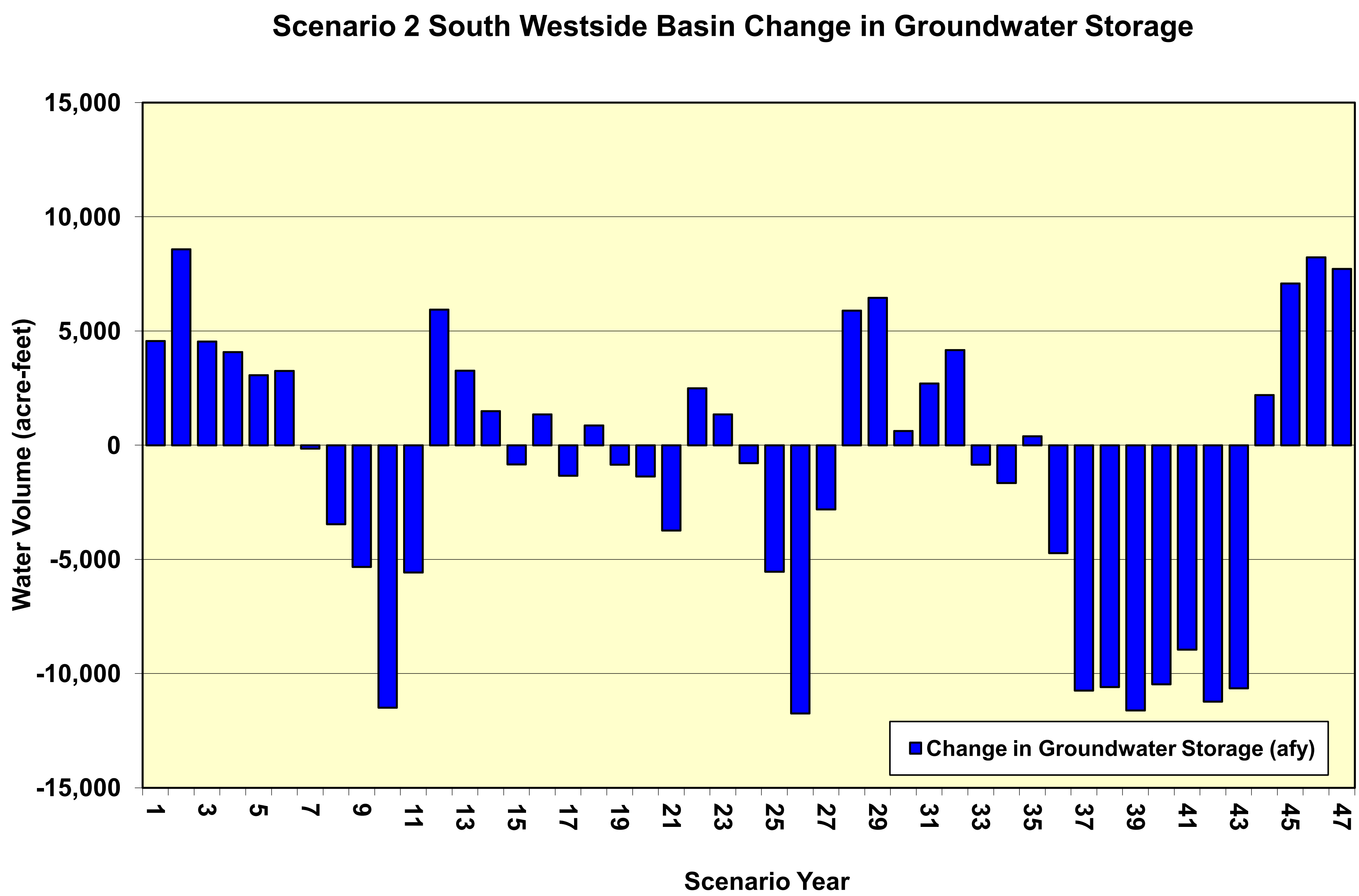
Scenario 2 South Westside Basin Water Balance Summary

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From North to South Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From South to North Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	3	0	7,904	0	1,587	-1,283	-3,441	0	-134	-71	4,566
2	3	0	11,370	0	1,487	-1,298	-2,770	0	-139	-72	8,581
3	3	0	7,580	0	1,354	-1,325	-2,850	0	-146	-74	4,542
4	3	0	7,559	0	1,248	-1,326	-3,180	0	-143	-75	4,085
5	3	0	6,531	0	1,160	-1,319	-3,085	0	-140	-77	3,073
6	3	0	6,873	0	1,093	-1,309	-3,196	0	-136	-77	3,251
7	3	0	7,302	0	1,130	-1,303	-7,061	0	-134	-78	-142
8	2	0	6,188	0	1,329	-1,291	-9,470	0	-134	-81	-3,456
9	2	0	6,225	0	1,464	-1,269	-11,528	0	-131	-84	-5,321
10	2	0	5,405	0	1,856	-1,237	-17,299	0	-129	-85	-11,488
11	2	0	7,611	0	2,077	-1,196	-13,847	0	-127	-87	-5,567
12	2	0	8,465	0	1,723	-1,170	-2,862	0	-126	-94	5,937
13	2	0	6,247	0	1,502	-1,163	-3,092	0	-126	-98	3,273
14	2	0	7,760	0	1,445	-1,159	-6,328	0	-124	-99	1,497
15	2	0	8,469	0	1,587	-1,157	-9,502	0	-125	-109	-836
16	2	0	10,364	0	1,683	-1,159	-9,296	0	-127	-117	1,350
17	2	0	7,695	0	1,725	-1,165	-9,328	0	-131	-124	-1,326
18	2	0	9,663	0	1,793	-1,164	-9,167	0	-129	-130	867
19	2	0	8,066	0	1,828	-1,172	-9,296	0	-133	-136	-842
20	2	0	7,492	0	1,853	-1,171	-9,267	0	-132	-141	-1,365
21	2	0	5,293	0	1,859	-1,161	-9,456	0	-130	-134	-3,727
22	2	0	11,269	0	1,925	-1,159	-9,273	0	-128	-135	2,500
23	2	0	9,930	0	1,926	-1,179	-9,045	0	-136	-144	1,354
24	2	0	7,964	0	1,907	-1,185	-9,183	0	-138	-149	-781
25	2	0	5,416	0	1,928	-1,173	-11,417	0	-133	-151	-5,528
26	2	0	4,834	0	2,234	-1,144	-17,393	0	-128	-139	-11,734
27	3	0	9,875	0	2,415	-1,109	-13,730	0	-125	-137	-2,809
28	3	0	8,482	0	2,028	-1,100	-3,238	0	-129	-145	5,901
29	3	0	9,043	0	1,796	-1,104	-3,006	0	-129	-149	6,453
30	3	0	7,065	0	1,691	-1,112	-6,733	0	-129	-153	632
31	3	0	11,168	0	1,836	-1,117	-8,895	0	-128	-157	2,711
32	4	0	12,815	0	1,910	-1,142	-9,116	0	-134	-162	4,174
33	3	0	8,388	0	1,935	-1,174	-9,695	0	-140	-166	-850
34	3	0	7,212	0	1,946	-1,176	-9,326	0	-139	-171	-1,651
35	3	0	9,104	0	1,982	-1,173	-9,210	0	-136	-176	395
36	3	0	6,306	0	2,002	-1,178	-11,540	0	-137	-176	-4,720
37	3	0	5,900	0	2,306	-1,158	-17,493	0	-134	-163	-10,738
38	4	0	5,544	0	2,501	-1,121	-17,225	0	-129	-152	-10,578
39	4	0	4,657	0	2,626	-1,082	-17,544	0	-126	-140	-11,607
40	5	0	5,576	0	2,744	-1,037	-17,496	0	-122	-130	-10,461
41	6	0	6,900	0	2,863	-997	-17,471	0	-121	-128	-8,948
42	8	0	4,601	0	2,969	-959	-17,601	0	-120	-120	-11,223
43	10	0	4,737	0	3,118	-911	-17,373	0	-116	-107	-10,642
44	12	0	9,876	0	3,136	-868	-9,733	0	-114	-103	2,205
45	14	0	8,968	0	2,663	-867	-3,467	0	-118	-107	7,086
46	17	0	9,812	0	2,390	-888	-2,875	0	-121	-107	8,227
47	19	0	9,710	0	2,191	-919	-3,043	0	-125	-107	7,725
Average (afy)	**4**	**0**	**7,770**	**0**	**1,952**	**-1,145**	**-9,307**	**0**	**-130**	**-122**	**-978**
Maximum (afy)	**19**	**0**	**12,815**	**0**	**3,136**	**-867**	**-2,770**	**0**	**-114**	**-71**	**8,581**
Minimum (afy)	**2**	**0**	**4,601**	**0**	**1,093**	**-1,326**	**-17,601**	**0**	**-146**	**-176**	**-11,734**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.


Scenario 2 South Westside Basin Water Balance
Water Volume (acre-feet)
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Rain + Irrigation (afy)
Seepage from Lake Merced (afy)
Outflow to Bay & Ocean (afy)
Seepage to Lake Merced (afy)
To North Westside Basin (afy)
Seepage from Golden Gate Park Lakes (afy)
Inflow from Bay & Ocean (afy)
Wells - Pumping (afy)
From North Westside Basin (afy)
Drains (afy)

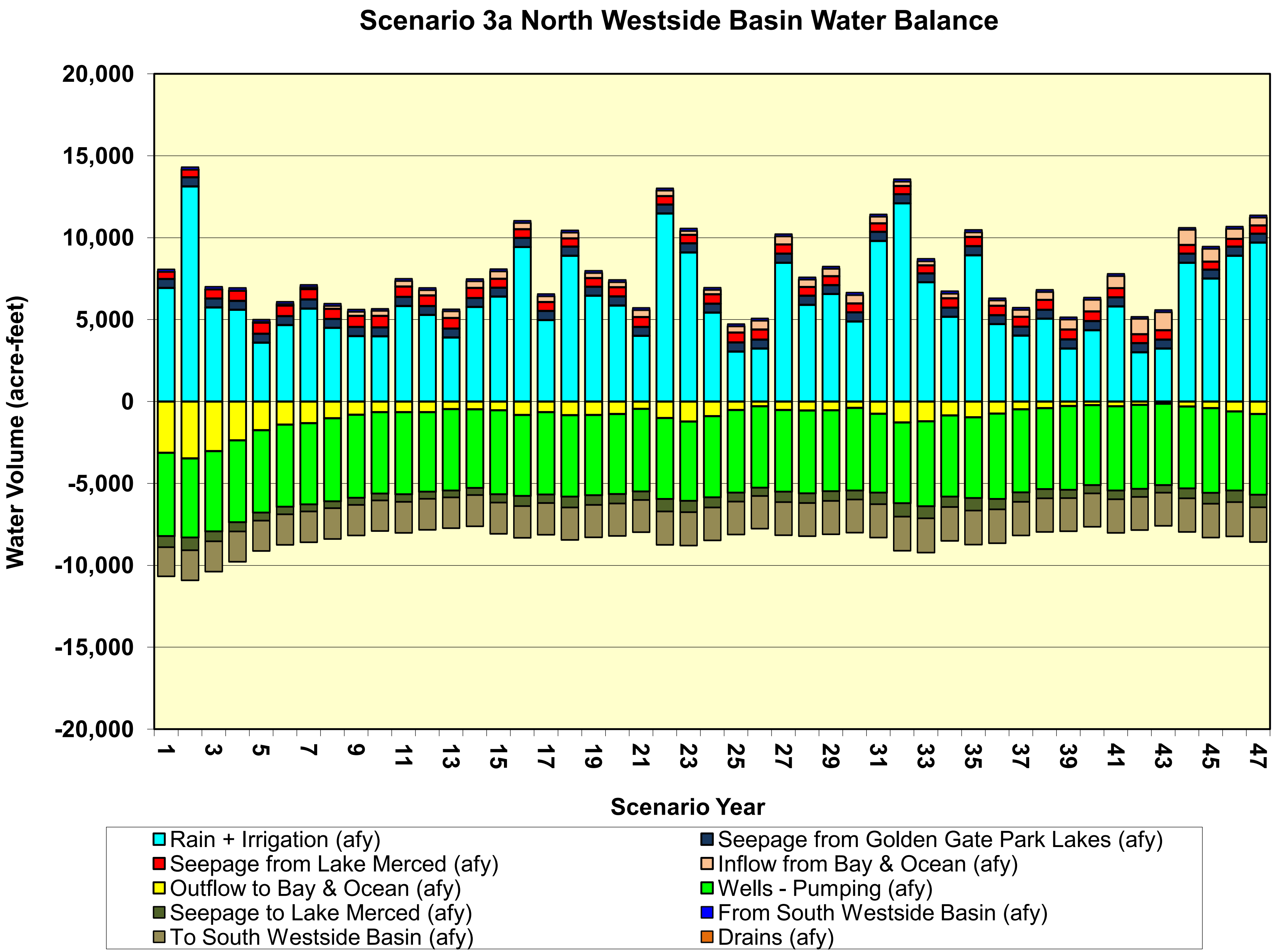

Scenario 2 South Westside Basin Change in Groundwater Storage
Water Volume (acre-feet)
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Change in Groundwater Storage (afy)

Scenario 3a North Westside Basin Water Balance Summary

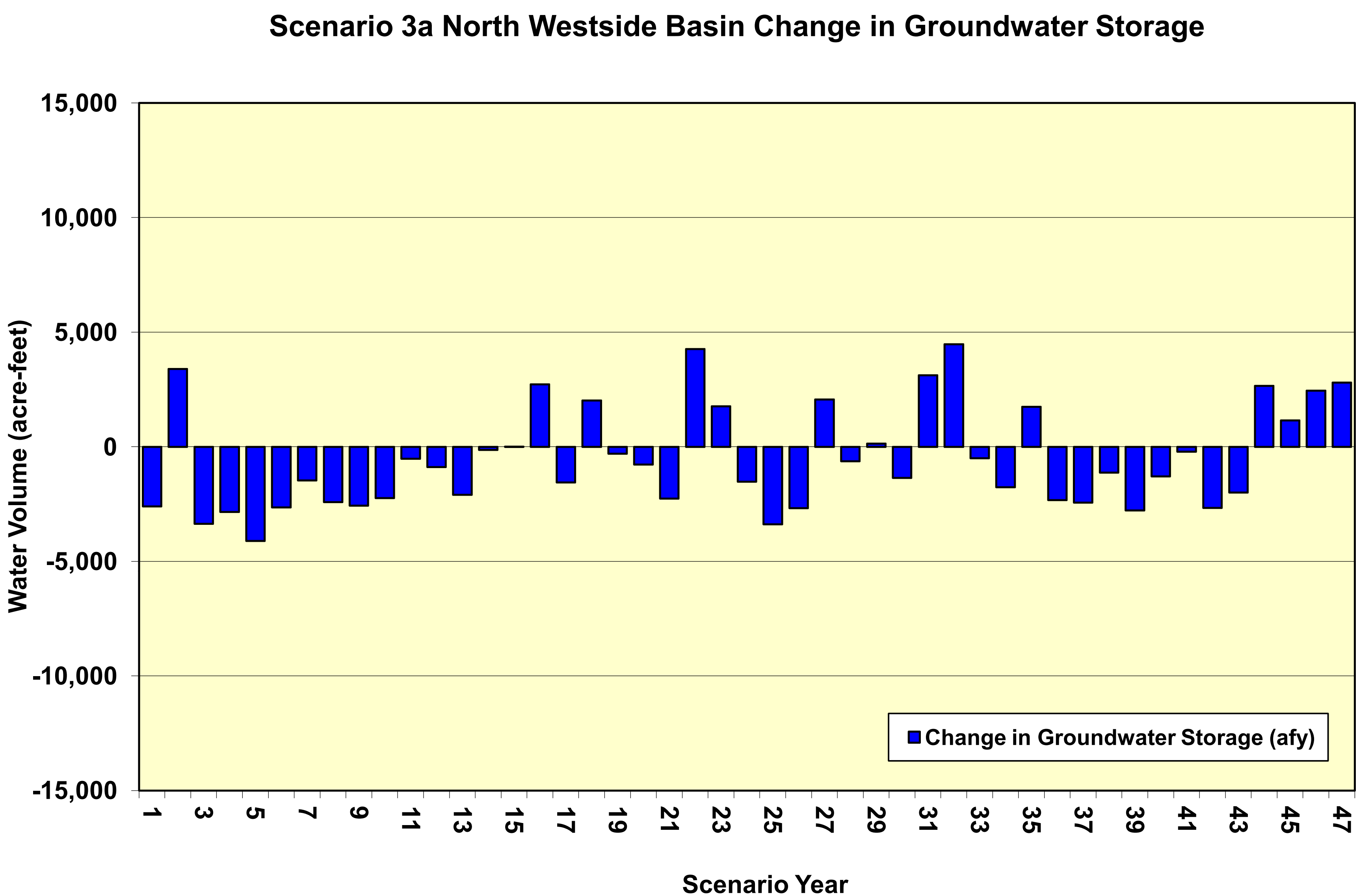
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From South to North Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From North to South Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	2	546	6,941	445	134	-3,124	-5,090	-670	-1,777	0	-2,594
2	3	558	13,135	478	139	-3,474	-4,832	-772	-1,836	0	3,400
3	8	552	5,749	560	147	-3,026	-4,898	-612	-1,840	0	-3,360
4	23	549	5,610	617	143	-2,360	-5,010	-560	-1,847	0	-2,834
5	51	549	3,598	674	140	-1,752	-5,022	-487	-1,852	0	-4,101
6	91	551	4,673	650	135	-1,401	-5,024	-461	-1,858	0	-2,644
7	126	552	5,687	628	133	-1,313	-4,960	-440	-1,871	0	-1,458
8	182	545	4,503	616	133	-1,014	-5,078	-418	-1,874	0	-2,405
9	245	549	4,009	684	130	-799	-5,083	-422	-1,872	0	-2,559
10	302	554	3,982	707	128	-650	-4,965	-417	-1,875	0	-2,234
11	346	549	5,843	635	126	-640	-5,025	-461	-1,890	0	-517
12	334	556	5,286	640	126	-640	-4,861	-429	-1,894	0	-881
13	410	553	3,915	638	126	-458	-4,972	-412	-1,888	0	-2,089
14	426	558	5,773	605	124	-464	-4,806	-440	-1,903	0	-127
15	461	549	6,407	542	125	-526	-5,134	-500	-1,908	0	15
16	390	556	9,441	525	127	-814	-4,953	-606	-1,938	0	2,727
17	369	549	4,984	543	131	-637	-5,038	-519	-1,932	0	-1,551
18	354	554	8,904	515	129	-831	-4,978	-663	-1,966	0	2,019
19	310	553	6,466	529	132	-822	-4,896	-595	-1,977	0	-300
20	324	556	5,871	553	132	-754	-4,888	-579	-1,981	0	-766
21	431	548	4,017	595	130	-447	-5,037	-520	-1,968	0	-2,251
22	335	554	11,482	517	128	-1,006	-4,938	-771	-2,026	0	4,273
23	246	556	9,106	519	135	-1,217	-4,840	-699	-2,037	0	1,770
24	270	549	5,433	572	137	-885	-4,969	-606	-2,019	0	-1,518
25	380	549	3,062	607	133	-517	-5,044	-548	-2,001	0	-3,379
26	542	550	3,238	621	128	-279	-4,977	-503	-1,991	0	-2,672
27	511	552	8,480	559	125	-513	-4,995	-629	-2,021	0	2,069
28	465	549	5,916	531	129	-537	-5,071	-583	-2,025	0	-626
29	455	553	6,566	538	130	-528	-4,946	-588	-2,032	0	147
30	524	550	4,895	549	130	-389	-5,045	-548	-2,019	0	-1,352
31	411	556	9,806	529	129	-748	-4,818	-692	-2,048	0	3,126
32	279	556	12,107	502	134	-1,274	-4,931	-820	-2,078	0	4,475
33	251	545	7,280	497	141	-1,207	-5,186	-737	-2,082	0	-497
34	287	554	5,178	582	140	-843	-4,957	-638	-2,065	0	-1,762
35	292	553	8,941	556	137	-959	-4,935	-753	-2,085	0	1,746
36	334	545	4,727	574	138	-734	-5,212	-630	-2,067	0	-2,325
37	422	545	4,032	607	134	-464	-5,086	-573	-2,053	0	-2,435
38	485	554	5,061	603	130	-404	-4,938	-560	-2,051	0	-1,120
39	615	549	3,248	605	128	-272	-5,118	-495	-2,034	0	-2,775
40	720	556	4,359	594	124	-220	-4,887	-493	-2,037	0	-1,283
41	750	549	5,814	565	123	-278	-5,154	-531	-2,045	0	-206
42	946	550	3,017	546	123	-195	-5,137	-485	-2,031	0	-2,665
43	1115	549	3,238	567	120	-132	-4,977	-450	-2,024	0	-1,995
44	937	552	8,481	527	119	-292	-5,014	-597	-2,053	0	2,659
45	792	545	7,522	477	124	-402	-5,179	-656	-2,069	0	1,155
46	616	556	8,902	487	127	-604	-4,833	-697	-2,098	0	2,457
47	489	545	9,712	502	131	-755	-4,939	-752	-2,121	0	2,811
Average (afy)	**397**	**551**	**6,264**	**568**	**131**	**-885**	**-4,993**	**-575**	**-1,978**	**0**	**-520**
Maximum (afy)	**1115**	**558**	**13,135**	**707**	**147**	**-132**	**-4,806**	**-412**	**-1,777**	**0**	**4,475**
Minimum (afy)	**2**	**545**	**3,017**	**445**	**119**	**-3,474**	**-5,212**	**-820**	**-2,121**	**0**	**-4,101**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Scenario 3a North Westside Basin Water Balance
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Rain + Irrigation (afy)
Seepage from Golden Gate Park Lakes (afy)
Seepage from Lake Merced (afy)
Inflow from Bay & Ocean (afy)
Outflow to Bay & Ocean (afy)
Wells - Pumping (afy)
Seepage to Lake Merced (afy)
From South Westside Basin (afy)
To South Westside Basin (afy)
Drains (afy)


Scenario 3a North Westside Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
Change in Groundwater Storage (afy)
1
3
5
7
9
11
13
15
17
19
21
23
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31
33
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37
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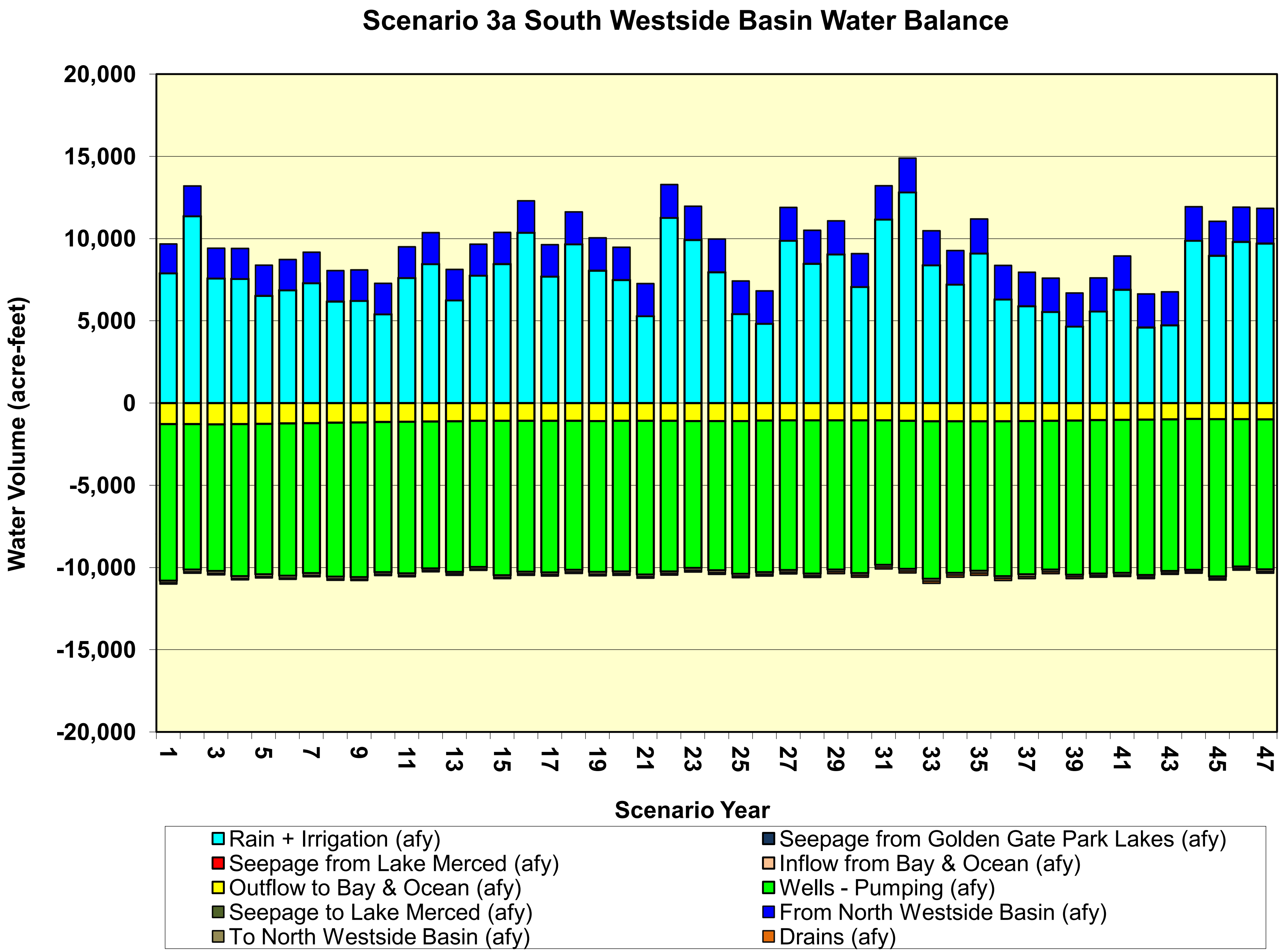
41
43
45
47
Scenario Year

Scenario 3a South Westside Basin Water Balance Summary

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From North to South Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From South to North Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	3	0	7,904	0	1,777	-1,276	-9,513	0	-134	-71	-1,310
2	3	0	11,370	0	1,836	-1,277	-8,842	0	-139	-72	2,879
3	3	0	7,580	0	1,840	-1,289	-8,922	0	-147	-73	-1,008
4	3	0	7,559	0	1,847	-1,275	-9,252	0	-143	-74	-1,336
5	3	0	6,531	0	1,852	-1,255	-9,157	0	-140	-74	-2,240
6	3	0	6,873	0	1,858	-1,230	-9,268	0	-135	-73	-1,972
7	3	0	7,302	0	1,871	-1,211	-9,131	0	-133	-72	-1,372
8	3	0	6,188	0	1,874	-1,195	-9,362	0	-133	-71	-2,696
9	3	0	6,225	0	1,872	-1,172	-9,405	0	-130	-70	-2,678
10	3	0	5,405	0	1,875	-1,148	-9,130	0	-128	-68	-3,191
11	3	0	7,611	0	1,890	-1,126	-9,228	0	-126	-68	-1,045
12	3	0	8,465	0	1,894	-1,111	-8,934	0	-126	-74	117
13	3	0	6,247	0	1,888	-1,096	-9,164	0	-126	-76	-2,322
14	4	0	7,760	0	1,903	-1,078	-8,884	0	-124	-75	-495
15	4	0	8,469	0	1,908	-1,069	-9,394	0	-125	-81	-288
16	4	0	10,364	0	1,938	-1,070	-9,188	0	-127	-84	1,838
17	4	0	7,695	0	1,932	-1,076	-9,220	0	-131	-88	-882
18	5	0	9,663	0	1,966	-1,074	-9,059	0	-129	-92	1,280
19	5	0	8,066	0	1,977	-1,081	-9,188	0	-132	-96	-450
20	5	0	7,492	0	1,981	-1,080	-9,159	0	-132	-100	-993
21	5	0	5,293	0	1,968	-1,069	-9,348	0	-130	-92	-3,372
22	6	0	11,269	0	2,026	-1,067	-9,165	0	-128	-94	2,847
23	6	0	9,930	0	2,037	-1,087	-8,937	0	-135	-101	1,713
24	6	0	7,964	0	2,019	-1,093	-9,075	0	-137	-105	-422
25	6	0	5,416	0	2,001	-1,082	-9,294	0	-133	-106	-3,191
26	7	0	4,834	0	1,991	-1,061	-9,224	0	-128	-96	-3,677
27	7	0	9,875	0	2,021	-1,046	-9,111	0	-125	-96	1,524
28	8	0	8,482	0	2,025	-1,049	-9,310	0	-129	-104	-78
29	8	0	9,043	0	2,032	-1,047	-9,078	0	-130	-108	719
30	8	0	7,065	0	2,019	-1,043	-9,290	0	-130	-112	-1,482
31	8	0	11,168	0	2,048	-1,042	-8,786	0	-129	-115	3,153
32	8	0	12,815	0	2,078	-1,067	-9,008	0	-134	-117	4,574
33	8	0	8,388	0	2,082	-1,099	-9,587	0	-141	-121	-469
34	8	0	7,212	0	2,065	-1,100	-9,218	0	-140	-124	-1,297
35	8	0	9,104	0	2,085	-1,097	-9,102	0	-137	-127	736
36	8	0	6,306	0	2,067	-1,101	-9,417	0	-138	-128	-2,402
37	8	0	5,900	0	2,053	-1,088	-9,324	0	-134	-120	-2,705
38	8	0	5,544	0	2,051	-1,071	-9,056	0	-130	-112	-2,766
39	8	0	4,657	0	2,034	-1,056	-9,375	0	-128	-104	-3,965
40	9	0	5,576	0	2,037	-1,036	-9,327	0	-124	-99	-2,963
41	10	0	6,900	0	2,045	-1,020	-9,302	0	-123	-99	-1,590
42	10	0	4,601	0	2,031	-1,006	-9,440	0	-123	-94	-4,020
43	11	0	4,737	0	2,024	-982	-9,224	0	-120	-86	-3,640
44	13	0	9,876	0	2,053	-964	-9,166	0	-119	-86	1,607
45	14	0	8,968	0	2,069	-968	-9,567	0	-124	-93	299
46	15	0	9,812	0	2,098	-975	-8,953	0	-127	-97	1,773
47	16	0	9,710	0	2,121	-986	-9,116	0	-131	-99	1,514
Average (afy)	**7**	**0**	**7,770**	**0**	**1,978**	**-1,096**	**-9,196**	**0**	**-131**	**-93**	**-761**
Maximum (afy)	**16**	**0**	**12,815**	**0**	**2,121**	**-964**	**-8,786**	**0**	**-119**	**-68**	**4,574**
Minimum (afy)	**3**	**0**	**4,601**	**0**	**1,777**	**-1,289**	**-9,587**	**0**	**-147**	**-128**	**-4,020**

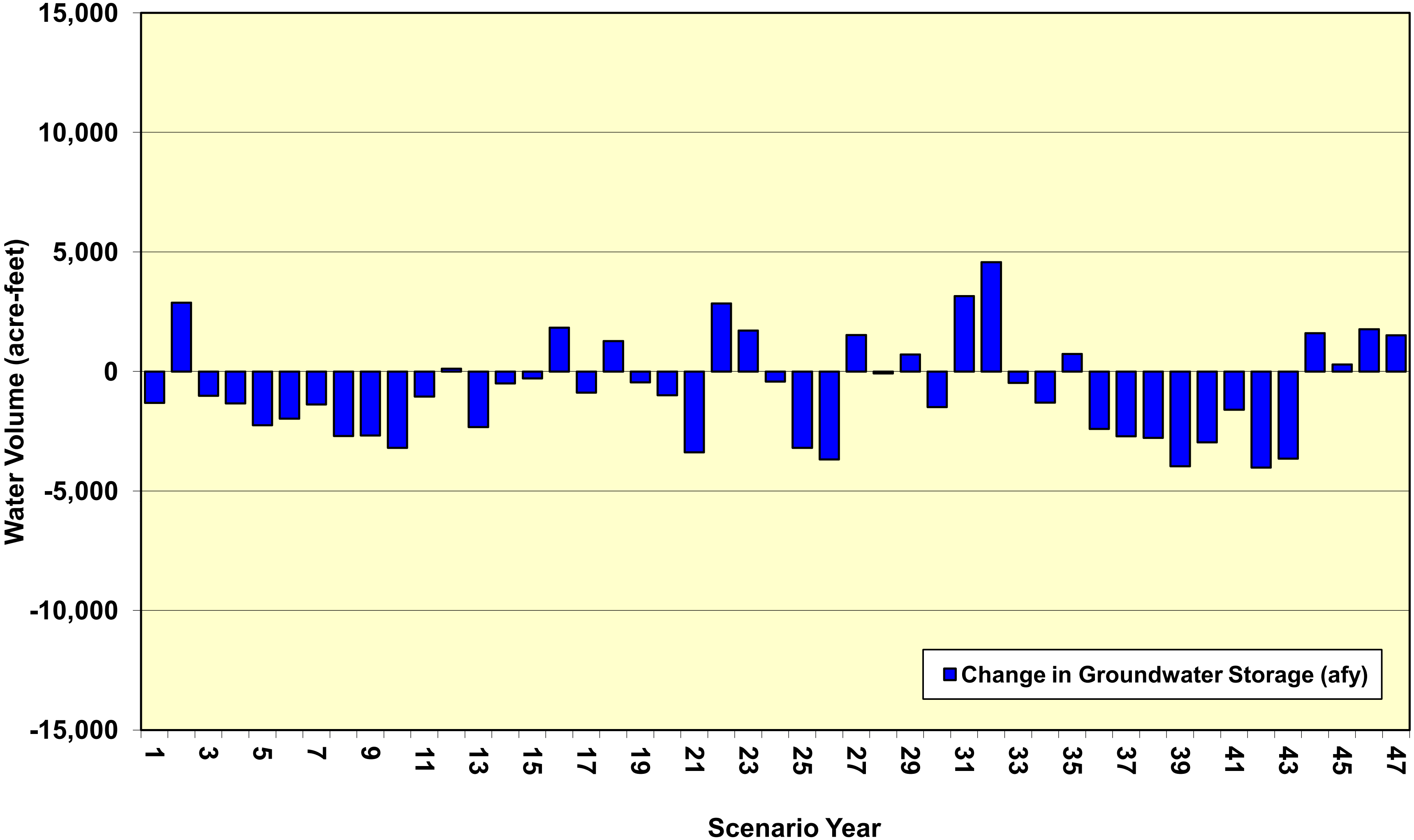
Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Scenario 3a South Westside Basin Water Balance
Water Volume (acre-feet)
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Rain + Irrigation (afy)
Seepage from Golden Gate Park Lakes (afy)
Seepage from Lake Merced (afy)
Inflow from Bay & Ocean (afy)
Outflow to Bay & Ocean (afy)
Wells - Pumping (afy)
Seepage to Lake Merced (afy)
From North Westside Basin (afy)
To North Westside Basin (afy)
Drains (afy)

Scenario 3a South Westside Basin Change in Groundwater Storage

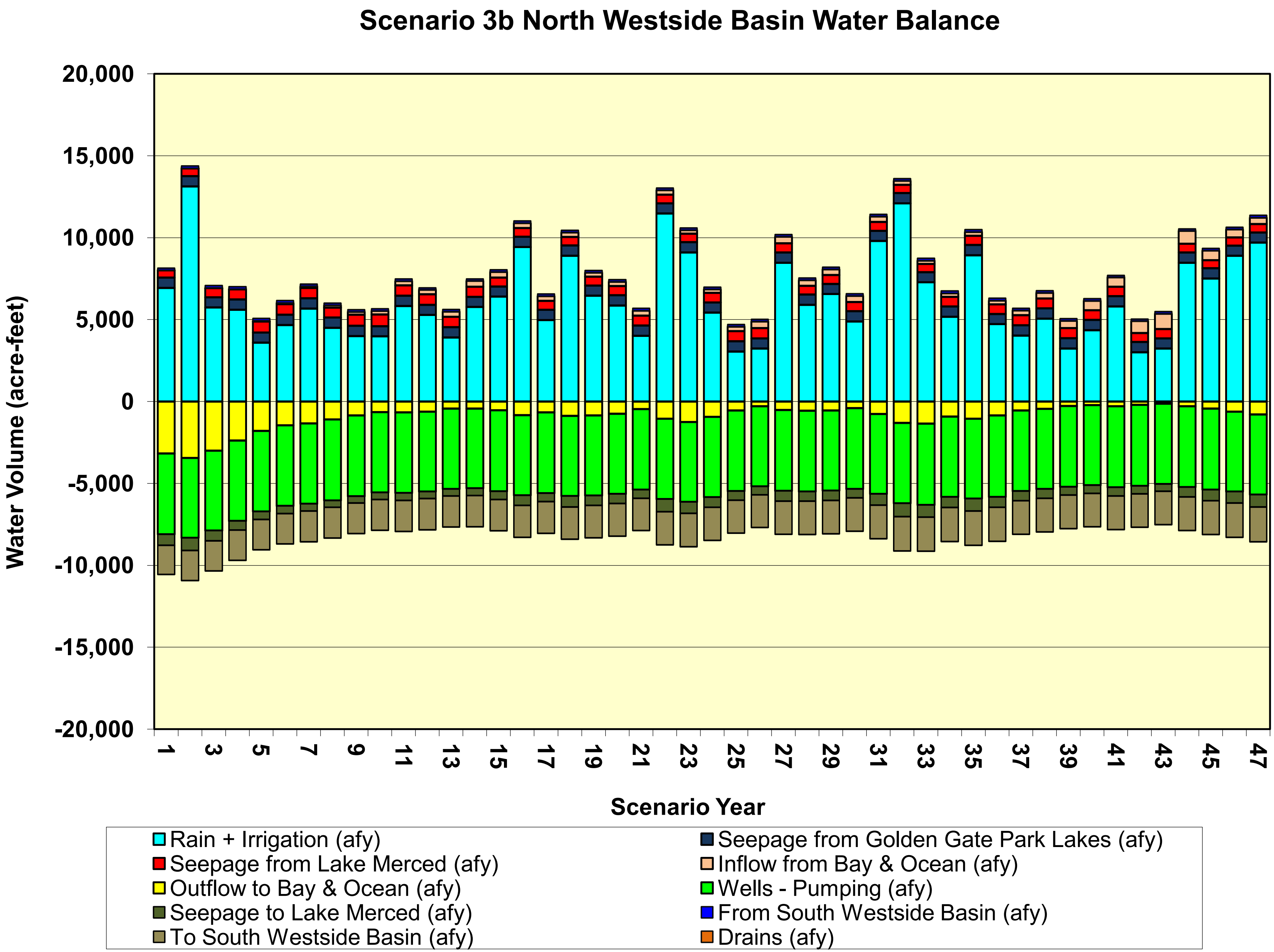


Scenario 3b North Westside Basin Water Balance Summary

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From South to North Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From North to South Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	2	626	6,941	444	134	-3,164	-4,939	-672	-1,777	0	-2,404
2	3	628	13,135	476	139	-3,443	-4,869	-777	-1,837	0	3,454
3	7	626	5,749	556	147	-2,990	-4,887	-618	-1,841	0	-3,252
4	20	626	5,610	614	143	-2,377	-4,905	-565	-1,848	0	-2,683
5	42	626	3,598	672	140	-1,788	-4,918	-492	-1,853	0	-3,973
6	74	628	4,673	651	135	-1,444	-4,924	-466	-1,860	0	-2,533
7	101	626	5,687	626	133	-1,337	-4,903	-444	-1,874	0	-1,385
8	134	626	4,503	615	133	-1,093	-4,936	-423	-1,877	0	-2,318
9	177	626	4,009	671	130	-845	-4,927	-415	-1,875	0	-2,448
10	223	628	3,982	707	128	-649	-4,902	-422	-1,878	0	-2,184
11	256	626	5,843	637	126	-653	-4,921	-468	-1,893	0	-447
12	267	626	5,286	641	126	-611	-4,881	-435	-1,898	0	-878
13	318	626	3,915	640	126	-428	-4,909	-419	-1,892	0	-2,025
14	357	628	5,773	607	124	-424	-4,867	-447	-1,907	0	-155
15	342	626	6,407	545	125	-523	-4,946	-507	-1,912	0	156
16	305	626	9,441	528	127	-827	-4,900	-613	-1,942	0	2,745
17	278	626	4,984	547	131	-662	-4,924	-526	-1,936	0	-1,484
18	275	628	8,904	519	129	-867	-4,898	-670	-1,970	0	2,050
19	251	626	6,466	533	132	-844	-4,890	-603	-1,981	0	-310
20	258	626	5,871	557	132	-749	-4,889	-587	-1,985	0	-765
21	315	626	4,017	600	130	-457	-4,918	-527	-1,972	0	-2,187
22	276	628	11,482	521	128	-1,044	-4,898	-778	-2,030	0	4,283
23	211	626	9,106	524	135	-1,240	-4,876	-706	-2,041	0	1,739
24	216	626	5,433	577	137	-937	-4,897	-613	-2,023	0	-1,481
25	276	626	3,062	613	133	-540	-4,924	-555	-2,005	0	-3,315
26	405	628	3,238	626	128	-280	-4,895	-511	-1,995	0	-2,657
27	400	626	8,480	563	125	-520	-4,921	-636	-2,025	0	2,092
28	338	626	5,916	535	129	-559	-4,931	-589	-2,029	0	-563
29	343	626	6,566	543	130	-540	-4,900	-595	-2,037	0	138
30	381	628	4,895	554	130	-404	-4,925	-555	-2,023	0	-1,319
31	340	626	9,806	534	129	-758	-4,868	-699	-2,052	0	3,057
32	242	626	12,107	506	134	-1,308	-4,896	-827	-2,082	0	4,503
33	192	626	7,280	502	141	-1,350	-4,957	-743	-2,086	0	-395
34	218	628	5,178	588	140	-923	-4,902	-645	-2,069	0	-1,788
35	230	626	8,941	562	137	-1,041	-4,882	-760	-2,090	0	1,722
36	235	626	4,727	580	137	-848	-4,971	-637	-2,071	0	-2,221
37	288	626	4,032	613	134	-542	-4,925	-581	-2,057	0	-2,412
38	342	628	5,061	608	130	-440	-4,899	-567	-2,055	0	-1,193
39	445	626	3,248	611	128	-277	-4,932	-502	-2,038	0	-2,692
40	568	626	4,359	600	124	-216	-4,885	-500	-2,041	0	-1,365
41	575	626	5,814	570	123	-278	-4,949	-538	-2,049	0	-105
42	723	628	3,017	551	123	-196	-4,943	-492	-2,035	0	-2,625
43	933	626	3,238	573	120	-129	-4,895	-457	-2,028	0	-2,019
44	783	626	8,481	532	119	-288	-4,926	-605	-2,057	0	2,666
45	598	626	7,522	482	124	-423	-4,958	-663	-2,073	0	1,234
46	490	626	8,902	492	127	-616	-4,871	-704	-2,102	0	2,345
47	399	618	9,712	507	131	-786	-4,896	-759	-2,125	0	2,801
Average (afy)	**307**	**626**	**6,264**	**571**	**131**	**-908**	**-4,910**	**-581**	**-1,981**	**0**	**-481**
Maximum (afy)	**933**	**628**	**13,135**	**707**	**147**	**-129**	**-4,867**	**-415**	**-1,777**	**0**	**4,503**
Minimum (afy)	**2**	**618**	**3,017**	**444**	**119**	**-3,443**	**-4,971**	**-827**	**-2,125**	**0**	**-3,973**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.


Scenario 3b North Westside Basin Water Balance
Water Volume (acre-feet)
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
1
3
5
7
9
11
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15
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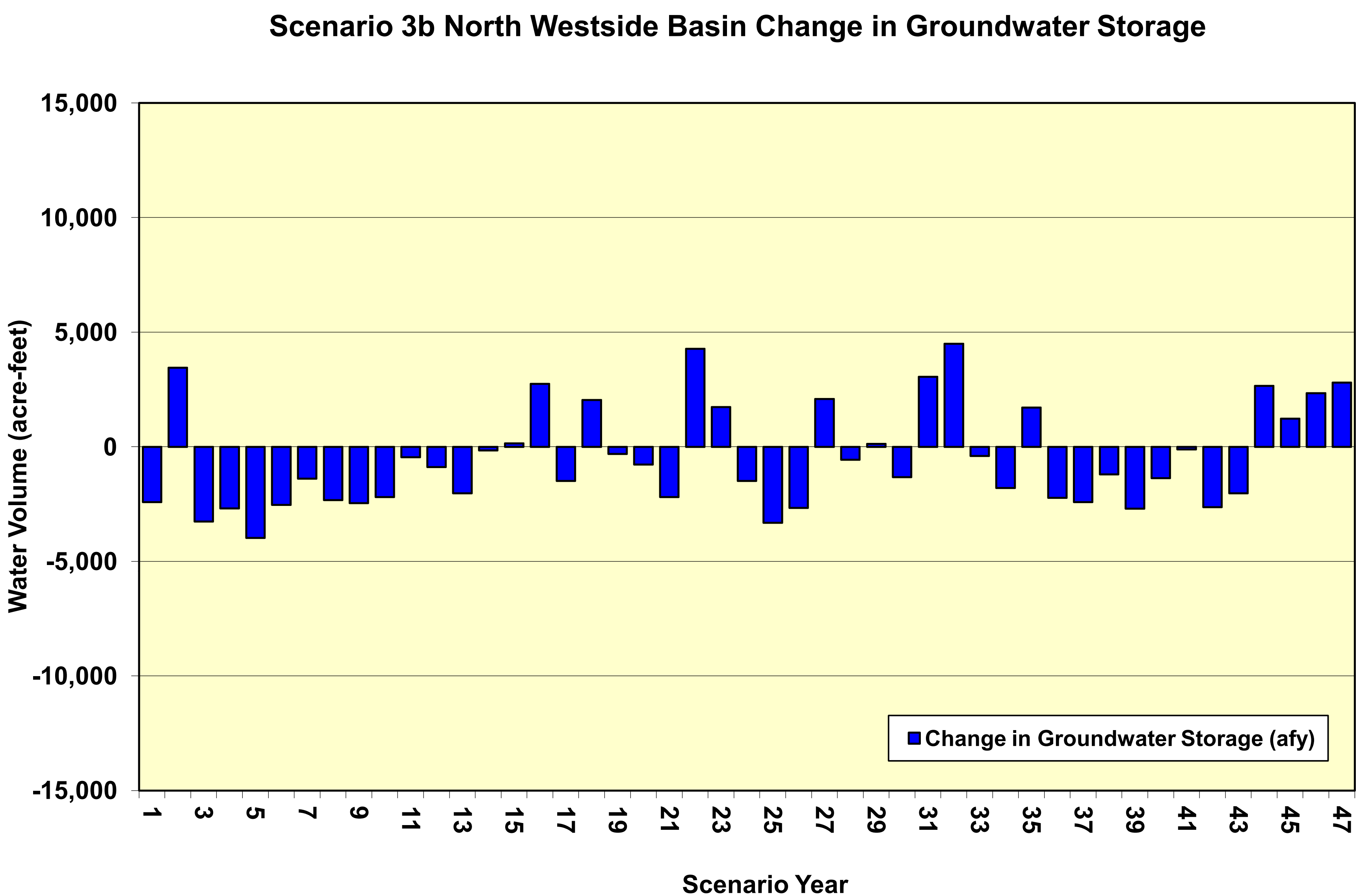
Scenario Year
Rain + Irrigation (afy)
Seepage from Golden Gate Park Lakes (afy)
Seepage from Lake Merced (afy)
Inflow from Bay & Ocean (afy)
Outflow to Bay & Ocean (afy)
Wells - Pumping (afy)
Seepage to Lake Merced (afy)
From South Westside Basin (afy)
To South Westside Basin (afy)
Drains (afy)



Scenario 3b North Westside Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
Change in Groundwater Storage (afy)
1
3
5
7
9
11
13
15
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47
Scenario Year

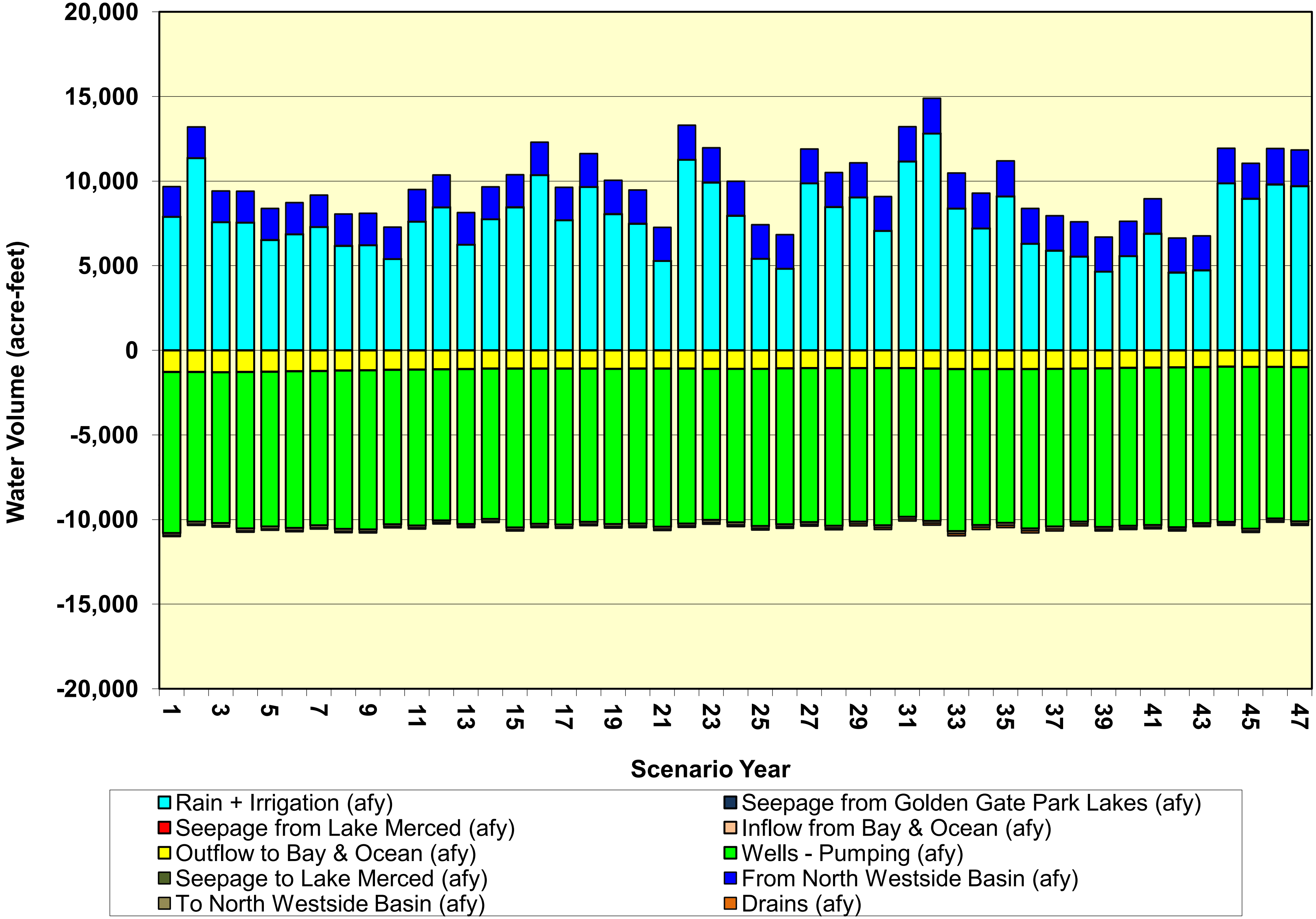
Scenario 3b South Westside Basin Water Balance Summary

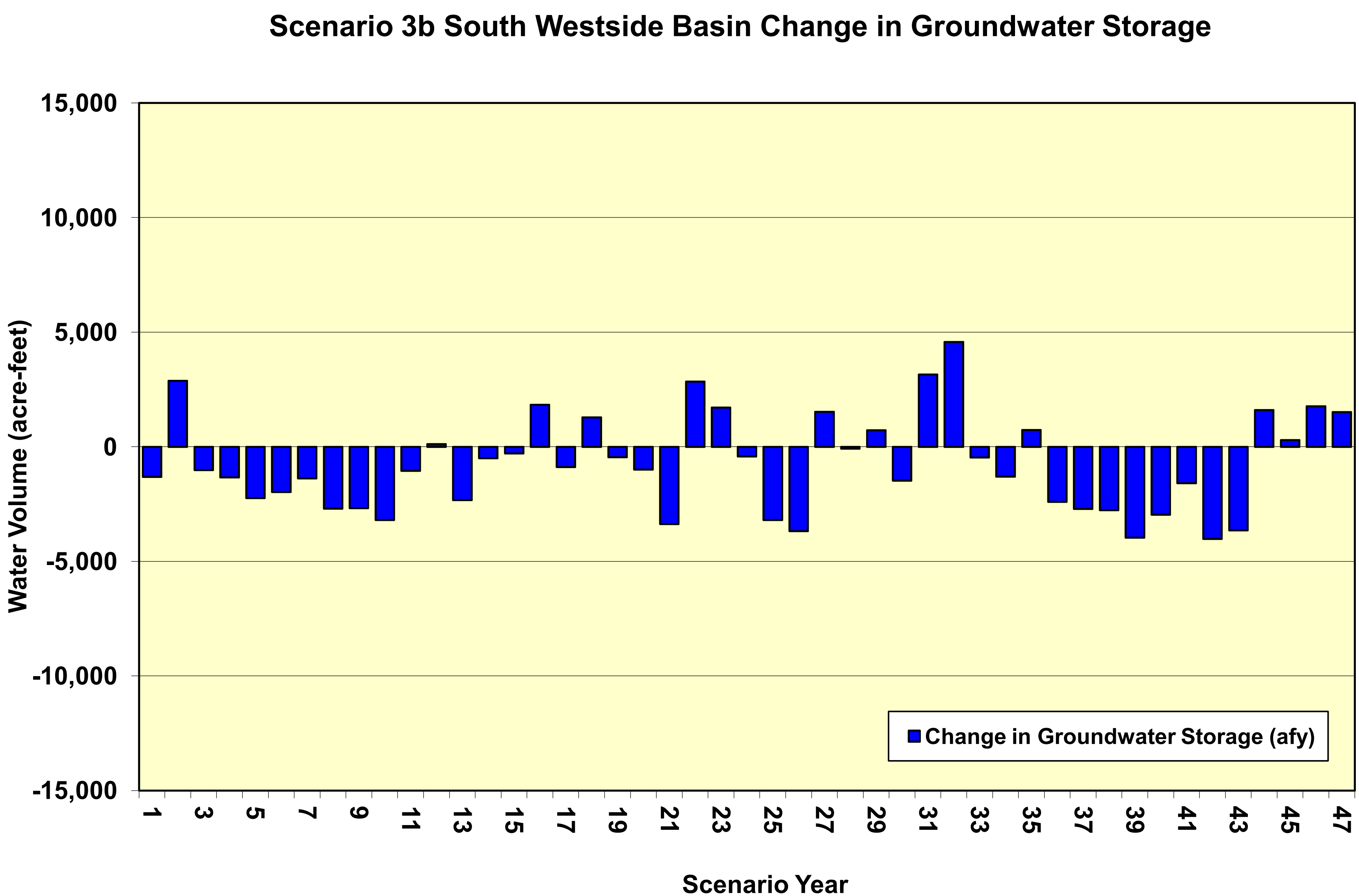
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From North to South Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From South to North Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	3	0	7,904	0	1,777	-1,276	-9,513	0	-134	-71	-1,310
2	3	0	11,370	0	1,837	-1,277	-8,842	0	-139	-72	2,879
3	3	0	7,580	0	1,841	-1,289	-8,922	0	-147	-73	-1,007
4	3	0	7,559	0	1,848	-1,275	-9,252	0	-143	-74	-1,335
5	3	0	6,531	0	1,853	-1,255	-9,157	0	-140	-74	-2,238
6	3	0	6,873	0	1,860	-1,230	-9,268	0	-135	-73	-1,969
7	3	0	7,302	0	1,874	-1,211	-9,131	0	-133	-72	-1,369
8	3	0	6,188	0	1,877	-1,195	-9,362	0	-133	-71	-2,693
9	3	0	6,225	0	1,875	-1,172	-9,405	0	-130	-70	-2,675
10	3	0	5,405	0	1,878	-1,148	-9,130	0	-128	-68	-3,188
11	3	0	7,611	0	1,893	-1,126	-9,228	0	-126	-68	-1,042
12	3	0	8,465	0	1,898	-1,112	-8,934	0	-126	-74	120
13	3	0	6,247	0	1,892	-1,096	-9,164	0	-126	-76	-2,318
14	4	0	7,760	0	1,907	-1,078	-8,884	0	-124	-75	-491
15	4	0	8,469	0	1,912	-1,070	-9,394	0	-125	-81	-284
16	4	0	10,364	0	1,942	-1,070	-9,188	0	-127	-84	1,842
17	4	0	7,695	0	1,936	-1,076	-9,220	0	-131	-88	-878
18	5	0	9,663	0	1,970	-1,074	-9,059	0	-129	-92	1,284
19	5	0	8,066	0	1,981	-1,081	-9,188	0	-132	-96	-446
20	5	0	7,492	0	1,985	-1,080	-9,159	0	-132	-100	-989
21	5	0	5,293	0	1,972	-1,069	-9,348	0	-130	-92	-3,368
22	6	0	11,269	0	2,030	-1,067	-9,165	0	-128	-94	2,851
23	6	0	9,930	0	2,041	-1,087	-8,937	0	-135	-101	1,717
24	6	0	7,964	0	2,023	-1,093	-9,075	0	-137	-105	-418
25	6	0	5,416	0	2,005	-1,082	-9,294	0	-133	-106	-3,187
26	7	0	4,834	0	1,995	-1,061	-9,224	0	-128	-96	-3,673
27	7	0	9,875	0	2,025	-1,046	-9,111	0	-125	-96	1,528
28	8	0	8,482	0	2,029	-1,050	-9,310	0	-129	-104	-75
29	8	0	9,043	0	2,037	-1,047	-9,078	0	-130	-108	723
30	8	0	7,065	0	2,023	-1,043	-9,290	0	-130	-112	-1,478
31	8	0	11,168	0	2,052	-1,042	-8,786	0	-129	-115	3,157
32	8	0	12,815	0	2,082	-1,067	-9,008	0	-134	-117	4,578
33	8	0	8,388	0	2,086	-1,099	-9,587	0	-141	-121	-465
34	8	0	7,212	0	2,069	-1,101	-9,218	0	-140	-124	-1,293
35	8	0	9,104	0	2,090	-1,097	-9,102	0	-137	-127	740
36	8	0	6,306	0	2,071	-1,101	-9,417	0	-137	-128	-2,398
37	8	0	5,900	0	2,057	-1,089	-9,324	0	-134	-120	-2,701
38	8	0	5,544	0	2,055	-1,072	-9,056	0	-130	-112	-2,762
39	8	0	4,657	0	2,038	-1,057	-9,375	0	-128	-104	-3,961
40	9	0	5,576	0	2,041	-1,036	-9,327	0	-124	-99	-2,959
41	10	0	6,900	0	2,049	-1,020	-9,302	0	-123	-99	-1,586
42	10	0	4,601	0	2,035	-1,006	-9,440	0	-123	-94	-4,016
43	11	0	4,737	0	2,028	-982	-9,224	0	-120	-86	-3,636
44	13	0	9,876	0	2,057	-965	-9,166	0	-119	-86	1,610
45	14	0	8,968	0	2,073	-969	-9,567	0	-124	-93	303
46	15	0	9,812	0	2,102	-976	-8,953	0	-127	-97	1,776
47	16	0	9,710	0	2,125	-987	-9,116	0	-131	-99	1,518
Average (afy)	**7**	**0**	**7,770**	**0**	**1,981**	**-1,096**	**-9,196**	**0**	**-131**	**-93**	**-757**
Maximum (afy)	**16**	**0**	**12,815**	**0**	**2,125**	**-965**	**-8,786**	**0**	**-119**	**-68**	**4,578**
Minimum (afy)	**3**	**0**	**4,601**	**0**	**1,777**	**-1,289**	**-9,587**	**0**	**-147**	**-128**	**-4,016**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.

Scenario 3b South Westside Basin Water Balance





Scenario 3b South Westside Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
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23
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41
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45
47
Scenario Year
Change in Groundwater Storage (afy)

Scenario 4 North Westside Basin Water Balance Summary

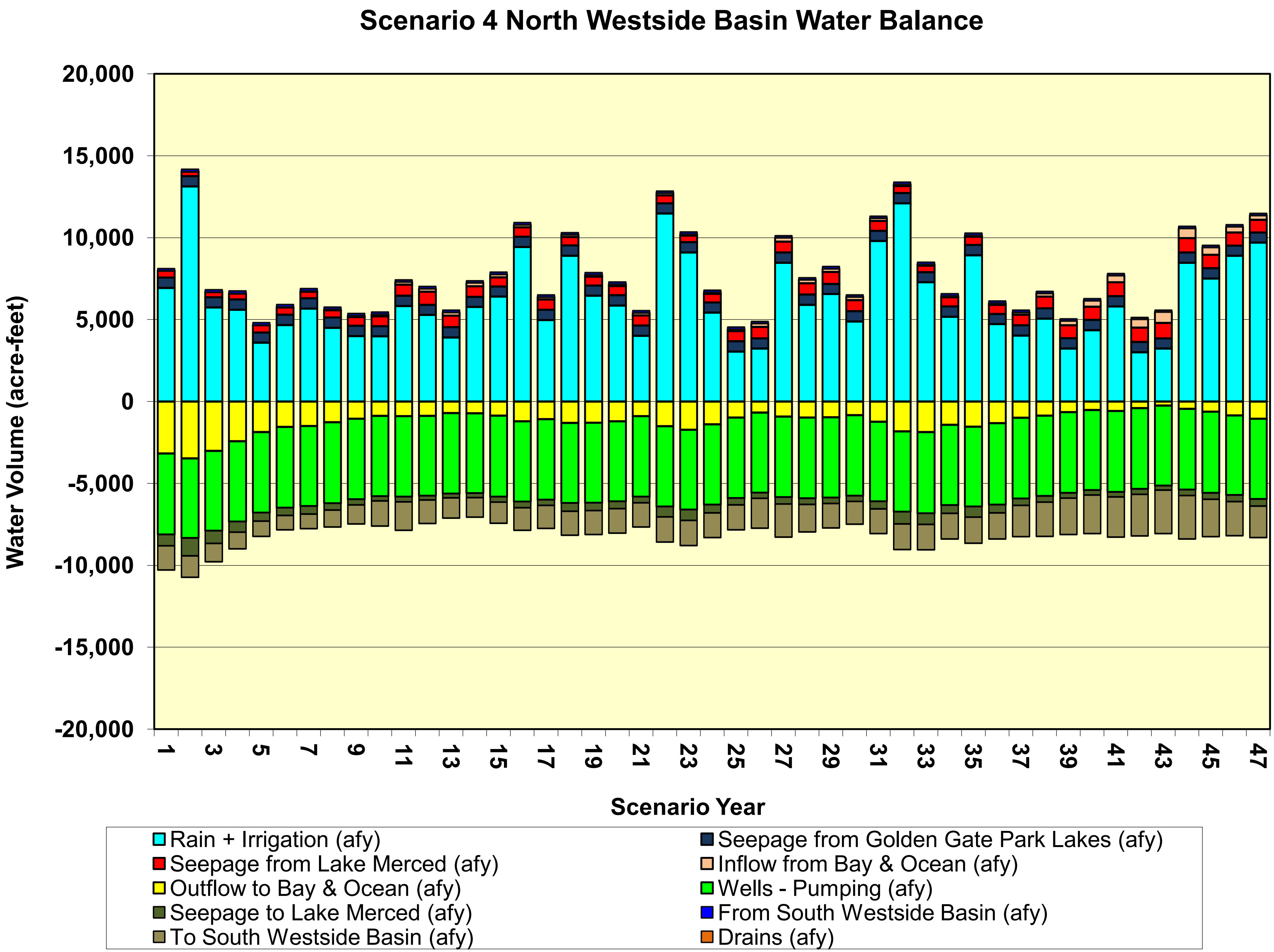
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From South to North Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From North to South Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	2	626	6,941	416	134	-3,172	-4,939	-694	-1,480	0	-2,165
2	2	628	13,135	282	139	-3,462	-4,869	-1,089	-1,306	0	3,460
3	2	626	5,749	305	147	-3,004	-4,887	-762	-1,130	0	-2,954
4	6	626	5,610	365	146	-2,415	-4,905	-645	-1,022	0	-2,235
5	15	626	3,598	439	146	-1,858	-4,918	-519	-939	0	-3,409
6	29	628	4,673	450	147	-1,551	-4,924	-473	-880	0	-1,901
7	39	626	5,687	404	138	-1,483	-4,903	-475	-895	0	-862
8	56	626	4,503	449	134	-1,266	-4,936	-417	-1,041	0	-1,892
9	84	626	4,009	526	131	-1,042	-4,927	-343	-1,152	0	-2,089
10	122	628	3,982	604	128	-868	-4,902	-298	-1,527	0	-2,133
11	169	626	5,843	670	125	-891	-4,921	-305	-1,744	0	-427
12	189	626	5,286	800	123	-873	-4,881	-252	-1,441	0	-423
13	204	626	3,915	712	122	-705	-4,909	-256	-1,242	0	-1,534
14	211	628	5,773	641	120	-722	-4,867	-281	-1,187	0	316
15	188	626	6,407	559	121	-857	-4,946	-328	-1,293	0	477
16	162	626	9,441	576	123	-1,204	-4,900	-382	-1,376	0	3,065
17	138	626	4,984	630	127	-1,073	-4,924	-337	-1,408	0	-1,236
18	135	628	8,904	524	125	-1,302	-4,898	-502	-1,457	0	2,157
19	115	626	6,466	534	127	-1,292	-4,890	-465	-1,474	0	-253
20	117	626	5,871	559	126	-1,197	-4,889	-453	-1,484	0	-723
21	151	626	4,017	627	123	-885	-4,918	-371	-1,479	0	-2,108
22	132	628	11,482	487	121	-1,503	-4,898	-640	-1,537	0	4,271
23	89	626	9,106	406	128	-1,712	-4,876	-668	-1,527	0	1,572
24	89	626	5,433	524	130	-1,391	-4,897	-503	-1,507	0	-1,496
25	124	626	3,062	610	126	-967	-4,924	-411	-1,526	0	-3,281
26	214	628	3,238	694	120	-665	-4,895	-339	-1,830	0	-2,836
27	242	626	8,480	660	117	-916	-4,921	-413	-2,020	0	1,855
28	213	626	5,916	688	120	-972	-4,931	-377	-1,678	0	-395
29	197	626	6,566	732	121	-963	-4,900	-360	-1,487	0	532
30	193	628	4,895	677	121	-826	-4,925	-347	-1,392	0	-976
31	164	626	9,806	600	121	-1,225	-4,868	-451	-1,511	0	3,262
32	106	626	12,107	429	127	-1,825	-4,896	-749	-1,558	0	4,367
33	76	626	7,280	393	134	-1,866	-4,957	-672	-1,554	0	-540
34	87	628	5,178	557	132	-1,415	-4,902	-510	-1,556	0	-1,802
35	95	626	8,941	496	128	-1,529	-4,882	-648	-1,587	0	1,640
36	97	626	4,727	553	129	-1,323	-4,971	-498	-1,599	0	-2,258
37	135	626	4,032	656	125	-993	-4,925	-418	-1,901	0	-2,663
38	195	628	5,061	723	120	-866	-4,899	-372	-2,095	0	-1,505
39	276	626	3,248	783	117	-642	-4,932	-315	-2,221	0	-3,059
40	383	626	4,359	803	113	-522	-4,885	-305	-2,343	0	-1,770
41	409	626	5,814	850	111	-566	-4,949	-304	-2,456	0	-464
42	508	628	3,017	878	110	-396	-4,943	-317	-2,541	0	-3,056
43	675	626	3,238	938	106	-242	-4,895	-264	-2,655	0	-2,474
44	611	626	8,481	872	104	-450	-4,926	-359	-2,656	0	2,304
45	463	626	7,522	818	108	-612	-4,958	-387	-2,290	0	1,291
46	364	626	8,902	793	111	-839	-4,871	-397	-2,077	0	2,613
47	279	618	9,712	767	116	-1,051	-4,896	-439	-1,920	0	3,185
Average (afy)	**182**	**626**	**6,264**	**606**	**125**	**-1,221**	**-4,910**	**-449**	**-1,617**	**0**	**-395**
Maximum (afy)	**675**	**628**	**13,135**	**938**	**147**	**-242**	**-4,867**	**-252**	**-880**	**0**	**4,367**
Minimum (afy)	**2**	**618**	**3,017**	**282**	**104**	**-3,462**	**-4,971**	**-1,089**	**-2,656**	**0**	**-3,409**

Key:

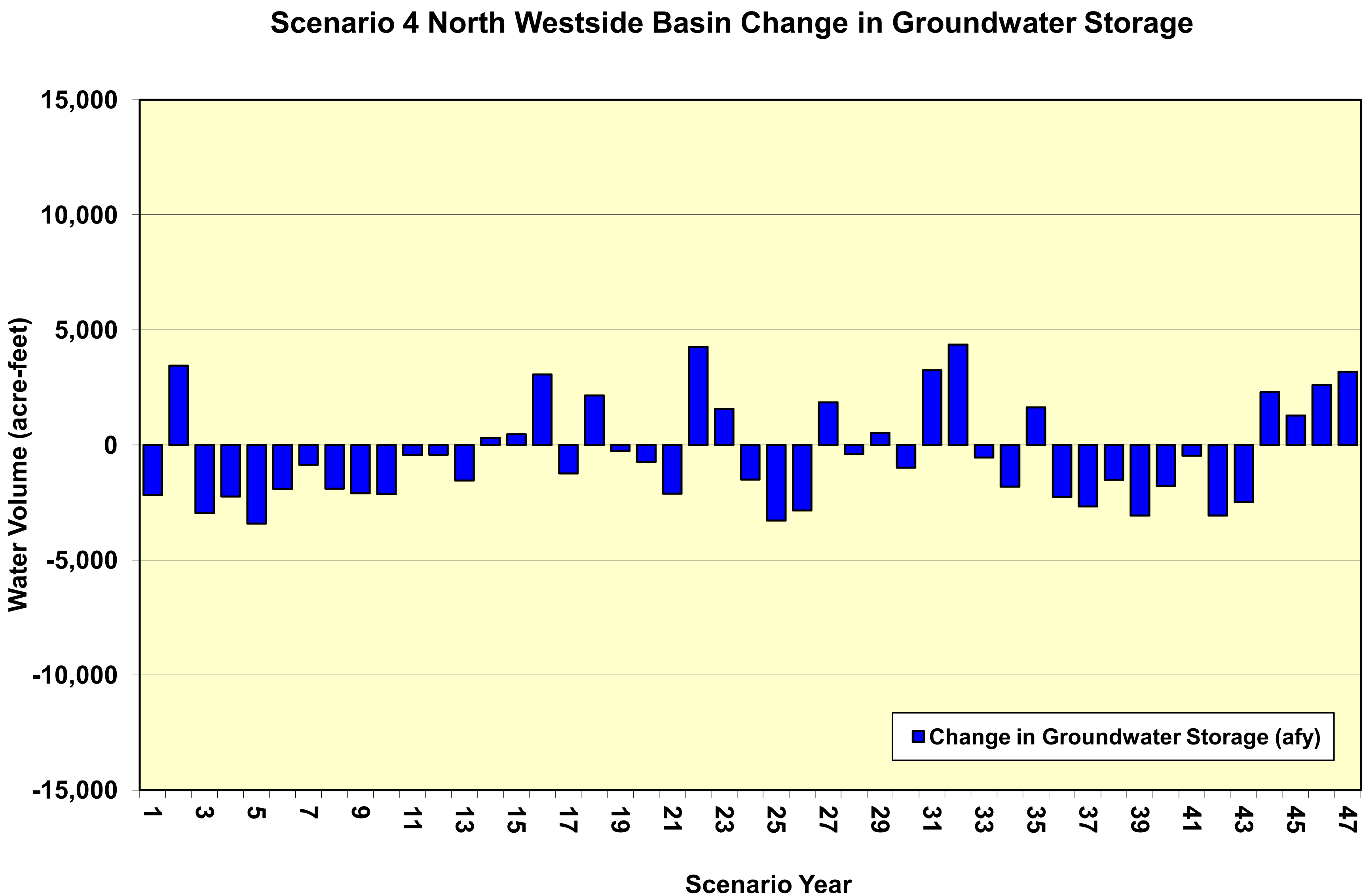
afy - acre-feet per year

GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Scenario 4 North Westside Basin Water Balance
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Rain + Irrigation (afy)
Seepage from Golden Gate Park Lakes (afy)
Seepage from Lake Merced (afy)
Inflow from Bay & Ocean (afy)
Outflow to Bay & Ocean (afy)
Wells - Pumping (afy)
Seepage to Lake Merced (afy)
From South Westside Basin (afy)
To South Westside Basin (afy)
Drains (afy)



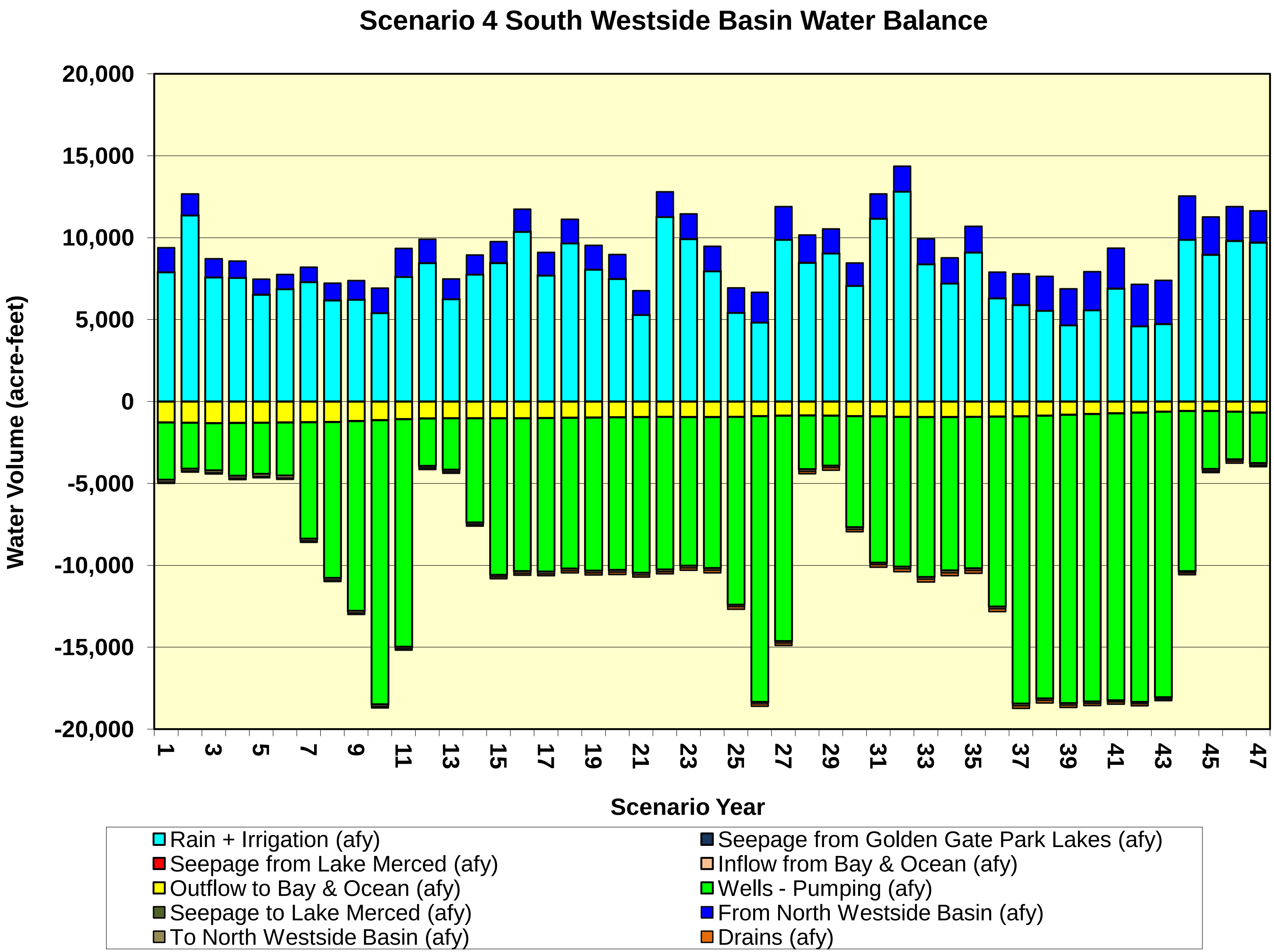
Scenario 4 North Westside Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Change in Groundwater Storage (afy)

Scenario 4 South Westside Basin Water Balance Summary

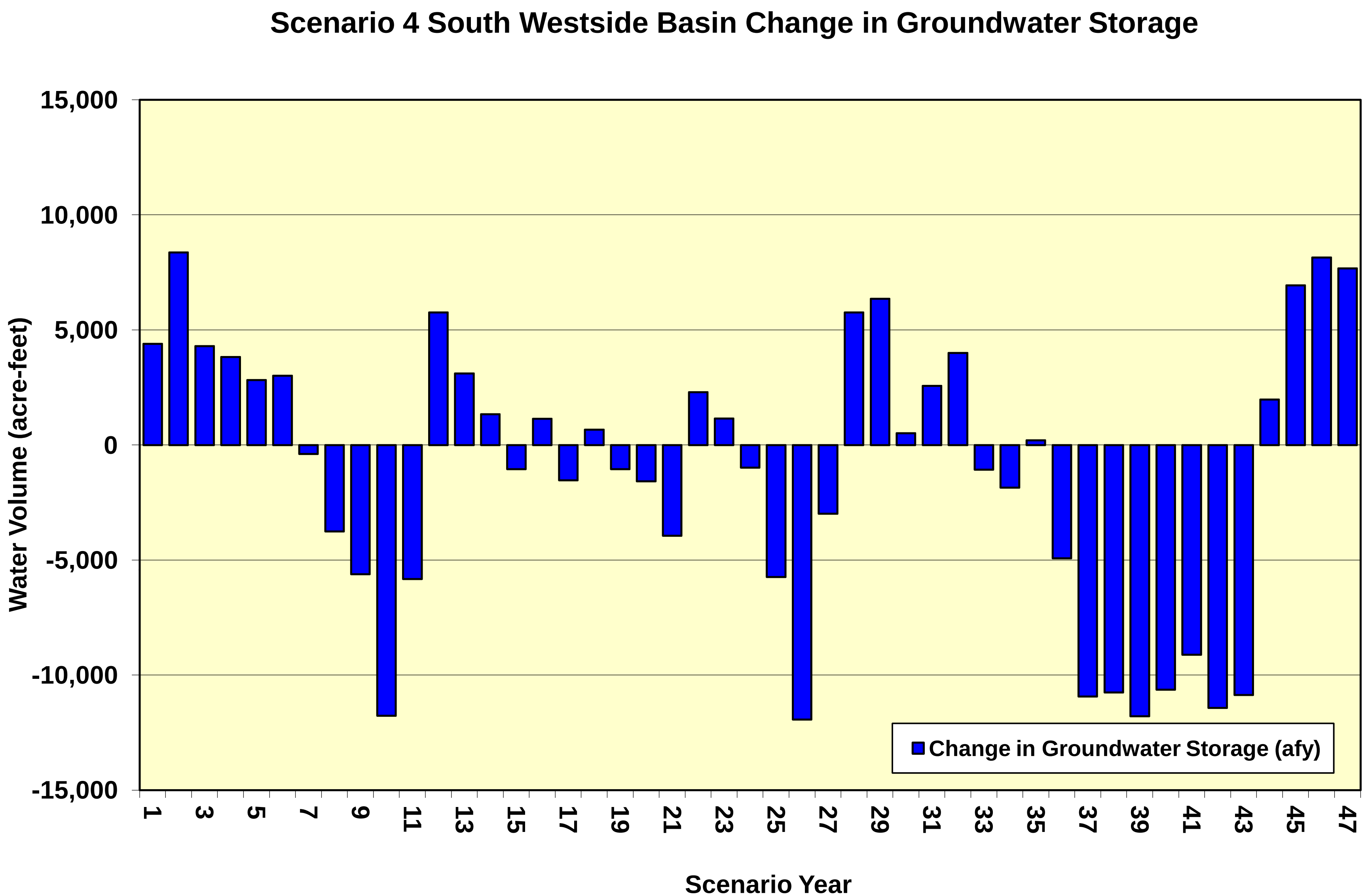
Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	From North to South Westside Basin (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	From South to North Westside Basin (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	3	0	7,904	0	1,480	-1,281	-3,496	0	-134	-71	4,405
2	3	0	11,370	0	1,306	-1,291	-2,802	0	-139	-72	8,374
3	3	0	7,580	0	1,130	-1,312	-2,884	0	-147	-74	4,297
4	3	0	7,559	0	1,022	-1,305	-3,228	0	-146	-75	3,830
5	3	0	6,531	0	939	-1,293	-3,128	0	-146	-77	2,829
6	3	0	6,873	0	880	-1,276	-3,243	0	-147	-77	3,012
7	3	0	7,302	0	895	-1,266	-7,105	0	-138	-78	-388
8	2	0	6,188	0	1,041	-1,240	-9,522	0	-134	-81	-3,746
9	2	0	6,225	0	1,152	-1,193	-11,582	0	-131	-84	-5,611
10	2	0	5,405	0	1,527	-1,134	-17,343	0	-128	-85	-11,756
11	2	0	7,611	0	1,744	-1,067	-13,894	0	-125	-87	-5,817
12	2	0	8,465	0	1,441	-1,025	-2,898	0	-123	-95	5,768
13	2	0	6,247	0	1,242	-1,017	-3,136	0	-122	-98	3,118
14	2	0	7,760	0	1,187	-1,022	-6,362	0	-120	-100	1,345
15	2	0	8,469	0	1,293	-1,022	-9,556	0	-121	-110	-1,046
16	2	0	10,364	0	1,376	-1,013	-9,343	0	-123	-118	1,145
17	2	0	7,695	0	1,408	-1,002	-9,375	0	-127	-125	-1,525
18	2	0	9,663	0	1,457	-985	-9,209	0	-125	-131	672
19	2	0	8,066	0	1,474	-979	-9,342	0	-127	-137	-1,044
20	2	0	7,492	0	1,484	-965	-9,313	0	-126	-142	-1,569
21	2	0	5,293	0	1,479	-944	-9,509	0	-123	-135	-3,938
22	2	0	11,269	0	1,537	-933	-9,319	0	-121	-136	2,299
23	2	0	9,930	0	1,527	-945	-9,082	0	-128	-145	1,159
24	2	0	7,964	0	1,507	-944	-9,226	0	-130	-150	-976
25	2	0	5,416	0	1,526	-927	-11,468	0	-126	-152	-5,728
26	2	0	4,834	0	1,830	-892	-17,441	0	-120	-140	-11,927
27	3	0	9,875	0	2,020	-852	-13,773	0	-117	-138	-2,983
28	3	0	8,482	0	1,678	-843	-3,287	0	-120	-146	5,766
29	3	0	9,043	0	1,487	-862	-3,048	0	-121	-150	6,353
30	3	0	7,065	0	1,392	-890	-6,783	0	-121	-154	513
31	4	0	11,168	0	1,511	-907	-8,926	0	-121	-158	2,571
32	4	0	12,815	0	1,558	-928	-9,156	0	-127	-162	4,002
33	4	0	8,388	0	1,554	-950	-9,757	0	-134	-167	-1,062
34	3	0	7,212	0	1,556	-941	-9,373	0	-132	-172	-1,846
35	3	0	9,104	0	1,587	-927	-9,253	0	-128	-176	210
36	3	0	6,306	0	1,599	-923	-11,595	0	-129	-176	-4,914
37	3	0	5,900	0	1,901	-895	-17,544	0	-125	-163	-10,924
38	4	0	5,544	0	2,095	-852	-17,266	0	-120	-153	-10,748
39	4	0	4,657	0	2,221	-807	-17,598	0	-117	-140	-11,780
40	5	0	5,576	0	2,343	-757	-17,547	0	-113	-130	-10,623
41	7	0	6,900	0	2,456	-713	-17,521	0	-111	-128	-9,110
42	8	0	4,601	0	2,541	-671	-17,664	0	-110	-120	-11,414
43	10	0	4,737	0	2,655	-620	-17,426	0	-106	-107	-10,857
44	12	0	9,876	0	2,656	-576	-9,778	0	-104	-103	1,983
45	15	0	8,968	0	2,290	-578	-3,536	0	-108	-107	6,944
46	17	0	9,812	0	2,077	-614	-2,917	0	-111	-107	8,156
47	19	0	9,710	0	1,920	-666	-3,086	0	-116	-107	7,674
Average (afy)	**4**	**0**	**7,770**	**0**	**1,617**	**-958**	**-9,354**	**0**	**-125**	**-122**	**-1,168**
Maximum (afy)	**19**	**0**	**12,815**	**0**	**2,656**	**-576**	**-2,802**	**0**	**-104**	**-71**	**8,374**
Minimum (afy)	**2**	**0**	**4,601**	**0**	**880**	**-1,312**	**-17,664**	**0**	**-147**	**-176**	**-11,927**

Key:
afy - acre-feet per year
GGP - Golden Gate Park

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.



Scenario 4 South Westside Basin Water Balance
20,000
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
-20,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Rain + Irrigation (afy)
Seepage from Golden Gate Park Lakes (afy)
Seepage from Lake Merced (afy)
Inflow from Bay & Ocean (afy)
Outflow to Bay & Ocean (afy)
Wells - Pumping (afy)
Seepage to Lake Merced (afy)
From North Westside Basin (afy)
To North Westside Basin (afy)
Drains (afy)



Scenario 4 South Westside Basin Change in Groundwater Storage
15,000
10,000
5,000
0
-5,000
-10,000
-15,000
Water Volume (acre-feet)
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
33
35
37
39
41
43
45
47
Scenario Year
Change in Groundwater Storage (afy)

Attachment 10.1-E

Model Scenario Water Balance Results – San Francisco, Daly City, Colma, South San Francisco, and San Bruno Water Budget Zones

Scenario 1 - Summary of Zone Budget Analyses in Subareas

Daly City — Zone 1

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	538	Storage	308	Storage	-230
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	4253	Pumpage	-4253
Drains	0	Drains	0	Drains	0
Recharge	1155	Recharge	0	Recharge	1155
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 2	660	To Zone 2	82	Zone 2	578
From Zone 8	2183	To Zone 8	71	Zone 8	2112
From Zone 11	199	To Zone 11	0	Zone 11	199

Colma — Zone 2

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	436	Storage	334	Storage	-103
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	716	Pumpage	-716
Drains	0	Drains	0	Drains	0
Recharge	917	Recharge	0	Recharge	917
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 1	82	To Zone 1	659	Zone 1	-577
From Zone 3	479	To Zone 3	468	Zone 3	11
From Zone 11	269	To Zone 11	0	Zone 11	269

Cal Water — Zone 3

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	393	Storage	253	Storage	-140
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	1535	Pumpage	-1535
Drains	0	Drains	0	Drains	0
Recharge	1453	Recharge	0	Recharge	1453
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 2	467	To Zone 2	478	Zone 2	-12
From Zone 4	376	To Zone 4	1023	Zone 4	-647
From Zone 5	180	To Zone 5	139	Zone 5	41
From Zone 11	562	To Zone 11	0	Zone 11	562

San Bruno — Zone 4

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	213	Storage	229	Storage	15
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	2104	Pumpage	-2104
Drains	0	Drains	0	Drains	0
Recharge	796	Recharge	0	Recharge	796
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 3	1023	To Zone 3	373	Zone 3	650
From Zone 5	498	To Zone 5	308	Zone 5	190
From Zone 6	870	To Zone 6	387	Zone 6	484
From Zone 11	3	To Zone 11	0	Zone 11	3

Bay Plain/Bay — Zone 5

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	59	Storage	68	Storage	9
Constant Head	6	Constant Head	110	Constant Head	-103
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	93	Drains	-93
Recharge	332	Recharge	0	Recharge	332
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 3	139	To Zone 3	179	Zone 3	-40
From Zone 4	308	To Zone 4	498	Zone 4	-190
From Zone 6	283	To Zone 6	265	Zone 6	18
From Zone 7	112	To Zone 7	26	Zone 7	86

Millbrae — Zone 6

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	168	Storage	153	Storage	-15
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	110	Pumpage	-110
Drains	0	Drains	0	Drains	0
Recharge	557	Recharge	0	Recharge	557
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 4	387	To Zone 4	870	Zone 4	-484
From Zone 5	265	To Zone 5	283	Zone 5	-18
From Zone 7	65	To Zone 7	25	Zone 7	40

Burlingame — Zone 7

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	361	Storage	290	Storage	-70
Constant Head	0	Constant Head	12	Constant Head	-12
Pumpage	0	Pumpage	468	Pumpage	-468
Drains	0	Drains	0	Drains	0
Recharge	537	Recharge	0	Recharge	537
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 5	26	To Zone 5	112	Zone 5	-86
From Zone 6	25	To Zone 6	65	Zone 6	-40

Lake Merced/GGP — Zone 8

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	1652	Storage	1497	Storage	-155
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	551	Pumpage	1618	Pumpage	-1067
Drains	0	Drains	0	Drains	0
Recharge	5979	Recharge	0	Recharge	5979
Lake Seepage	544	Lake Seepage	649	Lake Seepage	-105
From Zone 1	71	To Zone 1	2175	Zone 1	-2104
From Zone 10	257	To Zone 10	3139	Zone 10	-2882
From Zone 11	24	To Zone 11	1	Zone 11	23

Ocean — Zone 10

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	50	Storage	44	Storage	-7
Constant Head	5	Constant Head	4055	Constant Head	-4050
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	0	Drains	0
Recharge	0	Recharge	0	Recharge	0
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 8	3139	To Zone 8	257	Zone 8	2882
From Zone 11	1182	To Zone 11	21	Zone 11	1161

Thornton Beach — Zone 11

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	594	Storage	480	Storage	-114
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	0	Drains	0
Recharge	2101	Recharge	0	Recharge	2101
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 1	0	To Zone 1	199	Zone 1	-199
From Zone 2	0	To Zone 2	269	Zone 2	-269
From Zone 3	0	To Zone 3	562	Zone 3	-562
From Zone 4	0	To Zone 4	3	Zone 4	-3
From Zone 8	1	To Zone 8	24	Zone 8	-23
From Zone 10	21	To Zone 10	1180	Zone 10	-1159

Subareas 1, 2, 3, 4, and 8

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	3233	Storage	2620	Storage	-613
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	551	Pumpage	10227	Pumpage	-9676
Drains	0	Drains	0	Drains	0
Recharge	10301	Recharge	0	Recharge	10301
Lake Seepage	544	Lake Seepage	649	Lake Seepage	-105
Ocean	257	Ocean	3139	Ocean	-2882
Bay Plain/Bay	678	Bay Plain/Bay	447	Bay Plain/Bay	231
Millbrae	870	Millbrae	387	Millbrae	484
Thornton Beach	1057	Thornton Beach	1	Thornton Beach	1056

Notes: (1) The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flow out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced. Negative storage values represent losses of storage from the aquifer, while positive storage values represent gains in storage in the aquifer.

(2) Water balance components represent annual average values on a water year basis, from October to September. The first three months of the simulation period, which represent July through September conditions, are omitted from the annual averages because they represent only a partial water year. The volumes presented represent the 47 complete water years for the simulation period.

(3) Volumes are calculated using the USGS program ZONEBUDGET (Harbaugh, 1990). As noted in Harbaugh (1990), ZONEBUDGET tabulates boundary conditions differently from how they are reported in the MODFLOW output file. Also, ZONEBUDGET calculates volumes using the volumetric flow rate rather than the cumulative volume. Therefore, the water balance presented in Attachment 10.1-C, calculated using the cumulative volume as reported in the MODFLOW output file, may differ from the results reported on this table. However, the volumes calculated by the two methods are correct with respect to each method.

(4) [green] The five water budget areas that are collectively referred to as "Developed Subbasin" as defined by HydroFocus (2011): San Francisco (Lake Merced and Golden Gate Park), Daly City, Colma, South San Francisco, and San Bruno.

[pink] The five water budget areas that are adjacent to the Developed Subbasin as defined by HydroFocus (2011): San Francisco Bay Plain, Millbrae, Burlingame, Pacific Ocean, and Thornton Beach (across the Serra Fault).

Scenario 2 - Summary of Zone Budget Analyses in Subareas

	Daly City	Zone 1	Colma	Zone 2	Cal Water	Zone 3	San Bruno	Zone 4	Bay Plain/Bay	Zone 5	Millbrae	Zone 6	Burlingame	Zone 7	Lake Merced/GGP	Zone 8	Ocean	Zone 10	Thornton Beach	Zone 11	Subareas 1, 2, 3, 4, and 8	
IN (acre-feet/year)	Storage	1116	Storage	737	Storage	926	Storage	496	Storage	131	Storage	225	Storage	360	Storage	1704	Storage	54	Storage	634	Storage	4979
	Constant Head	0	Constant Head	0	Constant Head	0	Constant Head	0	Constant Head	4	Constant Head	0	Constant Head	0	Constant Head	0	Constant Head	6	Constant Head	0	Constant Head	0
	Pumpage	0	Pumpage	0	Pumpage	0	Pumpage	0	Pumpage	0	Pumpage	0	Pumpage	0	Pumpage	551	Pumpage	0	Pumpage	0	Pumpage	551
	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0
	Recharge	1155	Recharge	917	Recharge	1453	Recharge	796	Recharge	332	Recharge	557	Recharge	537	Recharge	5979	Recharge	0	Recharge	2101	Recharge	10301
	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	496	Lake Seepage	0	Lake Seepage	0	Lake Seepage	496
	From Zone 2	461	From Zone 1	216	From Zone 2	565	From Zone 3	725	From Zone 3	130	From Zone 4	350	From Zone 5	20	From Zone 1	63	From Zone 8	3333	From Zone 1	0	Ocean	228
	From Zone 8	1958	From Zone 3	560	From Zone 4	404	From Zone 5	449	From Zone 4	282	From Zone 5	243	From Zone 6	28	From Zone 10	228	From Zone 11	1220	From Zone 2	0	Bay Plain/Bay	617
	From Zone 11	184	From Zone 11	268	From Zone 5	168	From Zone 6	787	From Zone 6	254	From Zone 7	60			From Zone 11	21			From Zone 3	0	Millbrae	787
					From Zone 11	576	From Zone 11	3	From Zone 7	110									From Zone 4	0	Thornton Beach	1052
																			From Zone 8	1		
																			From Zone 10	21		
OUT (acre-feet/year)	Storage	705	Storage	457	Storage	552	Storage	412	Storage	121	Storage	188	Storage	293	Storage	1523	Storage	44	Storage	497	Storage	3649
	Constant Head	0	Constant Head	0	Constant Head	0	Constant Head	0	Constant Head	122	Constant Head	0	Constant Head	13	Constant Head	0	Constant Head	4319	Constant Head	0	Constant Head	0
	Pumpage	3921	Pumpage	1198	Pumpage	2120	Pumpage	1836	Pumpage	0	Pumpage	179	Pumpage	468	Pumpage	1618	Pumpage	0	Pumpage	0	Pumpage	10692
	Drains	0	Drains	0	Drains	1	Drains	0	Drains	122	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0	Drains	1
	Recharge	0	Recharge	0	Recharge	0	Recharge	0	Recharge	0	Recharge	0	Recharge	0	Recharge	0	Recharge	0	Recharge	0	Recharge	0
	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	645	Lake Seepage	0	Lake Seepage	0	Lake Seepage	645
	To Zone 2	207	To Zone 1	482	To Zone 2	558	To Zone 3	398	To Zone 3	166	To Zone 4	787	To Zone 5	110	To Zone 1	1923	To Zone 8	228	To Zone 1	184	Ocean	3333
	To Zone 8	63	To Zone 3	566	To Zone 4	725	To Zone 5	282	To Zone 4	449	To Zone 5	254	To Zone 6	60	To Zone 10	3333	To Zone 11	21	To Zone 2	267	Bay Plain/Bay	412
	To Zone 11	0	To Zone 11	0	To Zone 5	130	To Zone 6	350	To Zone 6	243	To Zone 7	28			To Zone 11	2			To Zone 3	574	Millbrae	350
					To Zone 11	0	To Zone 11	0	To Zone 7	20									To Zone 4	3	Thornton Beach	2
																			To Zone 8	22		
																			To Zone 10	1211		
NET (acre-feet/year)	Storage	-411	Storage	-280	Storage	-374	Storage	-84	Storage	-10	Storage	-37	Storage	-67	Storage	-181	Storage	-10	Storage	-136	Storage	-1330
	Constant Head	0	Constant Head	0	Constant Head	0	Constant Head	0	Constant Head	-118	Constant Head	0	Constant Head	-13	Constant Head	0	Constant Head	-4313	Constant Head	0	Constant Head	0
	Pumpage	-3921	Pumpage	-1198	Pumpage	-2120	Pumpage	-1836	Pumpage	0	Pumpage	-179	Pumpage	-468	Pumpage	-1067	Pumpage	0	Pumpage	0	Pumpage	-10141
	Drains	0	Drains	0	Drains	-1	Drains	0	Drains	-122	Drains	0	Drains	0	Drains	0	Drains	0	Drains	0	Drains	-1
	Recharge	1155	Recharge	917	Recharge	1453	Recharge	796	Recharge	332	Recharge	557	Recharge	537	Recharge	5979	Recharge	0	Recharge	2101	Recharge	10301
	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	0	Lake Seepage	-149	Lake Seepage	0	Lake Seepage	0	Lake Seepage	-149
	Zone 2	254	Zone 1	-266	Zone 2	8	Zone 3	328	Zone 3	-35	Zone 4	-437	Zone 5	-90	Zone 1	-1859	Zone 8	3104	Zone 1	-184	Ocean	-3104
	Zone 8	1895	Zone 3	-7	Zone 4	-322	Zone 5	167	Zone 4	-167	Zone 5	-11	Zone 6	-32	Zone 10	-3104	Zone 11	1199	Zone 2	-267	Bay Plain/Bay	205
	Zone 11	184	Zone 11	268	Zone 5	38	Zone 6	437	Zone 6	11	Zone 7	32			Zone 11	20			Zone 3	-574	Millbrae	437
					Zone 11	576	Zone 11	3	Zone 7	90									Zone 4	-3	Thornton Beach	1051
																			Zone 8	-20		
																			Zone 10	-1190		

Notes: **(1) The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flow out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced. Negative storage values represent losses of storage from the aquifer, while positive storage values represent gains in storage in the aquifer.**

(2) Water balance components represent annual average values on a water year basis, from October to September. The first three months of the simulation period, which represent July through September conditions, are omitted from the annual averages because they represent only a partial water year. The volumes presented represent the 47 complete water years for the simulation period.

(3) Volumes are calculated using the USGS program ZONEBUDGET (Harbaugh, 1990). As noted in Harbaugh (1990), ZONEBUDGET tabulates boundary conditions differently from how they are reported in the MODFLOW output file. Also, ZONEBUDGET calculates volumes using the volumetric flow rate rather than the cumulative volume. Therefore, the water balance presented in Attachment 10.1-C, calculated using the cumulative volume as reported in the MODFLOW output file, may differ from the results reported on this table. However, the volumes calculated by the two methods are correct with respect to each method.

(4) [green] **The five water budget areas that are collectively referred to as "Developed Subbasin" as defined by HydroFocus (2011): San Francisco (Lake Merced and Golden Gate Park), Daly City, Colma, South San Francisco, and San Bruno.**

[pink] **The five water budget areas that are adjacent to the Developed Subbasin as defined by HydroFocus (2011): San Francisco Bay Plain, Millbrae, Burlingame, Pacific Ocean, and Thornton Beach (across the Serra Fault).**

Scenario 3a - Summary of Zone Budget Analyses in Subareas

Daly City — Zone 1

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	613	Storage	285	Storage	-328
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	4253	Pumpage	-4253
Drains	0	Drains	0	Drains	0
Recharge	1155	Recharge	0	Recharge	1155
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 2	754	To Zone 2	86	Zone 2	668
From Zone 8	1983	To Zone 8	67	Zone 8	1915
From Zone 11	209	To Zone 11	0	Zone 11	209

Colma — Zone 2

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	458	Storage	318	Storage	-140
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	716	Pumpage	-716
Drains	0	Drains	0	Drains	0
Recharge	917	Recharge	0	Recharge	917
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 1	86	To Zone 1	749	Zone 1	-663
From Zone 3	501	To Zone 3	446	Zone 3	56
From Zone 11	275	To Zone 11	0	Zone 11	275

Cal Water — Zone 3

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	413	Storage	242	Storage	-170
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	1535	Pumpage	-1535
Drains	0	Drains	0	Drains	0
Recharge	1453	Recharge	0	Recharge	1453
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 2	443	To Zone 2	499	Zone 2	-57
From Zone 4	378	To Zone 4	1016	Zone 4	-638
From Zone 5	180	To Zone 5	137	Zone 5	43
From Zone 11	566	To Zone 11	0	Zone 11	566

San Bruno — Zone 4

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	216	Storage	225	Storage	9
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	2104	Pumpage	-2104
Drains	0	Drains	0	Drains	0
Recharge	796	Recharge	0	Recharge	796
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 3	1016	To Zone 3	375	Zone 3	641
From Zone 5	499	To Zone 5	308	Zone 5	191
From Zone 6	872	To Zone 6	388	Zone 6	485
From Zone 11	3	To Zone 11	0	Zone 11	3

Bay Plain/Bay — Zone 5

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	60	Storage	67	Storage	6
Constant Head	7	Constant Head	110	Constant Head	-103
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	93	Drains	-93
Recharge	332	Recharge	0	Recharge	332
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 3	137	To Zone 3	179	Zone 3	-42
From Zone 4	308	To Zone 4	499	Zone 4	-191
From Zone 6	284	To Zone 6	266	Zone 6	18
From Zone 7	112	To Zone 7	26	Zone 7	86

Millbrae — Zone 6

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	168	Storage	152	Storage	-16
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	110	Pumpage	-110
Drains	0	Drains	0	Drains	0
Recharge	557	Recharge	0	Recharge	557
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 4	388	To Zone 4	872	Zone 4	-485
From Zone 5	266	To Zone 5	284	Zone 5	-18
From Zone 7	65	To Zone 7	25	Zone 7	40

Burlingame — Zone 7

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	361	Storage	290	Storage	-71
Constant Head	0	Constant Head	12	Constant Head	-12
Pumpage	0	Pumpage	468	Pumpage	-468
Drains	0	Drains	0	Drains	0
Recharge	537	Recharge	0	Recharge	537
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 5	26	To Zone 5	112	Zone 5	-86
From Zone 6	25	To Zone 6	65	Zone 6	-40

Lake Merced/GGP — Zone 8

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	2079	Storage	1407	Storage	-672
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	551	Pumpage	4990	Pumpage	-4439
Drains	0	Drains	0	Drains	0
Recharge	5979	Recharge	0	Recharge	5979
Lake Seepage	573	Lake Seepage	566	Lake Seepage	8
From Zone 1	67	To Zone 1	1974	Zone 1	-1907
From Zone 10	560	To Zone 10	904	Zone 10	-344
From Zone 11	30	To Zone 11	0	Zone 11	30

Ocean — Zone 10

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	58	Storage	40	Storage	-18
Constant Head	381	Constant Head	1885	Constant Head	-1505
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	0	Drains	0
Recharge	0	Recharge	0	Recharge	0
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 8	904	To Zone 8	560	Zone 8	344
From Zone 11	1166	To Zone 11	23	Zone 11	1143

Thornton Beach — Zone 11

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	599	Storage	477	Storage	-122
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	0	Drains	0
Recharge	2101	Recharge	0	Recharge	2101
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 1	0	To Zone 1	209	Zone 1	-209
From Zone 2	0	To Zone 2	275	Zone 2	-275
From Zone 3	0	To Zone 3	566	Zone 3	-566
From Zone 4	0	To Zone 4	3	Zone 4	-3
From Zone 8	0	To Zone 8	31	Zone 8	-30
From Zone 10	23	To Zone 10	1163	Zone 10	-1140

Subareas 1, 2, 3, 4, and 8

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	3779	Storage	2478	Storage	-1301
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	551	Pumpage	13599	Pumpage	-13048
Drains	0	Drains	0	Drains	0
Recharge	10301	Recharge	0	Recharge	10301
Lake Seepage	573	Lake Seepage	566	Lake Seepage	8
Ocean	560	Ocean	904	Ocean	-344
Bay Plain/Bay	679	Bay Plain/Bay	446	Bay Plain/Bay	234
Millbrae	872	Millbrae	388	Millbrae	485
Thornton Beach	1084	Thornton Beach	0	Thornton Beach	1083

Notes: (1) The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flow out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced. Negative storage values represent losses of storage from the aquifer, while positive storage values represent gains in storage in the aquifer.

(2) Water balance components represent annual average values on a water year basis, from October to September. The first three months of the simulation period, which represent July through September conditions, are omitted from the annual averages because they represent only a partial water year. The volumes presented represent the 47 complete water years for the simulation period.

(3) Volumes are calculated using the USGS program ZONEBUDGET (Harbaugh, 1990). As noted in Harbaugh (1990), ZONEBUDGET tabulates boundary conditions differently from how they are reported in the MODFLOW output file. Also, ZONEBUDGET calculates volumes using the volumetric flow rate rather than the cumulative volume. Therefore, the water balance presented in Attachment 10.1-C, calculated using the cumulative volume as reported in the MODFLOW output file, may differ from the results reported on this table. However, the volumes calculated by the two methods are correct with respect to each method.

(4) [green] The five water budget areas that are collectively referred to as "Developed Subbasin" as defined by HydroFocus (2011): San Francisco (Lake Merced and Golden Gate Park), Daly City, Colma, South San Francisco, and San Bruno.

[pink] The five water budget areas that are adjacent to the Developed Subbasin as defined by HydroFocus (2011): San Francisco Bay Plain, Millbrae, Burlingame, Pacific Ocean, and Thornton Beach (across the Serra Fault).

Scenario 3b - Summary of Zone Budget Analyses in Subareas

Daly City — Zone 1

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	611	Storage	286	Storage	-326
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	4253	Pumpage	-4253
Drains	0	Drains	0	Drains	0
Recharge	1155	Recharge	0	Recharge	1155
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 2	752	To Zone 2	86	Zone 2	667
From Zone 8	1987	To Zone 8	67	Zone 8	1919
From Zone 11	209	To Zone 11	0	Zone 11	209

Colma — Zone 2

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	457	Storage	318	Storage	-139
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	716	Pumpage	-716
Drains	0	Drains	0	Drains	0
Recharge	917	Recharge	0	Recharge	917
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 1	86	To Zone 1	748	Zone 1	-661
From Zone 3	501	To Zone 3	446	Zone 3	55
From Zone 11	275	To Zone 11	0	Zone 11	275

Cal Water — Zone 3

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	412	Storage	243	Storage	-170
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	1535	Pumpage	-1535
Drains	0	Drains	0	Drains	0
Recharge	1453	Recharge	0	Recharge	1453
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 2	443	To Zone 2	499	Zone 2	-56
From Zone 4	378	To Zone 4	1016	Zone 4	-638
From Zone 5	180	To Zone 5	137	Zone 5	43
From Zone 11	566	To Zone 11	0	Zone 11	566

San Bruno — Zone 4

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	216	Storage	226	Storage	9
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	2104	Pumpage	-2104
Drains	0	Drains	0	Drains	0
Recharge	796	Recharge	0	Recharge	796
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 3	1016	To Zone 3	375	Zone 3	642
From Zone 5	499	To Zone 5	308	Zone 5	191
From Zone 6	872	To Zone 6	388	Zone 6	485
From Zone 11	3	To Zone 11	0	Zone 11	3

Bay Plain/Bay — Zone 5

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	60	Storage	67	Storage	6
Constant Head	7	Constant Head	110	Constant Head	-103
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	93	Drains	-93
Recharge	332	Recharge	0	Recharge	332
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 3	137	To Zone 3	179	Zone 3	-42
From Zone 4	308	To Zone 4	499	Zone 4	-191
From Zone 6	284	To Zone 6	266	Zone 6	18
From Zone 7	112	To Zone 7	26	Zone 7	86

Millbrae — Zone 6

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	168	Storage	152	Storage	-16
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	110	Pumpage	-110
Drains	0	Drains	0	Drains	0
Recharge	557	Recharge	0	Recharge	557
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 4	388	To Zone 4	872	Zone 4	-485
From Zone 5	266	To Zone 5	284	Zone 5	-18
From Zone 7	65	To Zone 7	25	Zone 7	40

Burlingame — Zone 7

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	361	Storage	290	Storage	-70
Constant Head	0	Constant Head	12	Constant Head	-12
Pumpage	0	Pumpage	468	Pumpage	-468
Drains	0	Drains	0	Drains	0
Recharge	537	Recharge	0	Recharge	537
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 5	26	To Zone 5	112	Zone 5	-86
From Zone 6	25	To Zone 6	65	Zone 6	-40

Lake Merced/GGP — Zone 8

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	1922	Storage	1292	Storage	-630
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	626	Pumpage	4906	Pumpage	-4281
Drains	0	Drains	0	Drains	0
Recharge	5979	Recharge	0	Recharge	5979
Lake Seepage	576	Lake Seepage	572	Lake Seepage	4
From Zone 1	67	To Zone 1	1978	Zone 1	-1910
From Zone 10	466	To Zone 10	919	Zone 10	-453
From Zone 11	30	To Zone 11	0	Zone 11	30

Ocean — Zone 10

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	44	Storage	26	Storage	-17
Constant Head	294	Constant Head	1908	Constant Head	-1614
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	0	Drains	0
Recharge	0	Recharge	0	Recharge	0
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 8	919	To Zone 8	466	Zone 8	453
From Zone 11	1166	To Zone 11	22	Zone 11	1143

Thornton Beach — Zone 11

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	599	Storage	477	Storage	-122
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	0	Drains	0
Recharge	2101	Recharge	0	Recharge	2101
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 1	0	To Zone 1	209	Zone 1	-209
From Zone 2	0	To Zone 2	275	Zone 2	-275
From Zone 3	0	To Zone 3	566	Zone 3	-566
From Zone 4	0	To Zone 4	3	Zone 4	-3
From Zone 8	0	To Zone 8	30	Zone 8	-30
From Zone 10	23	To Zone 10	1163	Zone 10	-1141

Subareas 1, 2, 3, 4, and 8

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	3619	Storage	2363	Storage	-1256
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	626	Pumpage	13515	Pumpage	-12890
Drains	0	Drains	0	Drains	0
Recharge	10301	Recharge	0	Recharge	10301
Lake Seepage	576	Lake Seepage	572	Lake Seepage	4
Ocean	466	Ocean	919	Ocean	-453
Bay Plain/Bay	679	Bay Plain/Bay	446	Bay Plain/Bay	234
Millbrae	872	Millbrae	388	Millbrae	485
Thornton Beach	1083	Thornton Beach	0	Thornton Beach	1083

Notes: (1) The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flow out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced. Negative storage values represent losses of storage from the aquifer, while positive storage values represent gains in storage in the aquifer.

(2) Water balance components represent annual average values on a water year basis, from October to September. The first three months of the simulation period, which represent July through September conditions, are omitted from the annual averages because they represent only a partial water year. The volumes presented represent the 47 complete water years for the simulation period.

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[pink] The five water budget areas that are adjacent to the Developed Subbasin as defined by HydroFocus (2011): San Francisco Bay Plain, Millbrae, Burlingame, Pacific Ocean, and Thornton Beach (across the Serra Fault).

Scenario 4 - Summary of Zone Budget Analyses in Subareas

Daly City — Zone 1

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	1050	Storage	659	Storage	-391
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	3421	Pumpage	-3421
Drains	0	Drains	0	Drains	0
Recharge	1155	Recharge	0	Recharge	1155
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 2	367	To Zone 2	237	Zone 2	130
From Zone 8	1614	To Zone 8	55	Zone 8	1559
From Zone 11	175	To Zone 11	0	Zone 11	175

Colma — Zone 2

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	736	Storage	468	Storage	-267
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	1243	Pumpage	-1243
Drains	0	Drains	0	Drains	0
Recharge	917	Recharge	0	Recharge	917
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 1	248	To Zone 1	382	Zone 1	-135
From Zone 3	539	To Zone 3	593	Zone 3	-54
From Zone 11	245	To Zone 11	0	Zone 11	245

Cal Water — Zone 3

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	931	Storage	558	Storage	-372
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	2120	Pumpage	-2120
Drains	0	Drains	1	Drains	-1
Recharge	1453	Recharge	0	Recharge	1453
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 2	593	To Zone 2	536	Zone 2	57
From Zone 4	401	To Zone 4	717	Zone 4	-317
From Zone 5	169	To Zone 5	132	Zone 5	37
From Zone 11	524	To Zone 11	0	Zone 11	524

San Bruno — Zone 4

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	497	Storage	410	Storage	-87
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	1836	Pumpage	-1836
Drains	0	Drains	0	Drains	0
Recharge	796	Recharge	0	Recharge	796
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 3	717	To Zone 3	395	Zone 3	323
From Zone 5	450	To Zone 5	282	Zone 5	168
From Zone 6	789	To Zone 6	351	Zone 6	438
From Zone 11	3	To Zone 11	0	Zone 11	3

Bay Plain/Bay — Zone 5

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	131	Storage	121	Storage	-10
Constant Head	4	Constant Head	121	Constant Head	-117
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	122	Drains	-122
Recharge	332	Recharge	0	Recharge	332
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 3	132	To Zone 3	166	Zone 3	-35
From Zone 4	282	To Zone 4	450	Zone 4	-168
From Zone 6	254	To Zone 6	244	Zone 6	10
From Zone 7	110	To Zone 7	20	Zone 7	90

Millbrae — Zone 6

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	226	Storage	188	Storage	-38
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	179	Pumpage	-179
Drains	0	Drains	0	Drains	0
Recharge	557	Recharge	0	Recharge	557
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 4	351	To Zone 4	789	Zone 4	-438
From Zone 5	244	To Zone 5	254	Zone 5	-10
From Zone 7	60	To Zone 7	28	Zone 7	32

Burlingame — Zone 7

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	360	Storage	293	Storage	-67
Constant Head	0	Constant Head	13	Constant Head	-13
Pumpage	0	Pumpage	468	Pumpage	-468
Drains	0	Drains	0	Drains	0
Recharge	537	Recharge	0	Recharge	537
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 5	20	To Zone 5	110	Zone 5	-90
From Zone 6	28	To Zone 6	60	Zone 6	-32

Lake Merced/GGP — Zone 8

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	1881	Storage	1325	Storage	-556
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	626	Pumpage	4906	Pumpage	-4281
Drains	0	Drains	0	Drains	0
Recharge	5979	Recharge	0	Recharge	5979
Lake Seepage	592	Lake Seepage	452	Lake Seepage	141
From Zone 1	55	To Zone 1	1578	Zone 1	-1523
From Zone 10	346	To Zone 10	1241	Zone 10	-895
From Zone 11	24	To Zone 11	1	Zone 11	23

Ocean — Zone 10

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	46	Storage	28	Storage	-19
Constant Head	169	Constant Head	2093	Constant Head	-1924
Pumpage	0	Pumpage	0	Pumpage	0
Drains	0	Drains	0	Drains	0
Recharge	0	Recharge	0	Recharge	0
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 8	1241	To Zone 8	346	Zone 8	895
From Zone 11	1031	To Zone 11	21	Zone 11	1010

Thornton Beach — Zone 11

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	833	Storage	486	Storage	-346
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	0	Pumpage	484	Pumpage	-484
Drains	0	Drains	0	Drains	0
Recharge	2101	Recharge	0	Recharge	2101
Lake Seepage	0	Lake Seepage	0	Lake Seepage	0
From Zone 1	0	To Zone 1	175	Zone 1	-175
From Zone 2	0	To Zone 2	244	Zone 2	-244
From Zone 3	0	To Zone 3	522	Zone 3	-522
From Zone 4	0	To Zone 4	3	Zone 4	-3
From Zone 8	1	To Zone 8	24	Zone 8	-23
From Zone 10	21	To Zone 10	1017	Zone 10	-996

Subareas 1, 2, 3, 4, and 8

IN (acre-feet/year)		OUT (acre-feet/year)		NET (acre-feet/year)	
Storage	5095	Storage	3422	Storage	-1674
Constant Head	0	Constant Head	0	Constant Head	0
Pumpage	626	Pumpage	13526	Pumpage	-12901
Drains	0	Drains	1	Drains	-1
Recharge	10301	Recharge	0	Recharge	10301
Lake Seepage	592	Lake Seepage	452	Lake Seepage	141
Ocean	346	Ocean	1241	Ocean	-895
Bay Plain/Bay	619	Bay Plain/Bay	413	Bay Plain/Bay	205
Millbrae	789	Millbrae	351	Millbrae	438
Thornton Beach	970	Thornton Beach	1	Thornton Beach	969

Notes: (1) The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flow out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced. Negative storage values represent losses of storage from the aquifer, while positive storage values represent gains in storage in the aquifer.

(2) Water balance components represent annual average values on a water year basis, from October to September. The first three months of the simulation period, which represent July through September conditions, are omitted from the annual averages because they represent only a partial water year. The volumes presented represent the 47 complete water years for the simulation period.

(3) Volumes are calculated using the USGS program ZONEBUDGET (Harbaugh, 1990). As noted in Harbaugh (1990), ZONEBUDGET tabulates boundary conditions differently from how they are reported in the MODFLOW output file. Also, ZONEBUDGET calculates volumes using the volumetric flow rate rather than the cumulative volume. Therefore, the water balance presented in Attachment 10.1-C, calculated using the cumulative volume as reported in the MODFLOW output file, may differ from the results reported on this table. However, the volumes calculated by the two methods are correct with respect to each method.

(4) [green] The five water budget areas that are collectively referred to as "Developed Subbasin" as defined by HydroFocus (2011): San Francisco (Lake Merced and Golden Gate Park), Daly City, Colma, South San Francisco, and San Bruno.

[pink] The five water budget areas that are adjacent to the Developed Subbasin as defined by HydroFocus (2011): San Francisco Bay Plain, Millbrae, Burlingame, Pacific Ocean, and Thornton Beach (across the Serra Fault).

Attachment 10.1-F

Model Scenario Groundwater Elevation Contour Maps for Selected Time Periods

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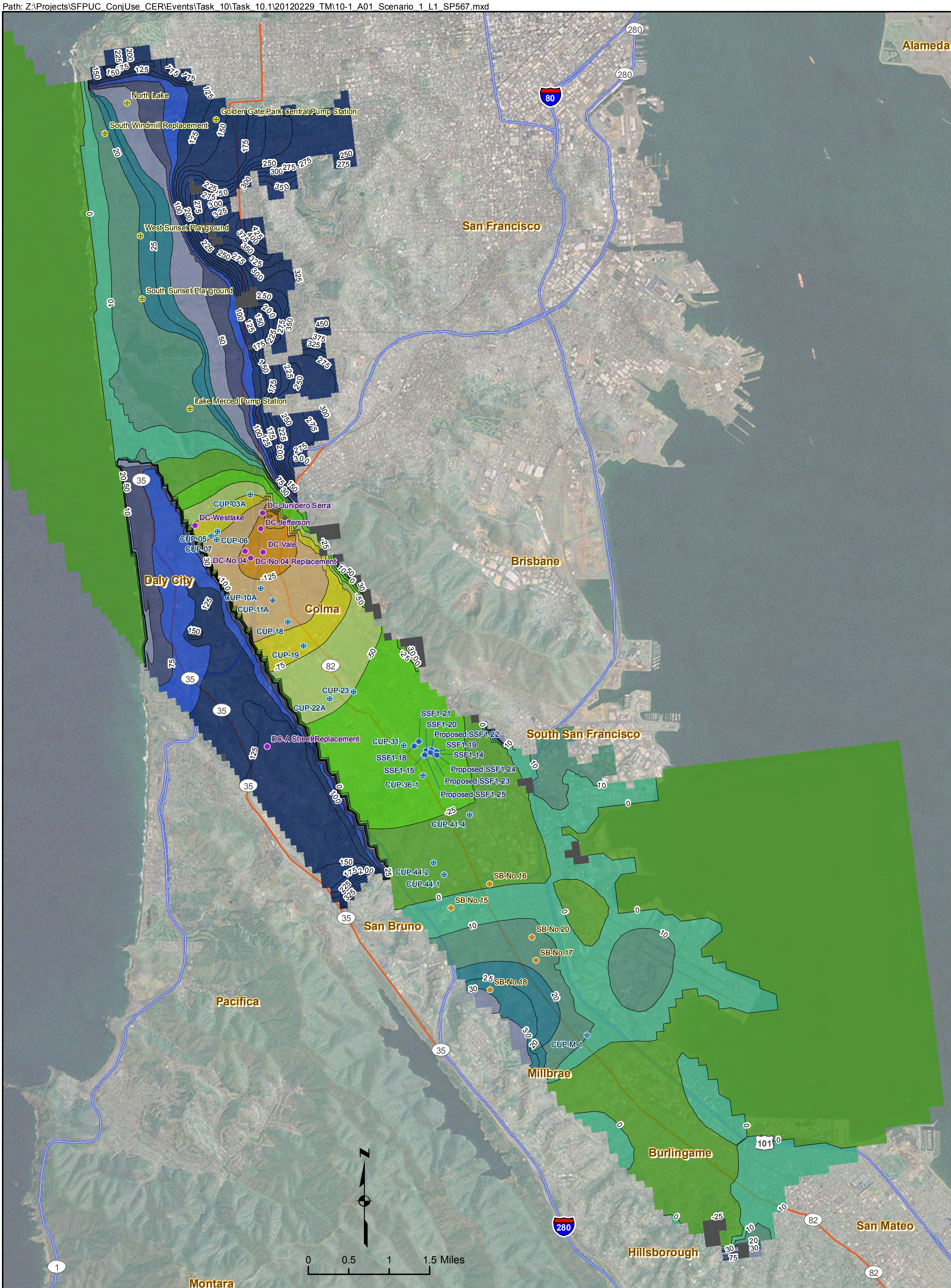

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

100 -500	20 - 30	-75 - -50
75 - 100	10 - 20	-100 - -75
50 - 75	0 - 10	-125 - -100
30 - 50	-25 - 0	-200 - -125
	-50 - -25	Dry Cell

CITY AND COUNTY OF SAN FRANCISCO
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Model Simulated Groundwater Elevation Contour Map

SCENARIO 1, LAYER 1
End of Hydrologic Sequence

Scenario Year 47

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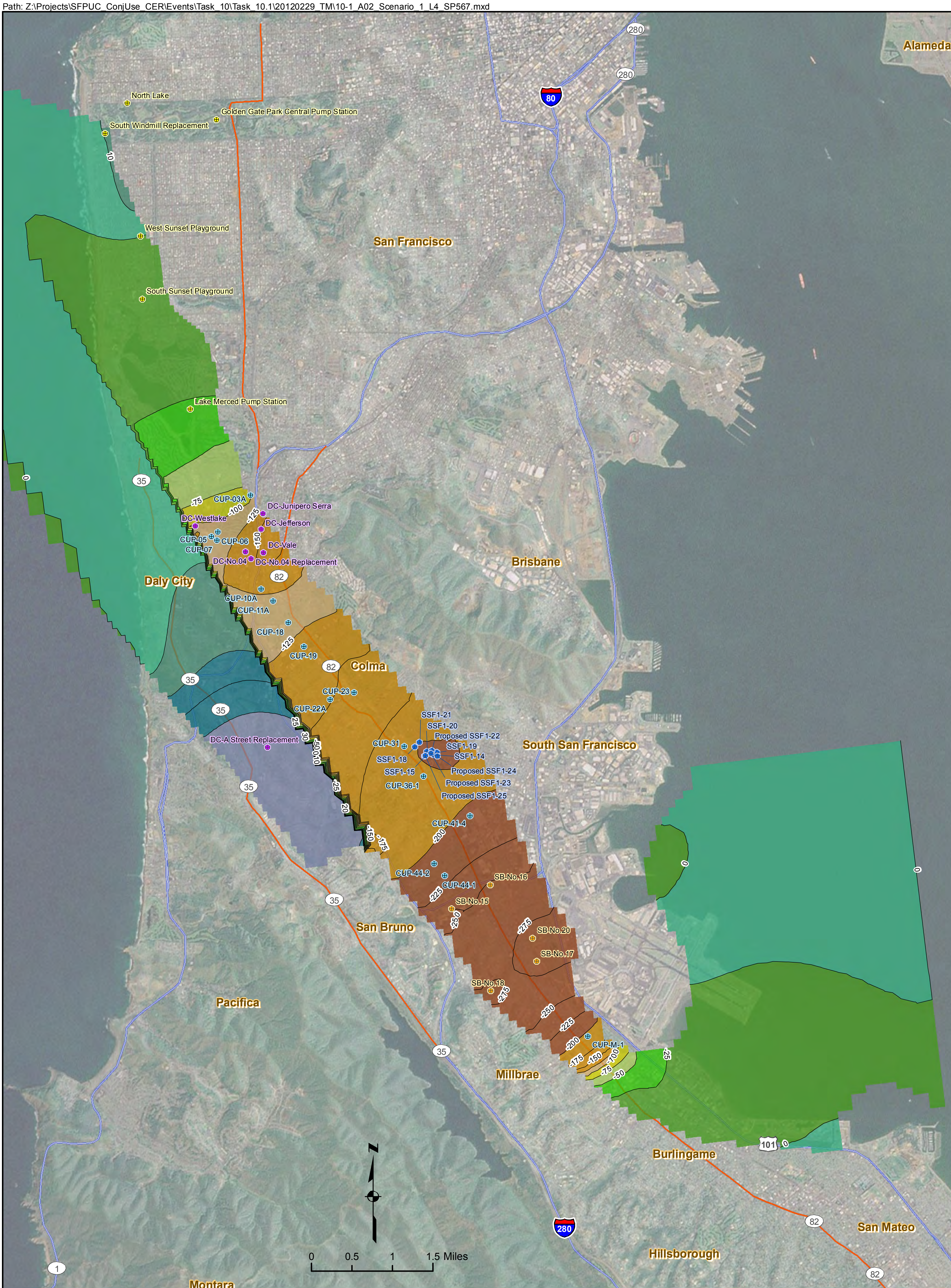

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

- 100 - 150
- 75 - 100
- 50 - 75
- 30 - 50
- 20 - 30
- 10 - 20
- 0 - 10
- -25 - 0
- -50 - -25
- -75 - -50
- -100 - -75
- -125 - -100
- -200 - -125
- -300 - -200

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Model Simulated Groundwater Elevation Contour Map

SCENARIO 1, LAYER 4
End of Hydrologic Sequence

Scenario Year 47

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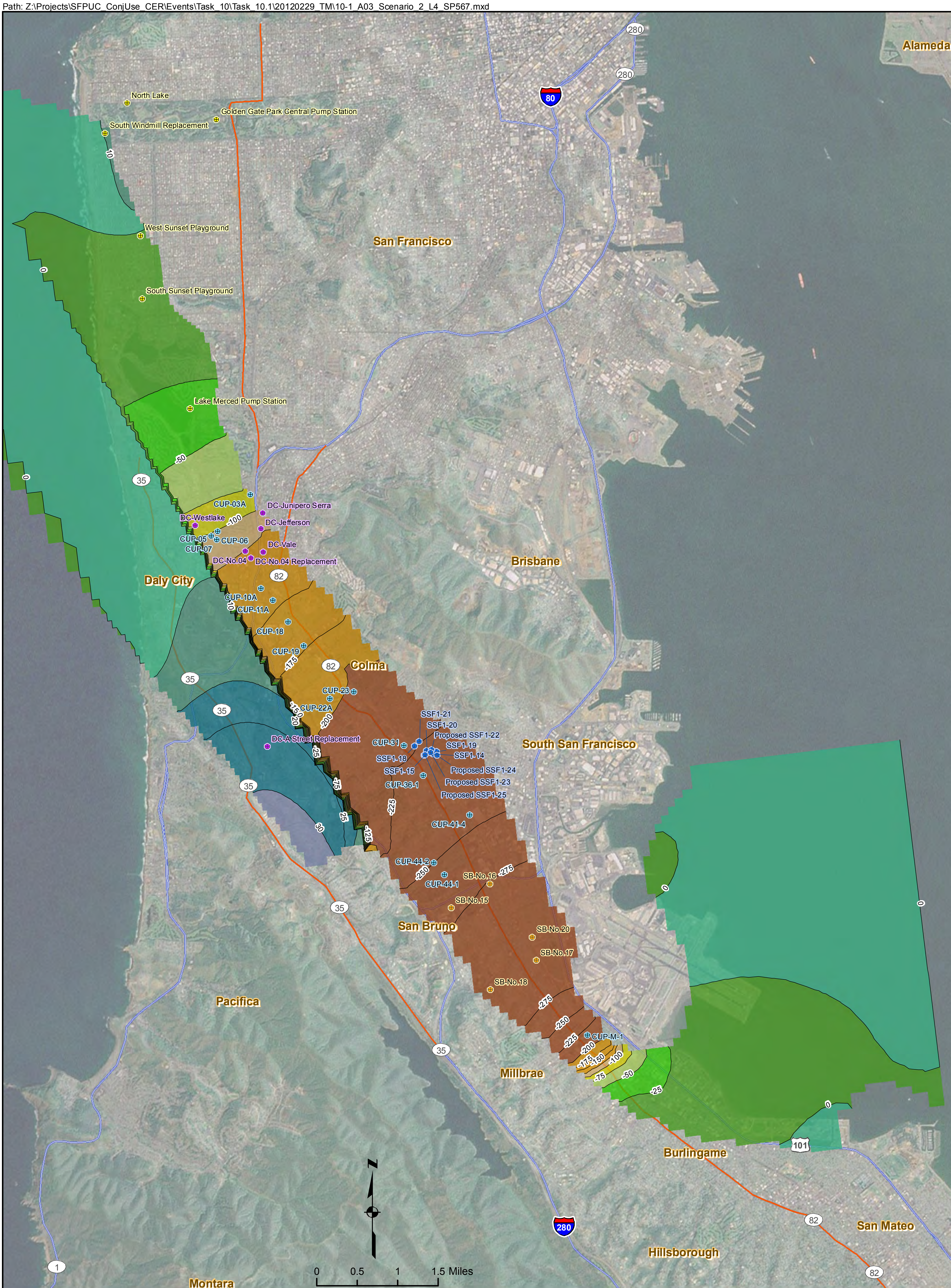

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

- 100 - 150
- 75 - 100
- 50 - 75
- 30 - 50
- 20 - 30
- 10 - 20
- 0 - 10
- -25 - 0
- -50 - -25
- -75 - -50
- -100 - -75
- -125 - -100
- -200 - -125
- -300 - -200

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Model Simulated Groundwater Elevation Contour Map

SCENARIO 2, LAYER 4
End of Hydrologic Sequence

Scenario Year 47

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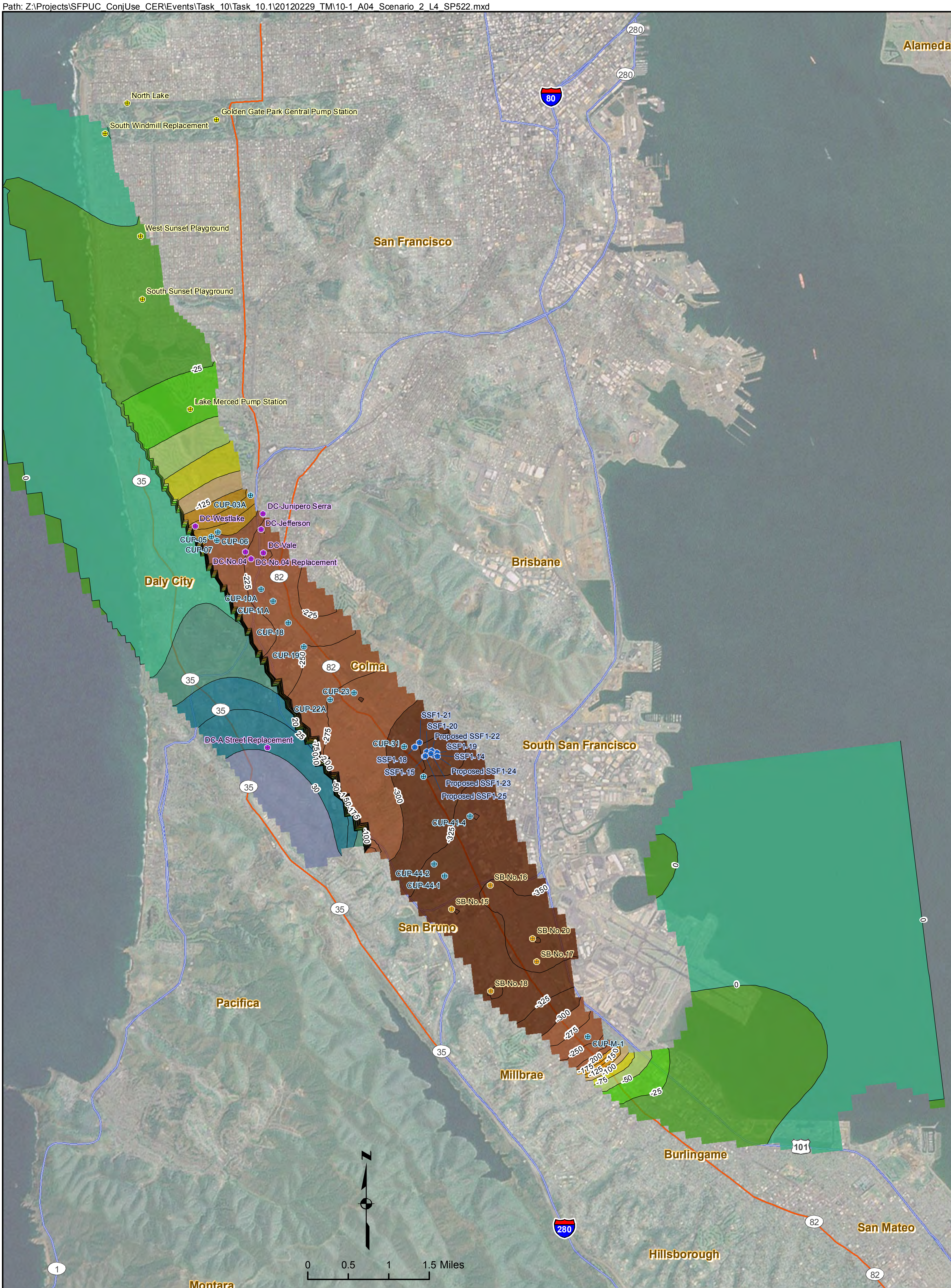

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

75 - 100	10 - 20	-125 - -100
50 - 75	0 - 10	-200 - -125
30 - 50	-25 - 0	-300 - -200
20 - 30	-50 - -25	-400 - -300
	-75 - -50	
	-100 - -75	

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Model Simulated Groundwater Elevation Contour Map

SCENARIO 2, LAYER 4
End of Design Drought

Scenario Year 44

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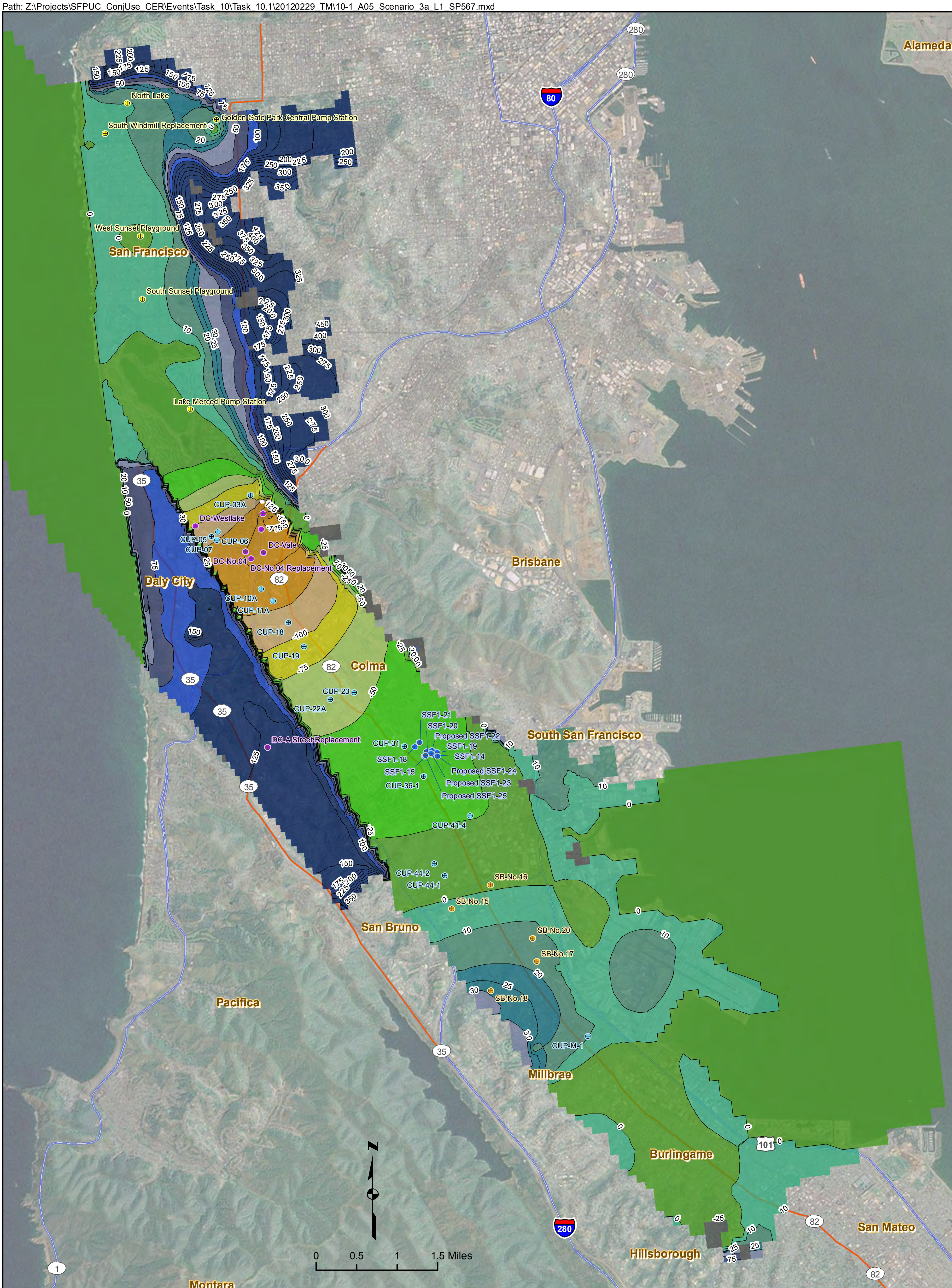

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

- 100 - 500
- 75 - 100
- 50 - 75
- 30 - 50
- 20 - 30
- 10 - 20
- 0 - 10
- -25 - 0
- -50 - -25
- -75 - -50
- -100 - -75
- -125 - -100
- -200 - -125
- Dry Cells

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Model Simulated Groundwater Elevation Contour Map

SCENARIO 3A, LAYER 1
End of Hydrologic Sequence

Scenario Year 47

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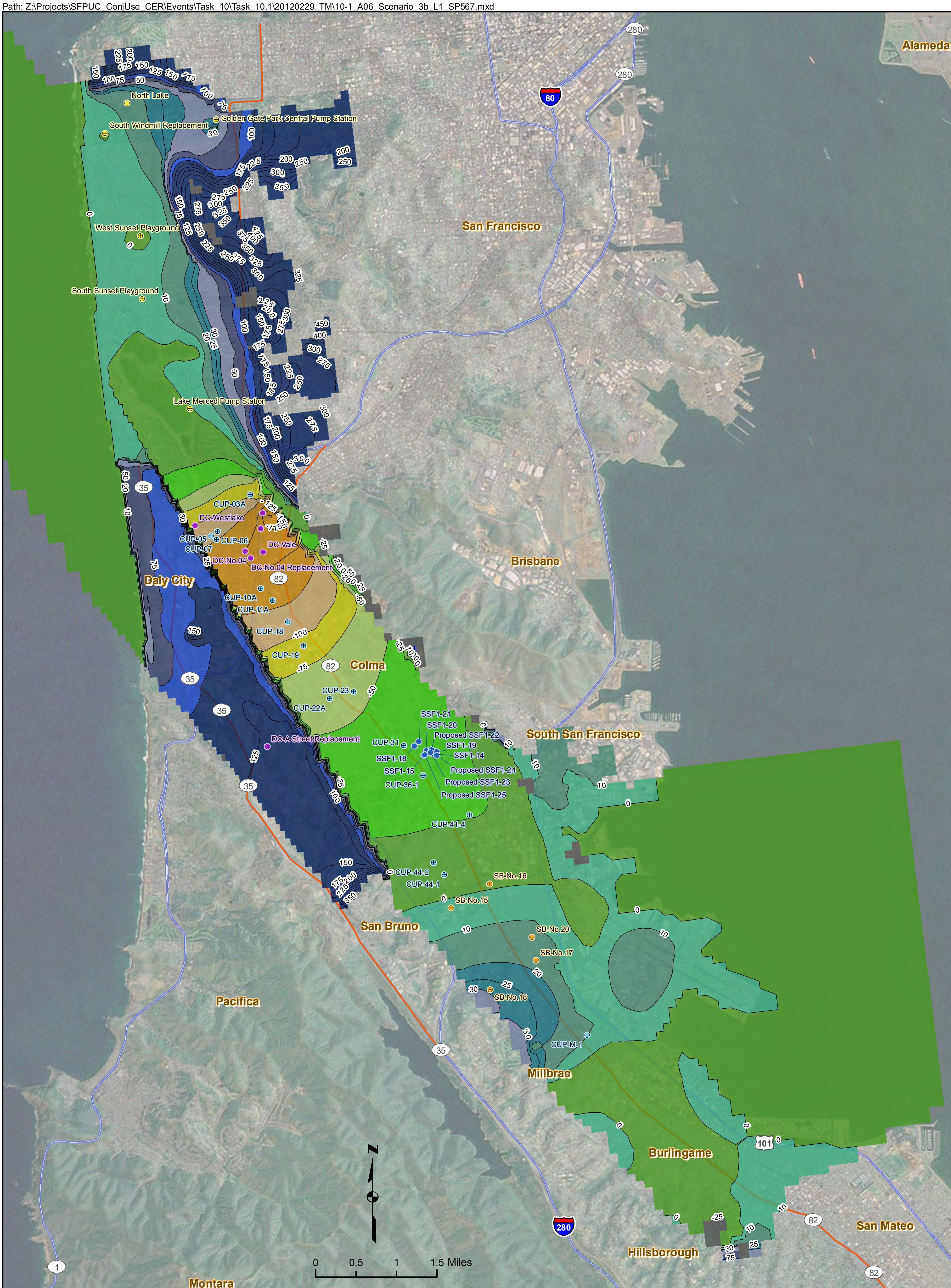

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

- 100 - 500
- 75 - 100
- 50 - 75
- 30 - 50
- 20 - 30
- 10 - 20
- 0 - 10
- -25 - 0
- -50 - -25
- -75 - -50
- -100 - -75
- -125 - -100
- -200 - -125
- Dry Cells

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Model Simulated Groundwater Elevation Contour Map

SCENARIO 3B, LAYER 1
End of Hydrologic Sequence

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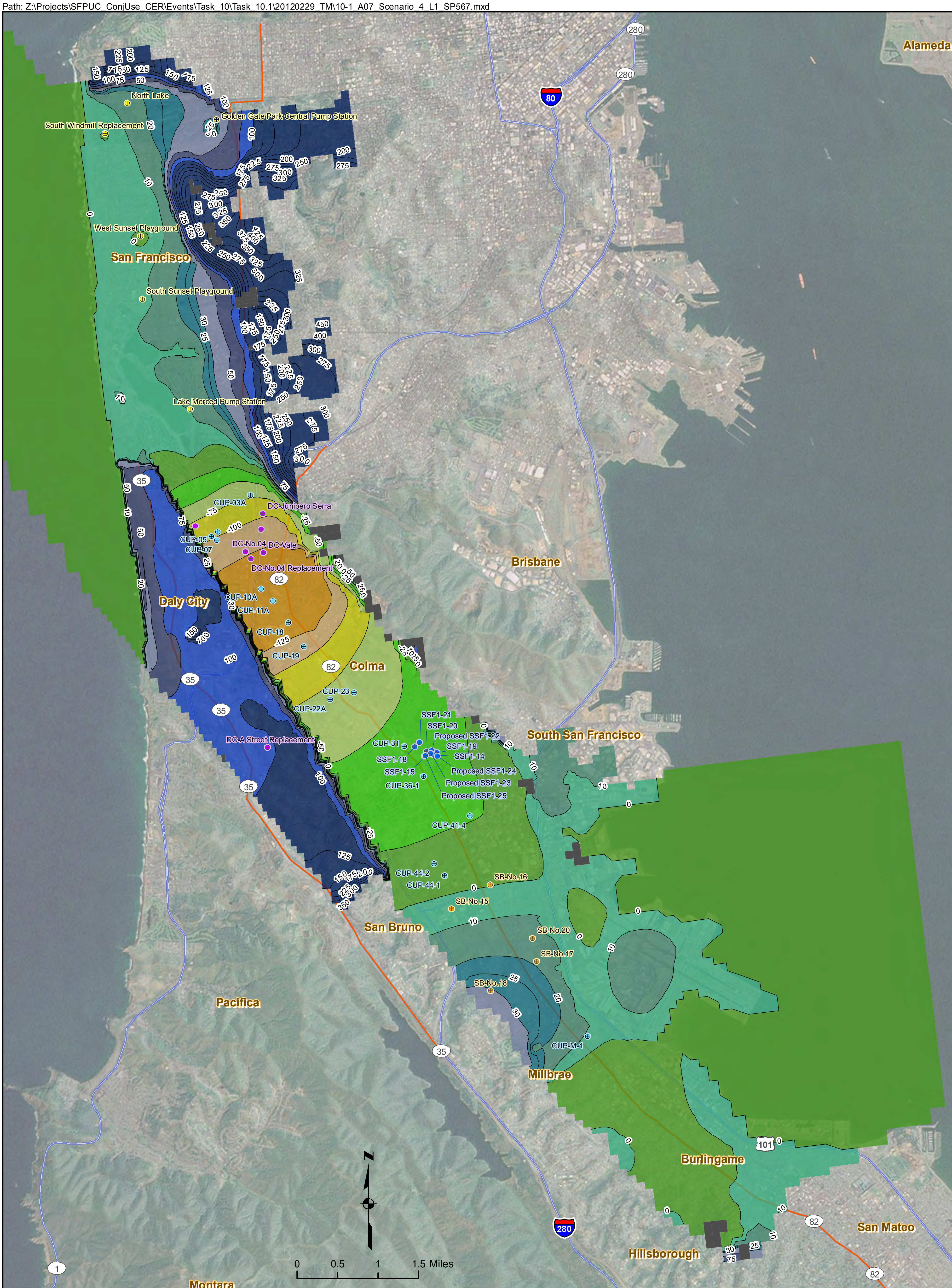

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

- 100 - 500
- 75 - 100
- 50 - 75
- 30 - 50
- 20 - 30
- 10 - 20
- 0 - 10
- -25 - 0
- -50 - -25
- -75 - -50
- -100 - -75
- -125 - -100
- -200 - -125
- Dry Cells

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Model Simulated Groundwater Elevation Contour Map

SCENARIO 4, LAYER 1
End of Hydrologic Sequence

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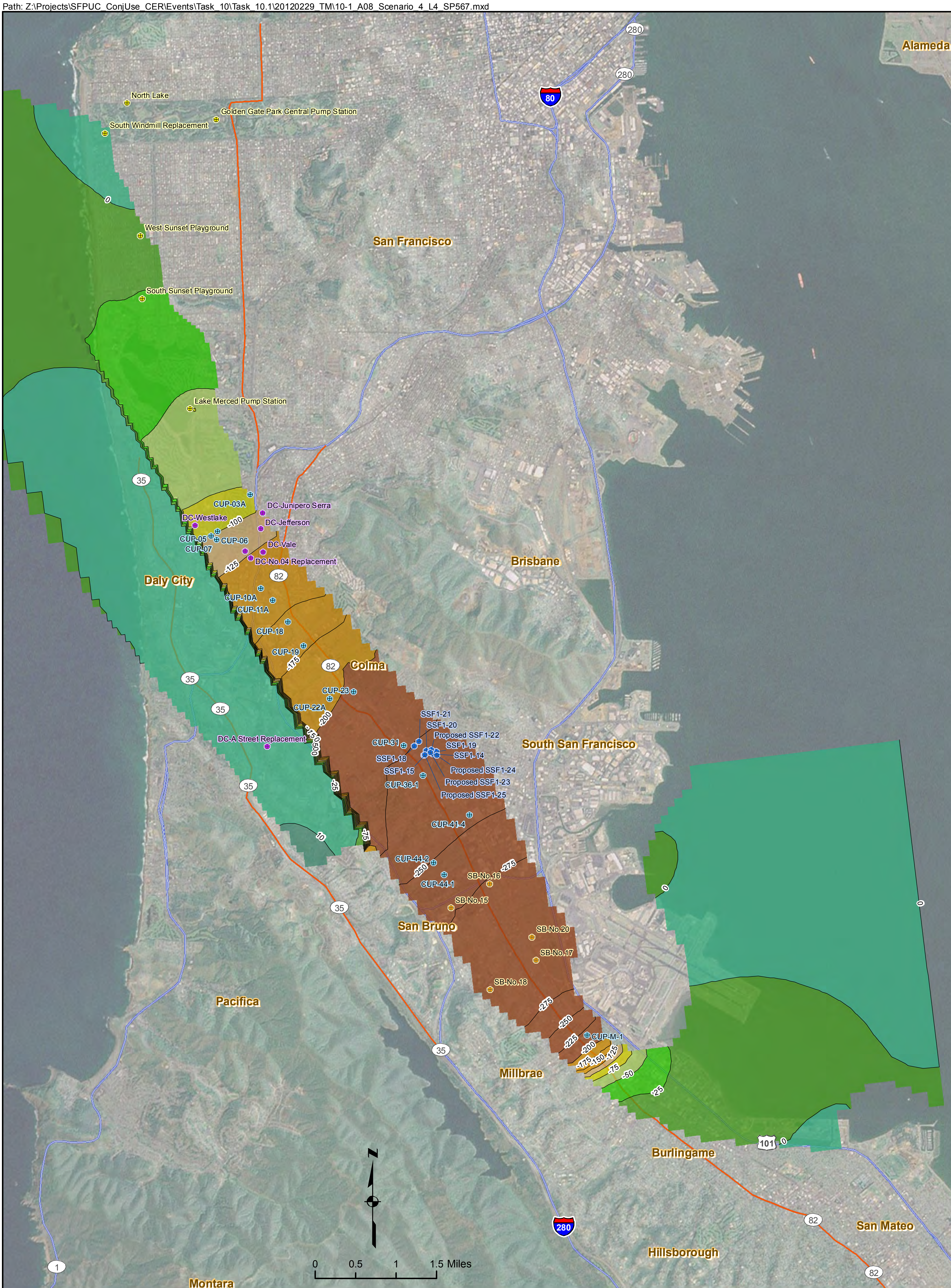

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

- 100 - 150
- 75 - 100
- 50 - 75
- 30 - 50
- 20 - 30
- 10 - 20
- 0 - 10
- -25 - 0
- -50 - -25
- -75 - -50
- -100 - -75
- -125 - -100
- -200 - -125
- -300 - -200

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Model Simulated Groundwater Elevation Contour Map

SCENARIO 4, LAYER 4
End of Hydrologic Sequence

Scenario Year 47

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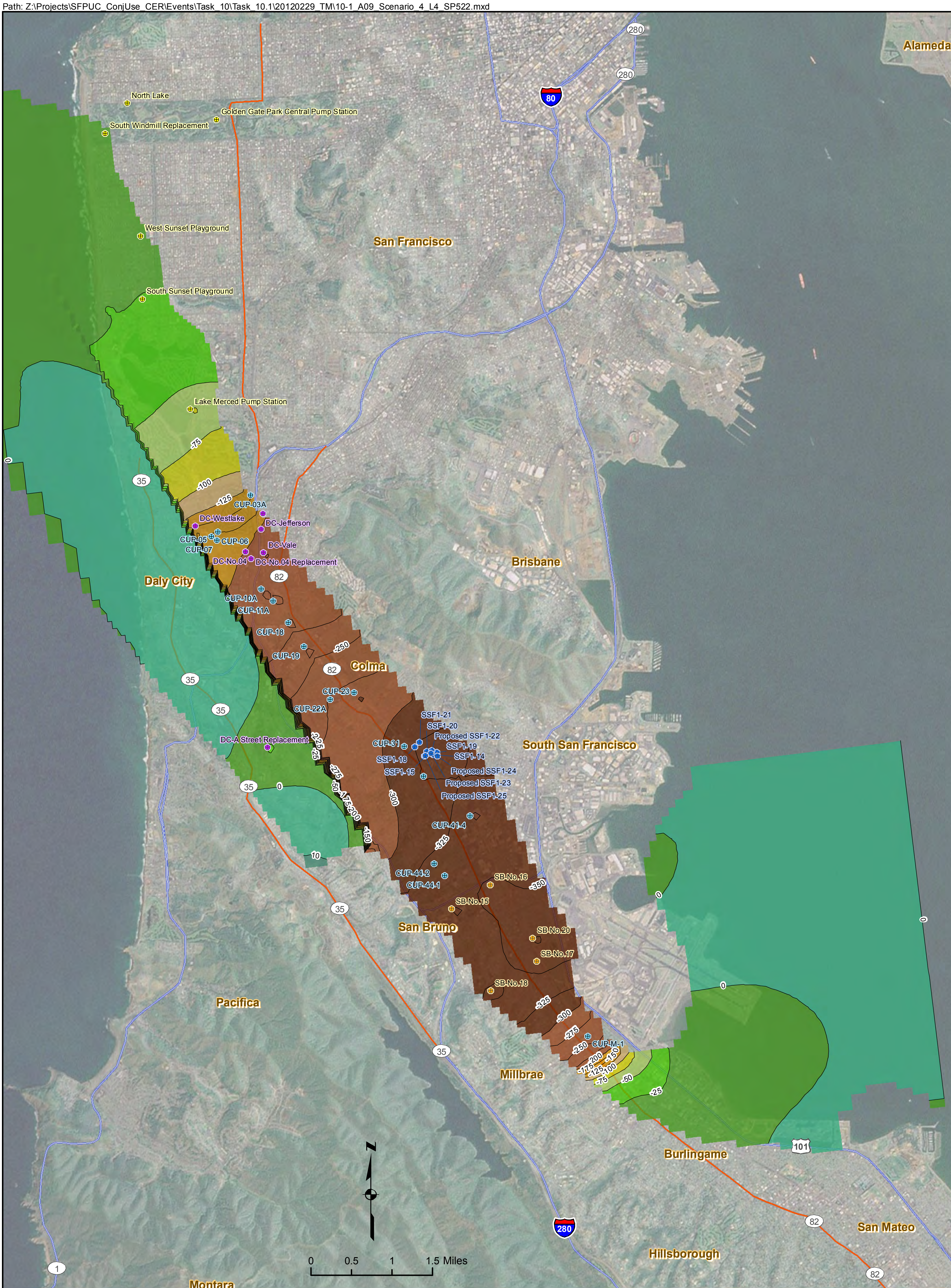

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Note:
Contoured areas shown in the Pacific Ocean and San Francisco Bay Area are part of the Westside Basin Groundwater-Flow Model domain.

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Simulated Groundwater Elevation (feet NGVD29)

Model Simulated Groundwater Elevation (feet NGVD29)

75 - 100	10 - 20	-125 - -100
50 - 75	0 - 10	-200 - -125
30 - 50	-25 - 0	-300 - -200
20 - 30	-50 - -25	-400 - -300
	-75 - -50	
	-100 - -75	

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Model Simulated Groundwater Elevation Contour Map

SCENARIO 4, LAYER 4
End of Design Drought

Scenario Year 44

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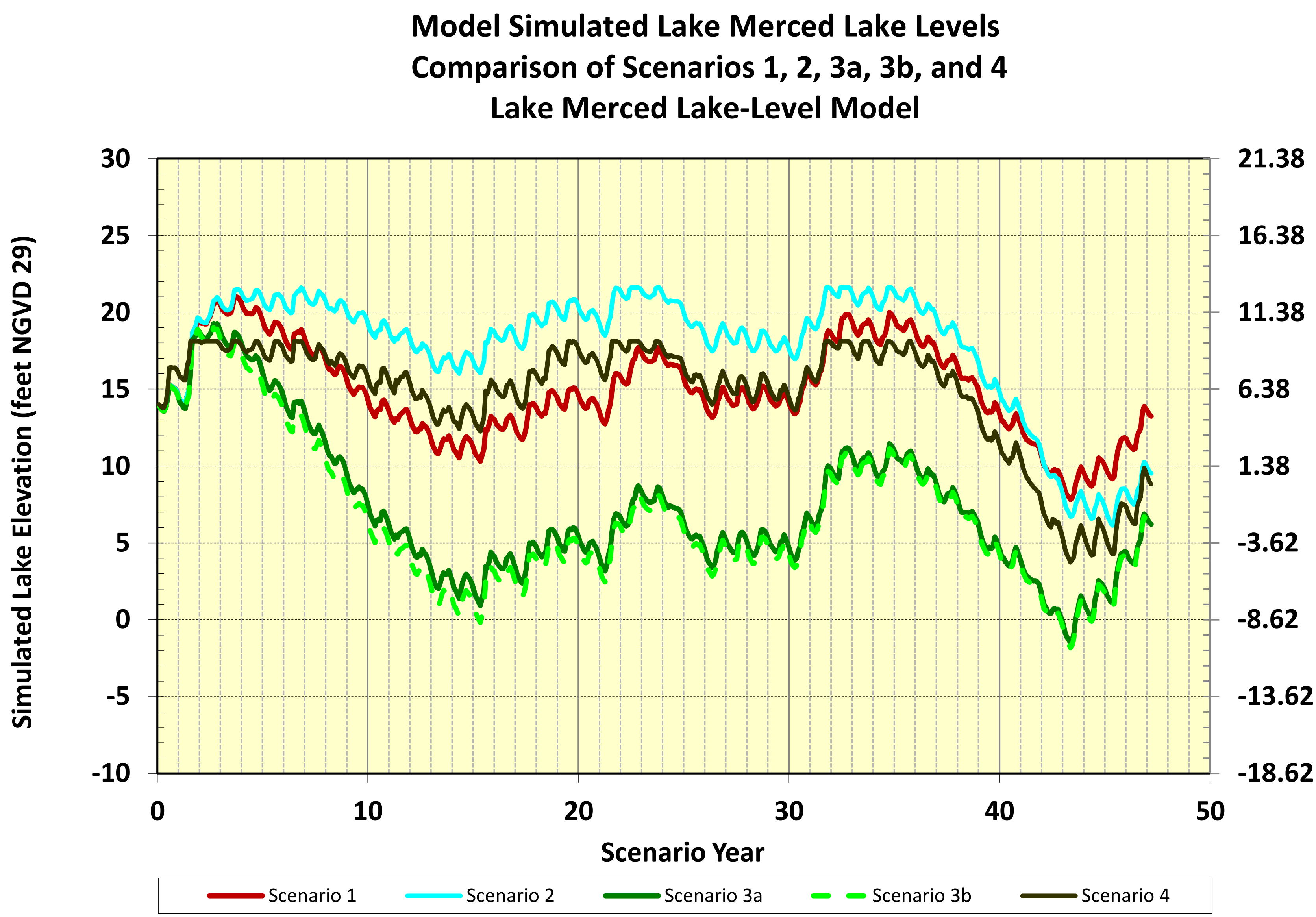
Attachment 10.1-G

Model Scenario Lake Hydrographs from Lake Merced Lake-Level Model

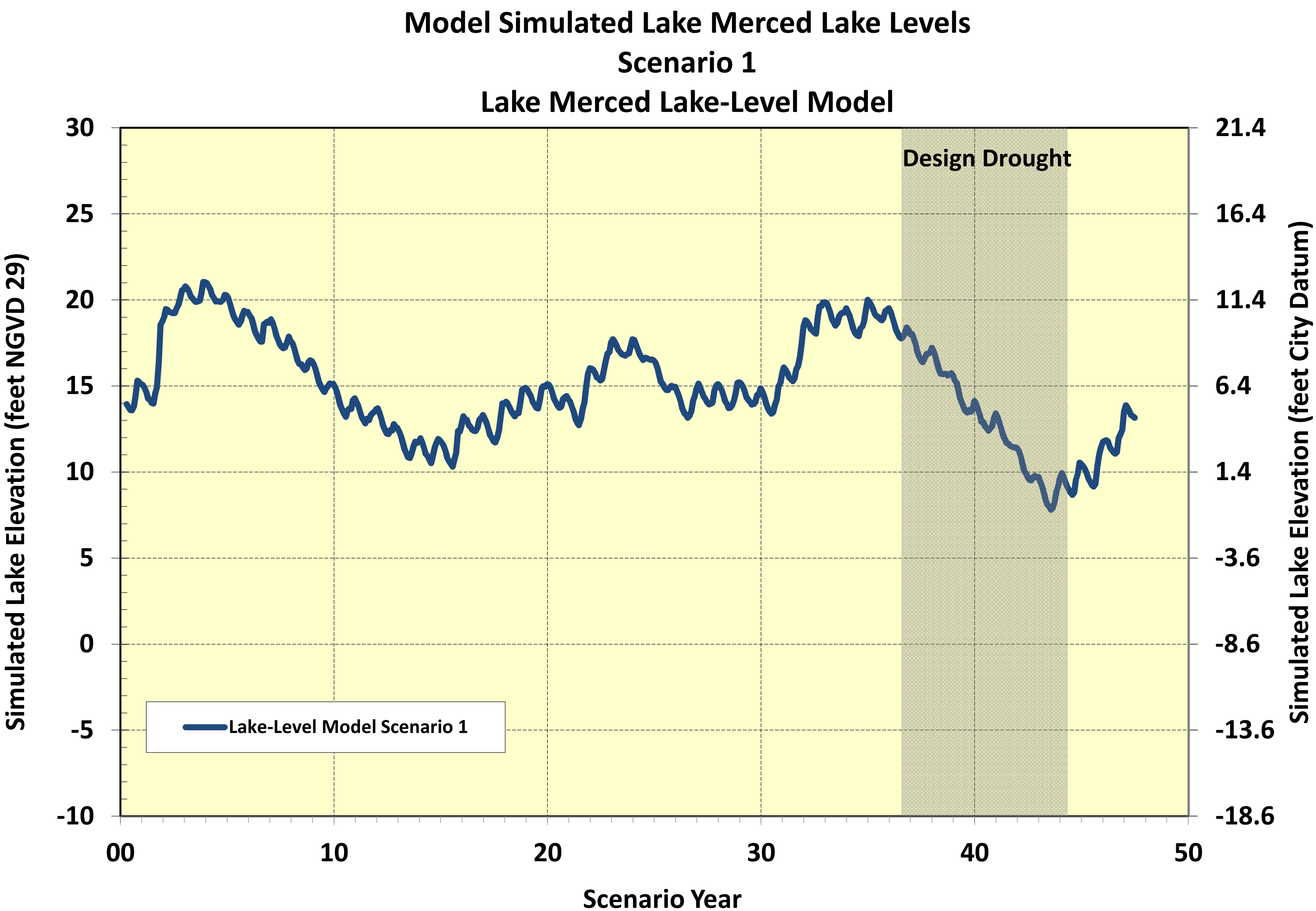


Model Simulated Lake Merced Lake Levels
Comparison of Scenarios 1, 2, 3a, 3b, and 4
Lake Merced Lake-Level Model
Simulated Lake Elevation (feet NGVD 29)
Simulated Lake Elevation (feet City Datum)
30
25
20
15
10
5
0
-5
-10
21.38
16.38
11.38
6.38
1.38
-3.62
-8.62
-13.62
-18.62
0
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

Lake Merced Lake-Level Model Water Balance
Scenario 1
SFPUC GSR and SFGW Projects Technical Analysis

Assumptions: (in feet City Datum)		Initial Lake Level 5.7		Wetland Source None		VG Stormwater No		Number of Wells No Wells		Diversion Elevation 13.0		Spillway Elevation 13.0	
		Lake Merced Natural Hydrology						Lake Merced Lake Level Management				Summary	
Historical Water Year	Scenario Year	Precipitation (af)	Stormwater Runoff (af)	Evaporation (af)	Transpiration (af)	Groundwater Inflow-Outflow (af)	Natural Hydrology Subtotal (af)	Lake Additions from Engineered Wetland (af)	Lake Additions from Vista Grande Canal Stormflow (af)	Lake Additions from Wells (af)	Flow over the Spillway (af)	Annual (Sept to Sept) Change in Lake Level (feet)	Lake Merced Change in Storage (af)
1996	0	1	0	-241	-49	78	-211	0	0	0	0	-	-
1997	1	499	189	-718	-144	289	116	0	0	0	0	0.41	116
1998	2	1,186	668	-680	-134	518	1,559	0	0	0	0	5.22	1,559
1999	3	484	134	-648	-129	382	224	0	0	0	0	0.72	224
2000	4	481	132	-702	-135	211	-13	0	0	0	0	-0.04	-13
2001	5	300	70	-673	-133	57	-378	0	0	0	0	-1.22	-378
2002	6	382	104	-671	-132	29	-288	0	0	0	0	-0.94	-288
2003	7	514	198	-702	-136	20	-106	0	0	0	0	-0.33	-106
1959	8	360	103	-688	-136	10	-352	0	0	0	0	-1.16	-352
1960	9	320	96	-658	-134	-65	-441	0	0	0	0	-1.47	-441
1961	10	369	108	-648	-134	-108	-412	0	0	0	0	-1.41	-412
1962	11	418	146	-599	-128	0	-163	0	0	0	0	-0.56	-163
1963	12	492	170	-651	-136	-48	-173	0	0	0	0	-0.60	-173
1964	13	316	101	-604	-131	-73	-391	0	0	0	0	-1.38	-391
1965	14	501	189	-584	-128	-19	-41	0	0	0	0	-0.14	-41
1966	15	416	157	-612	-133	99	-73	0	0	0	0	-0.25	-73
1967	16	717	354	-601	-130	217	557	0	0	0	0	2.00	557
1968	17	369	125	-649	-136	100	-191	0	0	0	0	-0.67	-191
1969	18	616	257	-608	-131	273	408	0	0	0	0	1.44	408
1970	19	536	203	-644	-133	178	141	0	0	0	0	0.50	141
1971	20	481	160	-610	-128	129	32	0	0	0	0	0.11	32
1972	21	310	95	-614	-130	16	-324	0	0	0	0	-1.12	-324
1973	22	810	338	-625	-131	360	752	0	0	0	0	2.59	752
1974	23	721	239	-642	-131	270	457	0	0	0	0	1.53	457
1975	24	433	125	-642	-130	112	-103	0	0	0	0	-0.34	-103
1976	25	236	55	-651	-134	10	-483	0	0	0	0	-1.61	-483
1977	26	289	79	-647	-132	-50	-462	0	0	0	0	-1.58	-462
1978	27	646	239	-683	-138	148	211	0	0	0	0	0.74	211
1979	28	418	145	-652	-135	123	-101	0	0	0	0	-0.34	-101
1980	29	556	192	-641	-132	120	94	0	0	0	0	0.33	94
1981	30	382	125	-630	-133	59	-197	0	0	0	0	-0.67	-197
1982	31	778	290	-622	-130	236	551	0	0	0	0	1.89	551
1983	32	939	381	-719	-141	388	848	0	0	0	0	2.83	848
1984	33	523	184	-736	-141	290	121	0	0	0	0	0.40	121
1985	34	469	126	-723	-140	100	-169	0	0	0	0	-0.55	-169
1986	35	723	244	-741	-142	243	327	0	0	0	0	1.07	327
1987	36	326	91	-731	-140	91	-363	0	0	0	0	-1.18	-363
1988	37	360	96	-731	-141	4	-412	0	0	0	0	-1.35	-412
1989	38	460	137	-699	-140	-3	-246	0	0	0	0	-0.81	-246
1990	39	276	75	-703	-141	-80	-573	0	0	0	0	-1.94	-573
1991	40	410	140	-663	-137	-67	-317	0	0	0	0	-1.09	-317
1992	41	431	151	-716	-146	7	-273	0	0	0	0	-0.96	-273
1976	42	182	47	-624	-136	-26	-557	0	0	0	0	-2.01	-557
1977	43	264	90	-589	-132	-84	-452	0	0	0	0	-1.69	-452
1978	44	583	274	-632	-140	126	210	0	0	0	0	0.81	210
2004	45	437	198	-616	-137	233	115	0	0	0	0	0.44	115
2005	46	681	317	-599	-132	255	522	0	0	0	0	1.94	522
2006	47	693	331	-624	-133	288	556	0	0	0	0	1.98	556
Average (af)		**481**	**176**	**-648**	**-133**	**110**	**-22**	**0**	**0**	**0**	**0**	**-0.05**	**-18**
Maximum (af)		**1,186**	**668**	**-241**	**-49**	**518**	**1,559**	**0**	**0**	**0**	**0**	**5.22**	**1,559**
Minimum (af)		**1**	**0**	**-741**	**-146**	**-108**	**-573**	**0**	**0**	**0**	**0**	**-2.01**	**-573**

Key:
af - acre-feet
VG - Vista Grande

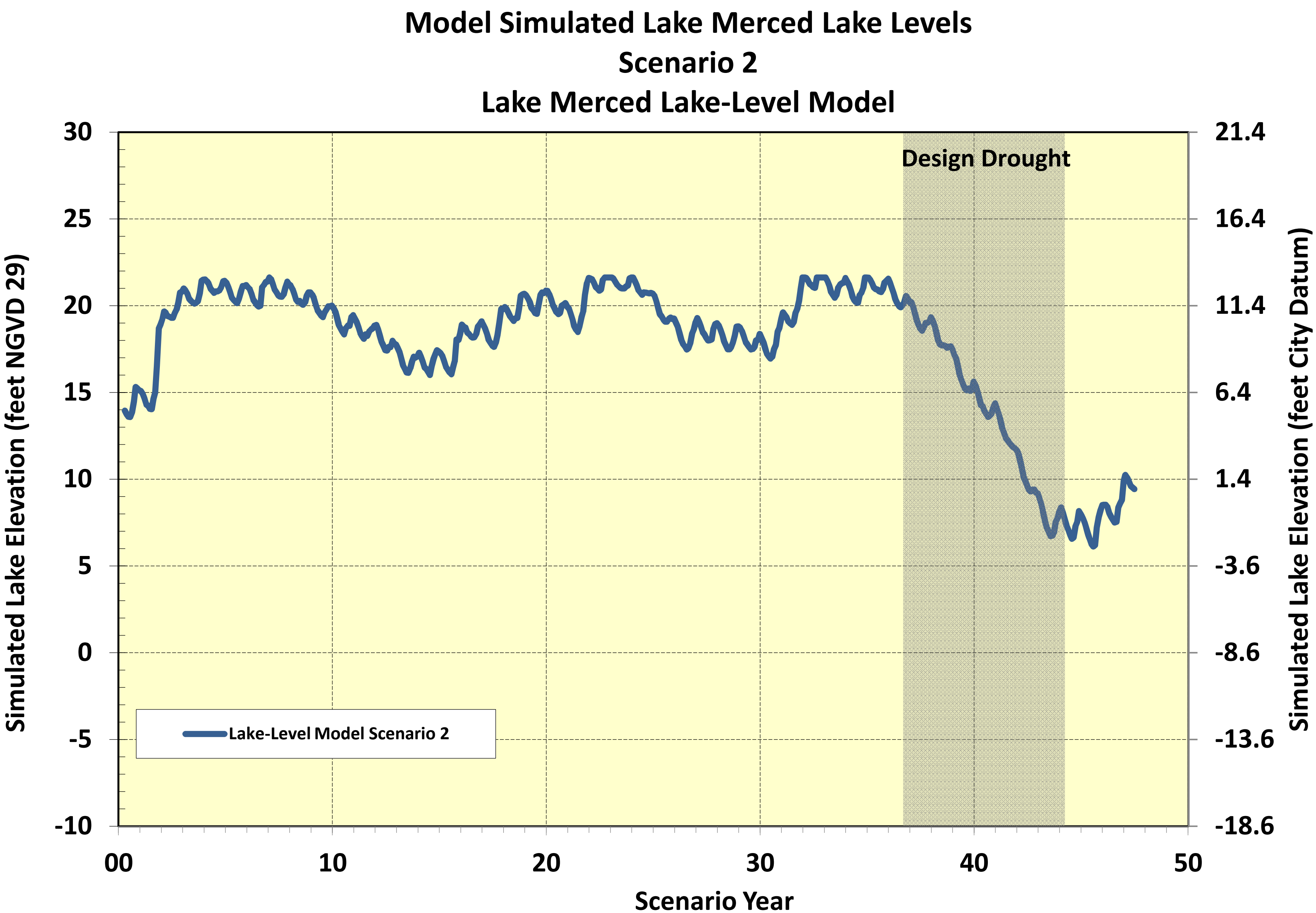


Model Simulated Lake Merced Lake Levels
Scenario 1
Lake Merced Lake-Level Model
Design Drought
Simulated Lake Elevation (feet NGVD 29)
Simulated Lake Elevation (feet City Datum)
Scenario Year
Lake-Level Model Scenario 1
30
25
20
15
10
5
0
-5
-10
21.4
16.4
11.4
6.4
1.4
-3.6
-8.6
-13.6
-18.6
00
10
20
30
40
50

Lake Merced Lake-Level Model Water Balance
Scenario 2
SFPUC GSR and SFGW Projects Technical Analysis

Assumptions: (in feet City Datum)		**Initial Lake Level**		**Wetland Source**		**VG Stormwater**		**Number of Wells**		**Diversion Elevation**		**Spillway Elevation**	
		5.7		None		No		No Wells		13.0		13.0	
		Lake Merced Natural Hydrology						**Lake Merced Lake Level Management**				**Summary**	
Historical Water Year	**Scenario Year**	**Precipitation (af)**	**Stormwater Runoff (af)**	**Evaporation (af)**	**Transpiration (af)**	**Groundwater Inflow-Outflow (af)**	**Natural Hydrology Subtotal (af)**	**Lake Additions from Engineered Wetland (af)**	**Lake Additions from Vista Grande Canal Stormflow (af)**	**Lake Additions from Wells (af)**	**Flow over the Spillway (af)**	**Annual (Sept to Sept) Change in Lake Level (feet)**	**Lake Merced Change in Storage (af)**
1996	0	1	0	-241	-49	78	-211	0	0	0	0	-	-
1997	1	499	189	-718	-144	303	129	0	0	0	0	0.46	129
1998	2	1,188	667	-681	-134	526	1,565	0	0	0	0	5.24	1,565
1999	3	485	133	-650	-129	433	273	0	0	0	0	0.88	273
2000	4	482	131	-705	-135	403	176	0	0	0	0	0.56	176
2001	5	303	69	-680	-133	279	-162	0	0	0	0	-0.51	-162
2002	6	389	100	-685	-132	273	-55	0	0	0	0	-0.17	-55
2003	7	528	190	-720	-136	329	191	0	0	0	-19	0.55	210
1959	8	374	95	-714	-136	275	-106	0	0	0	0	-0.34	-106
1960	9	335	88	-690	-134	144	-257	0	0	0	0	-0.82	-257
1961	10	389	99	-686	-134	38	-295	0	0	0	0	-0.95	-295
1962	11	445	131	-638	-128	62	-129	0	0	0	0	-0.42	-129
1963	12	526	151	-696	-136	-43	-198	0	0	0	0	-0.64	-198
1964	13	338	90	-647	-131	-45	-394	0	0	0	0	-1.30	-394
1965	14	539	168	-628	-128	57	7	0	0	0	0	0.03	7
1966	15	451	137	-660	-133	200	-5	0	0	0	0	-0.01	-5
1967	16	776	318	-649	-130	309	624	0	0	0	0	2.07	624
1968	17	398	110	-701	-136	163	-166	0	0	0	0	-0.54	-166
1969	18	665	228	-653	-131	325	435	0	0	0	0	1.42	435
1970	19	575	181	-688	-133	204	139	0	0	0	0	0.45	139
1971	20	513	142	-652	-128	141	16	0	0	0	0	0.06	16
1972	21	330	85	-657	-130	16	-357	0	0	0	0	-1.15	-357
1973	22	864	304	-662	-131	369	745	0	0	0	0	2.39	745
1974	23	763	214	-672	-131	478	652	0	0	0	-604	0.15	1,255
1975	24	450	115	-669	-130	245	12	0	0	0	-137	-0.39	149
1976	25	249	50	-682	-134	68	-450	0	0	0	0	-1.44	-450
1977	26	303	72	-680	-132	-39	-476	0	0	0	0	-1.54	-476
1978	27	682	217	-718	-138	108	151	0	0	0	0	0.50	151
1979	28	439	133	-684	-135	45	-201	0	0	0	0	-0.65	-201
1980	29	583	176	-669	-132	79	36	0	0	0	0	0.12	36
1981	30	400	115	-658	-133	74	-201	0	0	0	0	-0.66	-201
1982	31	813	268	-647	-130	288	592	0	0	0	0	1.94	592
1983	32	976	358	-743	-141	483	934	0	0	0	-257	2.17	1,190
1984	33	537	176	-752	-141	482	302	0	0	0	-496	-0.61	798
1985	34	477	122	-737	-140	199	-80	0	0	0	0	-0.25	-80
1986	35	740	234	-755	-142	403	480	0	0	0	-248	0.74	728
1987	36	332	88	-746	-140	163	-302	0	0	0	0	-0.96	-302
1988	37	367	93	-746	-141	22	-404	0	0	0	0	-1.30	-404
1989	38	471	130	-715	-140	-44	-297	0	0	0	0	-0.96	-297
1990	39	283	72	-719	-141	-176	-682	0	0	0	0	-2.26	-682
1991	40	420	135	-677	-137	-196	-455	0	0	0	0	-1.54	-455
1992	41	439	147	-727	-146	-166	-454	0	0	0	0	-1.57	-454
1976	42	184	46	-627	-136	-236	-770	0	0	0	0	-2.77	-770
1977	43	260	92	-579	-132	-326	-686	0	0	0	0	-2.61	-686
1978	44	566	284	-611	-140	-151	-51	0	0	0	0	-0.19	-51
2004	45	414	212	-584	-137	-38	-132	0	0	0	0	-0.51	-132
2005	46	635	344	-556	-132	52	343	0	0	0	0	1.37	343
2006	47	645	361	-582	-133	172	463	0	0	0	0	1.78	463
Average (af)		**496**	**168**	**-667**	**-133**	**142**	**-4**	**0**	**0**	**0**	**-37**	**-0.13**	**39**
Maximum (af)		**1,188**	**667**	**-241**	**-49**	**526**	**1,565**	**0**	**0**	**0**	**0**	**5.24**	**1,565**
Minimum (af)		**1**	**0**	**-755**	**-146**	**-326**	**-770**	**0**	**0**	**0**	**-604**	**-2.77**	**-770**

Key:
af - acre-feet
VG - Vista Grande


Model Simulated Lake Merced Lake Levels
Scenario 2
Lake Merced Lake-Level Model
Design Drought
Lake-Level Model Scenario 2
Simulated Lake Elevation (feet NGVD 29)
Simulated Lake Elevation (feet City Datum)
Scenario Year
30
25
20
15
10
5
0
-5
-10
21.4
16.4
11.4
6.4
1.4
-3.6
-8.6
-13.6
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40
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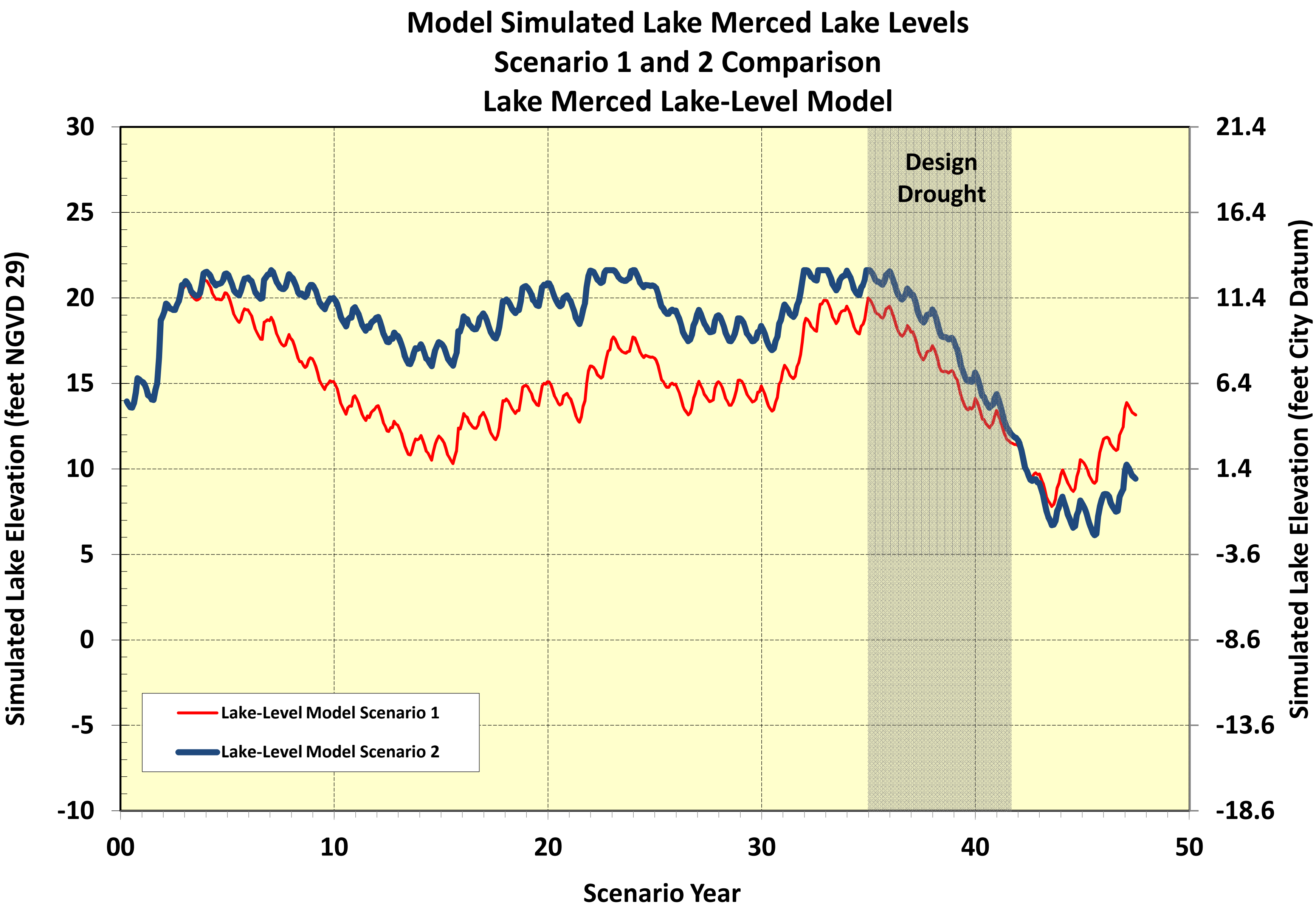

Model Simulated Lake Merced Lake Levels
Scenario 1 and 2 Comparison
Lake Merced Lake-Level Model
Simulated Lake Elevation (feet NGVD 29)
Simulated Lake Elevation (feet City Datum)
Scenario Year
Design Drought
Lake-Level Model Scenario 1
Lake-Level Model Scenario 2
30
25
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15
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21.4
16.4
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-8.6
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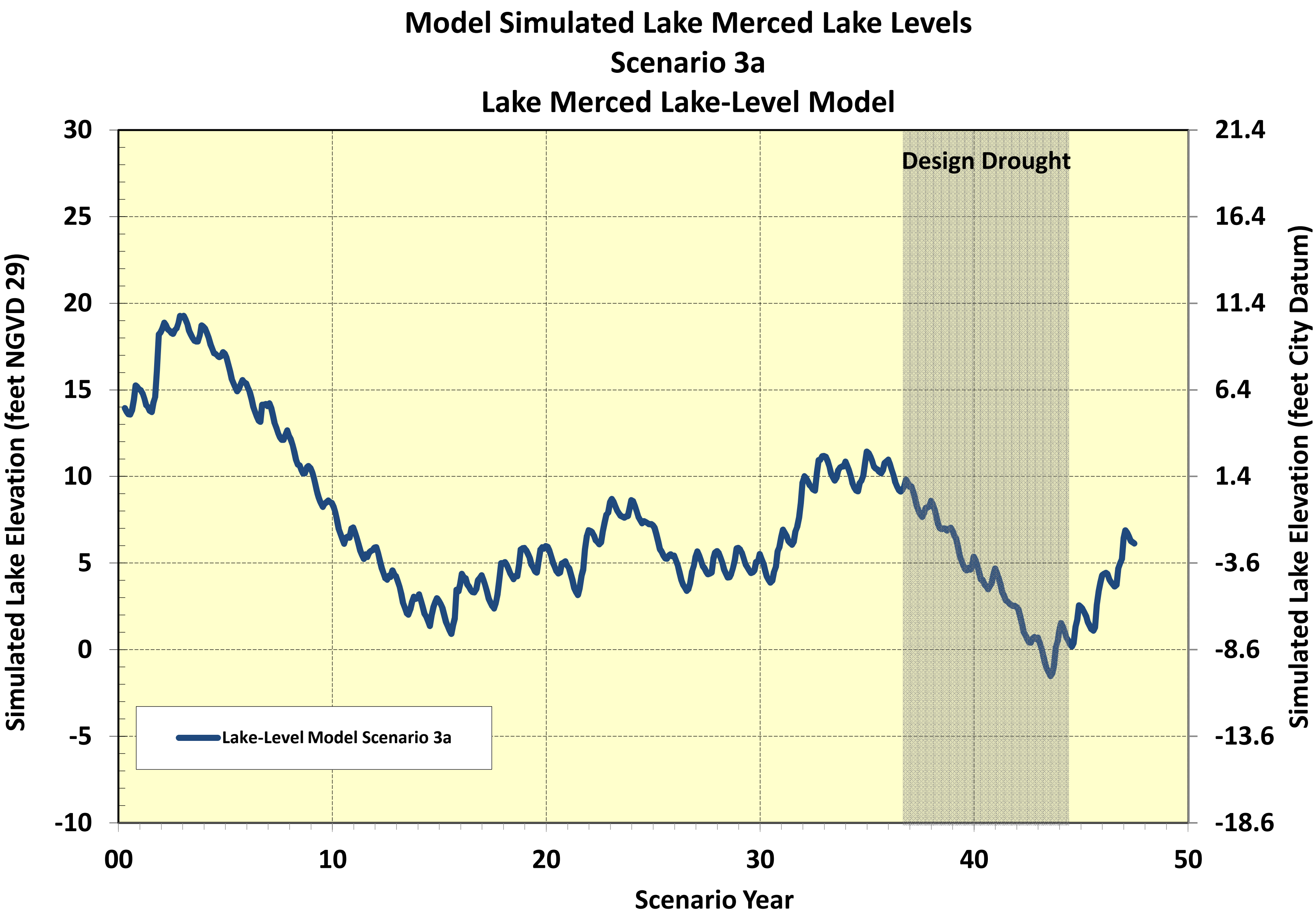
Lake Merced Lake-Level Model Water Balance
Scenario 3a
SFPUC GSR and SFGW Projects Technical Analysis

Assumptions: (in feet City Datum)		Initial Lake Level		Wetland Source		VG Stormwater		Number of Wells		Diversion Elevation		Spillway Elevation	
		5.7		None		No		No Wells		13.0		13.0	
		Lake Merced Natural Hydrology						Lake Merced Lake Level Management				Summary	
Historical Water Year	Scenario Year	Precipitation (af)	Stormwater Runoff (af)	Evaporation (af)	Transpiration (af)	Groundwater Inflow-Outflow (af)	Natural Hydrology Subtotal (af)	Lake Additions from Engineered Wetland (af)	Lake Additions from Vista Grande Canal Stormflow (af)	Lake Additions from Wells (af)	Flow over the Spillway (af)	Annual (Sept to Sept) Change in Lake Level (feet)	Lake Merced Change in Storage (af)
1996	0	1	0	-241	-49	76	-213	0	0	0	0	-	-
1997	1	499	189	-717	-144	226	54	0	0	0	0	0.20	54
1998	2	1,180	672	-677	-134	289	1,331	0	0	0	0	4.50	1,331
1999	3	478	137	-639	-129	60	-93	0	0	0	0	-0.30	-93
2000	4	471	137	-686	-135	-56	-268	0	0	0	0	-0.88	-268
2001	5	291	75	-649	-133	-184	-601	0	0	0	0	-2.00	-601
2002	6	366	112	-640	-132	-190	-485	0	0	0	0	-1.65	-485
2003	7	487	214	-661	-136	-189	-286	0	0	0	0	-0.98	-286
1959	8	336	115	-640	-136	-196	-521	0	0	0	0	-1.84	-521
1960	9	291	111	-597	-134	-262	-591	0	0	0	0	-2.18	-591
1961	10	326	130	-571	-134	-291	-540	0	0	0	0	-2.09	-540
1962	11	361	179	-517	-128	-177	-282	0	0	0	0	-1.13	-282
1963	12	419	210	-549	-136	-211	-267	0	0	0	0	-1.12	-267
1964	13	260	129	-487	-131	-225	-455	0	0	0	0	-2.01	-455
1965	14	386	255	-448	-128	-166	-103	0	0	0	0	-0.47	-103
1966	15	314	214	-462	-133	-45	-112	0	0	0	0	-0.51	-112
1967	16	548	458	-479	-130	76	474	0	0	0	0	2.32	474
1968	17	294	165	-518	-136	-22	-217	0	0	0	0	-0.94	-217
1969	18	487	334	-491	-131	144	343	0	0	0	0	1.57	343
1970	19	441	258	-533	-133	68	102	0	0	0	0	0.46	102
1971	20	395	208	-507	-128	27	-4	0	0	0	0	0.01	-4
1972	21	250	125	-495	-130	-74	-324	0	0	0	0	-1.39	-324
1973	22	656	434	-521	-131	248	685	0	0	0	0	2.94	685
1974	23	615	303	-551	-131	180	416	0	0	0	0	1.65	416
1975	24	372	156	-551	-130	36	-116	0	0	0	0	-0.45	-116
1976	25	201	69	-551	-134	-57	-472	0	0	0	0	-1.87	-472
1977	26	235	103	-524	-132	-116	-435	0	0	0	0	-1.83	-435
1978	27	519	315	-555	-138	63	205	0	0	0	0	0.91	205
1979	28	338	191	-530	-135	53	-83	0	0	0	0	-0.33	-83
1980	29	455	250	-527	-132	50	95	0	0	0	0	0.42	95
1981	30	310	164	-511	-133	-1	-171	0	0	0	0	-0.71	-171
1982	31	642	372	-521	-130	158	522	0	0	0	0	2.19	522
1983	32	806	464	-627	-141	314	815	0	0	0	0	3.18	815
1984	33	459	220	-652	-141	245	132	0	0	0	0	0.51	132
1985	34	413	155	-638	-140	58	-152	0	0	0	0	-0.55	-152
1986	35	640	294	-659	-142	193	326	0	0	0	0	1.21	326
1987	36	290	111	-648	-140	59	-328	0	0	0	0	-1.20	-328
1988	37	313	120	-637	-141	-32	-377	0	0	0	0	-1.41	-377
1989	38	397	170	-602	-140	-41	-216	0	0	0	0	-0.83	-216
1990	39	235	94	-593	-141	-110	-514	0	0	0	0	-2.07	-514
1991	40	337	178	-544	-137	-101	-267	0	0	0	0	-1.12	-267
1992	41	350	196	-581	-146	-38	-219	0	0	0	0	-0.94	-219
1976	42	138	63	-469	-136	-58	-463	0	0	0	0	-2.23	-463
1977	43	188	124	-415	-132	-116	-351	0	0	0	0	-1.88	-351
1978	44	390	392	-451	-140	63	254	0	0	0	0	1.60	254
2004	45	326	265	-467	-137	178	165	0	0	0	0	0.87	165
2005	46	535	405	-488	-132	210	530	0	0	0	0	2.57	530
2006	47	588	396	-537	-133	246	560	0	0	0	0	2.37	560
Average (af)		**409**	**217**	**-553**	**-133**	**2**	**-65**	**0**	**0**	**0**	**0**	**-0.21**	**-62**
Maximum (af)		**1,180**	**672**	**-241**	**-49**	**314**	**1,331**	**0**	**0**	**0**	**0**	**4.50**	**1,331**
Minimum (af)		**1**	**0**	**-717**	**-146**	**-291**	**-601**	**0**	**0**	**0**	**0**	**-2.23**	**-601**

Key:
af - acre-feet
VG - Vista Grande



Model Simulated Lake Merced Lake Levels
Scenario 3a
Lake Merced Lake-Level Model
Design Drought
Lake-Level Model Scenario 3a
Simulated Lake Elevation (feet NGVD 29)
Simulated Lake Elevation (feet City Datum)
Scenario Year
30
25
20
15
10
5
0
-5
-10
21.4
16.4
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1.4
-3.6
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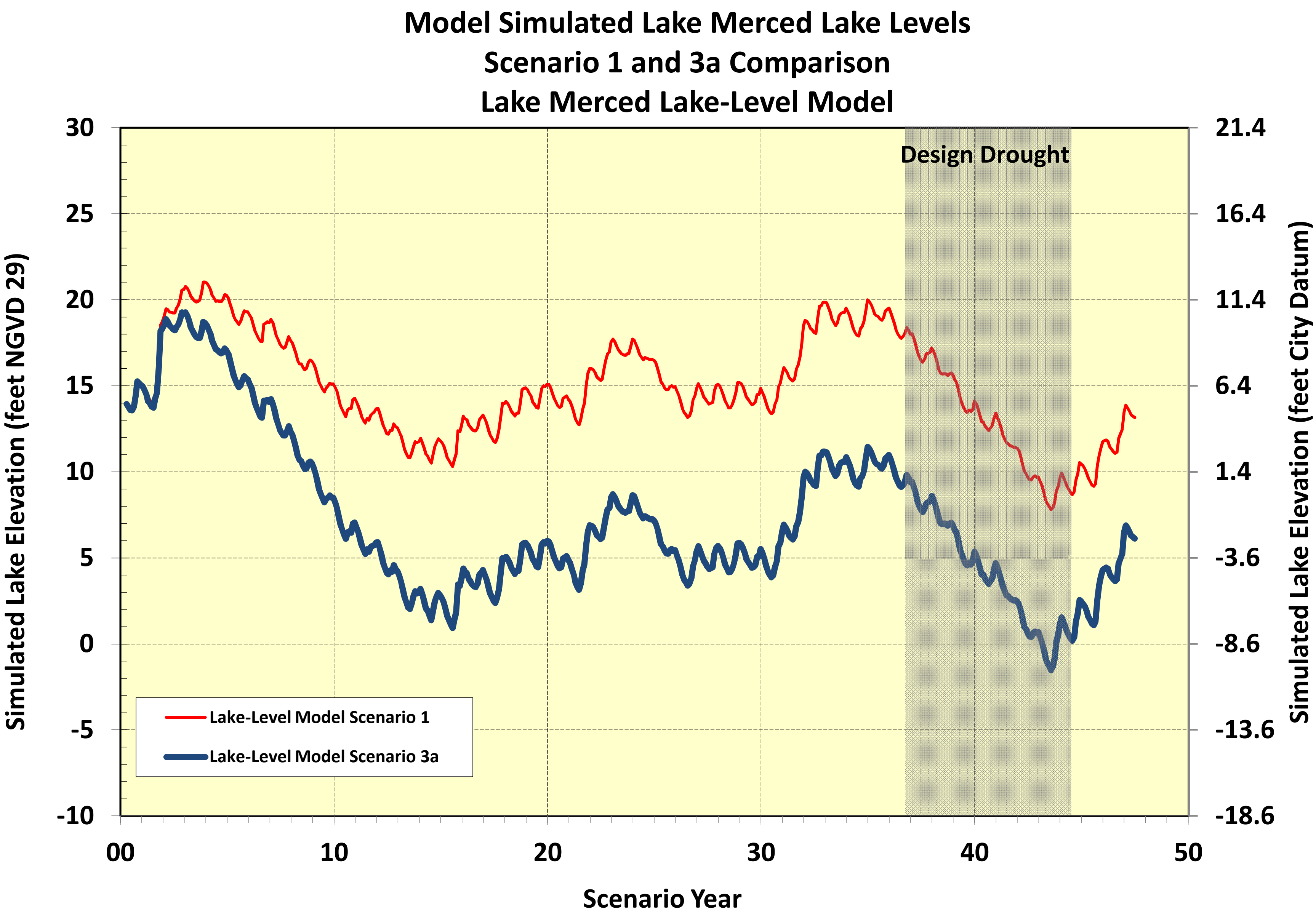

Model Simulated Lake Merced Lake Levels
Scenario 1 and 3a Comparison
Lake Merced Lake-Level Model
Design Drought
Lake-Level Model Scenario 1
Lake-Level Model Scenario 3a
Simulated Lake Elevation (feet NGVD 29)
Simulated Lake Elevation (feet City Datum)
Scenario Year
30
25
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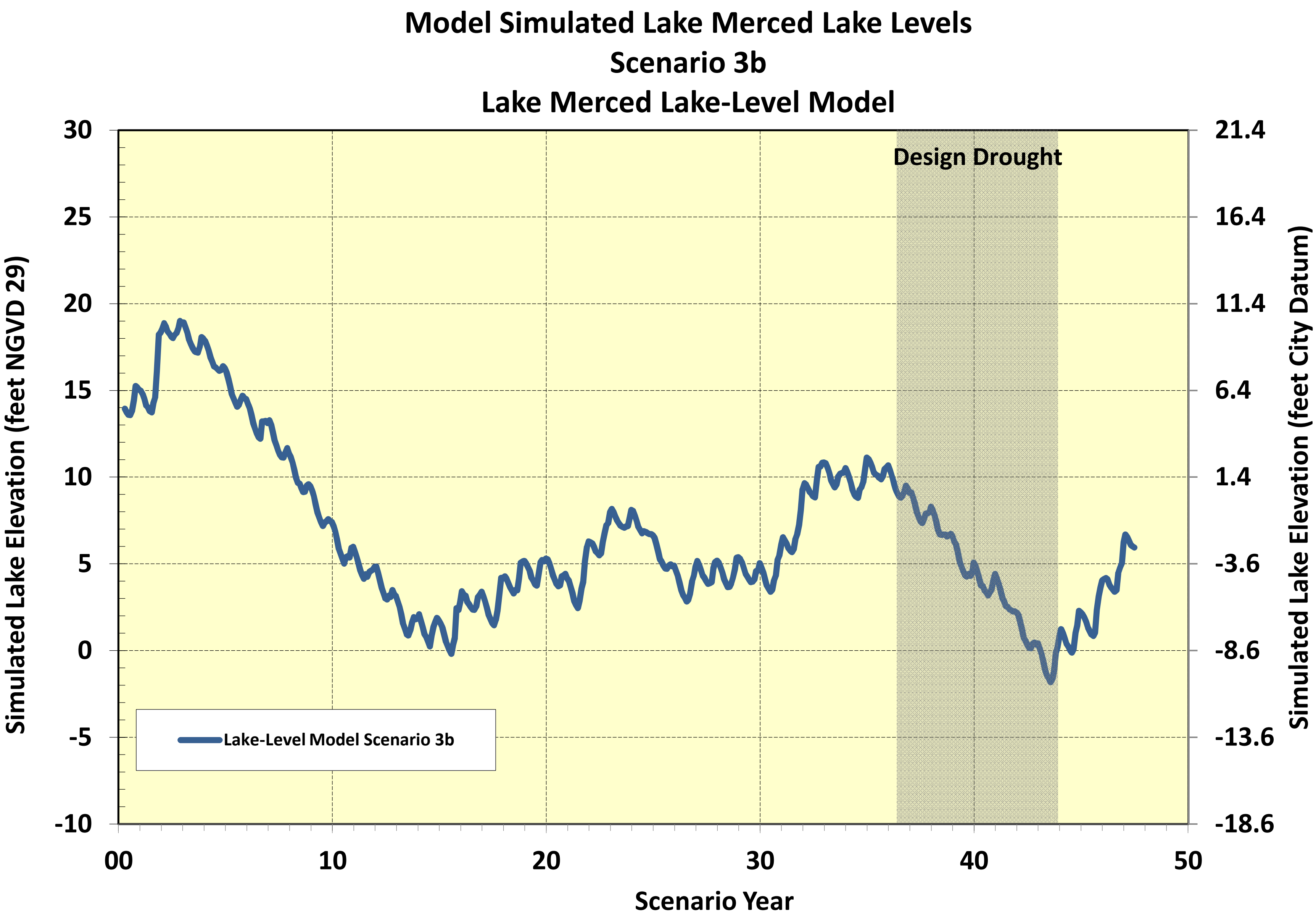
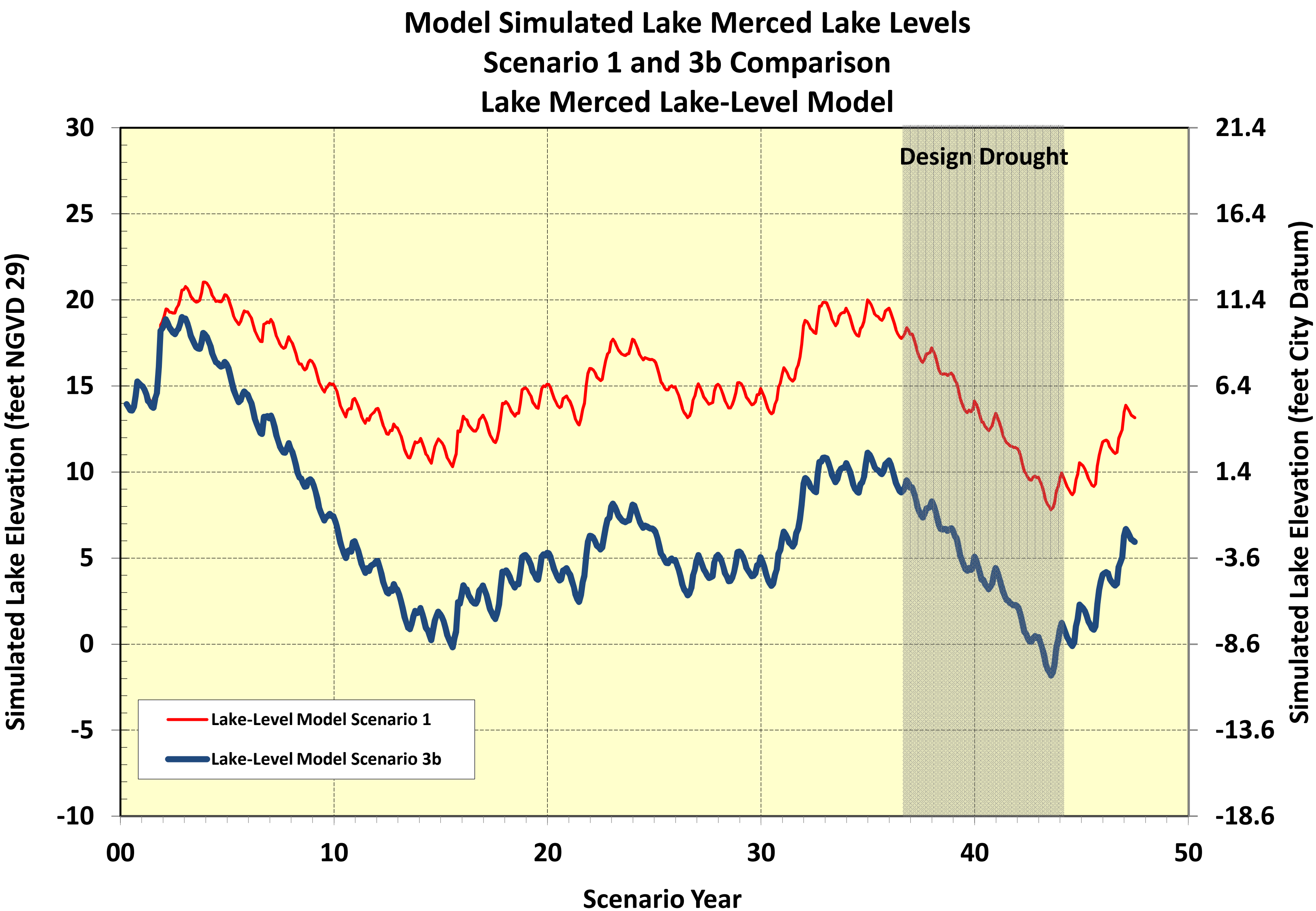
Lake Merced Lake-Level Model Water Balance
Scenario 3b
SFPUC GSR and SFGW Projects Technical Analysis

Assumptions:		**Initial Lake Level**		**Wetland Source**		**VG Stormwater**		**Number of Wells**		**Diversion Elevation**		**Spillway Elevation**	
(in feet City Datum)		**5.7**		**None**		**No**		**No Wells**		**13.0**		**13.0**	
		Lake Merced Natural Hydrology						**Lake Merced Lake Level Management**				**Summary**	
Historical Water Year	**Scenario Year**	**Precipitation (af)**	**Stormwater Runoff (af)**	**Evaporation (af)**	**Transpiration (af)**	**Groundwater Inflow-Outflow (af)**	**Natural Hydrology Subtotal (af)**	**Lake Additions from Engineered Wetland (af)**	**Lake Additions from Vista Grande Canal Stormflow (af)**	**Lake Additions from Wells (af)**	**Flow over the Spillway (af)**	**Annual (Sept to Sept) Change in Lake Level (feet)**	**Lake Merced Change in Storage (af)**
1996	0	1	0	-241	-49	76	-213	0	0	0	0	-	-
1997	1	499	189	-717	-144	229	57	0	0	0	0	0.21	57
1998	2	1,180	672	-677	-134	229	1,270	0	0	0	0	4.30	1,270
1999	3	477	138	-637	-129	-54	-206	0	0	0	0	-0.66	-206
2000	4	466	140	-680	-135	-113	-323	0	0	0	0	-1.06	-323
2001	5	287	76	-643	-133	-216	-629	0	0	0	0	-2.11	-629
2002	6	361	115	-632	-132	-216	-505	0	0	0	0	-1.74	-505
2003	7	480	218	-651	-136	-202	-292	0	0	0	0	-1.02	-292
1959	8	330	118	-629	-136	-206	-523	0	0	0	0	-1.89	-523
1960	9	285	114	-584	-134	-270	-589	0	0	0	0	-2.22	-589
1961	10	318	134	-556	-134	-297	-535	0	0	0	0	-2.13	-535
1962	11	348	186	-500	-128	-182	-276	0	0	0	0	-1.13	-276
1963	12	403	220	-528	-136	-216	-257	0	0	0	0	-1.12	-257
1964	13	247	135	-457	-131	-229	-434	0	0	0	0	-2.07	-434
1965	14	366	266	-426	-128	-169	-91	0	0	0	0	-0.44	-91
1966	15	300	221	-438	-133	-47	-96	0	0	0	0	-0.48	-96
1967	16	524	473	-456	-130	75	486	0	0	0	0	2.46	486
1968	17	278	174	-490	-136	-24	-198	0	0	0	0	-0.90	-198
1969	18	462	349	-477	-131	143	348	0	0	0	0	1.71	348
1970	19	425	268	-517	-133	67	110	0	0	0	0	0.52	110
1971	20	387	213	-494	-128	25	3	0	0	0	0	0.03	3
1972	21	247	126	-483	-130	-75	-316	0	0	0	0	-1.40	-316
1973	22	637	446	-513	-131	248	687	0	0	0	0	3.05	687
1974	23	603	310	-543	-131	180	418	0	0	0	0	1.71	418
1975	24	367	159	-544	-130	35	-113	0	0	0	0	-0.44	-113
1976	25	200	69	-544	-134	-59	-467	0	0	0	0	-1.88	-467
1977	26	233	104	-517	-132	-117	-429	0	0	0	0	-1.84	-429
1978	27	510	321	-547	-138	63	209	0	0	0	0	0.95	209
1979	28	337	191	-526	-135	53	-80	0	0	0	0	-0.33	-80
1980	29	450	252	-519	-132	49	101	0	0	0	0	0.44	101
1981	30	306	166	-505	-133	-1	-167	0	0	0	0	-0.70	-167
1982	31	625	383	-513	-130	159	524	0	0	0	0	2.28	524
1983	32	799	468	-621	-141	314	819	0	0	0	0	3.22	819
1984	33	458	221	-649	-141	245	134	0	0	0	0	0.52	134
1985	34	409	157	-634	-140	58	-150	0	0	0	0	-0.55	-150
1986	35	633	298	-654	-142	193	328	0	0	0	0	1.23	328
1987	36	287	113	-643	-140	58	-325	0	0	0	0	-1.20	-325
1988	37	313	120	-633	-141	-32	-374	0	0	0	0	-1.42	-374
1989	38	394	172	-598	-140	-41	-213	0	0	0	0	-0.82	-213
1990	39	234	95	-591	-141	-110	-514	0	0	0	0	-2.07	-514
1991	40	333	180	-538	-137	-101	-263	0	0	0	0	-1.11	-263
1992	41	341	201	-569	-146	-37	-211	0	0	0	0	-0.92	-211
1976	42	135	64	-462	-136	-58	-457	0	0	0	0	-2.23	-457
1977	43	186	125	-399	-132	-116	-336	0	0	0	0	-1.92	-336
1978	44	390	392	-450	-140	65	257	0	0	0	0	1.62	257
2004	45	322	268	-466	-137	179	166	0	0	0	0	0.90	166
2005	46	535	405	-488	-132	211	531	0	0	0	0	2.58	531
2006	47	578	402	-531	-133	247	563	0	0	0	0	2.44	563
Average (af)		**402**	**221**	**-544**	**-133**	**-5**	**-67**	**0**	**0**	**0**	**0**	**-0.22**	**-63**
Maximum (af)		**1,180**	**672**	**-241**	**-49**	**314**	**1,270**	**0**	**0**	**0**	**0**	**4.30**	**1,270**
Minimum (af)		**1**	**0**	**-717**	**-146**	**-297**	**-629**	**0**	**0**	**0**	**0**	**-2.23**	**-629**

Key:
af - acre-feet
VG - Vista Grande


Model Simulated Lake Merced Lake Levels
Scenario 3b
Lake Merced Lake-Level Model
Design Drought
Simulated Lake Elevation (feet NGVD 29)
Simulated Lake Elevation (feet City Datum)
Lake-Level Model Scenario 3b
Scenario Year
30
25
20
15
10
5
0
-5
-10
21.4
16.4
11.4
6.4
1.4
-3.6
-8.6
-13.6
-18.6
00
10
20
30
40
50

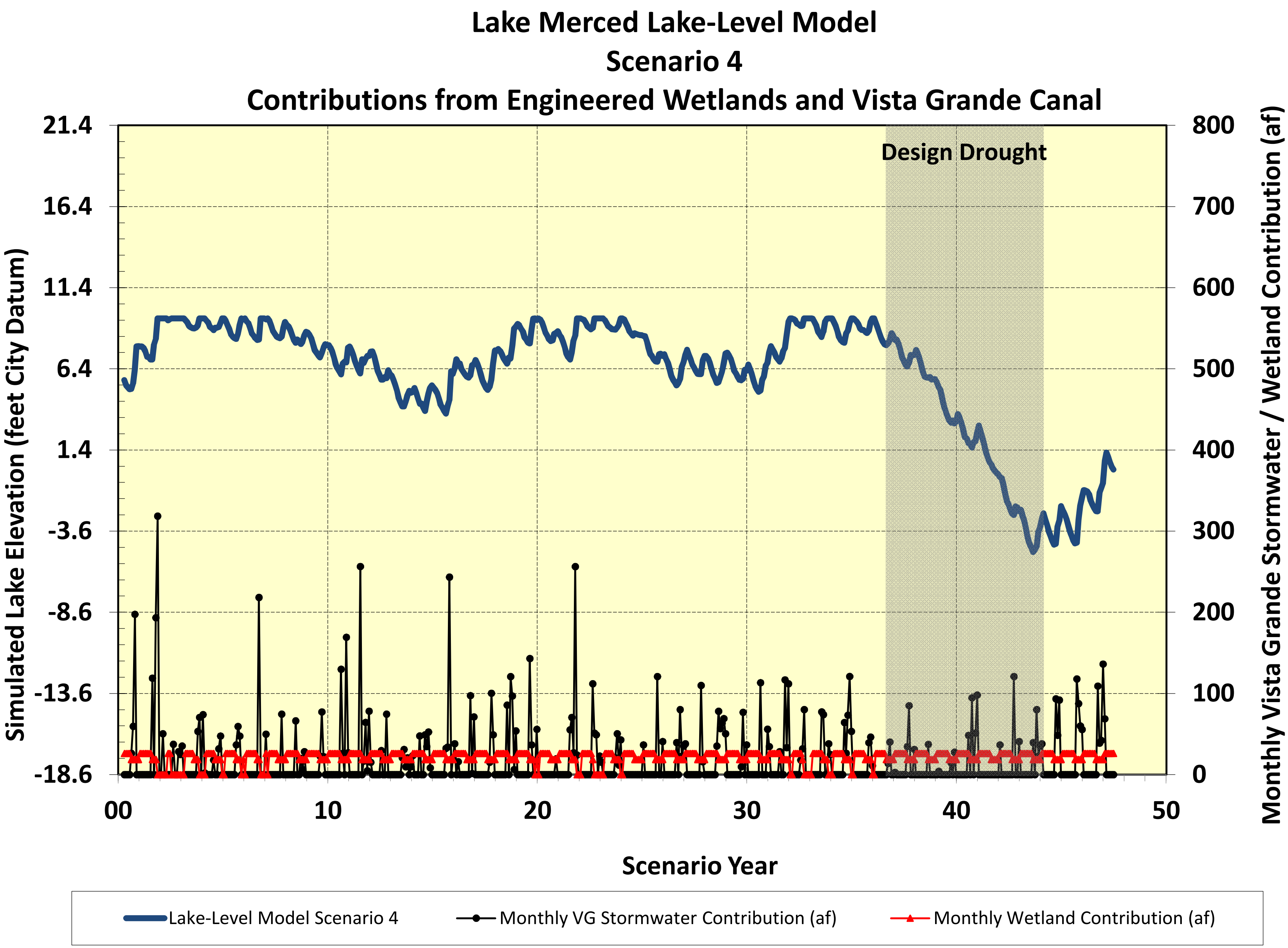

Model Simulated Lake Merced Lake Levels
Scenario 1 and 3b Comparison
Lake Merced Lake-Level Model
Design Drought
Simulated Lake Elevation (feet NGVD 29)
Simulated Lake Elevation (feet City Datum)
Scenario Year
Lake-Level Model Scenario 1
Lake-Level Model Scenario 3b
30
25
20
15
10
5
0
-5
-10
21.4
16.4
11.4
6.4
1.4
-3.6
-8.6
-13.6
-18.6
00
10
20
30
40
50

Lake Merced Lake-Level Model Water Balance
Scenario 4
SFPUC GSR and SFGW Projects Technical Analysis

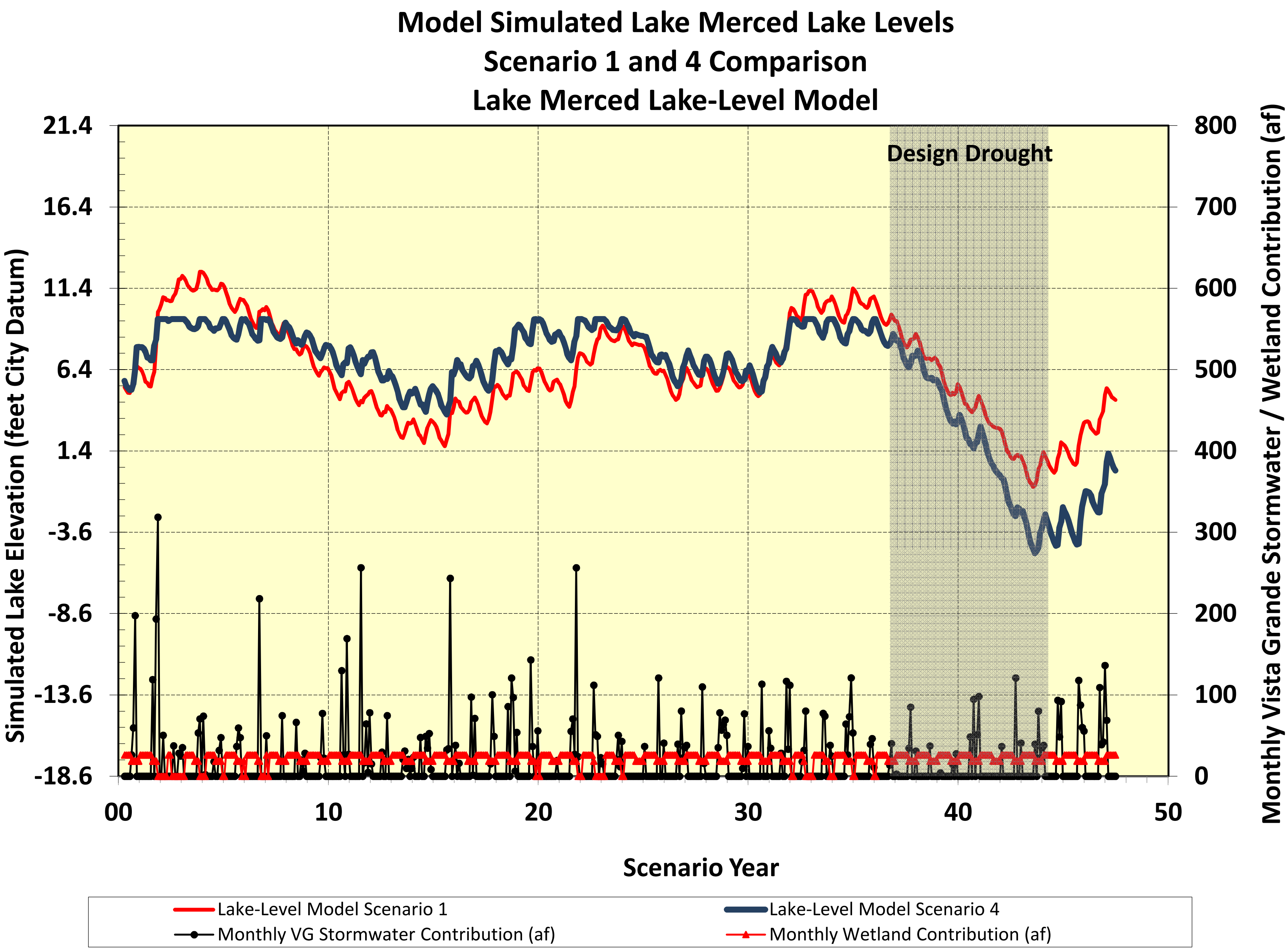
Assumptions:		Initial Lake Level		Wetland Source		VG Stormwater		Number of Wells		Diversion Elevation		Spillway Elevation
(in feet City Datum)		5.7		Baseflow		Yes		No Wells		9.5		9.5

		Lake Merced Natural Hydrology						Lake Merced Lake Level Management				Summary	
Historical Water Year	Scenario Year	Precipitation (AF)	Stormwater Runoff (af)	Evaporation (af)	Transpiration (af)	Groundwater Inflow-Outflow (af)	Natural Hydrology Subtotal (af)	Lake Additions from Engineered Wetland (af)	Lake Additions from Vista Grande Canal Stormflow (af)	Lake Additions from Wells (af)	Flow over the Spillway (af)	Annual (Sept to Sept) Change in Lake Level (feet)	Lake Merced Change in Storage (af)
1996	0	1	0	-241	-49	49	-239	78	0	0	0	-	-
1997	1	504	176	-729	-144	165	-28	277	283	0	0	1.82	532
1998	2	1,205	489	-678	-134	608	1,490	135	681	0	-1,547	2.53	3,852
1999	3	476	138	-634	-129	411	262	105	126	0	-678	-0.60	1,171
2000	4	469	134	-683	-135	191	-24	187	200	0	-397	-0.11	760
2001	5	293	74	-658	-133	12	-413	232	97	0	-64	-0.48	-20
2002	6	377	106	-663	-132	-58	-370	232	144	0	-10	-0.01	15
2003	7	512	172	-697	-136	-29	-178	194	268	0	-252	0.12	537
1959	8	360	102	-690	-136	-113	-476	277	141	0	0	-0.19	-59
1960	9	323	94	-665	-134	-250	-631	277	55	0	0	-0.99	-300
1961	10	374	106	-659	-134	-382	-695	277	122	0	0	-0.99	-296
1962	11	427	141	-614	-128	-490	-664	277	353	0	0	-0.11	-35
1963	12	508	161	-673	-136	-687	-827	277	436	0	0	-0.38	-114
1964	13	325	97	-622	-131	-532	-863	277	104	0	0	-1.65	-482
1965	14	515	182	-600	-128	-429	-461	277	163	0	0	-0.07	-21
1966	15	430	149	-632	-133	-302	-488	277	145	0	0	-0.22	-67
1967	16	741	297	-621	-130	-310	-23	277	384	0	0	2.22	638
1968	17	380	120	-670	-136	-381	-687	277	170	0	0	-0.81	-241
1969	18	634	233	-626	-131	-113	-2	277	165	0	0	1.51	439
1970	19	553	184	-666	-133	-198	-260	277	364	0	0	1.29	380
1971	20	497	151	-633	-128	-206	-319	232	236	0	-92	0.20	240
1972	21	322	89	-638	-130	-313	-671	277	19	0	0	-1.25	-375
1973	22	838	296	-642	-131	12	374	213	433	0	-464	1.86	1,484
1974	23	735	231	-649	-131	168	354	149	251	0	-750	0.02	1,504
1975	24	436	123	-644	-130	-95	-311	232	126	0	-169	-0.40	215
1976	25	239	54	-658	-134	-257	-756	277	37	0	0	-1.47	-443
1977	26	291	78	-653	-132	-439	-855	277	162	0	0	-1.41	-417
1978	27	655	233	-691	-138	-351	-292	277	216	0	0	0.69	200
1979	28	422	140	-659	-135	-389	-620	277	126	0	0	-0.73	-217
1980	29	561	189	-647	-132	-496	-526	277	353	0	0	0.37	104
1981	30	385	123	-634	-133	-410	-668	277	123	0	0	-0.91	-269
1982	31	779	282	-624	-130	-248	60	277	204	0	0	1.85	540
1983	32	943	338	-718	-141	193	615	224	291	0	-470	2.20	1,599
1984	33	519	166	-726	-141	211	30	176	130	0	-542	-0.68	878
1985	34	463	129	-714	-140	-137	-400	213	214	0	-126	-0.32	154
1986	35	715	235	-730	-142	20	98	232	338	0	-442	0.75	1,110
1987	36	321	94	-720	-140	-123	-568	232	97	0	-29	-0.88	-210
1988	37	354	99	-719	-141	-299	-706	277	57	0	0	-1.24	-373
1989	38	453	140	-689	-140	-432	-668	277	151	0	0	-0.81	-241
1990	39	270	78	-688	-141	-527	-1,009	277	42	0	0	-2.38	-691
1991	40	402	141	-646	-137	-545	-784	277	42	0	0	-1.65	-465
1992	41	413	161	-688	-146	-633	-893	277	292	0	0	-1.18	-324
1976	42	171	51	-586	-136	-574	-1,074	277	37	0	0	-2.92	-761
1977	43	243	99	-538	-132	-676	-1,004	277	162	0	0	-2.34	-565
1978	44	525	309	-572	-140	-524	-403	277	216	0	0	0.41	90
2004	45	391	226	-556	-137	-437	-513	277	234	0	0	0.02	-3
2005	46	610	340	-540	-132	-403	-124	277	321	0	0	1.99	474
2006	47	632	333	-573	-133	-371	-112	277	395	0	0	2.21	560
Average (af)		**479**	**168**	**-644**	**-133**	**-229**	**-366**	**248**	**198**	**0**	**-128**	**-0.16**	**216**
Maximum (af)		**1,205**	**489**	**-241**	**-49**	**608**	**1,490**	**277**	**681**	**0**	**0**	**2.53**	**3,852**
Minimum (af)		**1**	**0**	**-730**	**-146**	**-687**	**-1,074**	**78**	**0**	**0**	**-1,547**	**-2.92**	**-1,547**

Key:
af - acre-feet
VG - Vista Grande



Lake Merced Lake-Level Model
Scenario 4
Contributions from Engineered Wetlands and Vista Grande Canal
Design Drought
Simulated Lake Elevation (feet City Datum)
21.4
16.4
11.4
6.4
1.4
-3.6
-8.6
-13.6
-18.6
Monthly Vista Grande Stormwater / Wetland Contribution (af)
800
700
600
500
400
300
200
100
0
00
10
20
30
40
50
Scenario Year
Lake-Level Model Scenario 4
Monthly VG Stormwater Contribution (af)
Monthly Wetland Contribution (af)



Model Simulated Lake Merced Lake Levels
Scenario 1 and 4 Comparison
Lake Merced Lake-Level Model
Design Drought
Simulated Lake Elevation (feet City Datum)
21.4
16.4
11.4
6.4
1.4
-3.6
-8.6
-13.6
-18.6
Monthly Vista Grande Stormwater / Wetland Contribution (af)
800
700
600
500
400
300
200
100
0
00
10
20
30
40
50
Scenario Year
Lake-Level Model Scenario 1
Lake-Level Model Scenario 4
Monthly VG Stormwater Contribution (af)
Monthly Wetland Contribution (af)

Attachment 10.1-H

Lake Merced Lake-Level Model Development Technical Memorandum

17 April 2012

Technical Memorandum
Attachment H to Task 10.1 Technical Memorandum

San Francisco Public Utilities Commission

Lake Merced Lake-Level Model Development
Regional Groundwater Storage and Recovery Project and
San Francisco Groundwater Supply Project

Prepared for: Greg Bartow and Jeff Gilman, SFPUC

Prepared by: Michael Maley and Sevim Onsoy, Kennedy/Jenks Consultants

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1. Introduction

This Technical Memorandum (TM) was prepared to document work performed by Kennedy/Jenks Consultants (Kennedy/Jenks) for the San Francisco Public Utilities Commission (SFPUC) pursuant to the amended Task Order (TO) authorizations CUW30103-TO-1.12 of the Regional Groundwater Storage and Recovery (GSR) Project and CUW30102-TO-2.7 of the San Francisco Groundwater Supply (SFGW) Project. These projects are funded by the SFPUC's Water System Improvement Program (WSIP).

1.1. Objective

SFPUC is currently undertaking engineering and environmental studies for the GSR and SFGW Projects that includes evaluating the potential effects of these projects on Lake Merced. The Lake Merced Lake-Level Model is one the tools used to evaluate these effects.

The Lake Merced Lake-Level Model is a spreadsheet-based water-balance that applies a rule-based approach for the water balance. The model sums up the inflows and outflows from Lake Merced on a monthly time scale. The water balance components are each calculated independently. The sum represents the net change in water volume in the lake for that month. Based on this net change in water volume, a new lake level is calculated. The advantage of a rule-based approach is that once the rules are defined, they enhance the ability to then adapt the model for use in project simulations.

This technical memorandum documents the model calibration to historical lake levels over a 70-year period from 1939 to 2009. Calibrating the model over this long historical range allows for the historical analysis to be tested over a variety of hydrological conditions including wet, normal and dry precipitation years, flood events, and periods of high and low lake levels. The calibration process defines the level of confidence in the capability of the model to subsequently simulate future-case scenarios. A well calibrated model demonstrates a stronger conceptual understanding of the key hydrological factors that control lake levels. An improved historical calibration also increases confidence in the model's ability to forecast future conditions and reduces uncertainty in the model's applications to future conditions.

The setup and modifications to the Lake-Level Model necessary to apply the model for the GSR and SFGW projects is also documented herein, but the results of the modeling are presented in the main body of the Task 10.1 Technical Memorandum.

1.2. Previous Studies

Several previous studies have been conducted to evaluate Lake Merced. EDAW and Talavera & Richardson (2004) conducted a study to understand the cause for declining water levels and to develop plans to restore levels. Several detailed studies were conducted by Luhdorff & Scalmanini Consulting Engineers (LSCE) (LSCE 2002, 2004, and 2007) to provide a description of the aquifers underlying the lake to evaluate the lake-aquifer relationships. The Lake Merced Water Level Restoration Alternatives Analysis Report (AAR) (Metcalf & Eddy, Inc., 2008) identified preferred alternatives to meet recommended lake level elevations through a combination of treated stormwater from the Vista Grande Canal (VGC) and groundwater. A draft Conceptual Engineering Report (CER) was prepared to provide the first phase of the conceptual engineering design for an engineered wetland for stormwater treatment (Kennedy/Jenks, 2009a). The City of Daly City prepared the Vista Grande Drainage Basin Alternatives Analysis in 2011 (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012) to evaluate alternatives to reduce flooding and erosion along Lake Merced, and provide lake level augmentation.

Previous Lake Merced lake-level modeling studies have been conducted to characterize the water balance of Lake Merced and to estimate supplemental water necessary to raise and maintain lake levels. As a part of the EDAW study, a numerical groundwater model was developed to provide preliminary estimates of the volumes of water needed for maintaining lake levels within different target lake levels (EDAW and Talavera & Richardson, 2004). LSCE (2008) developed a spreadsheet-based analytical water-balance model to evaluate changes in lake levels in Lake Merced. This model was updated to support the draft Conceptual Engineering Report (CER) for the conceptual engineering design to increase and maintain Lake Merced Levels (Kennedy/Jenks, 2009a). The Kennedy/Jenks (2009b) model was modified for the Vista Grande Drainage Basin Alternatives Analysis in 2011 (Brown and Caldwell, 2010; Jacobs Associates, 2011a, 2011b) to evaluate lake-levels changes from diversions of stormwater from the VGC.

2. Physical Setting

This section provides a summary of the climatic, hydrological, and hydrogeological data representative of the physical setting of Lake Merced.

2.1. Lake Merced

Lake Merced is a freshwater lake located in the southwest corner of San Francisco, consisting of four inter-connected freshwater lakes - North Lake, South Lake, East Lake and Impound Lake (Figure 1). Until the early 1900s, Lake Merced was one large body of water that was fed by local runoff and springs, with an outflow to the Pacific Ocean via a stream from North Lake. The springs that flowed into the lake were primarily located on the eastern side and in the southern portion of Lake Merced and resulted in flow through the lake from south to north.

Lake Merced does not have a natural outlet; however Lake Merced has an overflow structure, also known as spillway, near the midpoint of the southwest side of South Lake at 13 feet City Datum. All lake elevations in this memorandum reference the City Datum, which is 11.37 feet higher than the North American Vertical Datum 1988 (NAVD) and 8.62 feet higher than the National Geodetic Vertical Datum 1929 (NGVD) (LSCE, 2002). Lake Merced elevations have historically referenced a Lake Merced Gage Board that has a datum 17.50 feet higher than the City Datum, 8.88 feet higher than NGVD, and 6.13 feet higher than NAVD.

North and East lakes are joined through a narrow channel and these lakes are separated from South Lake by natural or man-made barriers. A conduit between North and South lakes allows water to flow between the two lakes when the lake elevation in either lake is approximately 3.35 feet City Datum. When lake levels drop below that elevation, the two lakes are separated and typically exhibit different elevations. South and Impound lakes are separated below an elevation of approximately 4.26 feet City Datum. When the lake elevation in either lake is above 5 feet City Datum, water flows freely, connecting the two lakes.

2.2. History of Lake Levels

Lake levels have been measured daily in South Lake since 1926. Figure 2 shows the historical measured Lake Merced water levels as measured at South Lake. Historically, lake water levels have fluctuated. Prior to the beginning of Hetch-Hetchy aqueduct water delivery in 1935, lake levels typically ranged from 0 to -10 feet City Datum. In the late 1930s to early 1940s, lake levels increased to over 13 feet City Datum which is approximately the spillway elevation and represents the maximum potential lake level.

Lake levels started to decline in the 1940s. During the 1940s to late 1950s, lake levels varied between 8 and 13 feet City Datum. Between the late 1950s and early 1980s, the lake experienced an overall long-term declining trend when lake levels ranged between 4 and 10 feet City Datum (Figure 2). Previous reports cite the primary reasons for the overall declining lake levels as drought, groundwater pumping, evaporation, and urbanization diverting stormwater into the City’s combined sewer and stormwater system (Pezzetti and Bellows, 1998).

In the late 1980s and early 1990s, a major drought impacted the area. During this time, lake levels dropped significantly due to the drought and groundwater pumping. A lake level of about -3.2 feet City Datum observed in 1993 was the lowest since the 1930s (Figure 2).

Lake levels have been recovering since 1993. As of June 2009, the lake was at approximately 5.7 feet City Datum (Figure 2). Water level increases over the last 15 years are attributed to a combination of factors, including above average precipitation and direct recharge to the lake and the SFPUC water additions to the lake between 2002 and 2005. During the wet winters of 1997 and 1998, the lake level rose sharply.

Expanded lake-level monitoring was conducted from August 2001 to January 2004. This was during a time when the lake levels were near or below the hydraulic connections between the lakes. This condition caused the lakes to act more independently since the lake levels could not readily equilibrate. These measurements showed that the lake levels decrease progressively from north to south. North and East lakes had higher levels than South Lake, and South Lake was continuously higher than Impound Lake (LSCE, 2004). These observations reflected the predominant shallow groundwater gradient to the south and showed that lake levels separate at lower elevations and have distinct elevations.

2.3. Lake Merced Hydrological Conceptual Model

The hydrological conceptual model for Lake Merced provides a representation of the various inflow and outflow components for the overall lake system. The conceptual model also provides the basis for a representative water-balance model that can be used to develop future operations scenarios for managing the lake levels. The conceptual water-balance model described below consists of various key components that include inflows into and outflows from the lake systems.

Figure 3 demonstrates a schematic of the conceptual water-balance model with primary inflows and outflows that are pertinent for Lake Merced. The primary water balance components are defined as follows:

- <u>Change in Lake Storage</u> – Change in the volume of water in the lake. An increase in lake storage results in a rise in lake levels as water is added to the lake. Conversely, a decrease in lake storage results in a decline in lake levels as water is lost from the lake
- <u>Direct Precipitation</u> – Inflow to Lake Merced resulting from rainfall that falls directly onto Lake Merced surface.
- <u>Stormwater Runoff</u> – Inflow to Lake Merced resulting from runoff of precipitation that falls on the areas surrounding Lake Merced or from overflow from VGC during storm events. Stormwater runoff depends on the extent of drainage area that contributes to the runoff, the amount of precipitation, topography and surface conditions in the drainage areas.
- <u>Evaporation</u> – Outflow from Lake Merced resulting from evaporation, or the conversion of water at the lake surface into water vapor that is lost to the atmosphere. Evaporation is considered as the single largest water loss from the lake. Evaporation loss depends

on lake surface area that is subject to evaporation and evaporation rates that vary as a function of climate conditions (temperature, fog, wind).

- Transpiration – Outflow from Lake Merced resulting from transpiration, or the uptake of water from the lake by plants. The primary plant for consideration of transpiration is the California bulrush (*Scirpus californicus*), or tule. Transpiration loss from the lake is dependent upon the area covered by tules and on transpiration rates.
- Groundwater Inflow and Outflow – The net inflow or outflow of groundwater from the lake. Lake Merced is hydraulically connected to the Shallow Aquifer of the groundwater system (LSCE, 2002; LSCE, 2004); thus, groundwater inflow into and outflow from the lake system is an important water balance component. The direction and magnitude of the groundwater flux into or out of the lake is controlled by the relative difference of lake and groundwater levels.
- Singular Events – The net inflow or outflow to the lake resulting from man-made lake water additions or extractions. These are termed singular events because they are determined by arbitrary operating decisions; therefore, they cannot be estimated independently.

This conceptual water-balance model can be formulated mathematically as follows to track the inflow and outflow of water from the lake over time:

Change in Lake Storage = Direct Precipitation + Stormwater Runoff – Evaporation – Transpiration + Groundwater Inflow – Groundwater Outflow ± Singular Events

In this form, positive components represent inflows into the lake and negative components are outflows from the lake. When inflow exceeds outflow over a month period, the model outcome is a positive change in lake storage, indicating an increase in lake levels. Conversely, when outflow exceeds inflow, the model outcome is a negative change in lake storage, which indicates a decrease in lake levels.

2.4. Physical Lake Condition

As part of the modeling analysis presented here, the lake surface area was calculated as a function of lake level elevation derived from both bathymetric and surface contour data. Table 1 presents the estimated lake surface areas. The estimated lake surface area contours (feet, City Datum) along with the bathymetric contours (feet, City Datum) are shown in Figure 4. For the current lake level as of June 2009 at 5.7 feet City Datum, the total surface area of the lake, including the four lakes, was calculated to be approximately 296 acres. These values are incorporated into the model for converting lake storage into lake levels. This was a model improvement in an effort to refine the lake surface area estimates, which, in turn, improves water balance calculations.

Table 1 – Estimated Lake Merced Surface Area by Lake Levels

Lake Elevation (feet City Datum)	Estimated Lake Surface Area (Acres)
-13	106
-12	122
-11	157
-10	157
-9	193
-8	201
-7	209
-6	223
-5	234
-4	240
-3	250
-2	255
-1	261
0	267
1	273
2	279
3	284
4	288
5	292
6	296
7	300
8	304
9	307
10	310
11	313
12	316
13	319

Based on previous reports, estimates of the total lake surface area range from approximately 245 acres of open water (EIP Associates, 2000) to 276 acres (Yates et al., 1990) to 300 acres (EDAW and Talavera & Richardson, 2004). The variations are likely due to differences in lake levels and surrounding topography. Estimates of the capacity of the lake also vary greatly from a low of 768 million gallons to high of 1.93 billion gallons (Ecology and Environment, 1993). According to Camp Dresser and McKee (CDM) (1999), the volume of North and East lakes is approximately 280 million gallons, South Lake is approximately 700 million gallons and Impound Lake is approximately 26 million gallons, for a total of approximately 1 billion gallons of water in Lake Merced. Yates et al. (1990) estimates the lake's capacity at 1.2 billion gallons.

Based on the available lake bathymetry data discussed in previous reports, the maximum depth of North Lake is 24 feet with an average depth of 13 feet (Yates et al., 1990). South Lake has a maximum and average depth of 23 and 16 feet, respectively. The maximum and average depth of Impound Lake is 12 and 8 feet, respectively. The maximum water level at Lake Merced is controlled by an overflow structure near the midpoint of the southwest end of South Lake at approximately 13 feet City Datum. The bottom topography of the lake is reported to be generally flat and smooth. Only one reference was found to indicate modifications to the bottom of South Lake when dredging was conducted to remove lead shot in the proximity of the Pacific Rod and Gun Club (Ecology and Environment, 1993).

2.5. History of Lake Additions

SFPUC has added water to Lake Merced periodically to help maintain lake levels. These primarily have been diversions of Regional Water System water into South Lake at the Lake Merced Pump Station. Table 2 presents a summary of the known lake water additions based on information provided by the SFPUC (personal comm., Betsey Eagon) and gathered from previous documents (LSCE, 2002; LSCE, 2004). Additional lake water additions are known to have occurred, but records are not available at the time of this study to quantify the volume of water added (personal comm., Greg Bartow, 2009).

Table 2 – Records of Water Additions to Lake Merced

Calendar Year	Volume (AF)	Data Source
1965 -1969	740	LSCE
1978	1,200	LSCE
1992	840	LSCE
1994	920	LSCE
1997	129	SFPUC
2000	71	SFPUC
2002	345	SFPUC & LSCE
2003	816	SFPUC & LSCE
2004	2	SFPUC
2005	96	SFPUC

In the summer of 2003, decreasing lake levels from north to south changed as North and South lakes reached equilibrium in response to the SFPUC's intentional water additions to the lake (LSCE, 2004). Three water additions to the lake were made using the SFPUC Regional Water System water to evaluate the feasibility of direct water addition to the lake as a practical way to manage lake levels. The additions occurred between October 2002 and October 2003. During the first addition in October 2002, the total volume of water added to the lake was 345 af (Table 2). The impact from the first addition was notable in South Lake, with a measurable 1-1/2 foot rise to an elevation of 1.28 feet City Datum. No definitive response was seen in either North Lake or Impound Lake. The second water addition occurred in April 2003, by adding approximately 111 af to the lake. Similar to the first addition, the impact of the second addition was evident in South Lake and no measurable response was seen in North Lake and Impound Lake. During the third addition between July 25 and October 17, 2003, South Lake rose to a level of 3.35 feet City Datum where it began to spill to North Lake and East Lake, and the lakes reached equilibrium. Approximately 705 af was added during the third addition.

Groundwater monitoring during the 2002 and 2003 water additions also demonstrated that the Shallow Aquifer is in full hydraulic connection with Lake Merced (LSCE, 2004). Groundwater level response after October 2002 event was evident in shallow groundwater monitoring wells in the lake vicinity, located immediately adjacent to South Lake. The third addition provided a significant response in all the shallow monitoring wells around the lake.

2.6. Climate

Two weather stations with long-term climatological records were evaluated for this study. These include the Lake Merced Pump Station precipitation gauge operated by SFPUC adjacent to Lake Merced, and the Mission Dolores station located about 5 miles northeast of Lake Merced. The Lake Merced Pump Station gauge is considered to provide representative precipitation data for Lake Merced. Records go back to 1948 but continuous data begins in 1958 (WRCC, 2012a). The Mission Dolores station has a long-term record with continuous climate data records going back to 1914 for both precipitation and temperature (WRCC, 2012b).

2.6.1. Rainfall

The close proximity of Lake Merced to the Pacific Ocean results in distinct maritime Mediterranean climate primarily influenced by wind, fog, and precipitation. Based on the historical precipitation data from Lake Merced Pump Station, the majority of annual rainfall occurs from late October through March (Table 3). Precipitation typically declines during the late season and becomes minimal during the summer. Average annual rainfall (based on a water year of October through September) at the Lake Merced Pump Station gauge is approximately 20.7 inches with a record high of 47.6 inches in 1998 and a record low of 9.5 inches in 1976 (Figure 5). The long term historical record uses a combination of data from the Mission Dolores Station (1914 to 1958) combined with the Lake Merced Pump Station data. The long-term average for Mission Dolores is approximately 21.1 inches which is only slightly higher than Lake Merced Pump Station and, therefore, it is considered reasonable to include this data. The combined precipitation data set is provided in Appendix A.

2.6.2. Temperature

The maritime Mediterranean climate is characterized by cool, foggy summers and mild, rainy winters. In summer and fall, locations adjacent to the ocean, such as Lake Merced, are often enclosed in fog with cool temperature in the 50s and 60s ^{o}F. Lake Merced area often experiences its warmest weather in late September and early October as a result of less fog and occasional off-shore breezes (Table 4). Average monthly temperature from the Mission Dolores station ranges from 51 ^{o}F in January to nearly 63 ^{o}F in September, based on data from January 1914 to April 2009 (Table 4). The highest average monthly temperature was 69.4 ^{o}F in September 1984 and the lowest was 43.6 ^{o}F in January 1937 (see Appendix A).

Table 3 – Summary of Rainfall Data (inches) from Lake Merced Pump Station Precipitation Gauge Based on Records from October 1958 to September 2009

	Monthly Rainfall Data Statistics (October 1958 – September 2009)		
Month	**Average**	**Minimum**	**Maximum**
Jan	4.22	0.42	11.67
Feb	3.56	0.24	15.64
Mar	3.02	0.12	9.29
Apr	1.45	0.06	5.56
May	0.48	0.00	4.20
Jun	0.19	0.00	1.69
July	0.04	0.00	0.49
Aug	0.13	0.00	2.26
Sep	0.25	0.00	2.06
Oct	1.01	0.00	4.65
Nov	2.61	0.00	8.20
Dec	3.48	0.00	8.81

Table 4 – Summary of Temperature Data (°F) from the Mission Dolores, San Francisco, Weather Station Based on Records from January 1914 to April 2009

	Average Monthly Temperature Statistics (January 1914 – April 2009)		
Month	**Average**	**Minimum**	**Maximum**
Jan	51.0	43.6	56.6
Feb	53.9	48.3	58.9
Mar	55.2	50.9	60.7
Apr	56.3	50.7	62.6
May	57.5	53.3	62.7
Jun	59.5	56.2	65.9
July	59.8	56.0	66.0
Aug	60.6	56.4	66.6
Sep	62.7	58.3	69.4
Oct	61.8	56.9	66.7
Nov	57.4	51.9	61.0
Dec	52.1	47.2	57.5

2.6.3. Evapotranspiration

Fog is prevalent throughout the Lake Merced area and significantly affects sunshine and temperature conditions. This also affects evaporation, transpiration, and evapotranspiration rates. A United State Geological Survey (USGS) study was conducted at Lake Merced during 1987 and 1988 that collected pan evaporation measurements. These pan evaporation measurements were converted to equivalent lake evaporation and tule transpiration rates (Yates et al., 1990). A summary of the results of this study is provided in Table 5.

Evaporation rates for Lake Merced were assumed to be affected by temporal variations based on temperature conditions; however, these data are not available from Lake Merced. Reference evapotranspiration (ETo) data measured at the closest California Irrigation Management Information System (CIMIS) station at Castroville (http://wwwcimis.water.ca.gov/cimis/) were used as the basis to relate ETo to lake evaporation, similar to the approach taken by Yates (2003). Castroville was used because it represents a location with a similar climate near the ocean that is influenced by fog in the summertime. In this analysis, ETo data available from November 1982 to March 2009 at Castroville CIMIS station were used to estimate long-term lake evaporation.

A literature review indicated that evaporation is not directly measured by weather stations, but can be estimated based on ETo of cropped surfaces, using a procedure published by the Food and Agricultural Organization (FAO) Irrigation and Drainage Papers (FAO, 1977; FAO, 1998; Pruitt and Snyder, 1985). This approach is commonly applied in the literature, and it was used in this study to develop a time series of monthly lake evaporation from monthly ETo. Monthly ETo records at Castroville Station were multiplied by a coefficient of 0.735 to estimate monthly lake evaporation. This coefficient is within the typical range of 0.6 to 0.9 as reported by Yates (2003). The standard deviation was calculated for the estimated lake evaporation for each month to evaluate the seasonal variation in lake evaporation. The results of this analysis are provided in Table 6.

Table 5 – Monthly Evaporation Rates for Lake Merced (Yates et al., 1990)

Month	Pan Evaporation [(a)] (inches)	Lake Evaporation [(b)] (inches)	Tule Transpiration[(c)] (inches)
Jan	1.18	0.89	1.01
Feb	1.77	1.33	1.52
Mar	2.80	2.11	2.41
Apr	3.11	2.33	2.67
May	4.05	3.04	3.48
Jun	5.06	3.80	4.35
Jul	5.58	4.19	4.80
Aug	3.17	2.38	2.73
Sep	3.17	2.38	2.73
Oct	2.59	1.94	2.23
Nov	1.67	1.25	1.44
Dec	1.08	0.81	0.93
Total	**35.2**	**26.4**	**30.3**

Notes:

(a) Measurements at Lake Merced during Oct 1987 to Sept 1998 (Yates et al., 1990).
(b) Lake evaporation calculated as 75% of pan evaporation (Yates et al., 1990).
(c) Tule transpiration calculated as 86% of pan evaporation (Yates et al., 1990).

Table 6 – Summary of Evapotranspiration and Estimated Lake Evaporation Data from Castroville CIMIS Station Based on Records from November 1982 to March 2009

Month	Average Evapotranspiration	Average Estimated Lake Evaporation	Standard Deviation of Estimated Lake Evaporation
	(inches)	(inches)	(inches)
Jan	1.62	1.19	0.22
Feb	2.00	1.47	0.28
Mar	3.13	2.30	0.37
May	4.12	3.03	0.34
Apr	4.76	3.50	0.35
Jun	4.85	3.56	0.36
July	4.34	3.19	0.55
Aug	3.88	2.85	0.40
Sep	3.25	2.39	0.39
Oct	2.72	2.00	0.32
Nov	1.79	1.31	0.25
Dec	1.50	1.10	0.18

2.7. Hydrology

The original watershed that drained into Lake Merced has been estimated at approximately 6,320 acres; however, the current watershed is now estimated to be approximately 650 acres (SFSU, 2005; Pezzetti and Bellows, 1998). The current watershed is defined by the adjacent roadways that include Lake Merced Boulevard, Skyline Boulevard, and John Muir Boulevard.

A significant portion of stormwater that falls on the areas immediately surrounding the lake drains directly into the lake based on information provided by the SFPUC staff (personal comm., Greg Braswell). Overflow from VGC during storm events also has been discharged into the lake; thus, the lake has received additional stormwater runoff from the VGC overflows. Several catch basins draining into the lake are located primarily along the southern portion near the Impound Lake, and the majority of the stormwater drains located along the western shore of Lake Merced empty directly to the lake (Figure 6).

Much of the runoff from the original watershed is now diverted into the City’s combined wastewater system, which had an effect on the surface runoff into the lake. The urbanization of the lake watershed diverts stormwater runoff away from the lake into the City’s combined sewer and stormwater system and results in reduced recharge to the lake (SFSU, 2005). Runoff from the eastern and northern portions surrounding the lake is directed into the City’s combined wastewater system. However, the development of the lake’s watershed with impervious surfaces has tended to increase the runoff from these surfaces (SFSU, 2005).

Due to changes in the lake watershed hydrology, the flow through the lake has reversed over time, now flowing from north to south. The development of the urbanized watershed has also affected groundwater recharge to the Shallow Aquifer from precipitation, and in turn, reduced the amount of subsurface inflow to Lake Merced (SFPUC, 2008).

2.8. Groundwater

Lake Merced overlies the North Westside Basin, which is the northern portion of the greater Westside Groundwater Basin (Westside Basin). From north to south, the North Westside Basin underlies a portion of the Sunset District in San Francisco from Golden Gate Park to the San Francisco/San Mateo County line. From west to east, the North Westside Basin extends from the Pacific Ocean to inland bedrock exposures generally associated with Mount Sutro and Mount Davidson (LSCE, 2002; LSCE, 2004).

The groundwater aquifer system in the Lake Merced area is stratified consisting of three aquifer units: a shallow unconfined aquifer (Shallow Aquifer), an intermediate semi-confined aquifer (Primary Production Aquifer), and a deep confined aquifer (Deep Aquifer) (LSCE, 2002; LSCE, 2004; LSCE, 2005) (Figure 7). The Shallow Aquifer extends from the top of the zone of saturation (i.e., water table) to the top of the -100 foot clay in the Lake Merced area (LSCE, 2010). The thickness of the Shallow Aquifer varies from 100 to 150 feet. Beneath the unconfined aquifer lies a fairly extensive clay layer known locally as the -100 foot clay. This clay layer forms the top of the semi-confined Primary Production Aquifer that consists of a 250 to 300 foot thick sandy sequence. Beneath the Primary Production Aquifer is the confined Deep Aquifer consisting of a fine sand or loosely-consolidated sandstone.

Lake Merced is hydraulically connected to the unconfined Shallow Aquifer (LSCE, 2002; LSCE, 2004). Previous hydrogeological investigation also provided some evidence that the surface of the lake is essentially an exposed part of the water table that defines the upper boundary of the Shallow Aquifer (Yates et al., 1990). Groundwater monitoring during the SFPUC's 2002 and 2003 water additions to Lake Merced further demonstrated that the Shallow Aquifer is in full hydraulic connection with Lake Merced (LSCE, 2004).Groundwater level response after the October 2002 water addition was evident in shallow groundwater monitoring wells in the lake vicinity, located immediately adjacent to South Lake. The third addition between July 25 and October 17, 2003 provided a significant response in the shallow monitoring wells around the lake, suggesting increased seepage from the lake in response to water additions. Analysis by LSCE (2004) indicated that 70 to 80 percent of the volume of water added contributed to lake storage and the remaining 20 to 30 percent attributed to net outflow and evaporative losses during the addition period.

Interpretation of water level data and some anecdotal groundwater observations (e.g., spring discharge into Lake Merced) show that shallow groundwater previously flowed toward the ocean to the northwest of Lake Merced (LSCE, 2002). Interpretation of recent shallow water level data shows that shallow groundwater has a gradient potentially turned toward the pumping depression that expanded toward Daly City by 1970. At present (based on fall 2007 data), the direction of groundwater flow in the unconfined Shallow Aquifer is predominantly to the southwest, however, north of Lake Merced groundwater flow appears to be more westward toward the ocean (Figure 8). Groundwater elevations ranged from about 13.5 feet (NAVD 88) north of Lake Merced to 15.8 feet (NAVD 88) south of Lake Merced (SFPUC, 2008).

Groundwater levels in the Primary Production Aquifer ranged from 3.4 feet north of Lake Merced to -5.2 feet south of the lake (SFPUC, 2008). These are notably lower elevations than levels in the overlying Shallow Aquifer, suggesting semi-confined to confined conditions in the Primary Production Aquifer. As reported in the draft North Westside Groundwater Management Plan (LSCE, 2005), significant historical groundwater pumping south of Lake Merced toward Daly City has resulted in substantial pumping depression and decline in groundwater levels in the deeper portion of the aquifer. Over the period from the late 1940's to the 1970's, a significant reduction in water levels was seen in the Primary Production Aquifer near the southern end of Lake Merced. It appears that the decrease in groundwater levels in Daly City and South San Francisco resulted in a change in groundwater flow direction from northwesterly to southerly in the Lake Merced-northern San Mateo County area of the Westside Basin. As also reported in the previous studies (LSCE, 2002), general groundwater flow direction in the deeper portion of the aquifer exhibits a more pronounced north to south flow direction than in the Shallow Aquifer, likely due to greater pumping stresses in the deeper aquifer to the south. In addition, interpretation of deeper groundwater levels shows that the groundwater has a steeper gradient toward the pumping depression than the Shallow Aquifer (LSCE, 2002).

2.9. Groundwater Pumping

In the Westside Basin, municipal pumping mostly occurs south of Lake Merced, in Daly City and San Bruno, by the California Water Service Company (SFPUC, 2008). Historically, a significant amount of groundwater pumping (for municipal water supply and irrigation) has occurred from the Primary Production Aquifer and Deep Aquifer. Significant municipal pumping commenced in 1949, increased considerably through 1965, and for the most part has continued to the present day (SFPUC, 2008). Total municipal pumping in the Westside Basin was about 7,500 acre feet per year (AFY) from the mid-1970s to the mid-1980s, and then ranged generally between about 6,000 AFY and 8,000 AFY until 2001 (Figure 9). Between 2002 and 2005, municipal pumping was significantly reduced, as part of the conjunctive use pilot project which replaced the majority of groundwater pumping during normal and wet years with the SFPUC's system water.

In addition to municipal pumping in the Westside Basin, groundwater has been pumped for irrigation supply and other non-potable uses, mostly for golf courses around Lake Merced, the cemeteries in Colma, Golden Gate Park, and the San Francisco Zoo. Much of the groundwater pumping for irrigation is unmetered, and historical pumping records are scarce. Total pumping in the Westside Basin, including municipal pumping (metered) combined with irrigation (unmetered) pumping, was estimated to be nearly 15,000 AFY in the late 1960s and was reduced to about 7,500 AFY in 2007 (Figure 9). In 2005, groundwater use for golf course irrigation around Lake Merced reduced significantly as a result of initial deliveries of recycled water. The combination of the conjunctive use pilot project and recycled water deliveries for golf course irrigation resulted in reduced pumping of about 5,600 acre feet (af) in 2005 and 7,500 af in 2006. When the conjunctive use project ended in 2006, approximately 7,500 af of water was pumped based on metered municipal and estimated irrigation pumping.

Pumping in the Primary Production Aquifer and Deep Aquifer has a direct effect on the Shallow (unconfined) Aquifer in the Lake Merced vicinity and on the Lake itself, because the Shallow Aquifer is hydraulically connected to the Primary Production Aquifer and Deep Aquifer; the -100-foot clay is absent to the south of Lake Merced and the Primary Production Aquifer is semi-confined (LSCE, 2002; SFPUC, 2008). Qualitatively, it is generally agreed upon that pumping from the Primary Production Aquifer has led to an overall decline in the water level of Lake Merced. Additionally, pumping from the Shallow Aquifer is known to have occurred, but historical records are scarce. The water-level decline has not been quantified unequivocally due to the many uncertainties associated with incomplete groundwater withdrawal records, subsurface complexities, and urbanization. As reported in the previous studies (LSCE, 2002), greater pumping stresses to the south of Lake Merced have lowered groundwater levels and resulted in depressed aquifer conditions in the Primary Production and Deep Aquifers where most of the current municipal pumping is occurring. As also shown in the 2008 Annual Groundwater Monitoring Report of the Westside Basin (SFPUC, 2009), in the Primary Aquifer groundwater elevations decrease significantly from north of Lake Merced to south of Lake Merced and experience a prominent north to south flow direction, likely due to greater pumping to the south. Previous reports indicate water was pumped from the lake to irrigate Harding Park Golf Course (Yates et al., 1990), but pumping volumes are unknown.

3. Lake Merced Lake-Level Model

This section describes how the various water balance components from the hydrological conceptual model were incorporated into the spreadsheet based Lake Merced Lake-Level Model by characterizing each of the conceptual water balance components including data sources, assumptions, and parameters used for the historical analysis.

3.1. Model Setup

The Lake Merced Lake-Level Model includes monthly water balance calculations based on the conceptual model described above and is maintained as a spreadsheet-based water-balance model, similar to the original model setup by LSCE (LSCE, 2008). The model includes each component of the water balance needed to simulate lake hydrology, and tracks monthly flows into and out of Lake Merced. The water balance components are inputs to the conceptual model; change in lake storage (in acre-feet) and lake levels (in feet) are the model outputs.

The historical analysis was extended over a 70-year period from October 1939 through June 2009. Prior to 1935, Lake Merced was used as a water supply source for the City of San Francisco. Pumping from the lake and nearby groundwater pumping either directly or indirectly contributed to the substantial decline of lake levels through about 1932, but records are unavailable to quantify these activities. After Regional Water System delivery began around 1935, it took a period of several years for the lake levels to recover. Therefore, 1939 was considered an appropriate starting point for the model.

In addition, the spreadsheet model was made more user-friendly. This was done by setting up each water balance component as a separate spreadsheet tab so that the development of the water balance can be traced. Supporting data are also included in separate data tabs. The calculation of the lake level is done in a summary table that is linked to the individual water balance components so that the contribution of each water balance component in calculating the lake level is clearly shown.

A more detailed discussion of how each of the water balance components was incorporated into the Lake Merced Lake-Level Model is provided below.

3.2. Direct Precipitation

In the Lake Merced Lake-Level Model, precipitation includes only the water that falls directly onto the lake surface as rainfall. To calculate the volume for the water balance, the monthly rainfall was multiplied by the lake surface area in acres to estimate the total volume of rainfall entering the lake. The calculation is as follows:

*Direct Precipitation = Precipitation Rate * Lake Surface Area*

The data used in calculating the precipitation component of the water balance are shown below:

- Precipitation Rate is the monthly precipitation data. Precipitation data from the Mission Dolores weather station were used from 1939 to 1958, and from the Lake Merced Pump Station gauge from 1958 to 2009. Data were incorporated directly into the model.
- Lake Surface Area is the lake surface area in acres. The area of the lake surface varies with the lake level, as described above (Table 1). The calculation was based on the starting lake level for the month.

The precipitation contribution was calculated for each month. The total volume of precipitation is listed in the water balance components in acre-feet and is added to the water balance. Potential water losses due to evaporation and other mechanisms are handled separately by the model.

3.3. Stormwater Runoff

Historically, stormwater runoff was a major inflow into Lake Merced. However, much of the original watershed is now diverted away from Lake Merced and into the City's combined stormwater system (SFSU, 2005). Currently, stormwater runoff into Lake Merced is generally limited to only those areas immediately adjacent to the lake. Several catch basins draining into the lake are located primarily along the southern portion near the Impound Lake and the majority of the stormwater drains located along the western shore of Lake Merced empty directly to the lake (Figure 10).

Specific runoff measurements into Lake Merced were not available; therefore, the stormwater runoff contribution was calculated using a variation of the Rational Method (Chow, Maidment and Mays 1988). The stormwater runoff contribution was calculated for each month and total volume was listed in the water balance components in acre-feet. The formula for calculating stormwater runoff is as follows:

*Stormwater Runoff = (Precipitation Rate - Rainfall Threshold) * Runoff Coefficient * Drainage Area*

The data used in calculating the stormwater component of the water balance is discussed below:

- Precipitation Rate is the monthly precipitation data. Precipitation data from the Mission Dolores weather station from 1939 to 1958, and from the Lake Merced Pump Station gauge from 1958 to 2009.
- Rainfall Threshold is the minimum amount of monthly rainfall required to generate runoff and was defined for each category. The rainfall threshold was subtracted from the monthly precipitation data. If the threshold was greater than the monthly rainfall, then no stormwater runoff was generated.
- Runoff Coefficient is the percentage of the precipitation, minus the rainfall threshold, that reaches Lake Merced as stormwater runoff.

- Drainage Area is the surface area that is receiving precipitation and contributing stormwater runoff to Lake Merced.

The calculation of stormwater runoff contributions to the lake was based on four drainage (or catch basin) areas surrounding the lake that could potentially contribute stormwater runoff to the lake during the historical period. The surface area for each of these four drainage areas was estimated based on the locations of storm drains and site topography (Figure 10). The stormwater runoff was calculated separately for each of the following drainage (or catch basin) areas:

- Adjacent to Lake – Approximately 123 acres of unpaved, relatively pervious areas adjacent to Lake Merced within the boundary defined by John Muir Drive, Skyline Boulevard and Lake Merced Boulevard.
- Impervious Area – Approximately 31 acres of paved, hardpacked or relatively impervious areas (e.g., roads and parking lots) within the boundary defined by John Muir Drive, Skyline Boulevard and Lake Merced Boulevard.
- Harding Park – Approximately 183 acres that includes Harding Park Municipal Golf Course. This area generally allows precipitation to percolate into the soil, but stormwater runoff does occur during periods of high rainfall.
- Pre-1955 Catch Basin – Pre-1955 total catch basin areas were assumed to be 650 acres during model calibration, which is consistent with the size of the lake watershed. This assumes approximately 313 acres east of Lake Merced Boulevard that drained into Lake Merced before this area was connected to the City’s combined sewer and stormwater system. It was assumed that pre-1955 runoff into Lake Merced was only for the period prior to 1955.
- Lake Bed – The surface area of Lake Merced changes with changing lake levels. When the lake level falls below 7.0 feet (City Datum), direct precipitation falling on the dry portion of the lake bed is treated as stormwater using the same assumptions as those for the areas adjacent to the lake. When the lake level rises above 7.0 feet (City Datum), the area available to contribute stormwater from the areas adjacent to the lake is reduced for the stormwater calculation. Because the calculation is dependent upon the calculation of the lake level, it is calculated separately from the other stormwater contributions, but is included in the stormwater for the water balance.

Prior to the mid-1950s, the total drainage area into Lake Merced was assumed to be larger, thus resulting in higher runoff before the combined sewer and stormwater system was established around the mid-1950s. For the purpose of this analysis, the combined system was assumed to be developed in 1955, based on inputs from the SFPUC.

For each of the drainage areas defined above, a runoff coefficient and rainfall threshold were developed that were reflective of average conditions of the topography and surface conditions. A potential range of runoff coefficients was developed for each area based on standard references (CalTrans, 1987; Chow, Maidment, and Mays, 1988). Table 7 summarizes the stormwater runoff parameters, including the estimated drainage areas, runoff coefficients, and thresholds associated with each drainage area.

The rainfall threshold was developed empirically based on model calibration. The rainfall threshold is an adaptation added to the Rational Method that was intended to account for the fact that light rainfall amounts do not generally generate stormwater runoff. The use of the rainfall threshold reduced the stormwater runoff in the lower precipitation months. Also, by using the rainfall threshold, the runoff coefficients were increased to the upper parts of their range. These were adjusted during model calibration. By using the combination of runoff coefficient and rainfall threshold, the Lake Merced Lake-Level Model was better able to capture the seasonal variations in lake levels.

Table 7 – Summary of Stormwater Runoff Components, Coefficients, and Thresholds

	Area (Acres)[(a)]	Runoff Coefficient [(b)]	Threshold (inches) [(c)]
Pre-1955 Catch Basin	313	0.42	1
Adjacent to Lake	123	0.7	0.5
Impervious Area	31	0.9	0.25
Harding Park	183	0.35	6
Total	**650**	**-**	**-**

Notes:

(a) Estimated based on locations of catch basin drains using the data provided by the SFPUC.
(b) Assumed based on average topography and surface conditions using reference values from Cal Trans Highway Design Manual (1987) and Chow, Maidment, and Mays (1988).
(c) Empirically developed as part of the model calibration.

An adjustment to the stormwater runoff was made based on the surface area of Lake Merced. As noted in Table 1, the surface area of the lake varies with lake level. The drainage area adjacent to the lake was based on an assumption of a lake surface area of 300 acres. If the lake surface area was greater than 300 acres, then there was the potential to double account for areas that received direct precipitation to the lake. If the lake surface area was less than 300 acres, then there was an area that would generate stormwater runoff that was not accounted for. This would potentially be an issue during periods of high precipitation at low lake levels. Therefore, the difference between the estimated lake level and the assumed 300-acre lake surface area for the drainage areas was calculated using the Adjacent to Lake conditions and was added or subtracted from the stormwater runoff water balance component as appropriate.

Flooding from the VGC was calculated separately as part of the stormwater runoff. VGC overflow occurs during storm events when surface water flow in the VGC exceeds its discharge capacity. The water tends to backup where the VGC goes from a surface water canal to a subsurface pipeline. During these periods, water in the VGC overflows from the canal and over John Muir Drive into Impound and South Lakes for a period of hours to days.

To estimate these flooding events, an empirical formula was developed based on model calibration. This formula is as follows:

*VGC Flood = (Precipitation Rate - Rainfall Threshold) * Flood Factor*

The data used in calculating the VGC flood component of the water balance is discussed below:

- Precipitation Rate is the monthly precipitation data. Precipitation data from the Mission Dolores weather station from 1939 to 1958, and from the Lake Merced Pump Station gauge from 1958 to 2009.
- Rainfall Threshold is the minimum amount of monthly rainfall required to generate runoff and was defined for each category. A rainfall threshold of 6.5 inches per month was developed for VGC flooding based on model calibration. The rainfall threshold was subtracted from the monthly precipitation data. If the threshold was greater than the monthly rainfall, then no stormwater runoff was generated.
- Flood Factor is an empirically-derived number based on the model calibration that is used to estimate the flood volume. A flood factor of 140 was developed for VGC flooding based on model calibration.

The VGC is assumed to have been developed in the mid-1950s. For the Lake Merced Lake-Level Model, estimates of VGC flooding are calculated for the period from 1955 to 2009. No flooding is assumed to have occurred prior to 1955. By using a relatively high rainfall threshold of 6.5 inches per month, VGC flooding occurs during 42 months during the period from 1955 through 2009. The primary objective in developing the flood factor was determining a consistent value that was representative for all time periods so that VGC flooding could be incorporated into future case simulations.

3.4. Evaporation

Evaporation accounts for water at the lake surface that is converted into water vapor and lost to the atmosphere. Previous studies conducted for Lake Merced consider evaporation as the single largest outflow from the lake (Yates et al., 1990; Yates, 2003). To estimate the total evaporation loss from the lake, the monthly evaporation rate was multiplied by the lake surface area. The calculation is as follows:

*Evaporation = Lake Evaporation Rate * Lake Surface Area*

The evaporation loss was calculated for each month. The total evaporation loss is listed in the water balance components in acre-feet and is subtracted from the water balance. The data used in calculating the evaporation component of the water balance are shown below:

- Lake Evaporation Rate is the estimated monthly evaporation rate for Lake Merced. The monthly evaporation rate varies as a function of the average temperature, based on the Mission Dolores weather station (Appendix A).
- Lake Surface Area is the lake surface area in acres. The lake surface area varies with changes in the lake level, as described above (Table 1). The calculation was based on the starting lake level for the month.

Variations in temperature conditions result in temporal variations in the lake evaporation rate. Table 8 presents estimated monthly lake evaporation data as a function of temperature conditions. An estimation of the lake evaporation rate was developed for three different relative temperature conditions that are defined as cool, normal, and warm, which are defined as follows:

- Normal temperature conditions were defined when the average monthly temperature was within one standard deviation of the long-term average temperature for the month (Table 4 and Appendix A). The normal lake evaporation rate (Table 8) is based on the estimated monthly average lake evaporation rate (Table 5).
- Cool temperature conditions were defined when the average monthly temperature was below one standard deviation of the long-term average temperature for the month (Table 4 and Appendix A). The cool lake evaporation rate (Table 8) is estimated to be the monthly average lake evaporation rate minus one standard deviation based on the monthly measured ET data from Castroville (Table 6).
- Warm temperature conditions were defined when the average monthly temperature was above one standard deviation of the long-term average temperature for the month (Table 4 and Appendix A). The warm lake evaporation rate (Table 8) is estimated to be the normal lake evaporation rate plus one standard deviation based on the monthly measured ET data from Castroville (Table 6).

Table 8 – Monthly Lake Evaporation based on Temperature Conditions

	Lake Evaporation Rate (1982-2007)		
	(inches)	(inches)	(inches)
Month	**Warm**	**Normal**	**Cool**
Jan	1.11	0.89	0.66
Feb	1.61	1.33	1.05
Mar	2.47	2.10	1.73
Apr	2.67	2.33	1.99
May	3.39	3.04	2.68
Jun	4.16	3.80	3.43
Jul	4.73	4.19	3.64
Aug	2.78	2.38	1.98
Sep	2.77	2.38	1.99
Oct	2.26	1.94	1.62
Nov	1.50	1.25	1.01
Dec	0.99	0.81	0.63
Total	**30.4**	**26.4**	**22.4**

3.5. Transpiration

According to the natural resources inventory of Lake Merced prepared by the SFPUC in 1998, tules border almost the entire lake. In the Lake Merced Lake-Level Model, transpiration water loss from the lake represents water uptake by tules in the immediate areas surrounding the lake. To estimate the total transpiration loss from the lake, the monthly transpiration rate was multiplied by the area covered by the vegetation. The calculation is as follows:

*Transpiration = Transpiration Rate * Tule Area*

The transpiration loss was calculated for each month. The total transpiration loss is listed in the water balance components in acre-feet and is subtracted from the water balance. The data used in calculating the transpiration component of the water balance are shown below:

- Transpiration Rate is the estimated monthly transpiration rate for Lake Merced based on Yates et al. (1990). The monthly evaporation rate is varied based on the average temperature from the Mission Dolores weather station (Appendix A).
- Tule Area is the area of the lake containing tules. Tules extend out up to 150 feet from the lake shore (SFSU, 2005). Thus, for the purpose of this analysis, the area covered by tules around the lake, reported to be 53 acres (Yates et al., 1990), was taken into account.

Monthly transpiration rates reported by Yates et al. (1990) for the Lake Merced area were assumed to reflect normal or average temperature conditions. Similar to the approach taken for lake evaporation, temporal distribution of transpiration data was identified based on monthly temperature conditions for three different relative temperature conditions that are defined as cool, normal, and warm, and which are defined as follows:

- Normal temperature conditions were defined when the average monthly temperature was within one standard deviation of the long-term average temperature for the month. The normal transpiration rate was based on the estimated monthly average lake evaporation rate (Tables 4 and 9).
- Cool temperature conditions were defined when the average monthly temperature was below one standard deviation of the long-term average temperature for the month. The cool lake transpiration rate was assumed to be ten percent less than the estimated monthly average lake evaporation rate for the month (Table 9).
- Warm temperature conditions were defined when the average monthly temperature was above one standard deviation of the long-term average temperature for the month. The warm lake transpiration rate was assumed to be ten percent greater than the estimated monthly average lake evaporation rate for the month (Table 9).

Table 9 – Monthly Transpiration Based on Temperature Conditions

	Transpiration		
	(inches)	(inches)	(inches)
Month	**warm**	**normal**	**cool**
Jan	1.11	1.01	0.92
Feb	1.67	1.52	1.38
Mar	2.65	2.41	2.19
Apr	2.94	2.67	2.43
May	3.83	3.48	3.16
Jun	4.79	4.35	3.95
Jul	5.28	4.80	4.36
Aug	3.00	2.73	2.48
Sep	3.00	2.73	2.48
Oct	2.45	2.23	2.03
Nov	1.58	1.44	1.31
Dec	1.02	0.93	0.85
Total	**33.33**	**30.30**	**27.55**

3.6. Groundwater Inflow/Outflow

Of the various water balance components, groundwater inflow and outflow from Lake Merced had the highest degree of uncertainty. Conceptually, the direction and magnitude of the groundwater flux into and out of the lake is controlled by the relative difference in lake and groundwater levels. However, consistent groundwater elevation data for the Shallow Aquifer do not exist prior to the late 1990s. Therefore, an empirical approach was applied for defining the water balance calculation for groundwater inflow and outflow.

This approach was initially applied for the previous lake level model (LSCE, 2008) to define a set monthly groundwater inflow or outflow depending upon climatic conditions. Climatic conditions were defined in terms of the total rainfall during the preceding 12-months starting with the month being calculated. The basic assumption for this approach is that during periods of below-average precipitation, there is typically less groundwater recharge to the aquifer which causes groundwater levels to decrease relative to lake levels. The lower groundwater levels cause either reduced groundwater discharge into the lake or increased lake water recharge to the groundwater aquifer depending on aquifer conditions. Alternatively, during periods of above-average precipitation, there is typically higher groundwater recharge to the aquifer which causes groundwater levels to increase relative to lake levels. These higher groundwater levels cause either increased groundwater discharge into the lake or decreased lake water recharge to the groundwater aquifer depending on aquifer conditions.

For the Lake Merced Lake-Level Model, climatic conditions were grouped into three categories based on the combined precipitation data from the Lake Merced Pump Station and Mission Dolores weather stations (Appendix A). By defining the climatic conditions based on the preceding 12-month period, the climatic conditions were allowed to vary on a month-to-month basis. The climatic conditions were defined as follows.

- Normal rainfall conditions were defined when the total precipitation for the preceding 12-months was between 16.5 and 25.5 inches.
- Dry rainfall conditions were defined when the total precipitation for the preceding 12-months was less than 16.5 inches.
- Wet rainfall conditions were defined when the total precipitation for the preceding 12-months was greater than 25.5 inches.

This approach was expanded for this version of the Lake Merced Lake-Level Model to represent a range of aquifer conditions. The Lake Merced Lake-Level Model is a spreadsheet-based water-balance model; therefore, it does not have a mechanism to predict reactions of groundwater and lake levels to pumping. To account for groundwater-lake interactions, assumptions were developed empirically during model calibration. The aquifer conditions were grouped into five categories that provided a qualitative representation of the regional groundwater conditions and the relative groundwater lake conditions. The aquifer conditions were defined in the Lake Merced Lake-Level Model per water year for the period from October through the following September. The aquifer condition category definitions include the following.

- Recovering aquifer conditions were defined as periods of high rainfall along with reduced groundwater pumping when lake levels rose significantly.
- Rising aquifer conditions were defined as periods of reduced groundwater pumping or when groundwater levels were generally higher than lake levels.
- Stable aquifer conditions were defined as periods of reduced groundwater pumping or when groundwater levels were generally similar to lake levels.
- Low aquifer conditions were defined as periods of moderate groundwater pumping or when groundwater levels were generally similar to or lower than lake levels.

- Stressed aquifer conditions were defined as periods of high groundwater pumping or when groundwater levels were generally lower than lake levels.
- Declining aquifer conditions were defined as periods of maximum groundwater pumping or when groundwater levels were generally lower than lake levels.

In the spreadsheet-based Lake Merced Lake-Level Model, a lookup table was set up to approximate the net groundwater flux. Table 10 summarizes the monthly groundwater inflow and outflow volumes relative to Lake Merced based on the assumptions discussed above. Positive numbers represent a net gain of water to the lake signifying an overall net discharge of groundwater into the lake. Conversely, negative numbers represent a net loss of water from the lake signifying an overall net discharge of lake water to the Shallow Aquifer.

Table 10 – Summary of GW Inflow/Outflow Assumptions

Aquifer Condition	Groundwater Inflow/Outflow (af per month)		
	Dry	Normal	Wet
Recovering	10	15	25
Rising	1	5	15
Stable	-5	1	10
Low	-10	-2	5
Stressed	-15	-10	1
Declining	-35	-30	-10

3.7. Singular Events

Man-made water additions to the lake and pumping from the lake have occurred in the past; however, records of these events are limited. These are characterized as singular events in the Lake Merced Lake-Level Model because they represent independent operational decisions.

Lake additions are the results of water additions by the SFPUC at the Lake Merced Pump Station. These were done periodically in the past to help maintain lake levels. The occurrence of recorded additions as identified based on SFPUC records and previously reported data is presented in Table 2 (LSCE, 2002). Other lake additions were known to have occurred in the past; however, the records for these events were not available. Similarly, pumping of water from the lake for golf course irrigation and other uses was known to occur; however, no records are available of the duration and extent of this pumping.

During calibration, singular events were kept within the range of recorded lake additions. Table 11 presents a summary of the estimated annual lake additions and extractions (singular events) by water year (defined as October through September).

For the Lake Merced Lake-Level Model, the available data were used in developing a history of lake additions and extractions. Additional lake additions and extractions were added to the model history during model calibration. During calibration, significant increases or decreases in lake levels that could not be ascribed to natural phenomenon were considered to represent these singular events. In the model, a volume of water was added for those months when the unexplained change in lake levels occurred until a sufficient lake level was achieved. Some modifications were made to known lake additions as shown in Table 2.

Although singular events are interpreted as representing lake additions or extractions, it is also possible that these may also represent, at least in part, necessary adjustments to compensate for natural variations in the lake hydrology. These potential natural variations may reflect unusual hydrological conditions that are not well represented by the rule-based approach.

Table 11 – Estimated Annual Man-Made Additions and Extractions (Singular Events) from Lake Merced

Water Year	Estimated Lake Addition/Extraction (acre-feet)	Water Year	Estimated Lake Addition/Extraction (acre-feet)	Water Year	Estimated Lake Addition/Extraction (acre-feet)
1940	0	1964	150	1988	-300
1941	0	1965	1,340	1989	0
1942	0	1966	250	1990	0
1943	0	1967	400	1991	0
1944	0	1968	-100	1992	840
1945	0	1969	400	1993	-600
1946	0	1970	-250	1994	920
1947	250	1971	250	1995	-75
1948	250	1972	650	1996	0
1949	-600	1973	0	1997	0
1950	0	1974	0	1998	0
1951	0	1975	250	1999	0
1952	-650	1976	50	2000	0
1953	0	1977	250	2001	0
1954	750	1978	1,450	2002	0
1955	600	1979	-400	2003	1,161
1956	500	1980	500	2004	2
1957	250	1981	0	2005	0
1958	0	1982	100	2006	0
1959	-150	1983	0	2007	0
1960	250	1984	0	2008	0
1961	250	1985	0	2009	0
1962	250	1986	0		
1963	250	1987	0		

4. Model Calibration Results

Model calibration provides an evaluation of the long-term performance of the Lake Merced Lake-Level Model to match the observed lake levels. The overall objective of the historical analysis was to develop a rule-based approach for the water balance and to calibrate the model results to measured lake levels. The following discussion characterizes the match of simulated to historical Lake Merced lake levels.

4.1. Comparison of Simulated and Historical Lake Levels

The Lake Merced Lake-Level Model was calibrated to historical lake levels over a 70 year period from October 1939 to June 2009. This period includes a variety of hydrological conditions including wet, normal and dry precipitation years, flood events, and periods of high and low lake levels, thus representing a variety of conditions that may be representative of future conditions.

The comparison of simulated and historical lake levels between October 1939 and June 2009 is presented on Figure 11. Model calibration was conducted primarily as a visual comparison of simulated and historical lake levels. This visual comparison was considered as an appropriate level of calibration to meet the objectives of the historical analysis. Additional statistical analysis could be conducted in the future if necessary.

Overall, the Lake Merced Lake-Level Model closely follows both the long-term and short-term trends, demonstrating a very strong correlation of both the magnitude of annual and seasonal fluctuations. Below is a summary of some of the observations:

- The model results follow the long-term trends in lake levels. The model simulates high and low lake levels as appropriate.
- The model results demonstrate the capability to capture the seasonal variations in lake levels during the year under a wide range of climatic and aquifer conditions. The model results provide approximately the same amplitude of lake level variation per year for each year from 1939 to 2009.
- The model was able to simulate the period of high lake levels near the level of the spillway in the 1940s. This demonstrates that the model provides a realistic evaluation of lake levels and is not overly conservative.
- The model results demonstrate a strong capability of reproducing the period of drought during 1976-77 and the late 1980s and early 1990s. The model produces a similar minimum lake level of approximately -3.3 feet City Datum in 1993.
- The model results show the capability to simulate the recovery of lake levels during the period of above-average precipitation from 1995 to 2006.

Overall, with the improved historical match, the Lake Merced Lake-Level Model builds enough confidence to develop future lake filling scenarios to help evaluate the volumes of water necessary to manage Lake Merced water levels.

4.1.1. Comparison to MODFLOW Model

The Westside Basin Groundwater Model, (HydroFocus, 2007, 2009, and 2011) is a numerical groundwater model that has the capacity to evaluate the effect of changes in groundwater pumping and other stresses on groundwater levels in the Lake Merced area. Understanding the changes in groundwater levels is one key aspect to understanding groundwater-surface water interactions. This model also has the capacity to calculate the flux between Lake Merced and the groundwater aquifer.

The comparison of the calibrated 1958 to 2009 historical simulation using the Westside Basin Groundwater-Flow Model to the measured Lake Merced lake levels and the simulated results from the Lake Merced Lake Level Model is presented in Figure 11. The MODFLOW model shows a divergence from the measured data from 1958 to 1971 with MODFLOW simulated lake levels about 3 to 6 feet higher and have significantly different trends. From 1971 to 1996, the MODFLOW model shows a closer correlation with simulated lake levels within about 1 to 2 feet of the measured data. From 1996 to 2009, the MODFLOW simulated lake levels show similar trends to the measured data but are about 2 to 5 feet higher than the measured data.

Comparing the performance of the MODFLOW model to the Lake-Level model shows that the Lake-Level model has a significantly stronger correlation to the measured Lake Merced lake levels over the same period. Since the general approach between the MODFLOW Lake Package and the Lake-Level Model are similar, and the models use similar data sets, the improved performance by the Lake-Level model is attributed to more site-specific and detailed handling of the hydrologic conditions.

The Lake-Level Model is a spreadsheet-based mass balance model that is used to evaluate changes in water levels of Lake Merced. MODFLOW treats Lake Merced as a boundary condition using the LAK3 package, which relies on a mass balance approach to calculate the lake level. The Lake-Level Model uses a site-specific characterization of Lake Merced that is more complex than that used by the MODFLOW model. Some of the key advantages of the Lake-Level Model include the following:

- Allows changes in the surface area of Lake Merced as a function of lake level, based on measured bathymetry data. This is essential because key water balance components (such as precipitation and evaporation) are dependent upon the lake surface area, as briefly described below.
    - Precipitation accounts for rainfall falling directly onto the lake. As lake levels decline, rain that would have fallen directly onto a fuller lake falls instead on the dry lakebed. In the Lake-Level Model, this is treated as stormwater runoff, only a fraction of which actually reaches the lake.
    - Evaporation is dependent on the surface area of the lake open to the atmosphere; as the surface area declines with lowering lake levels, the overall evaporation losses also decline.

- At lower lake levels, the volume of the lake is smaller; therefore, the volume of water required to change the lake level by a certain amount is less than at higher lake levels.
- The Lake-Level Model includes a more complete evaluation of stormwater runoff that incorporates varied land surface types within the limited lake watershed area, including high runoff coefficients the for paved areas surrounding the lake.
- The Lake-Level Model accounts for flooding events resulting from overflows from the Vista Grande Canal. These are short-tem, high-volume events that can significantly affect lake levels.
- The Lake-Level Model has been more closely calibrated to historical lake levels than was the MODFLOW model, showing that this more site-specific characterization of Lake Merced applies appropriate assumptions that provide the capability to properly evaluate lake conditions.

The primary limitation of the Lake-Level Model is that the GW/SW interactions are based on assumptions of annual average groundwater flux into or out of Lake Merced. To address this limitation, the MODFLOW-calculated groundwater flux for Lake Merced was used, which is calculated on a monthly basis and dynamically incorporates the effects of changing groundwater levels. In this manner, the combined approach provides the best available analysis of the changes in Lake Merced.

A more detailed discussion of the Westside Basin Groundwater-Flow Model and the Lake-Level Model is provided in the TM-10.1.

4.2. Water Balance

The Lake Merced Lake-Level Model tracked the contribution of each of the water balance components from the conceptual model. Reviewing these water balance results is another measure of calibration. The water balance results are provided in Appendix B as an annual summary for each of the water balance components. Figure 12 presents a summary of all water balance components on an annual basis. The Lake Merced water balance over the 70-year historical period is summarized in Table 12.

Table 12 – Water Balance Summary of 70-year Historical Analysis for Lake Merced (in acre-feet)

Statistics	Precipi-tation	Stormwater Runoff	Evapo-ration	Transpi-ration	Ground-water	Singular Events	Lake Storage
Average Inflow	514	221	0	0	69	179	188
Average Outflow	0	0	-647	-133	-171	-45	-193
Overall Average	514	221	-647	-133	-99	135	-5
Maximum	1,069	666	-263	-54	231	1,450	1,257
Minimum	238	55	-725	-146	-418	-650	-956
Total Volume	35,959	15,436	-45,314	-9,320	-6,948	9,438	-380

A summary of the average annual inflow for each of the relevant water balance components is provided in Table 12. A brief summary of the inflow components to Lake Merced is provided below.

- Direct precipitation was the largest inflow source. Year to year variations in precipitation are significant as a function of hydraulic conditions, ranging from 238 AFY (in 1976) to 1,069 AFY (in 1998), with a long-term average of 514 AFY. Direct precipitation accounted for approximately 55 percent of the average inflow to Lake Merced.
- Stormwater runoff, including estimated flooding events from the VGC, contributed an annual average inflow of 221 AFY. Stormwater runoff recharge to the lake ranged from 55 to 666 AFY, accounting for approximately 25 percent of the average inflow to Lake Merced.
- Groundwater inflow was an overall minor source of inflow to Lake Merced over the historical period. The average annual inflow was approximately 69 AFY with a maximum inflow of 231 AFY. Groundwater inflow accounted for approximately 1 percent of average inflow to Lake Merced.
- Singular events accounted for an annual average annual inflow of approximately 179 AFY over the 70-year history with a maximum inflow of 1,450 AFY. Inflow from singular events accounted for approximately 19 percent of average inflow to Lake Merced.

In addition, a summary of the average annual outflow for each of the relevant water balance components is provided in Table 12. A brief summary of the outflow components from Lake Merced is provided below.

- Evaporation was the largest outflow source with an annual average of approximately 650 AFY. The year to year variations in outflow ranged from about 263 to 725 AFY. Evaporation accounted for approximately 67 percent of the average outflow.
- Transpiration had an annual average outflow of approximately 133 AFY. The year to year variations ranged from about 54 to 146 AFY. Transpiration accounted for approximately 14 percent of the average outflow.
- Groundwater outflow accounted for an average annual outflow of approximately 171 AFY with a maximum outflow of 418 AFY. Groundwater outflow accounted for approximately 14 percent of average outflow from Lake Merced.
- Singular events were an overall minor source of outflow to Lake Merced accounting for an annual average annual outflow of approximately 45 AFY over the 70-year history with a maximum outflow of 650 AFY. Outflow from singular events accounted for approximately 5 percent of average outflow from Lake Merced.

The annual change in lake storage varied significantly over years from an increase of 1,257 af to a decrease of 956 af. Total decrease in lake storage over the entire 70 years was estimated to be 380 af, which is equivalent to about 5 AFY of loss on an annual basis (Table 12). This relatively small long-term loss represents the fact that while the lake levels experienced significant declines in the past, lake level increases during the last 15 years have reversed the declining trend.

The annual contribution from each of the water balance components is presented in graphical form in Figure 12, which demonstrates year-to-year variations. The primary recharge components of direct precipitation and stormwater runoff are significantly affected by variations in rainfall. However, the primary outflow components of evaporation and transpiration are much less variable. This shows why the lake is subject to variations in lake levels over time. The change in lake storage is the difference between the total inflow and the total outflow. Figure 13 provides a graphical summary of the annual change in lake storage. For nearly 50 percent of the years analyzed (32 years out of 70 years), the model results showed increasing lake storage (positive change in storage).

5. GSR and SFGW Project Model Setup

For the Project Analysis, the Lake Merced Lake-Level Model was modified to account for the hydrology and incorporate the changes resulting from the Daly City Vista Grande Drainage Area Improvements Project. Otherwise, the GSR and SFGW project scenarios rely on the conceptual hydrology used for the historical calibration analysis (Section 4). Below is a discussion of the setup for the Project Model.

5.1. GSR and SFGW Project Scenarios

Five different scenarios were developed for analysis. The initial model scenario simulated groundwater conditions within the Westside Basin influenced by recent (as of June 2009) municipal and irrigation pumping within the Basin; this is referred to as the "Existing Conditions" scenario. Additional modeled scenarios included the simulated operation of the GSR Project and the SFGW Project separately, and a cumulative scenario that includes the operation of the two Projects together with other reasonably foreseeable future water resources projects within the Basin. The following is a summary of the five scenarios used for the groundwater model analysis:

- Scenario 1 - Existing Conditions: The existing conditions scenario uses recent (as of June 2009) pumping conditions and provides a basis for comparison for the other project scenarios.
- Scenario 2 - GSR Project: Includes the GSR Project operations (i.e., in-lieu recharge in the South Westside Basin). Other conditions are the same as Scenario 1.
- Scenario 3a - SFGW Project (3 mgd): This scenario assumes that groundwater pumping for irrigation is still conducted in Golden Gate Park. The SFGW project includes pumping from 4 wells at an annual average rate of 3 million gallons per day (mgd). Other conditions are the same as Scenario 1.
- Scenario 3b - SFGW Project (4 mgd): This scenario assumes that irrigation pumping in Golden Gate Park is replaced with recycled water, so that the equivalent groundwater production may be used for the project. The SFGW project includes pumping from 6 wells at an annual average rate of 4 mgd. Other conditions are the same as Scenario 1.
- Scenario 4 - Cumulative Scenario: This scenario combines the conditions of the GSR Project (Scenario 2) and the SFGW Project (Scenario 3b). Other reasonably foreseeable future projects that are included primarily consist of the Vista Grande Drainage Area Improvements Project Lake Merced Alternative. Other conditions are the same as Scenario 1.

5.2. Modifications to the Lake Hydrology

For the Project Analysis, the Lake Merced Lake-Level Model was developed for a 47.25-year period based on the background hydrology developed in the historical calibration analysis. The lake-level model for the Project Analysis uses the same rearranged hydrologic sequence as was used for the MODFLOW scenarios. This sequence is based on historical hydrological conditions and includes an 8.5-year Design Drought period used in the PEIR (SFPUC, 2007; SFPUC, 2009a). The rationale for the rearranged hydrology is presented in the main body of the Task 10.1 Technical Memorandum.

The rearranged hydrologic sequence used for the five model scenarios presented in this analysis consists of the following:

- July 1996 to September 2003.
- October 1958 to November 1992.
- December 1975 to June 1978.
- July 2003 to September 2006.

For the Project Analysis, the following modifications were made to the Lake Merced Lake-Level Model used for the historical calibration analysis to represent anticipated future conditions. These modifications include:

- <u>Initial Lake Level</u> was set at 5.7 feet City Datum based on measured lake levels in South Lake during June 2009.
- <u>Groundwater Inflow and Outflow</u> in the historical calibration analysis was based on an empirical analysis developed during the model calibration. For the GSR and SFGW Project scenarios, the groundwater inflow to and outflow from Lake Merced were based on the equivalent MODFLOW scenario. The MODFLOW calculated groundwater-surface water exchange between Lake Merced and the groundwater was input directly into the Lake Merced Lake-Level Model. By so doing, the groundwater inflows and outflows were based on the groundwater model rather than an assumption relative change in groundwater levels in the Lake Merced area. The MODFLOW results are discussed in the main body of the Task 10.1 Technical Memorandum.
- <u>Stormwater Runoff</u> in the Historical Analysis included an area called the pre-1955 drainage area that represented expansion of the City's combined sewer and stormwater system in the Lake Merced watershed. This represents a historical event that is no longer relevant for future project operations. Therefore, this component was not included in the Project Analysis.
- <u>Singular Events</u> from the historical analysis were defined as historical lake additions and extractions; therefore, these are no longer relevant for future project operations. Since these represent historical events, the singular events from the Historical Analysis were not included in the Project Analysis.

All five of the model scenarios performed for the Project Analysis that are reported in this Technical Memorandum use identical lake hydrology to insure consistency in reviewing the results. The precipitation, lake evaporation, transpiration, and stormwater runoff components use the same data, apply the same assumptions, and incorporate the modifications listed above.

5.3. Modifications for the Vista Grande Drainage Area Improvements Project

For the cumulative scenario (Scenario 4), the use of Lake Merced as part of the Vista Grande Drainage Basin Alternatives Analysis project for Daly City is considered one of the other reasonably foreseeable future projects. Daly City's Vista Grande Drainage Basin Alternatives Analysis recommended the Lake Merced Alternative, in which stormwater flow from the Vista Grande Canal would be diverted to Lake Merced (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012).

5.3.1. Changes in Lake Merced Spillway

The Lake Merced Lake-Level Model has a provision for the spillway or overflow from Lake Merced. The existing spillway elevation is approximately 13 feet City Datum; therefore, the maximum lake level is set to 13 feet City Datum in the Project Analysis for Scenarios 1, 2, 3a and 3b. Lake levels in excess of 13 feet City Datum are removed from the lake via a spillway near the VGC, and not accounted for in the water balance.

For the Vista Grande Drainage Area Improvements Project, the assumption is that the spillway will be lowered to 9.5 feet City Datum. This lower spillway elevation is used for Scenario 4.

5.3.2. Engineered Wetland

The Lake Merced Alternative scenarios of Daly City's Vista Grande Drainage Basin Alternatives Analysis also include provisions for an engineered wetland and modification of the Lake Merced spillway (Brown and Caldwell, 2010). In the 75-cfs scenario, the average base flow in the Vista Grande Canal is assumed to be diverted into an engineered wetland for treatment and then discharged to Lake Merced on an ongoing basis. Typical flows in the Vista Grande Canal, or baseflow, would be continuously diverted through an engineered wetland for treatment prior to discharge into Lake Merced. Baseflows have been estimated to range from 18 to 26 af per month (Kennedy/Jenks, 2009).

For the Project Analysis, two different operating scenarios listed below were evaluated for the engineered wetland:

- <u>Baseflow Option</u> is based on the consistent monthly flow rate in the VGC or the minimum anticipated flow without significant input from storms.
- <u>Stormwater Option</u> has a variable monthly flow that includes stormwater flow from the VGC. The maximum stormwater option for the Project Analysis is constrained by the design flow rates for the engineered wetland rather than the maximum stormwater flow rates in the VGC.

An option was included in the Project Analysis to account for the engineering design that includes a diversion of water from the engineered wetland back to the VGC rather than to Lake Merced. For the GSR and SFGW project scenarios, this option was set to the spillway level. When lake levels reached the level of the spillway, the wetland contribution was not included in the annual total. The input for the engineered wetland component is listed in Table 13.

Table 13 – Calculated Stormwater Inflows from the Vista Grande Drainage Area Improvements Project

Scenario Year	Wetland Contribution	VGC Stormwater Diversions (acre-feet)	Scenario Year	Wetland Contribution	VGC Stormwater Diversions (acre-feet)
0	78	0	24	232	126
1	277	283	25	277	37
2	135	681	26	277	162
3	105	126	27	277	216
4	187	200	28	277	126
5	232	97	29	277	353
6	232	144	30	277	123
7	194	268	31	277	204
8	277	141	32	224	291
9	277	55	33	176	130
10	277	122	34	213	214
11	277	353	35	232	338
12	277	436	36	232	97
13	277	104	37	277	57
14	277	163	38	277	151
15	277	145	39	277	42
16	277	384	40	277	42
17	277	170	41	277	292
18	277	165	42	277	37
19	277	364	43	277	162
20	232	236	44	277	216
21	277	19	45	277	234
22	213	433	46	277	321
23	149	251	47	277	395

Note: Scenario Year represents a water year from October until the following September
Scenario Year 0 represents a 3-month period for July, August and September at the beginning of the model

5.3.3. VGC Stormwater Diversions

Scenario 4 incorporates the 75-cubic-feet-per-second (cfs) scenario of the Lake Merced Alternative of the Vista Grande Drainage Basin Alternatives Analysis (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012). The 75-cfs scenario assumes that stormwater discharge rates in the Vista Grande Canal exceeding 75 cfs would be diverted to Lake Merced (Brown and Caldwell, 2010). These flows would occur periodically in response to large storms, and have been calculated as part of the Vista Grande Drainage Basin Alternatives Analysis based on historical precipitation data. Stormwater diversions are calculated to occur in every year and range from 19 to 681 AFY, with an average of 207 AFY (Brown and Caldwell, 2010). The calculated stormwater diversion values are listed in Table 13. These calculated values are input into the Lake-Level model to account for the VGC stormwater diversion component.

5.4. Project Model Scenario Results

The results of the Project Analysis for the Lake Merced Lake-Level Model are documented in the main body and Attachment G of the Task 10.1 Technical Memorandum.

6. Summary and Conclusions

The Lake Merced Lake-Level Model has been developed as a spreadsheet-based model that simulates the hydrological conceptual model of Lake Merced. The conceptual model is composed of hydrologic and hydraulic components with inflows and outflows that simulate the Lake Merced water storage and water levels.

The Lake Merced Lake-Level Model is calibrated to historically measured lake levels over the past 70 years from October 1939 to June 2009. This historical calibration period includes a variety of hydrological conditions including wet, normal and dry precipitation years, flood events, and periods of high and low lake levels, thus representing a variety of conditions that are considered representative of future conditions.

In this study, the historical calibration analysis has been used to develop a rule-based approach that provides a mechanism to estimate the water balance for Lake Merced. The historical calibration analysis using the Lake Merced Lake-Level Model shows a very strong correlation to the historical (observed) lake levels over the entire 70-year period. This model calibration demonstrates a strong conceptual understanding of the key hydrological factors that control lake levels, and increases confidence in the model's ability to forecast future conditions.

The Lake Merced Lake-Level Model has been adapted from the historical calibration analysis to include potential future project conditions, such as the use of an engineered wetland to treat water from the VGC before discharge in Lake Merced, the diversion of stormwater directly from the VGC into Lake Merced, changes in the spillway elevation, and other operational variations. Based on the ability of the Lake-Level Model to simulate historical Lake Merced conditions and the ability to incorporate future project conditions, it is appropriate to use this model as a tool to evaluate the effects of the GSR, SFGW and Cumulative project scenarios on water levels in Lake Merced.

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Filename: Z:\Projects\SFPUC_ConjUseEvents\20090804_LakeMercedFigures\Figure1.mxd

Source: ESRI Online Aerial Imagery, 2007 (2ft resolution)

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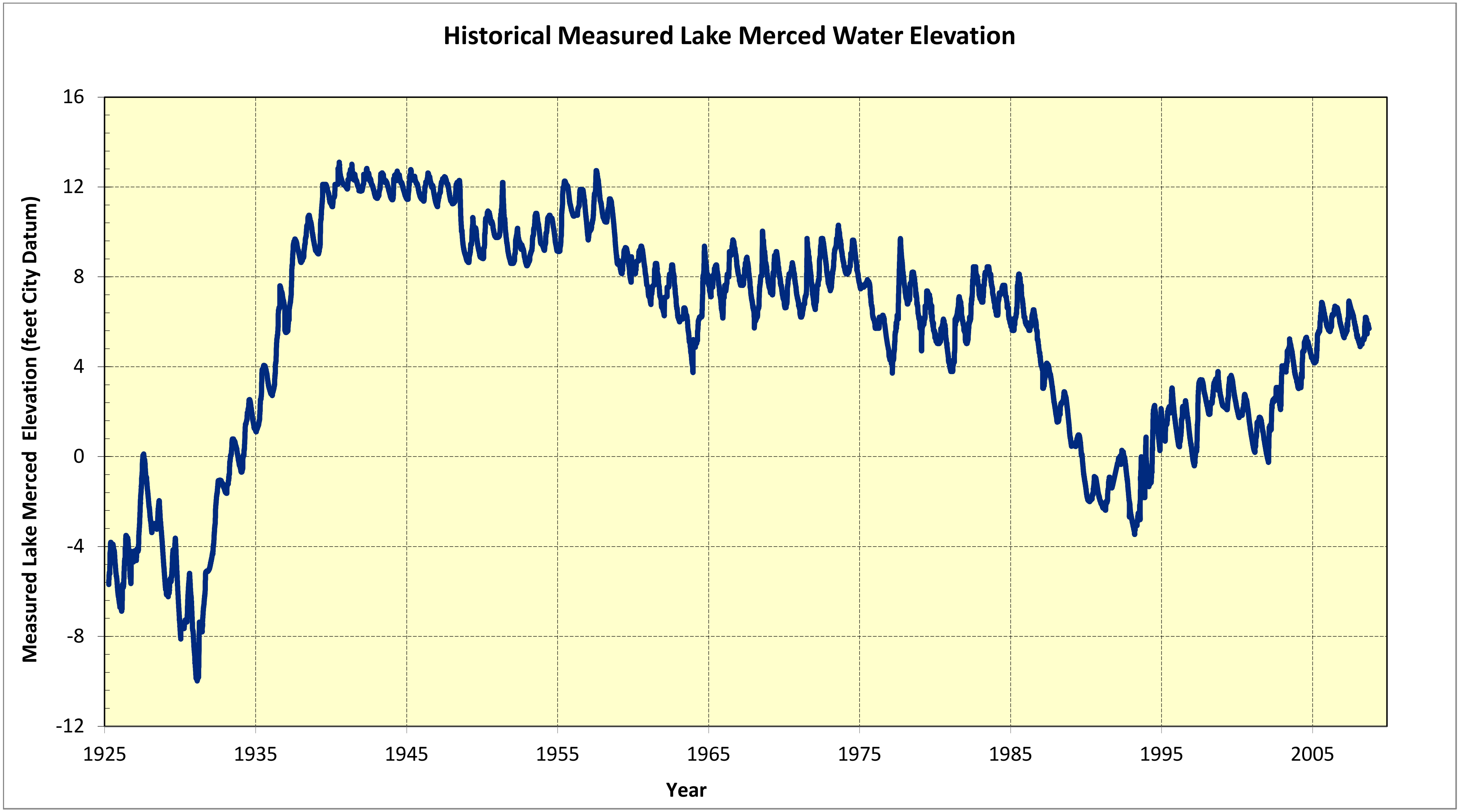
San Francisco Public Utilities Commission

Lake Merced Project Area

K/J 0864001
April 2012

Figure 1



Source: Historical Lake Merced water elevation data from the San Francisco Public Utilities Commission
City Datum = NAVD - 11.37 feet

Legend

Historical Measured Lake Merced Water Elevation (feet City Datum)

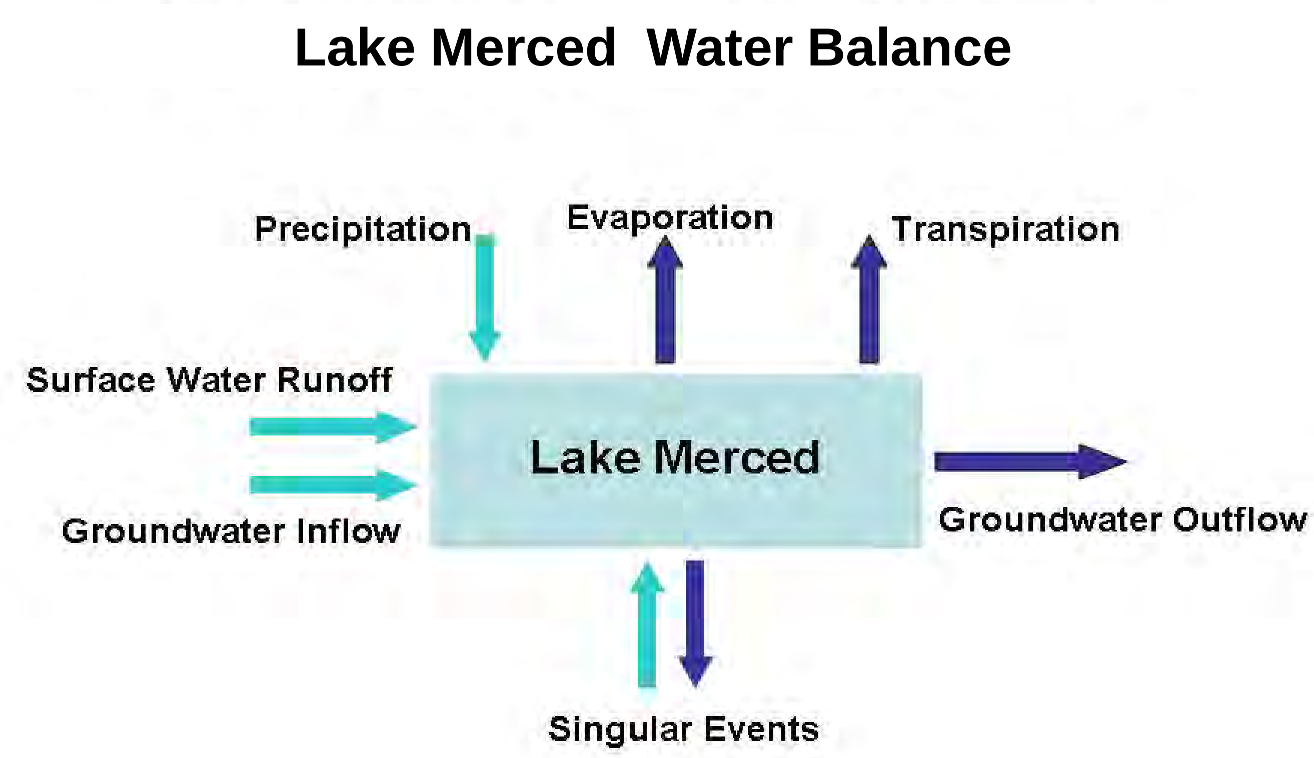
Kennedy/Jenks Consultants

Regional Groundwater Storage and Recovery Project
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Historical Lake Merced Water Elevation

K/J 0864001
April 2012

Figure 2



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San Francisco Public Utilities Commission

Schematic of Conceptual Lake Merced Water Balance Model

K/J 0864001
April 2012

Figure 3

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Source: ESRI Online Aerial Imagery, 2007 (2ft resolution)
Bathymetic, Elevation Contours, and Vista Grande Canal Location from SFPUC, 2008

Legend

- Vista Grande Canal
- Bathymetric Contour (City Datum, 2 foot contour intervals)

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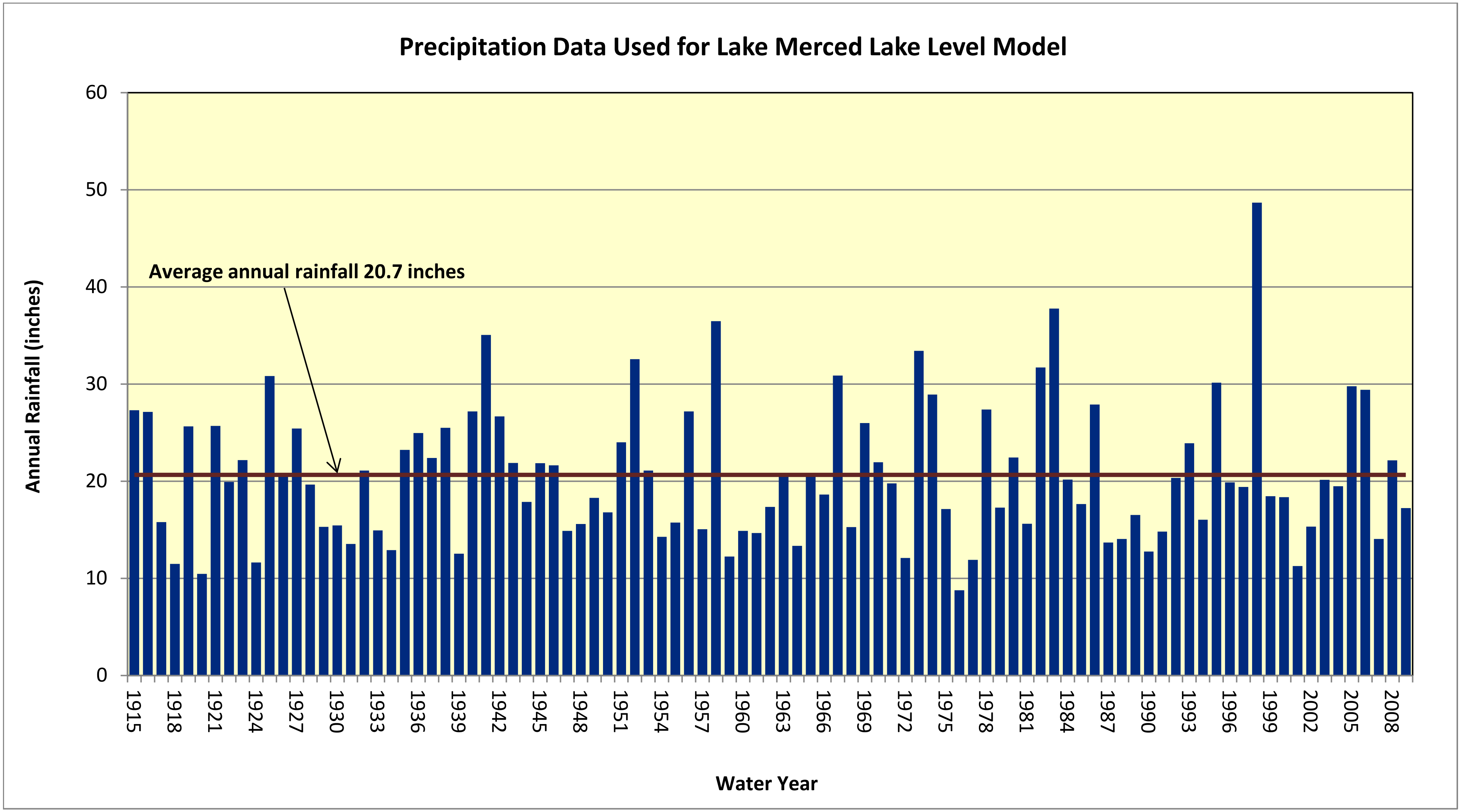
San Francisco Public Utilities Commission

Lake Merced Elevation Contours

K/J 0864001
April 2012

Figure 4



Source: San Francisco Mission Dolores Weather Station, Western Regional Climate Center website (http://www.wrcc.dri.edu/)

Note: Mission Dolores Weather Station Used 1915 to 1958; San Francisco Richmond Sunset station used 1958 to 2009.

Legend

Annual Rainfall (inches) — Average Rainfall (inches)

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San Francisco Public Utilities Commission

Lake Merced Annual Rainfall (inches)

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Figure 5

Source: ESRI Online Aerial Imagery, 2007 (2ft resolution)
Stormdrain Data from SFPUC, 2008

Legend

- Stormdrain Catch Basin
- Stormdrain Manhole
- Stormdrain Junction
- Vista Grande Canal
- Stormdrain Line

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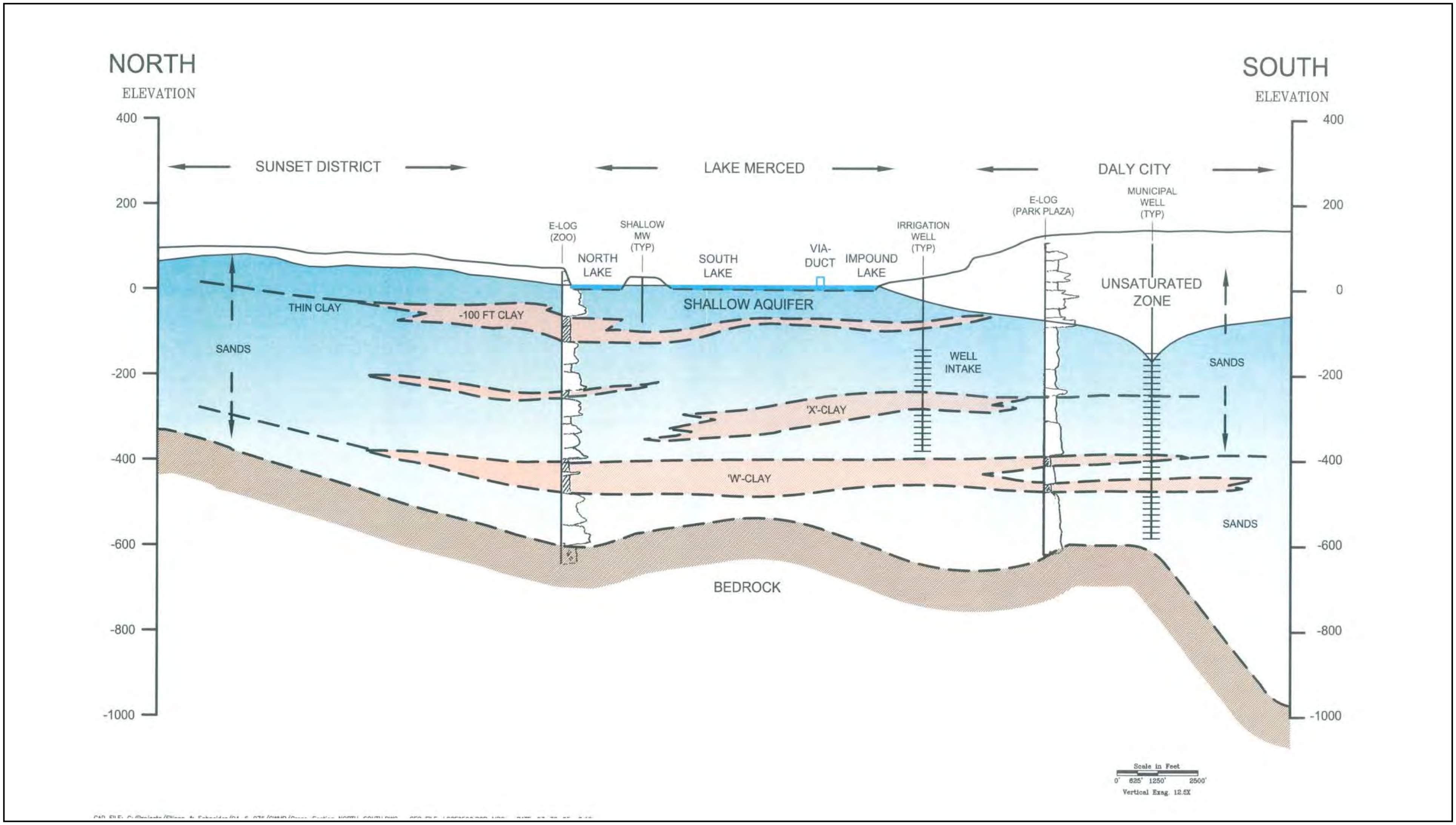
San Francisco Public Utilities Commission

Locations of Stormdrain Catch Basins

K/J 0864001
April 2012

Figure 6



Source: North Westside Groundwater Management Plan (LSCE, 2005)

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San Francisco Public Utilities Commission

Schematic North – South Cross-Section
North Westside Groundwater Basin

K/J 0864001
April 2012

Figure 7

Path: Z:\Projects\SFPUC_ConjUse\Events\20090804_LakeMercedFigures\Figure8.mxd

Source: ESRI Online Aerial Imagery, 2007 (2ft resolution)
Contours from "2007 Annual Groundwater Monitoring Report, Westside Basin, San Francisco and San Mateo Counties, California (SFPUC)

Legend

- Groundwater Elevation Measurement Location
- Approximate Groundwater Elevation Contour (ft NAVD 88)
- Contour dashed where inferred
- General Groundwater Flow Direction

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San Francisco Public Utilities Commission

Approximate Groundwater Elevation Contours, Shallow Aquifer, Fall 2007

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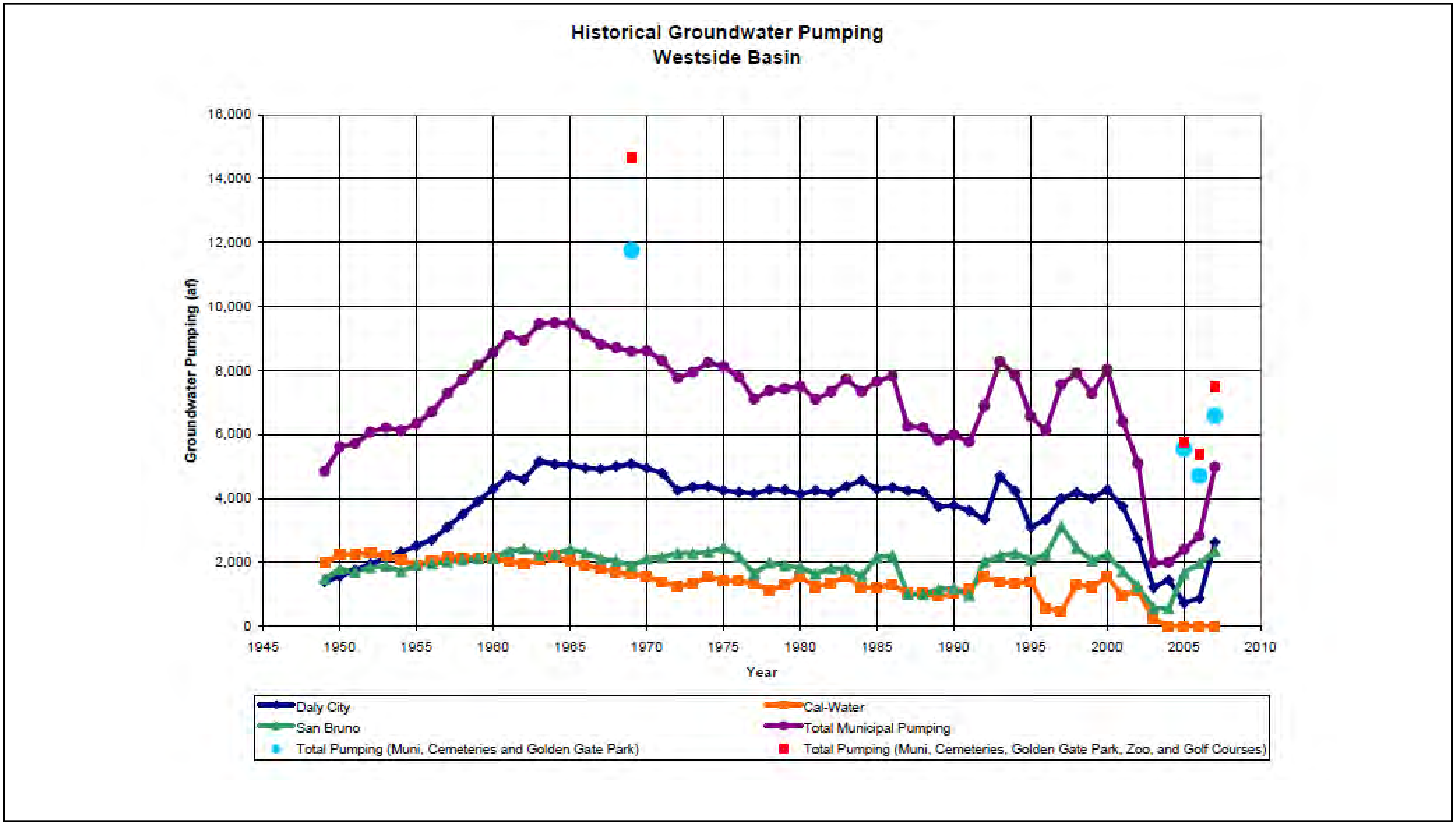
April 2012

Figure 8



Source: 2007 Annual Groundwater Monitoring Report Westside Basin San Francisco and San Mateo Counties, California, Prepared by San Francisco Public Utilities Commission

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and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Historical Groundwater Pumping
Westside Basin

K/J 0864001
April 2012

Figure 9

Filename: Z:\Projects\SFPUC_ConjUse\Events\20090804_LakeMerced\Figures\Figure10.mxd

Source: ESRI Online Aerial Imagery, 2007 (2ft resolution)
Stormdrain Data from SFPUC, 2008

Legend

- Stormdrain Catch Basin
- Stormdrain Manhole
- Stormdrain Junction
- Vista Grande Canal
- Stormdrain Line
- Adjacent to Lake (123 Acres)
- Impervious Areas (31 Acres)
- Harding Park Golf Course (183 Acres)

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San Francisco Public Utilities Commission

Locations of Stormdrain Catch Basins and Approximate Areas of Stormwater Runoff

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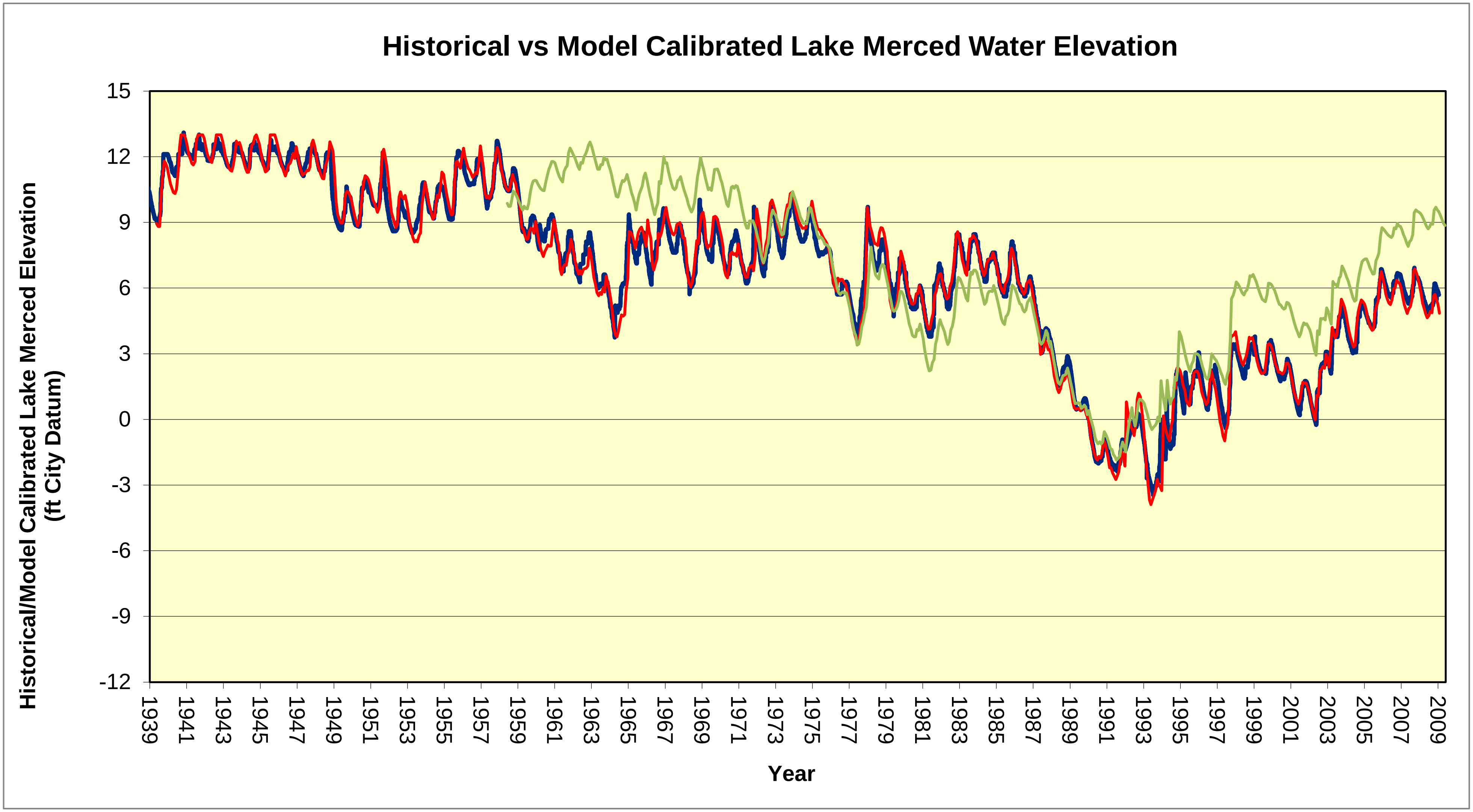
April 2012

Figure 10



Source: Historical Lake Merced water elevation data from the San Francisco Public Utilities Commission
City Datum = NAVD - 11.37 feet

Legend

- Historical Measured Lake Elevation (feet City Datum)
- Lake-Level Model Simulated Lake Elevation (feet City Datum)
- MODFLOW Simulated Lake Elevations (feet City Datum)

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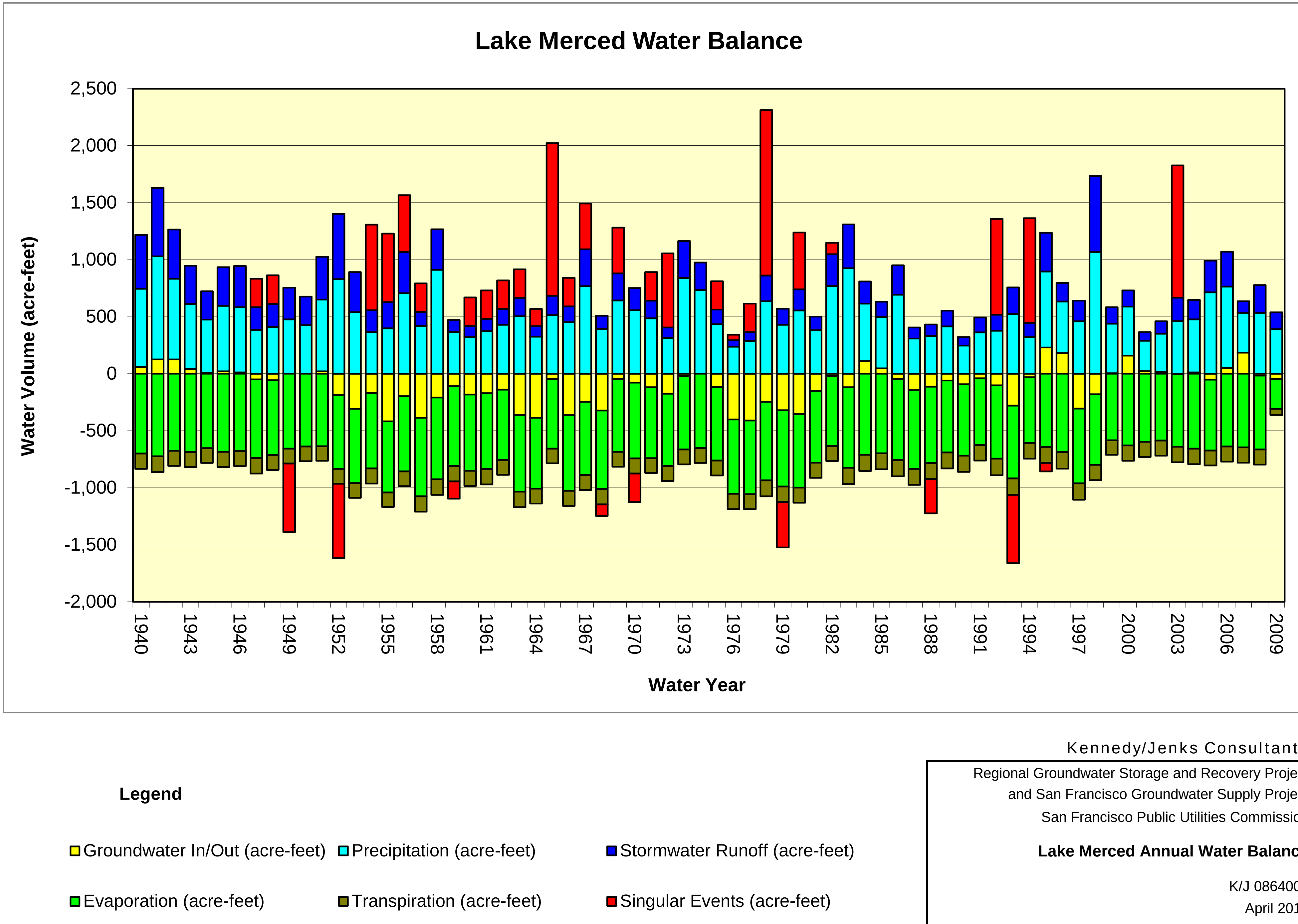
San Francisco Public Utilities Commission

Historical vs Simulated Lake Merced Levels

K/J 0864001
April 2012

Figure 11



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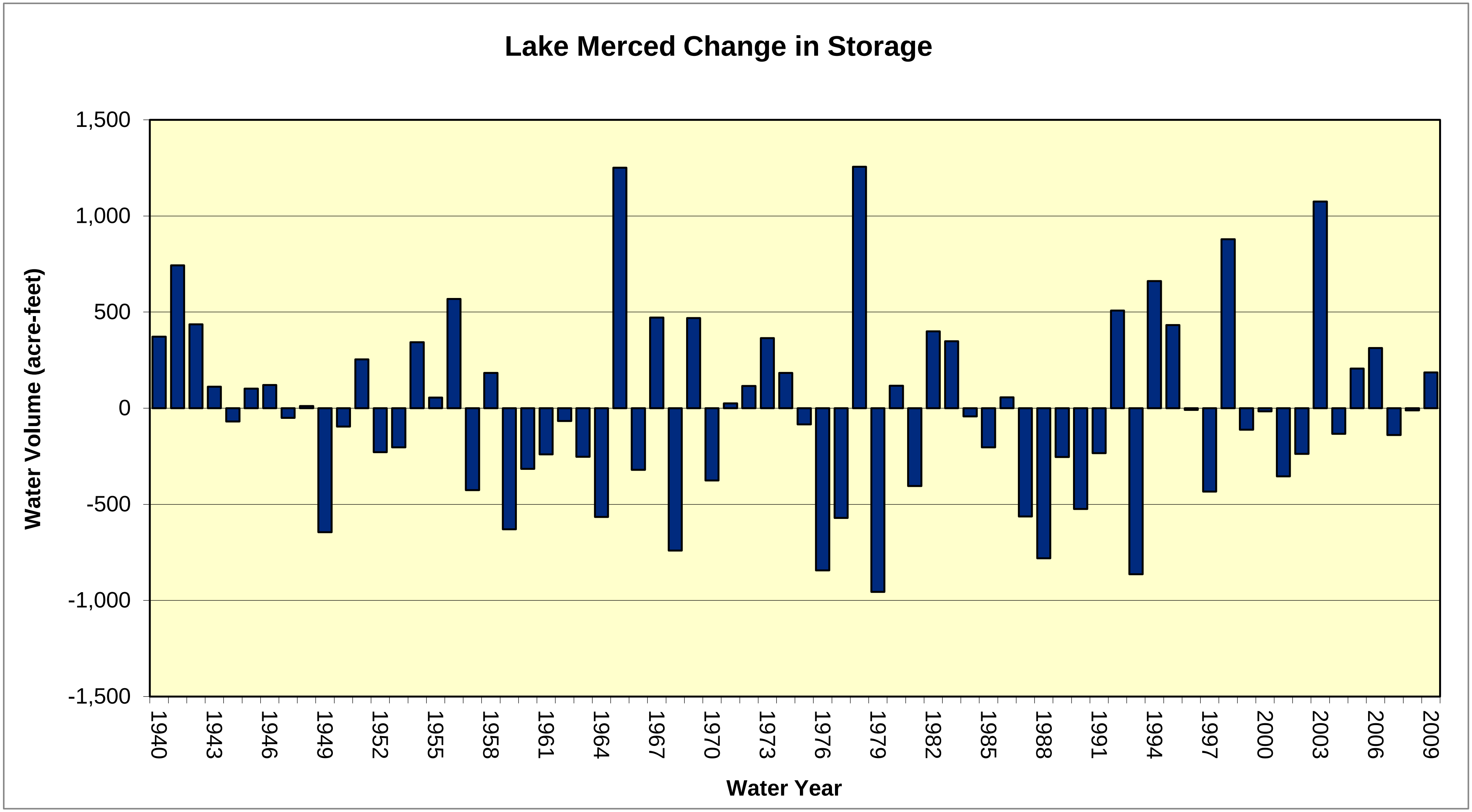
San Francisco Public Utilities Commission

Lake Merced Annual Water Balance

K/J 0864001
April 2012

Figure 12



Legend

■ Annual Change in Lake Storage (acre-feet)

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San Francisco Public Utilities Commission

Lake Merced Change in Storage

K/J 0864001

April 2012

Figure 13

Attachment 10.1-H

Appendix A

San Francisco Lake Merced Pump Station and Mission Dolores
Weather Station Data Summary

Monthly Rainfall Total at Used in Historical Lake Merced Lake-Level Model

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANN
1914	9.76	5.04	1.09	0.99	0.37	0.29	0.02	0.00	0.00	0.29	0.70	5.49	24.04
1915	6.64	7.36	3.02	0.62	3.17	0.00	0.01	0.00	0.00	0.01	0.92	6.42	28.17
1916	14.59	3.77	1.33	0.00	0.07	0.00	0.03	0.29	1.20	0.52	1.50	4.79	28.09
1917	1.83	3.81	1.42	0.33	0.06	0.00	0.00	0.00	0.02	0.00	0.81	0.72	9.00
1918	0.81	5.79	2.73	0.60	0.00	0.00	0.00	0.00	2.53	0.17	5.60	2.62	20.85
1919	2.57	9.31	2.74	0.10	0.00	0.00	0.01	0.00	0.39	0.27	0.44	3.21	19.04
1920	0.26	1.23	3.25	1.36	0.00	0.04	0.00	0.00	0.13	1.83	2.70	7.98	18.78
1921	6.30	1.38	2.28	0.54	2.54	0.00	0.00	0.00	0.35	0.52	1.43	6.39	21.73
1922	2.41	5.15	2.38	0.47	0.55	0.26	0.00	0.00	0.00	2.95	3.77	7.77	25.71
1923	2.84	0.77	0.03	3.92	0.06	0.06	0.00	0.01	0.44	0.46	0.49	1.91	10.99
1924	2.75	3.30	1.96	0.30	0.00	0.00	0.00	0.01	0.00	2.98	1.50	7.37	20.17
1925	1.62	7.90	2.63	2.73	4.02	0.05	0.06	0.00	0.45	0.31	2.32	1.01	23.10
1926	5.48	5.40	0.25	5.26	0.15	0.00	0.00	0.04	0.00	1.90	7.21	1.04	26.73
1927	3.77	6.85	2.19	1.95	0.10	0.38	0.00	0.00	0.00	1.93	3.18	3.94	24.29
1928	2.40	1.97	4.65	1.31	0.26	0.00	0.00	0.00	0.03	0.13	3.35	4.89	18.99
1929	1.32	2.14	1.56	1.01	0.01	0.86	0.00	0.00	0.00	0.01	0.00	3.09	10.00
1930	4.99	2.09	3.53	1.56	0.16	0.00	0.00	0.00	0.10	0.89	1.56	0.98	15.86
1931	5.50	1.10	1.68	0.31	1.10	0.32	0.00	0.00	0.00	0.68	2.93	9.24	22.86
1932	3.23	3.00	0.86	0.47	0.65	0.03	0.00	0.00	0.00	0.01	1.00	2.75	12.00
1933	5.68	1.13	2.93	0.06	1.36	0.01	0.00	0.00	0.14	1.49	0.00	4.19	16.99
1934	1.03	4.68	0.07	0.51	0.12	0.68	0.01	0.00	0.13	0.88	3.76	4.06	15.93
1935	6.23	2.38	2.31	3.45	0.01	0.00	0.00	0.25	0.08	1.44	1.24	3.25	20.64
1936	5.77	10.06	1.01	1.09	0.49	0.28	0.03	0.02	0.00	0.69	0.01	2.94	22.39
1937	5.26	4.88	7.05	0.86	0.06	0.59	0.00	0.00	0.00	0.90	2.46	3.73	25.79
1938	2.65	8.49	5.73	1.52	0.00	0.00	0.01	0.00	0.15	1.33	0.88	1.48	22.24
1939	3.07	1.94	2.62	0.42	0.63	0.00	0.00	0.00	1.06	0.17	0.20	1.05	11.16
1940	9.98	7.81	5.32	0.94	0.63	0.01	0.00	0.00	0.59	1.05	2.22	6.25	34.80
1941	8.24	6.71	4.75	4.05	1.18	0.01	0.01	0.03	0.00	0.93	1.99	7.30	35.20
1942	4.76	4.27	2.62	3.65	1.11	0.00	0.01	0.00	0.18	0.95	4.45	2.87	24.87
1943	6.15	1.95	3.18	1.88	0.13	0.13	0.00	0.00	0.02	0.74	0.80	2.69	17.67
1944	4.31	5.34	0.83	2.07	0.94	0.12	0.01	0.02	0.00	1.73	6.24	3.97	25.58
1945	1.33	3.43	4.15	0.32	0.64	0.01	0.00	0.00	0.04	1.95	3.24	9.84	24.95
1946	1.76	2.03	2.34	0.05	0.37	0.02	0.06	0.00	0.06	0.15	2.73	2.77	12.34
1947	1.35	2.65	3.64	0.17	0.67	0.64	0.00	0.00	0.00	2.09	1.39	1.84	14.44
1948	1.00	2.32	3.36	3.04	0.54	0.01	0.02	0.02	0.09	0.20	1.18	4.76	16.54
1949	2.20	3.04	5.85	0.00	0.93	0.00	0.06	0.04	0.00	0.08	1.18	2.77	16.15
1950	7.40	2.33	1.65	0.87	0.37	0.03	0.00	0.00	0.00	2.72	4.96	6.01	26.34
1951	4.41	3.00	1.32	0.89	0.65	0.04	0.01	0.43	0.08	0.81	3.33	7.92	22.89
1952	10.69	2.62	4.90	1.08	0.30	0.39	0.00	0.01	0.00	0.07	2.42	9.06	31.54
1953	3.26	0.04	1.83	3.42	0.38	0.61	0.00	0.07	0.00	0.34	1.88	0.82	12.65
1954	3.11	2.42	4.56	0.82	0.11	0.14	0.03	0.20	0.00	0.24	2.55	5.67	19.85
1955	4.05	1.18	0.29	1.49	0.04	0.00	0.02	0.00	0.02	0.03	2.38	11.47	20.97
1956	8.72	2.03	0.12	1.68	0.68	0.02	0.00	0.01	0.33	1.14	0.04	0.37	15.14
1957	2.84	3.58	2.39	1.09	3.19	0.06	0.01	0.00	1.46	3.46	1.13	3.60	22.81
1958	4.38	7.78	8.22	5.47	0.88	0.09	0.05	0.00	0.04	0.21	0.28	1.50	28.90
1959	4.17	4.50	0.49	0.91	0.08	0.00	0.00	0.02	2.06	0.09	0.00	1.75	14.07
1960	4.45	2.92	1.91	0.96	0.72	0.00	0.00	0.00	0.00	0.48	3.40	2.33	17.17
1961	2.78	1.30	2.47	0.96	0.91	0.03	0.01	0.04	0.27	0.08	4.72	2.10	15.67
1962	1.05	6.11	2.69	0.23	0.05	0.00	0.00	0.10	0.15	4.11	0.58	3.48	18.55
1963	2.25	2.55	3.71	2.92	0.66	0.03	0.00	0.00	0.16	1.46	3.26	0.82	17.82
1964	4.50	0.24	1.82	0.24	0.38	0.46	0.10	0.04	0.02	1.46	3.46	4.50	17.22
1965	3.68	0.90	2.48	3.92	0.00	0.05	0.00	0.97	0.00	0.02	5.34	4.58	21.94
1966	3.18	2.86	0.75	0.45	0.29	0.17	0.00	0.18	0.12	0.04	4.52	3.72	16.28
1967	10.14	0.64	4.14	5.56	0.13	1.69	0.00	0.00	0.02	0.73	1.00	2.15	26.20
1968	4.88	2.71	3.32	0.28	0.19	0.00	0.04	0.13	0.08	0.74	3.18	4.73	20.28
1969	7.14	6.98	1.00	1.84	0.05	0.08	0.00	0.00	0.13	2.77	0.93	5.79	26.71
1970	7.35	2.02	1.99	0.12	0.05	0.80	0.00	0.28	0.00	0.81	5.82	6.24	25.48
1971	1.98	0.41	2.64	1.14	0.46	0.00	0.00	0.00	0.15	0.15	1.68	4.74	13.35
1972	1.68	2.17	0.28	1.10	0.00	0.13	0.00	0.00	0.80	4.65	6.22	3.67	20.70
1973	8.38	6.64	2.93	0.06	0.06	0.00	0.21	0.00	0.40	2.01	5.90	5.19	31.78
1974	4.25	1.74	6.23	2.76	0.00	0.22	0.49	0.03	0.00	0.78	0.57	1.31	18.38
1975	1.18	5.07	5.99	1.57	0.05	0.10	0.33	0.11	0.02	2.40	0.81	0.35	17.98
1976	0.53	1.49	1.38	1.26	0.05	0.03	0.00	0.98	0.18	0.53	1.31	2.60	10.34
1977	1.84	1.02	2.63	0.13	0.66	0.02	0.00	0.00	1.00	0.24	2.13	3.67	13.34
1978	6.54	3.80	5.89	4.10	0.01	0.00	0.00	0.00	0.26	0.00	1.25	1.09	22.94
1979	6.70	4.14	2.63	0.94	0.23	0.03	0.06	0.00	0.00	1.55	2.63	3.50	22.41
1980	4.83	6.47	2.10	1.04	0.26	0.00	0.05	0.00	0.36	0.10	1.26	1.72	18.19

Monthly Rainfall Total at Used in Historical Lake Merced Lake-Level Model

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANN
1981	4.72	1.69	5.30	0.23	0.19	0.00	0.00	0.09	0.41	2.13	5.07	3.38	23.21
1982	7.10	3.00	5.81	4.53	0.00	0.18	0.04	0.00	0.55	2.62	5.56	2.89	32.28
1983	5.17	7.18	9.29	3.85	0.62	0.00	0.00	0.06	0.11	0.60	8.20	6.35	41.43
1984	0.42	2.31	1.04	0.86	0.07	0.13	0.00	0.23	0.08	2.69	4.82	2.29	14.94
1985	1.32	1.22	4.09	0.34	0.26	0.31	0.21	0.02	0.62	1.00	4.95	2.04	16.38
1986	3.74	7.01	7.18	0.84	0.14	0.13	0.00	0.00	1.07	0.21	0.18	1.94	22.44
1987	4.56	2.52	2.96	0.20	0.05	0.00	0.00	0.00	0.00	1.10	2.07	2.60	16.06
1988	4.24	0.42	0.20	2.67	0.40	0.36	0.00	0.00	0.00	0.64	2.90	3.68	15.51
1989	1.54	1.93	4.75	0.90	0.18	0.00	0.06	0.00	1.70	2.06	1.25	0.00	14.37
1990	1.90	2.25	1.20	0.45	1.78	0.10	0.00	0.00	0.12	0.06	0.61	2.10	10.57
1991	0.51	2.88	6.71	1.13	0.43	0.26	0.04	2.26	0.05	1.11	0.31	2.30	17.99
1992	2.52	5.78	5.09	0.41	0.00	0.46	0.04	0.03	0.00	1.39	0.19	5.77	21.68
1993	8.67	3.67	1.77	1.10	0.90	0.36	0.01	0.04	0.01	0.31	2.79	2.32	21.95
1994	2.75	4.70	0.35	1.23	1.47	0.05	0.00	0.00	0.14	0.12	5.16	3.22	19.19
1995	10.11	0.66	7.85	1.28	0.98	0.62	0.00	0.00	0.00	0.00	0.10	5.40	27.00
1996	3.29	5.28	2.43	1.87	1.49	0.00	0.00	0.02	0.01	1.14	2.95	6.37	24.85
1997	7.45	0.25	0.27	0.29	0.20	0.45	0.00	1.10	0.08	0.86	5.94	3.63	20.52
1998	11.67	15.64	2.77	2.73	4.20	0.05	0.02	0.00	0.05	0.69	2.69	2.04	42.55
1999	3.90	5.27	1.01	2.68	0.09	0.02	0.00	0.03	0.18	0.42	0.86	1.03	15.49
2000	4.74	6.79	1.75	1.20	0.54	0.80	0.00	0.00	0.25	1.40	0.30	0.57	18.34
2001	1.92	4.10	1.96	0.63	0.00	0.12	0.00	0.00	0.50	0.38	2.73	4.28	16.62
2002	3.50	0.84	1.94	0.29	0.86	0.00	0.00	0.00	0.00	0.00	1.18	8.81	17.42
2003	1.96	2.16	1.27	3.65	1.10	0.00	0.00	0.00	0.00	0.00	1.88	6.52	18.54
2004	3.56	6.42	0.94	0.15	0.00	0.00	0.00	0.00	0.00	0.25	2.01	8.13	21.46
2005	6.13	4.32	4.03	1.55	1.78	1.58	0.00	0.00	0.00	0.35	1.64	7.23	28.61
2006	3.03	3.14	8.85	4.82	0.33	0.00	0.00	0.00	0.00	0.51	2.45	4.33	27.46
2007	0.63	3.72	0.66	1.36	0.39	0.00	0.10	0.00	0.15	3.79	1.96	4.01	16.77
2008	9.75	2.14	0.12	0.12	0.00	0.00	0.03	0.04	0.00	0.29	2.08	2.58	17.15
2009	0.74	7.44	2.84	0.30	0.89	0.00	0.08	0.00	0.36				12.65

Period of Record Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANN
MEAN	**4.31**	**3.72**	**2.88**	**1.45**	**0.57**	**0.17**	**0.02**	**0.09**	**0.24**	**0.98**	**2.39**	**3.89**	**20.62**
S.D.	**2.91**	**2.63**	**2.12**	**1.40**	**0.81**	**0.30**	**0.07**	**0.29**	**0.45**	**1.02**	**1.88**	**2.43**	**6.47**
MAX	**14.59**	**15.64**	**9.29**	**5.56**	**4.20**	**1.69**	**0.49**	**2.26**	**2.53**	**4.65**	**8.20**	**11.47**	**42.55**
MIN	**0.26**	**0.04**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**9.00**
NO YRS	**96**	**96**	**96**	**96**	**96**	**96**	**96**	**96**	**96**	**95**	**95**	**95**	**96**

5.85 Precipitation Data from Mission Dolores Station

0.09 Precipitation Data from Lake Merced Pump Station Gauge

SAN FRAN MISSION DOLORE, CALIFORNIA

Monthly Average Temperature (Degrees Fahrenheit)

(047772)

File last updated on Jul 29, 2009
*** Note *** Provisional Data *** After Year/Month 200903
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR (S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1914	51.50	53.93	58.40	58.30	56.19	56.60	57.03	58.19	60.77	62.05	58.98	48.69	56.72
1915	50.69	52.82	57.89	57.07	57.60	58.90	60.26	61.16	62.40	61.26	56.13	52.11	57.36
1916	46.98	55.86	56.56	57.58	55.79	57.42	60.00	58.58	62.18	56.94	54.43	48.87	55.93
1917	47.58	52.20	51.68	55.10	53.98	58.60	59.82	57.48	63.98	62.29	58.67	54.58	56.33
1918	52.65	51.88	54.87	57.25	54.68	59.25	58.82	60.82	62.27	64.03	55.60	50.15	56.85
1919	51.21	51.59	52.61	55.98	57.15	57.78	57.06	58.32	61.98	60.71	56.02	48.82	55.77
1920	52.21	52.83	52.48	54.97	55.76	60.20	57.85	60.11	60.42	60.03	55.35	50.98	56.10
1921	49.61	52.91	54.55	54.88	54.31	61.42	59.79	59.55	63.28	61.48	57.78	52.92	56.87
1922	46.74	50.21	52.34	53.55	58.02	60.03	60.16	60.40	63.32	61.31	54.30	50.60	55.91
1923	48.10	52.18	56.74	56.07	57.21	57.18	60.81	61.69	63.95	62.50	60.80	51.06	57.36
1924	50.21	57.05	54.50	57.47	59.11	59.82	59.05	59.13	62.45	59.48	56.70	47.85	56.90
1925	51.42	55.18	55.39	56.95	58.98	60.72	61.21	61.15	62.72	62.19	56.62	52.71	57.94
1926	47.90	56.02	60.65	61.62	61.06	59.15	61.10	60.84	61.28	63.45	60.87	51.50	58.79
1927	51.31	54.02	54.23	55.50	58.19	59.83	58.66	59.79	62.38	62.48	58.12	51.82	57.19
1928	50.44	55.10	58.24	57.73	58.92	60.52	58.68	58.45	61.20	59.52	56.35	49.63	57.06
1929	47.56	51.77	54.24	53.35	56.50	63.00	61.55	61.11	61.42	63.48	59.70	54.24	57.33
1930	49.68	56.64	57.61	59.23	56.08	59.93	58.65	61.52	62.40	63.19	58.08	52.10	57.93
1931	52.27	56.70	59.02	59.02	61.85	62.02	62.31	60.45	62.67	59.73	54.45	49.24	58.31
1932	49.32	51.36	57.10	55.95	58.40	59.17	59.73	60.97	62.97	62.15	60.67	47.45	57.10
1933	47.02	51.21	55.42	55.47	55.15	57.62	59.50	59.77	61.13	62.34	60.03	50.47	56.26
1934	51.84	55.62	60.65	58.97	60.61	60.93	59.94	60.90	63.65	61.76	58.50	52.92	58.86
1935	50.77	54.12	52.63	58.52	58.68	61.32	60.16	59.97	60.53	60.97	54.87	52.85	57.12
1936	53.85	53.41	57.47	58.92	61.53	61.68	59.48	59.31	63.02	62.21	58.03	51.53	58.37
1937	43.58	49.89	54.81	54.52	57.15	61.37	59.29	58.90	61.43	63.37	58.28	54.71	56.44
1938	51.45	53.07	52.82	54.92	56.60	57.45	58.85	60.08	61.18	61.56	56.78	53.61	56.53
1939	51.97	51.23	52.74	55.75	56.97	57.88	58.98	60.69	66.17	62.97	59.15	55.32	57.49
1940	52.61	55.41	57.40	57.77	58.02	59.00	60.16	60.00	65.08	62.29	57.03	55.45	58.35
1941	53.97	55.36	58.39	55.82	61.18	60.03	60.16	61.21	63.48	60.82	58.40	53.45	58.52
1942	51.11	53.36	55.26	55.58	56.85	58.58	59.73	58.47	60.27	60.90	56.02	52.08	56.52

1943	51.89	54.75	55.61	55.58	58.61	57.35	59.05	59.84	63.45	61.32	59.23	53.58	57.52
1944	51.79	51.62	55.77	53.20	56.79	57.77	57.32	58.87	60.65	61.45	55.75	54.19	56.27
1945	50.19	54.34	51.82	55.90	55.39	61.30	59.55	58.65	62.52	61.56	56.38	52.74	56.70
1946	51.37	50.68	53.19	55.22	55.61	58.80	60.48	58.10	62.77	60.31	54.67	51.32	56.04
1947	47.18	53.61	55.98	58.47	57.76	61.82	60.11	61.76	61.40	62.03	55.33	50.97	57.20
1948	54.71	50.78	51.73	53.58	55.55	59.38	59.29	59.66	59.95	60.34	56.58	47.79	55.78
1949	44.68	48.30	53.21	55.55	56.71	58.78	57.53	59.39	62.48	58.50	59.82	50.60	55.46
1950	46.84	51.82	53.19	56.07	54.69	56.78	57.74	59.55	61.90	61.68	61.00	53.63	56.24
1951	50.26	52.18	54.05	52.32	57.29	56.28	56.24	57.29	59.75	61.52	56.22	49.95	55.28
1952	48.03	52.14	51.68	55.33	57.34	56.55	58.68	57.89	61.48	58.76	55.88	51.60	55.45
1953	54.34	54.00	53.18	52.67	56.58	57.78	57.23	59.50	62.52	61.56	56.67	54.98	56.75
1954	51.50	53.93	52.06	57.02	56.15	58.50	59.05	57.85	61.80	61.47	56.63	49.92	56.32
1955	48.11	52.21	54.81	52.25	56.60	57.00	56.85	56.37	59.03	59.63	56.22	53.05	55.18
1956	51.66	51.36	53.65	54.35	57.52	58.87	57.08	58.89	62.53	59.40	59.42	52.71	56.45
1957	48.82	53.96	54.11	57.65	57.89	61.38	59.55	59.52	63.57	62.31	56.80	51.45	57.25
1958	52.76	56.16	53.10	57.13	59.48	62.43	58.94	61.03	66.82	61.76	58.03	57.53	58.76
1959	54.00	53.43	58.16	57.85	56.76	59.37	59.98	61.82	62.92	65.18	60.17	54.84	58.71
1960	51.03	54.24	55.79	56.00	56.90	59.55	58.10	57.71	59.82	60.94	55.48	51.35	56.41
1961	49.05	55.43	54.24	56.90	55.71	60.12	59.98	60.92	63.37	61.19	56.47	50.02	56.95
1962	51.87	51.82	52.63	56.98	55.18	57.52	55.95	59.95	58.30	60.79	58.82	52.85	56.06
1963	50.39	58.38	54.10	54.37	57.19	58.07	59.69	59.76	64.73	62.89	56.62	48.23	57.03
1964	50.94	54.98	53.11	53.78	53.34	57.78	58.84	60.00	62.42	63.03	55.30	53.66	56.43
1965	51.39	53.98	54.39	55.65	54.84	56.17	57.42	61.19	61.18	64.95	58.10	48.32	56.47
1966	52.08	51.79	53.81	57.90	55.08	59.40	58.13	58.81	63.53	62.60	57.22	51.31	56.80
1967	52.61	53.16	52.69	50.73	57.85	57.07	58.85	59.15	63.48	65.48	59.95	51.85	56.91
1968	49.74	56.66	56.66	56.17	55.66	58.98	57.97	62.24	63.08	60.50	56.20	49.81	56.97
1969	48.55	50.04	54.21	54.17	56.98	58.65	57.61	59.32	60.85	61.87	59.32	55.76	56.44
1970	54.00	57.34	57.77	53.28	57.69	56.73	57.82	57.19	64.38	58.58	57.83	50.55	56.93
1971	50.82	51.91	53.29	53.10	54.55	57.30	57.44	61.05	64.68	57.79	55.58	49.00	55.54
1972	48.50	53.97	55.82	55.48	55.52	57.43	60.82	60.19	61.48	61.71	54.90	47.19	56.09
1973	50.15	54.86	52.53	57.20	56.27	60.67	58.56	57.08	61.30	60.95	55.32	51.98	56.41
1974	51.08	52.11	53.31	55.42	54.87	58.15	59.53	59.90	60.28	62.24	56.63	51.10	56.22
1975	51.02	53.30	53.08	51.90	57.16	56.88	58.84	59.45	59.43	59.65	55.55	53.39	55.80
1976	53.34	52.83	52.55	54.10	56.77	61.47	59.18	62.50	62.15	62.73	60.33	54.55	57.71
1977	49.87	56.09	53.18	56.07	55.31	57.05	59.02	61.52	61.93	60.53	58.55	54.92	57.00
1978	54.97	55.18	58.95	56.30	60.73	58.85	58.40	60.56	65.48	61.89	55.92	49.58	58.07
1979	50.94	52.89	55.68	56.42	59.15	58.58	60.21	60.79	66.32	63.16	57.65	55.34	58.09
1980	52.95	57.17	55.92	56.92	55.37	57.93	59.48	57.95	61.30	61.97	58.22	53.42	57.38
1981	52.39	56.02	54.94	55.77	56.76	62.18	57.79	59.21	60.37	59.29	58.32	53.97	57.25
1982	48.44	55.00	52.77	55.60	55.76	56.28	57.92	60.13	62.58	62.77	54.40	52.19	56.15
1983	49.37	54.62	55.29	56.80	59.66	61.78	63.42	65.90	67.07	63.97	56.12	52.82	58.90
1984	51.58	52.57	56.66	54.20	59.90	59.65	63.89	62.73	69.35	61.48	55.93	50.84	58.23
1985	49.95	55.98	53.16	59.80	58.05	63.83	64.05	64.08	64.08	63.15	54.95	51.24	58.53
1986	56.56	58.91	60.44	58.55	60.00	63.22	62.76	61.87	62.75	63.58	60.18	52.47	60.11
1987	51.79	56.41	57.11	60.43	61.06	60.47	61.48	63.45	63.78	65.03	58.73	52.24	59.33
1988	52.82	57.66	59.06	58.73	59.11	61.02	64.19	64.00	63.03	61.44	57.25	53.23	59.30
1989	51.26	49.98	55.35	60.87	59.26	61.55	62.42	63.00	61.80	62.00	58.80	52.60	58.24
1990	52.74	51.95	54.84	59.22	59.00	62.33	62.89	65.24	65.95	64.21	57.98	49.10	58.79

1991	53.37	57.88	53.19	57.03	56.77	58.58	61.29	63.00	63.12	64.35	60.05	53.39	58.50
1992	51.42	58.38	59.23	62.62	62.73	62.53	65.10	63.76	65.78	66.73	59.72	51.69	60.81
1993	51.08	53.77	59.00	59.42	62.45	65.92	63.39	66.56	63.38	64.27	58.17	51.52	59.91
1994	53.66	52.68	58.10	57.58	58.71	61.03	59.61	63.42	63.67	62.19	51.93	49.52	57.68
1995	54.03	56.91	56.15	56.92	57.39	61.67	65.98	64.05	64.68	64.58	60.85	55.50	59.89
1996	54.02	57.09	58.74	61.40	61.71	62.83	63.65	63.73	63.55	62.84	58.02	55.82	60.28
1997	52.65	56.09	58.21	58.10	62.60	61.62	62.27	65.74	67.75	62.45	59.30	53.82	60.05
1998	53.63	52.66	55.66	55.43	56.55	59.30	60.10	61.08	61.72	60.55	55.18	49.95	56.82
1999	50.50	51.45	51.18	54.88	53.74	56.37	58.66	60.87	61.48	62.42	57.78	54.23	56.13
2000	52.63	53.83	54.94	57.10	58.24	59.50	58.32	60.66	64.70	59.52	53.80	53.95	57.27
2001	51.37	52.05	55.85	52.50	61.52	61.30	60.47	61.50	61.00	62.65	58.63	52.76	57.63
2002	50.68	55.45	53.85	54.83	55.02	58.02	59.16	60.39	61.52	60.77	59.38	54.23	56.94
2003	56.27	54.59	56.45	53.92	58.03	60.50	59.32	63.48	64.83	62.97	55.33	52.85	58.21
2004	51.77	53.69	60.24	58.48	58.13	58.93	60.68	62.81	64.88	60.03	56.50	53.48	58.30
2005	50.32	55.84	57.52	55.92	59.10	59.33	60.92 a	59.77	59.67	60.52	60.25	55.48	57.89
2006	52.61	54.70	50.89	54.87	57.35	60.20	61.73	59.52	59.57	60.69	56.25	52.35	56.73
2007	49.97	53.02	57.17 a	55.40	57.29	59.12	61.44	61.95	63.40	60.35	57.28	50.77	57.26
2008	49.85 a	53.14	54.48	54.88	57.60	59.53	60.47	61.94	63.33	63.40	59.08	50.42	57.34
2009	54.11	52.78 a	54.11	55.85	58.02	60.39 b	59.48 h	-----z	-----z	-----z	-----z	-----z	55.88

Period of Record Statistics

MEAN	51.04	53.87	55.21	56.25	57.53	59.49	59.78	60.59	62.67	61.79	57.39	52.05	57.30
S.D.	2.32	2.19	2.40	2.23	2.12	1.98	1.98	2.06	1.98	1.72	1.93	2.19	1.22
SKEW	-0.46	0.11	0.42	0.29	0.54	0.47	0.79	0.62	0.60	0.01	-0.07	-0.10	0.72
MAX	56.56	58.91	60.65	62.62	62.73	65.92	65.98	66.56	69.35	66.73	61.00	57.53	60.81
MIN	43.58	48.30	50.89	50.73	53.34	56.17	55.95	56.37	58.30	56.94	51.93	47.19	55.18
NO YRS	96	96	96	96	96	96	95	95	95	95	95	95	95

Attachment 10.1-H

Appendix B

Lake Merced Lake-Level Model – Historical Analysis Annual Water Balance Data Summary

Lake Merced Lake-Level Model - Historical Analysis Annual Water Balance Data Summary

Water Year	Precipitation (AF)	Stormwater Runoff (AF)	Evaporation (AF)	Transpiration (AF)	Groundwater In/Out (AF)	Singular Events (AF)	Change in Lake Storage (AF)
1940	686	473	-699	-135	60	0	373
1941	905	601	-725	-137	126	0	743
1942	707	431	-676	-132	126	0	436
1943	572	334	-686	-132	41	0	112
1944	469	249	-653	-129	6	0	-70
1945	574	339	-685	-133	22	0	102
1946	570	363	-678	-132	13	0	120
1947	386	197	-689	-135	-50	250	-50
1948	411	203	-656	-130	-57	250	12
1949	477	277	-658	-131	0	-600	-645
1950	427	250	-638	-128	0	0	-95
1951	630	375	-635	-128	22	0	254
1952	829	573	-649	-130	-186	-650	-229
1953	540	352	-651	-130	-307	0	-203
1954	366	192	-662	-132	-168	750	343
1955	399	230	-624	-126	-418	600	55
1956	707	359	-659	-130	-196	500	568
1957	422	120	-689	-134	-387	250	-426
1958	912	355	-717	-138	-208	0	183
1959	366	105	-700	-136	-109	-150	-630
1960	324	96	-668	-134	-182	250	-316
1961	375	106	-666	-134	-171	250	-240
1962	430	138	-618	-128	-139	250	-67
1963	506	159	-673	-136	-362	250	-252
1964	325	93	-622	-131	-385	150	-566
1965	514	170	-611	-128	-46	1,340	1,251
1966	452	138	-663	-133	-364	250	-321
1967	768	324	-642	-130	-246	400	472
1968	392	116	-688	-136	-323	-100	-741
1969	642	239	-637	-131	-47	400	469
1970	557	194	-666	-133	-77	-250	-377
1971	487	154	-621	-128	-120	250	25
1972	315	91	-636	-130	-175	650	116
1973	839	325	-642	-131	-21	0	365
1974	734	239	-652	-131	1	0	184
1975	434	127	-646	-130	-116	250	-84
1976	238	55	-652	-134	-401	50	-844
1977	289	77	-645	-132	-411	250	-570
1978	635	227	-690	-138	-245	1,450	1,257
1979	430	140	-668	-135	-321	-400	-956
1980	556	184	-644	-132	-354	500	117
1981	382	119	-629	-133	-151	0	-405
1982	770	279	-615	-130	-20	100	399
1983	925	384	-706	-141	-119	0	348
1984	506	193	-712	-141	110	0	-43
1985	452	133	-697	-140	48	0	-203
1986	694	257	-710	-142	-47	0	57
1987	309	97	-693	-140	-141	0	-563
1988	332	101	-670	-141	-112	-300	-781
1989	415	138	-632	-140	-58	0	-254
1990	247	75	-627	-141	-92	0	-524

Lake Merced Lake-Level Model - Historical Analysis Annual Water Balance Data Summary

Water Year	Precipitation (AF)	Stormwater Runoff (AF)	Evaporation (AF)	Transpiration (AF)	Groundwater In/Out (AF)	Singular Events (AF)	Change in Lake Storage (AF)
1991	362	131	-583	-137	-41	0	-234
1992	378	140	-642	-146	-102	840	508
1993	525	232	-639	-144	-279	-600	-863
1994	324	120	-577	-138	-30	920	662
1995	665	340	-641	-140	231	-75	432
1996	452	163	-687	-146	182	0	-9
1997	461	181	-656	-144	-305	0	-434
1998	1,069	666	-620	-134	-180	0	878
1999	436	144	-583	-129	4	0	-112
2000	429	143	-628	-135	159	0	-16
2001	267	76	-597	-133	22	0	-355
2002	333	110	-586	-132	18	0	-238
2003	463	204	-635	-136	-5	1,161	1,075
2004	465	168	-656	-137	12	2	-134
2005	714	278	-621	-132	-52	0	206
2006	713	306	-638	-133	52	0	313
2007	349	101	-646	-134	185	0	-140
2008	534	243	-647	-134	-17	0	-11
2009	392	147	-263	-54	-44	0	186
Total	**35,959**	**15,436**	**-45,314**	**-9,320**	**-6,948**	**9,438**	**-380**
Average	**514**	**221**	**-647**	**-133**	**-99**	**135**	**-5**
Max	**1,069**	**666**	**-263**	**-54**	**231**	**1,450**	**1,257**
Min	**238**	**55**	**-725**	**-146**	**-418**	**-650**	**-956**
Std Dev	**182**	**129**	**57**	**11**	**159**	**379**	**476**
Years	**68**	**68**	**68**	**68**	**68**	**27**	**68**

Kennedy/Jenks Consultants

303 Second Street, Suite 300 South
San Francisco, California 94107
415-243-2150
FAX: 415-896-0999

Technical Memorandum 10.2

Assessment of Groundwater-Surface Water Interactions

for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

1 May 2012

Prepared for

San Francisco Public Utilities Commission
525 Golden Gate Avenue, 10th Floor
San Francisco, CA 94102

K/J Project No. 0864001

Supplemental Explanation for Hydrographs - TM10.2

This supplemental explanation is prepared to address discrepancies on several graphs presented in TM 10.2.

First, the x-axis on several graphs showing model results was shifted. The x-axis is named Scenario Year which should correspond to a water year[1]. However, the graph template was plotted using a calendar year, so the intervals on the x-axis represent the period from January to December. The result is that the graph is shifted 3-months later relative to Scenario Year.

Second, the shaded area representing the Design Drought was added manually and because of this process, it was not presented consistently on the graphs. By definition per the PEIR, the 8.5-year Design Drought includes one Hold year before the 7.5-year Take period. In addition, the Design Drought needs to be shifted 3-months later for the x-axis issue to be consistent with the model output. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.

The following is a list of figures in TM 10.2 where the Design Drought shaded area is shown slightly different and does not match the correct display of the Design Drought. The figures should be viewed based on the correct representation of the Design Drought as explained above.

- Figures 10.2-8 through 10.2-15 (a total of 13 figures) have the shifted x-axis. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.

[1] A water year is October 1 of the previous year to September 30 of the current (named) year.

1 May 2012

Task 10.2 Technical Memorandum

San Francisco Public Utilities Commission

Assessment of Groundwater-Surface Water Interactions for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Prepared For: Greg Bartow and Jeff Gilman, SFPUC

Prepared by: Michael Maley, Dennis Orlowski, Sevim Onsoy and Matt Baillie, Kennedy/Jenks Consultants

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1. Introduction

This Technical Memorandum (TM) was prepared to document work performed by Kennedy/Jenks Consultants (Kennedy/Jenks) for the San Francisco Public Utilities Commission (SFPUC) pursuant to the amended Task Order (TO) authorizations CUW30103-TO-1.12 of the Regional Groundwater Storage and Recovery (GSR) Project and CUW30102-TO-2.7 of the San Francisco Groundwater Supply (SFGW) Project. These projects are funded by the SFPUC's Water System Improvement Program (WSIP).

1.1. Objective

Implementation of the proposed GSR and SFGW Projects may influence groundwater levels within portions of the Westside Groundwater Basin (Basin). Depending on the magnitude of the potential changes in groundwater levels, existing and planned beneficial uses of major surface water features (lakes, streams, and wetlands) located within the Basin and connected to groundwater could be affected. Evaluation of the potential effects of groundwater / surface water (GW/SW) interaction is a key management issue for the long-term sustainability of the groundwater resources and the overall management of the Basin.

This TM was prepared to evaluate the potential interaction between groundwater and surface water for various surface water bodies overlying the Basin as a result of implementing the individual GSR and SFGW Projects, as well as combining both projects with other reasonably foreseeable future projects. For this evaluation, potential changes in future groundwater levels due to the operation of the GSR and SFGW Projects are assessed with respect to the potential to affect GW/SW interactions. Included as part of the evaluation is information related to past, current, and future conditions in the subsurface related to GW/SW interaction, along with a conceptual discussion of the mechanisms that control GW/SW interactions. The TM also includes an evaluation of the possible future groundwater conditions resulting from the implementation of the GSR and SFGW Projects as well as other reasonably foreseeable future projects. This evaluation is based upon the groundwater model scenarios developed based on the existing Westside Basin Groundwater Model (HydroFocus, 2007, 2009, and 2011) as described in TM-10.1.

1.2. General Approach

The general approach used to evaluate GW/SW interaction is first to identify the surface water features of interest in the Basin and to evaluate the existing GW/SW interactions for these features. Then in light of the degree of GW/SW interactions, the potential for the identified surface water features to be affected by the GSR and SFGW Projects is assessed based on an analysis of the changes in groundwater conditions in the Basin. Since each surface water feature may react differently depending upon the local conditions, each of the identified surface water features is evaluated separately.

This TM is part of a series of technical memoranda that address various aspects of the GSR and SFGW Projects. Two of these with significant data and analysis that are pertinent to this TM include the following:

- Task 8B Technical Memorandum No.1 Hydrologic Setting of the Westside Basin (referred to as TM#1) (LSCE, 2010).
- Task 10.1 Groundwater Modeling Analysis for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project (referred to as TM-10.1).

For each of the surface water features under consideration, the available documentation related to surface water hydrology, local hydrogeology, studies related to GW/SW interactions, and past or present management activities was reviewed. From this information, the following aspects of each surface water feature were addressed:

- Lake / Stream Characteristics: General descriptions of each surface water body, including physical characteristics, any anthropogenic modifications performed to the natural features and the historical use of the water body.
- Local Hydrogeology: An evaluation of the hydrogeologic conditions existing in the area of each surface water feature, with a focus on the conditions that are most likely to affect the GW/SW interaction process at a particular location (e.g., relative water levels for groundwater and surface water bodies and the presence or absence of major clay layers).
- Groundwater / Surface Water Interactions: A summary of available documented evidence for GW/SW interactions at a particular surface water body location.
- Managed Lake / Stream Levels: Where applicable, a summary of reported management activities intended to control water levels at a particular surface water feature.

The primary quantitative tools for evaluating potential future groundwater conditions are model scenarios developed using the existing Westside Basin Groundwater-Flow Model (Westside

Basin Groundwater Model) developed by HydroFocus (2007, 2009, and 2011). The development of the model scenarios is documented in TM-10.1. The Westside Basin Groundwater Model is considered a reasonable tool for regional, basin-wide assessment, but it has limited ability to evaluate GW/SW interactions on a local scale. Therefore, analysis of the potential effects with respect to GW/SW interactions is based on an empirical evaluation of the surface water hydrology and GW/SW interactions.

The Lake Merced Lake-Level Model is an empirical / conceptual quantitative tool, (referred to as the Lake-Level Model in this TM), used to evaluate changes in Lake Merced with respect to the GW/SW interactions. The Lake-Level Model is a spreadsheet-based water balance model that incorporates the key surface water components as well as groundwater-surface water interactions. The development of the Lake-Level Model is discussed in TM-10.1, Attachment 10.1-H.

1.3. GSR and SFGW Project Descriptions

The GSR Project is a conjunctive use project that would allow for increased groundwater supplies in the southern portion of the Westside Basin (South Westside Basin) during periods of drought when SFPUC surface water supplies become limited (MWH, 2008). The GSR Project will be designed to provide up to 60,500 acre-feet (af) of stored groundwater to help meet the SFPUC's system demands during the last 7.5 years of SFPUC's Design Drought. The SFPUC plans to install 16 new production wells for the GSR Project to recover the stored groundwater. Under the Draft GSR Operating Agreement, the SFPUC would "store" water in the South Westside Basin through the mechanism of in-lieu recharge by providing surface water as a substitute for groundwater pumping by the City of Daly City (Daly City), the City of San Bruno (San Bruno), and California Water Service Company (Cal Water). Daly City, San Bruno, and Cal Water are collectively referred to as the Partner Agencies (PAs). During shortages of SFPUC system water due to drought, emergencies, or scheduled maintenance, the PAs would return to pumping from their existing wells. During drought periods the SFPUC would extract groundwater from their new wells as long as a positive balance exists in the SFPUC Storage Account.

The SFGW Project would provide a reliable, local source of high-quality groundwater in the northern portion of the Westside Basin (North Westside Basin). The SFGW Project would construct up to six wells and associated facilities in the western part of San Francisco and extract an annual average of up to 4.0 million gallons per day (mgd) of groundwater from the North Westside Basin (SFPUC, 2009b). The extracted groundwater, which would be used both for regular and emergency water supply purposes, would be blended in small quantities with imported surface water before entering the municipal drinking water system for distribution. The SFGW Project includes two phases. In Phase One, SFPUC would build four new municipal supply groundwater wells at the Lake Merced Pump Station, West Sunset Playground, South Sunset Playground, and the Golden Gate Park Central Pump Station. In Phase Two, SFPUC would modify two existing irrigation wells (South Windmill Replacement and North Lake) in Golden Gate Park, converting them into municipal water supply wells.

The locations of the proposed GSR and SFGW Project wells and the existing and proposed PA municipal wells are shown on Figure 10.2-1. Additional detailed discussion of the GSR and SFGW Projects and pumping conditions under each project is provided in TM-10.1.

1.4. Daly City Vista Grande Drainage Basin Improvements Project

Daly City prepared the Vista Grande Drainage Basin Alternatives Analysis in 2011 based on the recommendations of the Vista Grande Watershed Plan. The purpose of the alternatives analysis is to develop and evaluate alternatives that will reduce or eliminate flooding of the canal, reduce erosion along Lake Merced, and provide other potential benefits such as habitat enhancement and lake level augmentation. The recommended program outlined in the plan includes:

- Partial replacement of the existing Vista Grande Canal to incorporate a gross solid screening device;
- Construction of a treatment wetland, and diversion and discharge structure to route some stormwater (and authorized non-stormwater) flows from the Vista Grande Canal to South Lake Merced;
- Replacement of the existing Vista Grande Tunnel to expand the capacity and
- Replacement of the existing outfall structure at Fort Funston. (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012).

Daly City's Vista Grande Drainage Basin Alternatives Analysis recommended the South Lake Merced Alternative in which stormwater flow from the Vista Grande Canal would be diverted to Lake Merced (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012). In the assessment of GW/SW interactions, the use of Lake Merced as part of the Vista Grande Drainage Basin Improvements Project for Daly City is considered a reasonably foreseeable future projects.

2. Conceptual Understanding

This section presents a basic framework for understanding the natural hydrogeologic processes and anthropogenic factors that can affect GW/SW interactions in the Westside Basin.

2.1. Surface Water Hydrology

Located within the Westside Basin are several prominent surface water features that could potentially be influenced by implementation of the GSR, SFGW Projects and other reasonably foreseeable future projects. These surface water features include the following:

- Lake Merced is a 300-acre freshwater lake located in the southwestern corner of San Francisco just north of the San Francisco County-San Mateo County line (Figure 10.2-2). Lake Merced is a major natural habitat for many species of birds and waterfowl, and is a popular recreational venue offering fishing, boating, bicycling, and wildlife viewing opportunities.
- Pine Lake is a 3-acre freshwater lake located north-northeast of Lake Merced in the westernmost portion of Pine Lake Park, which is adjacent to Stern Grove (Figure 10.2-2). Pine Lake (also known as Laguna Puerca) is one of the few natural lakes that still exist in San Francisco.
- The Golden Gate Park Lakes consist of twelve lakes or ponds located within Golden Gate Park (GGP) in the northernmost extent of the Westside Basin (Figure 10.2-3). The lakes provide a multitude of benefits in GGP, including wildlife habitat, recreation, and ornamental purposes.
- Three principal streams, along with their tributaries, exist in the South Westside Basin area: Colma Creek, San Bruno Creek, and Millbrae Creek in San Mateo County (Figure 10.2-1).

These surface water features are identified as the primary focus of this TM. Specific characteristics, local hydrogeology, and the potential for GW/SW interactions for each of the surface water features are discussed in more detail later in this TM.

2.2. Westside Groundwater Basin

This section provides an brief overview of the physical setting and hydrogeology of the Westside Basin to provide relevant context for the analysis presented in this TM. More detailed descriptions of the evaluations of the hydrogeology of the Westside Basin are presented in TM#1 (LSCE, 2010) and TM-10.1. In the Westside Basin, there are three regional aquifer systems, commonly referred to as the Shallow Aquifer, Primary Production Aquifer, and Deep Aquifer, as briefly described below and shown on Figure 10.2-4:

- The Shallow Aquifer is present in the northern part of the Basin, in the vicinity of Lake Merced and the southern portion of the Sunset district of San Francisco. The base of the Shallow Aquifer is defined as the top of the “-100 foot clay.”

- The Primary Production Aquifer is present throughout the Basin, overlying the “W-clay” where present. Where the W-clay is not present in locations to the south (in the South San Francisco area), the Primary Production Aquifer is divided into shallow and deep units separated by a clay unit at an elevation of approximately -300 feet mean sea level (msl).
- The Deep Aquifer underlies the W-clay, and thus its extent is limited to the generally-known extent of that clay unit.

The three aquifer systems are separated by thick, extensive clay units (e.g., the -100 foot clay and W-clay). Because of the discontinuous nature of these clay layers, the Basin is considered to be a semi-confined aquifer system where limited flow occurs between the different aquifer systems.

2.3. Conceptual Understanding of Groundwater-Surface Water Interactions

The phrase “groundwater-surface water interaction” refers to the movement of water between areas beneath the land surface (groundwater) and areas above the ground surface, such as streams, lakes, and wetlands (surface water). The conceptual understanding of this process provides the basic framework for understanding the natural processes that affect GW/SW interactions.

Several general conditions are required for the GW/SW interactions to occur. First, the depth to groundwater (or water table) has to be sufficiently shallow in relation to the bottom of surface water bodies such as streams, lakes, and wetlands. While there does not have to be an actual connection between surface water and the groundwater table to result in some degree of GW/SW interaction, there cannot be significant distance between the two. For instance, if the water table is tens or hundreds of feet below the level of the surface water, then GW/SW interactions are likely negligible.

In addition to the presence of a relatively shallow water table, there also has to be a relatively permeable pathway in the subsurface between the surface water body and groundwater. In other words, the presence of a low permeability clay deposit composing a lakebed might block, or at least greatly limit, the transfer of water flow between the lake and underlying groundwater. A higher permeability lakebed of sand would, on the other hand, allow the transfer of water for a more dynamic GW/SW interaction system. However, even with a natural sand lakebed, settling of silt and organic-rich sediments from the water column to the lake bottom over time would reduce the permeability of the lake bottom. Because of the presence of low permeability sediments on the lake bottom, groundwater interactions can often occur primarily through sediments along the edges of the lake.

Surface water bodies (e.g., lakes and streams) can interact with groundwater in three basic ways (Figure 10.2-5): 1) they can gain water from inflow of groundwater through the streambed or lakebed (gaining system); 2) they can lose water to groundwater by outflow through the streambed or lakebed (losing system); or 3) they can do both, gaining water in some reaches and losing water in others. The relative difference between the elevations of the surface water and the water table determines the relative direction of water flow. For groundwater to discharge into a surface water body, the groundwater level has to be higher than the water level in the surface water body. In this case the stream is considered to “gain” flow through the contribution of groundwater. Conversely, for surface water to be able to seep to groundwater, the level of the groundwater table near the stream has to be lower than the level of the stream surface. Under this condition the stream is considered to “lose” water to the groundwater system. A stream can be both gaining and losing at various reaches along its course, depending on the relative water levels at a specific location.

The seepage rate between the lakebed or streambed and the groundwater system is controlled by the permeability of the subsurface geology and the thickness and character of the streambed or lakebed. If the sediments at the bottom of the lake or stream are composed of clayey materials, then the rate of seepage may be low and the levels in the surface water body may not be in equilibrium with groundwater. Conversely, if the lake or stream has a sandy bottom, then the rate of seepage may be high and the groundwater levels may closely mimic the surface water.

Lakes and streams can be connected to the groundwater system by a continuous saturated zone, such as that depicted on Figure 10.2-5, or they can be disconnected from groundwater by an intervening unsaturated zone. In the latter case, as shown on Figure 10.2-6, the water table might exhibit a discernible mound beneath the stream, if the recharge rate through the streambed and unsaturated zone is greater than the rate of lateral flow of groundwater away from the mound. An important feature of streams that are disconnected from groundwater is that pumping of shallow groundwater near the stream does not affect the flow of the stream near the pumped wells. On the other hand, streams in connection with groundwater could be affected by such pumping (Winter, et al., 1998).

Another type of GW/SW interaction occurs when water from a surface water body moves into adjacent shallow sediments along the margin of the stream or lake. This process, termed “bank storage”, is a dynamic process in which an increase in water level in the surface water body creates a corresponding rise of the water table in these shallow sediments. The difference between bank storage and seepage to an aquifer is that the water in bank storage is not lost to the surface water body; rather the bank storage process provides a temporary storage for surface water during high water periods and a source of water during low water periods. The water can remain in this temporary storage if the water in the shallow sediments is not hydraulically connected to an underlying aquifer system. This can occur if a geologic feature, such as a laterally continuous clay layer, separates the shallow sediments from the underlying aquifer.

3. Groundwater-Surface Water Analysis

To evaluate groundwater conditions resulting from the operations of the GSR and SFGW Projects, a series of model scenarios was developed using the Westside Basin Groundwater-Flow Model. The development of the model scenarios is documented in TM-10.1. This section provides an evaluation of model-predicted changes in groundwater conditions with respect to the GW/SW interactions resulting from the implementation of the GSR and SFGW Projects.

3.1. Modeling Scenarios

Five model scenarios were constructed and simulated to evaluate the potential groundwater and related hydrological effects from the GSR and SFGW Projects and other reasonably foreseeable future projects. The following is a summary of the five scenarios used for the groundwater model analysis:

- Scenario 1 - Existing Conditions: Scenario 1 represents Existing Conditions and does not include the SFPUC Projects (either the GSR or SFGW Project). Groundwater pumping by the PAs and irrigation pumping are representative of the existing pumping conditions (as of June 2009). The PA pumping was established based on historical pumping rates, using the median of the 1959-2009 pumping data for individual agencies.
- Scenario 2 - GSR Project: Scenario 2 represents implementation of the GSR Project operations including: “put” periods when groundwater pumping by SFPUC and the PAs does not occur, except for exercising of the wells, and groundwater is placed into storage in the SFPUC Storage Account through in-lieu recharge; “hold” periods when the PAs are pumping and no in-lieu recharge is occurring because the SFPUC Storage Account is full; and “take” periods when both SFPUC and the PAs are pumping from the South Westside Basin.
- Scenario 3a - SFGW Project (3 mgd): For Scenario 3a, the four new wells constructed for the SFGW Project would pump at an annual average rate of 3.0 mgd; however, the two existing irrigation wells would remain irrigation wells, and their pumping rates would be the same as in Scenario 1.
- Scenario 3b - SFGW Project (4 mgd): For Scenario 3b, the four new wells constructed for the SFGW Project and the two modified irrigation wells in Golden Gate Park would pump at an annual average rate of 4.0 mgd. Irrigation in Golden Gate Park is assumed to be replaced by the Westside Recycled Water Project. Total combined pumping in the Westside Basin for Scenario 3b is slightly less than Scenario 3a, because the total SFGW Project pumping in Scenario 3b would increase by 1.0 mgd, whereas the irrigation pumping that is replaced would be slightly more than 1.0 mgd.
- Scenario 4 - Cumulative Scenario: Scenario 4 represents the implementation of both the GSR and SFGW Projects (Scenarios 2 and 3b) along with other reasonably foreseeable future projects. The other foreseeable projects are discussed in more detail in TM-10.1, but primarily include the Daly City Vista Grande Drainage Basin Improvements Project

(which increases stormwater diversions into Lake Merced) and minor variations in irrigation pumping based upon the planned build-out of the Holy Cross cemetery.

Table 10.2-1 presents a summary of the estimated Basin-wide average pumping rates corresponding to each of the model scenarios. Note that in addition to the pumping by the proposed GSR and SFGW Project wells, average pumping rates are also provided for the PA wells and for irrigation and other non-potable uses in the Basin.

As discussed in TM-10.1, the strongest predictive capability of the Westside Basin Groundwater-Flow Model is its ability to forecast relative changes in water levels over time, rather than to estimate the absolute water levels. Therefore, it is more appropriate to analyze the results of the groundwater model using differences in water levels relative to a base case rather than absolute groundwater elevations. Scenario 1 represents the Existing Conditions and forms the base case against which the results for the GSR and SFGW Projects, and the Cumulative Scenario, are compared.

To allow for the model scenarios to be directly comparable, all five model scenarios are set up using similar initial conditions and background hydrology. All of the modeled scenarios have the same projected simulation period of 47.25 years and use initial groundwater conditions that represent June 2009 conditions. All five model scenarios use the same hydrologic sequence and include the 8.5-year Design Drought period used in the Program Environmental Impact Report (PEIR; SFPUC, 2007; SFPUC, 2009a). The Design Drought repeats the December 1975 to March 1978 drought period following the dry conditions of July 1987 to November 1992. To incorporate the Design Drought, the historical hydrological sequence was rearranged. A more detailed discussion of the development of the background hydrology is presented in TM-10.1.

The GSR-Only Scenario and the Cumulative Scenario (Scenarios 2 and 4) involve the SFPUC Storage Account, which is a book account tracking of the volume of groundwater stored in the Basin from in-lieu recharge during put periods minus the amount of groundwater pumped from the SFPUC Storage Account during take periods. As part of the initial conditions, the accrued volume in the SFPUC Storage Account at the start of the model scenarios is approximately 20,000 acre-feet (af) based on records of in-lieu exchange with the Partner Agencies prior to July 2009. During the Design Drought, the SFPUC Storage Account is taken from a full condition of 60,500 af to an empty condition of no in-lieu storage available at the end of the Design Drought. During the Recovery Period following the Design Drought, the scenarios include a 3-year put period that adds 20,000 af to the SFPUC Storage Account. Using this condition, the SFPUC Storage Account begins and ends with 20,000 af for both Scenarios 2 and 4. This allows for a more direct comparison while evaluating the long-term changes in groundwater levels and storage without having to factor in differences in the amount of in-lieu storage.

3.2. MODFLOW Model

The existing Westside Basin Groundwater-Flow Model (HydroFocus, 2007, 2009 and 2011) was used as one of the quantitative tools to evaluate the groundwater component of GW/SW interactions as a result of the GSR and SFGW Projects. The setup and results of the MODFLOW model scenarios are documented in TM-10.1.

A limitation of this MODFLOW model is that the groundwater model has difficulty in accurately simulating the absolute Lake Merced levels, although it is capable of reproducing the trends and relative changes seen in the available historical data. The model generally reproduces the lake levels and trends during the period from 1972 to 1995. During the first 14 years (1958 to 1972) and the last 13 years of the simulation (1996 - 2009), simulated lake levels were consistently 2 to 3 feet higher than measured lake levels, with differences as high as 7 feet (HydroFocus, 2011). Since the simulation of absolute lake levels was necessary for the analysis presented in this TM, the Lake Merced Lake-Level Model was used. The Lake-Level Model is described in the next section.

3.3. Lake Merced Lake Level Model

Because of the limitations of the MODFLOW model in simulating absolute Lake Merced levels, the assessment of the GW/SW interactions for Lake Merced utilizes the Lake Model. A more complete discussion of the development of the Lake Model is included in TM-10.1, Attachment 10.1-H. Below is a summary of the application of the model to the evaluation of Lake Merced for the GSR and SFGW Projects, and the Cumulative Scenario.

The Lake Merced Lake-Level Model is a spreadsheet-based water-balance that applies a rule-based approach for the water balance. Each water balance component is calculated independently. The model sums up the inflows and outflows from Lake Merced on a monthly time scale, and that sum represents the net change in water volume in the lake for that month. Based on this net change in water volume, a new lake level is calculated.

The Lake Merced Lake-Level Model was calibrated to historical lake levels over a 70-year period from October 1939 to June 2009 (Figure 10.2-7). This period includes a representative sample of hydrological conditions including wet, normal and dry precipitation years. Overall, the Lake Merced Lake-Level Model closely follows both long-term and short-term historical trends. Further details of the model and its development and adaption for use with the GSR and SFGW projects are discussed in TM-10.1, Attachment 10.1-H.

4. Lake Merced

This section provides a summary of the climatic, hydrological, and hydrogeological data representative of the physical setting of Lake Merced. Elevations for Lake Merced are typically reported using San Francisco City Datum (City Datum), which is 11.37 feet higher than NAVD88, and 8.62 feet higher than NGVD 1929 (LSCE, 2002). In other words 0.0 feet City Datum is equal to 11.37 feet NAVD88 and 8.62 feet NGVD 1929. Lake Merced lake levels are reported in City Datum for this TM.

4.1. Lake Merced Conditions

Lake Merced is a freshwater lake located in the southwestern corner of San Francisco approximately 0.25 mile east of the Pacific Ocean, and bounded by Skyline Boulevard, Lake Merced Boulevard, and John Muir Boulevard. Lake Merced is within the North Westside Groundwater Basin, just north of the San Francisco County-San Mateo County line (Figures 10.2-1 and 10.2-2).

4.1.1. Physical Setting

Lake Merced consists of four inter-connected lakes - North Lake, South Lake, East Lake and Impound Lake (Figure 10.2-2). North and East lakes are joined through a narrow channel and these lakes are separated from South Lake by natural or man-made barriers. A conduit between North and South lakes allows water to flow between the two lakes when the lake elevation in either lake is approximately 3.35 feet (City Datum) or higher. When lake levels drop below that elevation, the North and South lakes are separated and typically exhibit different elevations. When the lake elevation in the North and South lake is above 5.0 feet (City Datum), then water can flows between the two lakes. The South and Impound lakes are also partially separated by a low berm. Flow between the South and Impound Lakes is restricted below an elevation of approximately 4.3 feet (City Datum).

The only physical outlet from Lake Merced is an overflow structure, also known as spillway, near the midpoint of the southwestern side of South Lake at an elevation of 13 feet (City Datum). The spillway is a 30-inch-diameter pipe that connects to the existing Daly City Tunnel immediately downstream of the tunnel connection to the Vista Grande Canal. The estimated capacity for the overflow is approximately 400 cubic feet per second (cfs) in its current configuration (Kennedy/Jenks, 2009, Jacobs, 2011b).

Lake Merced is a major natural habitat for many species of waterfowl and other birds, and is a popular recreational venue offering fishing, boating, bicycling, and wildlife viewing opportunities. However, prior to the mid-1930s, Lake Merced was used as a potable water supply source for the City of San Francisco (City). After the City began receiving water from the Hetch-Hetchy Aqueduct system in 1935, Lake Merced became an emergency and irrigation water supply source only. In 1950, San Francisco Recreation and Parks District was given the authority to manage the lake for recreational and ecological purposes. In addition to these types of uses, Lake Merced continues to serve as an emergency non-potable water supply for the City and County of San Francisco (SFPUC, 2010).

4.1.2. Lake Merced Hydrology

Currently, Lake Merced is replenished primarily by direct precipitation on the lake surface, local runoff from the immediately surrounding land area, and shallow groundwater inflow. Because the portion of subsurface inflow has been reduced from historical rates, short-term lake levels are quite sensitive to annual changes in precipitation, and the lake is also slower to recover from drought conditions (LSCE, 2004).

Urbanization of the Basin has resulted in substantial reductions in the amount of surface water that previously flowed into Lake Merced. The original watershed that drained into Lake Merced is estimated at approximately 6,320 acres; however, the current watershed is estimated to be approximately 650 acres (SFSU, 2005; Pezzetti and Bellows, 1998). The current watershed is defined by the adjacent roadways, which include Lake Merced Boulevard, Skyline Boulevard, and John Muir Boulevard. Urbanization has obstructed natural springs and diverted stormwater runoff that historically was a major source inflow into Lake Merced. Most of these flows are now diverted away from the lake into the City's combined wastewater system. The increase in impervious surfaces within the Basin (e.g., roads, parking lots, buildings) also has reduced the amount of recharge to the local shallow groundwater system, further reducing the amount of subsurface water contributions to Lake Merced (LSCE 2004, 2005a, 2005b; SFPUC 2009).

Historically, water additions and pumping have occurred in Lake Merced. Lake additions were water inflows to the lake typically from surface supplies, periodically done by SFPUC at the Lake Merced Pump Station to maintain or raise lake levels. Recorded additions were identified based on SFPUC records and previously reported data (LSCE, 2002). Other lake additions were known to have occurred in the past; however, the records for these events were not available. Similarly, pumping of water from the lake for golf course irrigation and other uses was known to occur; however, no records are available of the duration and extent of this pumping.

A more detailed discussion of Lake Merced conditions including a detailed water balance study of historical conditions is provided in TM-10.1, Attachment 10.1-H.

4.1.3. History of Lake Levels

Lake levels have generally been measured daily in South Lake since 1926. Figure 10.2-7 shows Lake Merced surface water levels, as measured at South Lake, over the historical period from 1939 to 2009. Prior to the beginning of Hetch-Hetchy aqueduct water delivery to San Francisco in 1935, lake levels typically ranged from elevations of 0 to -10 feet City Datum. In the late 1930s to early 1940s, lake levels increased to over 13 feet City Datum, which is the approximate elevation of the spillway, and thus the maximum controlled lake level.

Water levels in Lake Merced started to decline in the 1940s. During the 1940s to late 1950s, lake level elevations varied between 8 and 13 feet City Datum. Between the late 1950s and early 1980s, the lake experienced a long-term declining trend when levels ranged between

4 and 10 feet City Datum (Figure 10.2-7). Previous reports indicate that the reasons for the overall decline in lake levels during this period were drought, increased municipal groundwater pumping in the Basin, and increased urbanization that diverted stormwater into the City's combined sewer and stormwater system (Pezzetti and Bellows, 1998).

During the late 1980s and early 1990s, Lake Merced water levels declined well below the historical averages measured in the 1950s through early 1980s. A lake level of about -3.2 feet (City Datum) measured in 1993 was the lowest observed since the 1930s (Figure 10.2-7). It is understood that this decline was due to a combination of factors including reductions in the watershed area, the 1987-1992 drought, and regional and local groundwater pumping (Metcalf & Eddy, Inc. 2008).

Water levels in Lake Merced have been recovering steadily since 1993, with substantial rise during the wet winters of 1997 and 1998. As of June 2009, the lake level was approximately 5.7 feet City Datum (Figure 10.2-7). Water level increases over the last 15 years are attributed to a combination of factors, including several years with above average precipitation, SFPUC water additions to the lake between 2002 and 2005, reduced pumping by Lake Merced area golf courses as a result of recycled water deliveries, and reduced municipal pumping as part of the Pilot Conjunctive Use Study.

4.2. Groundwater-Surface Water Interactions

Lake Merced overlies the North Westside Basin, which is the northern portion of the greater Westside Groundwater Basin (Westside Basin). From north to south, the North Westside Basin underlies a portion of the Sunset District in San Francisco from Golden Gate Park to the San Francisco/San Mateo County line. From west to east, the North Westside Basin extends from the Pacific Ocean to inland bedrock exposures generally associated with Mount Sutro and Mount Davidson (LSCE, 2002, 2004).

Lake Merced is hydraulically connected to the unconfined Shallow Aquifer (LSCE, 2002, 2004). Previous hydrogeological investigation also provided some evidence that the surface of the lake is essentially an exposed part of the water table that defines the upper boundary of the Shallow Aquifer (Yates et al., 1990). Groundwater monitoring during the SFPUC's 2002 and 2003 water additions to Lake Merced further demonstrated that the shallow aquifer is in full hydraulic connection with Lake Merced (LSCE, 2004). During these events, 70 to 80 percent of the volume of water additions contributed to lake storage and the remaining 20 to 30 percent contributed to net outflow and evaporative losses during the water addition periods.

Currently, the direction of groundwater flow in the unconfined Shallow Aquifer is predominantly to the southwest; however, north of Lake Merced groundwater flow appears to be more westward toward the ocean (SFPUC, 2009b). Groundwater pumping in the South Westside Basin has resulted in a shift in the groundwater flow direction from northwesterly to southerly in the Lake Merced-northern San Mateo County area of the Westside Basin. The general groundwater flow direction in the deeper portion of the aquifer system (Primary Production Aquifer and Deep Aquifer) exhibits a more pronounced north to south flow direction than in the

Shallow Aquifer, likely due to greater pumping stresses in the deeper aquifer to the south. In addition, interpretation of deeper groundwater levels shows that the groundwater has a steeper gradient toward the pumping depression than the Shallow Aquifer (LSCE, 2002).

In 2009, an aquifer test was performed at the Lake Merced Pump Station (LMPS) Test Well located along the east shore of South Lake (note that this well is labeled as "Lake Merced Pump Station Well" on Figure 10.2-1). The LMPS Test Well is completed in the Primary Production Aquifer. The purpose of conducting the test was to characterize the yield of the LMPS Test Well and aquifer properties within the well's area of influence. Important conclusions derived from the aquifer test were that: 1) pumping and recovery responses in the LMPS Test Well and a nearby deep monitoring well (LMPS MW-440) (both completed in the Primary Production Aquifer) were consistent with a completely confined aquifer system; and 2), the Lake Merced / Shallow Aquifer system is unconfined and hydraulically separated from the pumped interval (within the Primary Production Aquifer) by multiple confining layers (LSCE, 2011). The results from the 2009 LMPS Test Well aquifer test substantiate the results of previous investigations which indicate that the Lake Merced / Shallow Aquifer system is, in the vicinity of Lake Merced, hydraulically isolated from the underlying Primary Production Aquifer system.

4.3. Daly City Vista Grande Drainage Basin Improvements Project

The City of Daly City prepared the Vista Grande Drainage Basin Alternatives Analysis to evaluate alternatives that would reduce or eliminate flooding, reduce erosion along Lake Merced, and provide other potential benefits such as habitat enhancement and lake level augmentation. The recommended program, known as the South Lake Merced Alternative, includes:

- Partial replacement of the existing Vista Grande Canal to incorporate a gross solid screening device;
- Construction of a treatment wetland, and diversion and discharge structure to route some stormwater (and authorized non-stormwater) flows from the Vista Grande Canal to South Lake Merced;
- Replacement of the existing Vista Grande Tunnel to expand the capacity and
- Replacement of the existing outfall structure at Fort Funston. (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012).

For this analysis, the 75 cubic-feet-per-second (cfs) scenario of the Lake Merced Alternative of the Vista Grande Drainage Basin Alternatives Analysis (Jacobs Associates, 2011a, 2011b; City of Daly City, 2012) has been selected. The 75-cfs flow represents a minimum flow threshold (or cutoff volume) for diversions to Lake Merced. In other words, all flows in the Vista Grande Canal that are greater than or equal to 75 cfs would be diverted to Lake Merced (Brown and Caldwell, 2010). Flows of this magnitude are generally associated with stormwater discharges. Stormwater flows are calculated to occur in every year, and range from 19 to 681 afy with an average of 207 afy (Brown and Caldwell, 2010).

The Lake Merced Alternative scenarios also include provisions for an engineered wetland and modification of the Lake Merced spillway (Brown and Caldwell, 2010). In the 75-cfs scenario, the average baseflow in the Vista Grande Canal is assumed to be diverted into an engineered wetland for treatment and then discharge to Lake Merced on an ongoing basis. Baseflows have been estimated to range from 18 to 26 af per month (Kennedy/Jenks, 2009).With respect to the spillway modification, it is assumed that the spillway would be lowered from its existing elevation of 13 feet City Datum to 9.5 feet City Datum. This lower spillway elevation is used in the Cumulative Scenario (Scenario 4).

4.4. Lake Merced Model Results

For the analysis of GW/SW interactions, the Westside Basin Groundwater-Flow Model was used to evaluate groundwater conditions and derive the magnitude and direction of flux of groundwater-surface water interactions. This output from the Westside Basin Groundwater-Flow Model was used as an input to the Lake-Level Model. The Lake Level model was then used to evaluate absolute lake levels. This approach therefore takes advantage of the strengths of both models.

4.4.1. Model Descriptions

The Westside Basin Groundwater-Flow Model is a numerical (MODFLOW) groundwater model that has the capability to evaluate the effect of changes in groundwater pumping and other stresses on groundwater levels in the Lake Merced area. This model also has the capacity to calculate fluxes such as the flux between Lake Merced and groundwater. As described previously, because the model is regional and calibrated only to historical conditions, its strength lies in the assessment of relative (rather than absolute) changes.

The Lake-Level Model is a spreadsheet-based mass balance model that is used to evaluate changes in water levels of Lake Merced. MODFLOW treats Lake Merced as a boundary condition using the LAK3 package, which relies upon a mass balance approach to calculate lake levels. The Lake-Level Model uses a site-specific characterization of Lake Merced that is more complex and accurate than that used by the MODFLOW model. Some of the key advantages of the Lake-Level Model include the following:

- The model allows changes in the surface area of Lake Merced as a function of lake level (as based on measured bathymetry data). This is essential for an accurate simulation of absolute lake levels, because key water balance components (such as precipitation and evaporation) are dependent upon the lake surface area. These components are described as follows:
    - The precipitation input accounts for rainfall falling directly onto the lake. For example, during dry periods, when lake levels decline and portions of the lakebed may be exposed, the model simulates this precipitation as stormwater runoff, only a fraction of which actually reaches the lake.

  - o Evaporation is dependent on the surface area of the lake open to the atmosphere. For example, if lake levels decline, then the surface area also declines, and the overall evaporation losses also decline.

- The model dynamically simulates changes in lake volume. For example, at lower lake levels, the volume of the lake is smaller; therefore, the volume of water required to change the lake level by a certain amount is less than at higher lake levels.
- The Lake-Level Model includes a more complete evaluation of stormwater runoff than the Westside Basin Groundwater-Flow Model. The Lake-Level Model incorporates varied land surface types within the limited lake watershed area, including high runoff coefficients for the paved areas surrounding the lake.
- The Lake-Level Model accounts for flooding events resulting from overflows of the Vista Grande Canal. These are short-term, high-volume events that can substantially affect lake levels. There is a method for estimating overflows from flood events under existing conditions for the Vista Grande Canal used for Scenarios 1, 2, 3a and 3b, and a separate method for estimating stormwater inflows from the Vista Grande Drainage Basin Improvements Project for Scenario 4.
- The Lake-Level Model is superior to the Westside Basin Groundwater-Flow Model in simulating absolute historical lake levels (see TM-10.1).

The primary limitation of the Lake-Level Model is that the GW/SW interactions are based on assumptions of annual average groundwater flux into or out of Lake Merced. To address this limitation, the MODFLOW-calculated groundwater flux for Lake Merced was used. This flux is calculated on a monthly basis and dynamically incorporates the effects of changing groundwater levels. An earlier version of the Lake-Level Model used a generalized assumption for groundwater-surface water interactions, because the model was developed to support projects in which groundwater conditions were assumed to remain stable. For the GSR and SFGW Project scenarios, the groundwater levels are changing; therefore, a different approach was required. The use of the MODFLOW model results was considered a more reliable method than developing a new approach within the spreadsheet model. The combined approach therefore provides the best available analysis of the possible changes to Lake Merced water levels that could be attributed to the GSR and SFGW Projects.

A more detailed discussion of the Westside Basin Groundwater-Flow Model and the Lake-Level Model is provided in TM-10.1.

4.4.2. Model Analysis Approach

The results of the Lake-Level Model for each of the five model scenarios are shown on Figure 10.2-8 (absolute lake levels) and 10.2-9 (changes in lake level relative to Scenario 1). These figures show the changes in the elevation of Lake Merced over time. Each scenario is based upon a resequenced hydrology and includes the Design Drought (see TM-10.1).

Summary statistics for the simulated lake levels from the Lake-Level Model are provided in Table 10.2-2. These summary statistics provide another basis of comparison to evaluate the relative change from the Existing Conditions (Scenario 1) to the simulation results for Scenarios 2, 3a, 3b and 4. Additional statistical data are provided in Attachment 10.2-A. The summary statistics are:

- Lake Levels Assessment denotes the percentage of time that the simulated lake levels occur in the specified elevation bands. The percentage of time that the lake levels occur between 1 and 13 feet (City Datum) are calculated in 2-foot bands. The percentage for lake levels less than 1 foot (City Datum) is grouped into a single band.
- Monthly Lake Levels are presented for the entire simulation for the mean, 95 percentile and 5 percentile. These statistics provide a means to evaluate the average, upper and lower lake levels experienced during the simulation. Using the 95 and 5 percentile eliminates any short-term extremes and provides a more consistent method for comparison.
- Annual Range of Lake Levels is the difference between the maximum and minimum lake level for each water year (October to September) for the 47 full water years included in the simulation. The range provides a method to evaluate whether the lake level fluctuations during a water year vary due to the effects of the project.

The groundwater flux to Lake Merced as simulated by the MODFLOW model and incorporated into the Lake-Level Model is presented in Figures 10.2-10a and 10.2-10b. The Figure 10.2-10a shows the simulated flux values. Positive values represent groundwater flow into Lake Merced and negative values represent flow from Lake Merced to groundwater. These flux values show considerable seasonal and annual fluctuations. To facilitate the evaluation, the Figure 10.2-10b presents the groundwater flow relative to Scenario 1.

The evaluation of groundwater levels uses simulated groundwater levels from the Westside Basin Groundwater-Flow Model Layers 1 and 4 at selected monitoring well locations. The following four monitoring well clusters, representing different parts of Lake Merced (Figure 10.2-2), were selected to evaluate model-predicted changes in groundwater levels:

- LMMW-1 (Figure 10.2-11), located along the west shore of the South Lake
- LMMW-2 (Figure 10.2-12), located between the North and South Lakes
- LMMW-3 (Figure 10.2-13), located adjacent to the west shore of Impound Lake
- LMMW-4 (Figure 10.2-14), located north of North Lake

On each figure, the upper hydrograph shows model-simulated groundwater elevations in feet (NGVD 29), while the lower pane shows the difference between the groundwater levels of each scenario and those of Scenario 1. Positive differences indicate that a given project scenario has a higher groundwater elevation relative to Scenario 1, while negative results indicate that a given project scenario has a lower groundwater elevation relative to Scenario 1.

The following is a discussion of the results of the model analysis for the GSR and SFGW Project Scenarios and the Cumulative Scenario.

4.4.3. Scenario 1 – Existing Conditions

Scenario 1 represents a continuation of Existing Conditions without either the GSR or SFGW Projects, and defines the background conditions including wet, normal and dry precipitation years. As discussed in TM-10.1, the hydrologic sequence used for all scenarios includes the Design Drought from Scenario Years 36 to 44. Water levels in Lake Merced clearly respond to these climatic variations (Figure 10.2-8). Initially, the lake levels show a sharp increase representing a period of above-average precipitation during Scenario Years 1 to 4. The period from Scenario Years 4 through 16 shows a steady decline in lake levels to about 1.5 feet during a dry period (City Datum). From Scenario Years 16 to 36, lake levels fluctuate in response to climatic conditions but show an overall increasing trend and rise to over 11 feet (City Datum). During the Design Drought period from Scenario Years 36 to 44, lake levels decline sharply to a minimum value of -0.8 feet (City Datum). Following the Design Drought, the lake levels recover to about 5 feet (City Datum).

Summary statistics for simulated lake levels for Scenario 1 are presented in Table 10.2-2 to provide another basis of comparison to evaluate the simulation for Scenarios 2, 3a, 3b and 4. The mean monthly lake level for Scenario 1 is 6.3 feet (City Datum) with an upper and lower lake level represented by the 95 and 5 percentile as 11.3 feet and 1.1 feet (City Datum). Lake levels occur below 3 feet (City Datum) about 13 percent of the simulation period for Scenario 1. The mean annual range of lake levels is 1.6 feet.

In the Lake Merced area, these climatic variations are seen more clearly in simulated groundwater levels in Model Layer 1 for all four locations (Figures 10.2-11 to 10.2-14), whereas groundwater levels in Model Layer 4 show less variability. Groundwater levels are generally higher for locations to the north and lower for locations to the south, which is characteristic of the Westside Basin. This pattern reflects the influence of groundwater pumping in the South Westside Basin. For Lake Merced, this means that there is a higher net outflow of lake water to groundwater in the South and Impound Lakes and more inflow of groundwater to Lake Merced in the North and East Lakes.

Figure 10.2-10a shows the flux of groundwater to Lake Merced based on the MODFLOW model. The overall pattern indicates that the GW/SW interaction is strongly influenced by the climatic conditions used for the simulation. The climatic conditions result in positive net flux for higher precipitation periods showing a net inflow of groundwater to Lake Merced. During the lower precipitation periods, the flux has negative values for a net loss of lake water to groundwater in response to groundwater level declines.

4.4.4. Scenario 2 – GSR Project

Scenario 2 represents the operation of the GSR Project, which is located in the South Westside Basin. The GSR Project contains put periods when in-lieu groundwater storage occurs with minimal pumping by SFPUC or the PAs, hold periods with no in-lieu recharge and normal pumping by the PAs and a full SFPUC Storage Account, and take periods when there is combined pumping by SPFUC and the PAs and no in-lieu recharge. The pumping assumptions used for the GSR Project are presented in Table 10.2-1, with further details provided in TM-10.1.

The level of Lake Merced under Scenario 2 shows a similar pattern of response to climatic variations as Scenario 1 (Figure 10.2-8). Lake levels increase by about 5 feet as compared to Scenario 1 during Scenario Years 1 through 10 (Figure 10.2-9). Under Scenario 2, the relative difference remains at about 5 feet higher than Scenario 1 until the start of the Design Drought in Scenario Year 36. There are two take periods from Scenario Years 10 through 36. Relative to Scenario 1, there is little change in Lake Merced lake levels in response to those take periods. During the Design Drought with 7.5 years of pumping by both SFPUC and the PAs, lake levels drop to their lowest level of -2.5 feet (City Datum), which is less than 1 feet lower than the lowest lake level for Scenario 1 at the end of the Design Drought period (Figure 10.2-8).

During the put period following the Design Drought, the lake levels rise to about 1 foot (City Datum), but the rise in lake levels for Scenario 2 is less than for Scenario 1. At the end of the simulation, the Scenario 2 lake-levels are about 4 feet lower compared to Scenario 1. The interpretation of this response is that the aquifer is taking time to recover from the combined (SFPUC and PA) pumping, which results in lower groundwater levels and slows down the recovery of Lake Merced as well. Additional discussion on the effects of Scenario 2 on regional groundwater levels is provided in TM10.4.

Table 10.2-2 provides summary statistics for lake levels for Scenario 2, and additional statistical data are provided in Attachment 10.2-A. The monthly mean lake level over the simulation period is 9.1 feet (City Datum), which is 2.8 feet higher than the mean level for Scenario 1. Lake levels occur below 3 feet (City Datum) about 2 percent of the simulation period for Scenario 2. This is a lower percentage than in Scenario 1 (where low lake levels occur for 13 percent of the simulation period).

In the Lake Merced area, the effects of GSR Project pumping are clearly seen in groundwater levels in the Primary Production Aquifer (Model Layer 4), whereas groundwater levels in the Shallow Aquifer (Model Layer 1) show more fluctuation related to climatic conditions (Figures 10.2-11 to 10.2-14). There are also variations from north to south across Lake Merced. In the Shallow Aquifer (Model Layer 1), groundwater levels following the Design Drought at the LMMW-3 location (Figure 10.2-13a) are about 10 feet lower than those at LMMW-4 (Figure 10.2-14a) to the north. In the Primary Production Aquifer (Model Layer 4), groundwater levels following the Design Drought at the LMMW-3 location (Figure 10.2-13b) are about 35 feet lower than those at LMMW-4 (Figure 10.2-14b) to the north. The effects of GSR Project pumping are more clearly evident in the southern locations. These include effects in both the Shallow and Primary Production Aquifers. The northern locations show little effect of GSR Project pumping upon the Shallow Aquifer and only a minor response in the Primary Production Aquifer.

Figure 10.2-10b shows the simulated net flux of groundwater to Lake Merced. In comparison to Scenario 1, a higher net inflow of groundwater into Lake Merced is estimated under Scenario 2 for Scenario Years 1 through 38 (Figure 10.2-10b). However, early through the Design Drought period, the response switches to a higher net outflow of groundwater from Lake Merced into the aquifer. This is interpreted as the lake responding to the lower groundwater conditions caused by the operation of the GSR Project with both the GSR and PA wells operating throughout the Design Drought.

4.4.5. Scenarios 3a and 3b – SFGW Project

Scenarios 3a and 3b simulate the operation of the SFGW Project, which is located in the North Westside Basin. The pumping assumptions used for Scenarios 3a and 3b are presented in Table 10.2-1. Scenario 3a assumes 1.142 mgd of irrigation pumping in Golden Gate Park and 3.0 mgd of pumping for municipal water supply throughout the North Westside Basin. Scenario 3b assumes 4.0 mgd of pumping for municipal water supply, and replacing irrigation pumping in Golden Gate Park with recycled water. In comparison to Scenario 3a, Scenario 3b assumes 0.142 mgd less pumping overall. Because of this minor change in pumping, the regional response of groundwater levels to these scenarios is very similar; therefore, the results for Scenarios 3a and 3b are discussed together.

During Scenario Years 1 and 2, Lake Merced levels tend to track those of Scenario 1. Afterwards, however, the level of Lake Merced clearly shows the effects of increased pumping in the North Westside Basin from the SFGW Project (Figure 10.2-8). The change in Lake Merced levels relative to Scenario 1 shows a steady decrease during Scenario Years 3 through 15 for both Scenarios 3a and 3b (Figure 10.2-9). However, during Scenario Years 15 through 44 (when the lake levels in Lake Merced vary in response to climatic conditions), there is an approximately stable difference (of about 9 to 10 feet) between the lake levels simulated in Scenarios 3a and 3b and those simulated in Scenario 1. During Scenario Years 44 to the end of the simulation, the lake levels for Scenarios 3a and 3b recover faster than Scenario 1, but the lake levels are still about 7 feet lower than in Scenario 1 (Figure 10.2-9). However, this faster recovery is due Lake Merced having a substantially smaller surface area at lower lake levels. This is incorporated into the Lake-Level Model so that an equal volume of water added to Lake Merced would result in a greater lake level rise because the volume of the lake is substantially smaller when the lake level is low. Additional information is included in TM10.1-Attachment 10.2-H, which provides more detail on the construction of the model.

Table 10.2-2 provides summary statistics for lake levels for Scenarios 3a and 3b, and additional statistical data are provided in Attachment 10.2-A. For Scenario 3a, the mean lake level over the simulation period is -1.3 feet (City Datum), which is 7.6 feet lower than the mean level for Scenario 1. Lake levels occur below 3 feet (City Datum) about 83 percent of the simulation period for Scenario 3a, as compared to only 13 percent for Scenario 1. For Scenario 3b, the monthly mean lake level over the simulation period was -1.9 feet (City Datum), which is 8.2 feet lower than the mean level for Scenario 1. Lake levels below 3 feet (City Datum) occur for about 85 percent of the simulation period for Scenario 3b.

In the Lake Merced area, the effects of the SFGW Project pumping are observed in groundwater levels in both the Shallow and Primary Production Aquifers (Model Layers 1 and 4) (Figures 10.2-11 to 10.2-14). There are also variations from north to south across Lake Merced.

In the Shallow Aquifer (Model Layer 1), groundwater elevations following the Design Drought at the LMMW-3 location (Figure 10.2-13a) are about 10 feet lower than those at LMMW-4 (Figure 10.2-14a) to the north. In the Primary Production Aquifer (Model Layer 4), groundwater elevations following the Design Drought at the LMMW-3 location (Figure 10.2-13b) are about 40 feet lower than those at LMMW-4 (Figure 10.2-14b) to the north. The groundwater levels at the LMMW-3 location (Figures 10.2-13b) in Model Layer 4 are substantially lower than those at the LMMW-4 location (Figures 10.2-14b) to the north. This reflects the proximity of the LMMW-3 location to the SFGW Project well at the Lake Merced Pump Station.

Figure 10.2-10b shows the net flux of groundwater to Lake Merced. Comparing Scenarios 3a and 3b to Scenario 1 with respect to groundwater flux (Figure 10.2-10b), it can be seen that there is a higher net outflow from Lake Merced to groundwater under Scenarios 3a and 3b relative to Scenario 1. This relative difference is greatest near the beginning of the simulation; however, as the simulation continues, this difference gradually diminishes during the remainder of the simulation. During the Design Drought, the groundwater flux in Scenarios 3a and 3b is similar to that of Scenario 1. As the relative difference in net outflow diminishes, the relative difference between simulated lake levels for Scenarios 3a and 3b and Scenario 1 becomes consistent as well (Figure 10.2-9).

4.4.6. Scenario 4 – Cumulative Scenario

Scenario 4 represents the combined operations of the GSR and SFGW Projects along with other reasonably foreseeable future projects. Scenario 4 uses the same pumping assumptions as Scenario 2 for the GSR Project and Scenario 3b for the SFGW Project. The most pertinent foreseeable future project for Lake Merced is the Daly City Vista Grande Drainage Basin Improvements Project, which is described in Section 4.3. For reference, the key features of this project are repeated as follows:

- Lowering of the existing spillway elevation from 13 feet City Datum to 9.5 feet City Datum.
- Diversion of all Vista Grande Canal stormwater flows in excess of 75 cfs directly into Lake Merced. These flows generally range from 19 to 681 afy with an average of 207 afy (Brown and Caldwell, 2010).
- Diversion of Vista Grande Canal baseflow through an engineered wetland (for treatment prior to discharge) and into Lake Merced. Baseflows were estimated to range from 18 to 26 af per month.

The water levels of Lake Merced for Scenario 4 show a similar pattern to Scenario 2 (GSR Project) but are consistently 2 to 4 feet lower due to the effects of SFGW Project pumping (Figure 10.2-8). Relative to Scenario 1 (Figure 10.2-9), the lake levels are generally within 3 feet higher or lower than Scenario 1 until Scenario Year 44 (the end of the Design Drought). For Scenario Years 44 to the end of the simulation, the lake levels are about 4 to 5 feet lower than Scenario 1. This is a similar pattern to that observed for Scenario 2. During the Design Drought, the lake levels under Scenario 4 drop to -4.9 feet (City Datum); this value is 4.1 feet lower than the lowest lake level under Scenario 1.

The lowering of the spillway level to 9.5 feet (City Datum) has an effect on the long-term lake levels for Scenario 4, resulting in a loss of storage in the lake such that there is less water available in the lake at the beginning of drought periods. However, this is somewhat counteracted by the inflow of stormwater from the Vista Grande Canal, which augments the volume of water in the lake.

Table 10.2-2 provides summary statistics for lake levels for Scenario 4, and additional statistical data are provided in Attachment 10.2-A. The monthly mean lake level over the simulation period is 6.1 feet (City Datum), which is 0.2 feet lower than the mean level for Scenario 1. Lake levels occur below 3 feet (City Datum) about 16 percent of the simulation period for Scenario 4, as compared to 13 percent for Scenario 1.

In the Lake Merced area, the groundwater levels tend to parallel those of Scenario 2 but at an elevation that is about 2 to 4 feet lower (Figures 10.2-11 to 10.2-14). The difference in groundwater levels varies from north to south across Lake Merced. Groundwater levels in the LMMW-3 location (Figures 10.2-13ab) are lower than those for LMMW-4 (Figures 10.2-14ab) to the north. However, the difference relative to Scenario 2 is greater in the northern locations. This is because of SFGW Project pumping.

Figure 10.2-10b shows the net flux of groundwater to Lake Merced. A higher portion of the net outflow from Lake Merced to the groundwater is estimated under Scenario 4 than in Scenario 1 throughout the simulation period. This is due to the continuous augmentation of stormwater and baseflow from the Vista Grande Canal to Lake Merced. With the increase in lake levels, the net outflow is a natural process that equilibrates the shallow groundwater levels with Lake Merced. Scenario 4 therefore has a distinctly different pattern of groundwater flux than that observed in the other scenarios.

4.5. Summary

This section summarizes the results of the evaluation of groundwater-surface water interaction based on the modeling analysis using the Lake-Level Model and the Westside Basin Groundwater-Flow model.

Scenario 2 (GSR Project) generally results in higher lake levels than Scenario 1 for most of the simulation period. During the Design Drought (in which the extended period of pumping from SFPUC and PA wells occurs over a 7.5-year take period), the simulated lake levels for Scenario 2 are below those of Scenario 1 toward the end of the Design Drought period. The lowest lake level estimated under Scenario 2 is -2.5 feet (City Datum) toward the end of the Design Drought period, which is similar to the lowest historical lake level of -3.2 (City Datum) experienced in 1993.

Scenarios 3a and 3b (SFGW Project) result in lake levels that are substantially lower than Scenario 1 for the entire simulation period. Lake levels decline during the first approximately 15 years of operation of the SFGW Project. During the final approximately 30 years of the simulation, lake levels are consistently about 10 feet lower than the Existing Conditions Scenario. The lowest lake levels for Scenario 3a and 3b are about 7 feet lower than the lowest historical lake level experienced in 1993 of -3.2 feet (City Datum).

Scenario 4 (Cumulative Scenario) includes operation of the GSR and SFGW Projects using the assumptions of Scenario 2 and 3b. In addition, other reasonably foreseeable future projects such as the Daly City Vista Grande Drainage Basin Improvements Project, are included. This Project would augment Lake Merced with stormwater and baseflow from the Vista Grande Canal. The result of the Cumulative Scenario is that the simulated lake levels are similar to Scenario 1. They also tend to mimic the pattern from Scenario 2 (GSR Project) but at a lower elevation (by about 3 to 4 feet) as a result of SFGW Project pumping. The lowest lake level under Scenario 4 is -4.9 feet (City Datum), which is about 1.5 feet lower than the lowest historical lake level experienced in 1993.

5. Pine Lake

Pine Lake, also known as Laguna Puerca, is located about 0.5 mile north-northeast of Lake Merced in the westernmost portion of the Stern Grove and Pine Lake Park (Figures 10.2-1 and 10.2-2).

5.1. Physical Setting and Lake Conditions

Pine Lake is a relatively shallow lake that is approximately 3.4 acres in area. It has been used only for recreational purposes and has never served as a water supply source. Records related to historic conditions and lake levels in Pine Lake are sparse until the past 10 to 15 years. In November 2004, the lake level was reported to be very low, at an elevation of 33.5 feet (NGVD 29; 24.9 feet City Datum). The design water level elevation for Pine Lake was established at 40.1 feet (NGVD 29, or 31.5 feet City Datum; SFDPW, 2005b), which is about 4 feet higher than average historic lake levels and about 7 feet higher than the lake level in 2004.

Pine Lake has changed physically over time. It is reported that in the 1930s, about one third of the total lake area at its eastern end was filled in to accommodate additional park development. Pine Lake has also become shallower over time. In the early 1900s the depth of the lake was reportedly around 20 feet; during the period of low lake levels in the early 2000s, maximum lake depths were only 7 to 8 feet (SFDPW, 2001; Bennett Consulting Group, 2005). The historic shallowing of Pine Lake was attributed to a combination of long-term sedimentation and local declines in groundwater levels (Pilat, 2002). It is also likely that intense urbanization in the area surrounding Pine Lake reduced the amount of natural inflow to the lake.

To address declining water level and ecological issues in Pine Lake, during the past decade SFRPD conducted studies and capital improvement projects. As part of a capital improvement project completed in 2007 (Pine Lake and Pine Lake Meadow Improvement Project), SFRPD performed substantial water quality and habitat upgrades at Pine Lake. The improvements included the eradication of invasive plants, which were replaced with native vegetation, installation of a new pump in the Stern Grove well, and construction of a 6-inch diameter pipe from the well to an outlet channel that drains to Pine Lake.

Lake levels in Pine Lake currently are maintained by adding groundwater from the nearby 270-foot-deep Stern Grove well. Based on discussions with the well’s operator, the Stern Grove Well is operated for 24 hours at a time with a pumping rate of about 270 gpm. The well is operated about 3 to 4 times each year to maintain the Pine Lake design water level. At that pumping rate and operational period, the total volume of groundwater added annually to Pine Lake to maintain the water level is approximately 4.8 acre-feet. At the design lake level, Pine Lake would be about 10 to 12 feet deep under the current lakebed configuration. The San Francisco Recreation and Park Department (SFRPD) will continue groundwater pumping from the rehabilitated Stern Grove well as part of a long-term program to augment water levels in Pine Lake (SFRPD, 2010, LSCE, 2010).

5.2. Groundwater Conditions near Pine Lake

Pine Lake overlies the Shallow Aquifer, which in this area comprises the upper portion of the Colma Formation. Groundwater levels measured in monitoring well LMMW-5S, which is located near the western end of Pine Lake, have consistently been about 6 to 7 feet bgs over the past ten years or so. Generally, lake levels are slightly higher than nearby groundwater levels due to the ongoing additions to the lake from the Stern Grove well. The 270-foot-deep Stern Grove well pumps groundwater from below the clay aquitard that forms the base of the Shallow Aquifer (LSCE, 2010); therefore, pumping from the well is not considered to directly affect groundwater levels near the lake.

Groundwater levels around Pine Lake are monitored in wells LMMW-5SS and LMMW-5S. LMMW-5SS is a shallow well completed between 38 and 48 ft bgs, designed to evaluate the shallow sediments near the lake. LMMW-5S is completed between 65 and 85 ft bgs, and was designed to evaluate groundwater levels in the Shallow Aquifer. Groundwater level data are available from both of these wells since 2002 (SFPUC, 2009a, 2011). Reviewing these data indicates that:

- Groundwater elevations in LMMW-5SS typically range between 37 to 40 feet (NGVD 29); however, during a period of low levels in Pine Lake, groundwater levels declined to about 33 feet. Since 2008, groundwater levels have varied between 38 and 40 feet (NGVD 29). Variations in groundwater elevations measured in LMMW-5SS appear to closely approximate changes in lake levels in Pine Lake.
- Groundwater elevations in LMMW-5S have ranged from 31 to 36 feet (NGVD 29), but show a trend over time. From 2002 to 2006, groundwater levels in LMMW-5S varied within a narrow range of 31 to 33 feet (NGVD 29). Groundwater levels steadily rose by about 2 feet from 2006 to 2008. From 2008 to 2010, groundwater levels varied within a narrow range of 35 to 36 feet (NGVD 29).
- Groundwater elevations in LMMW-5SS have typically been about 1 to 4 feet higher than elevations observed in LMMW-5S.

In November 2004, SFRPD performed a test filling of the lake using groundwater from the Stern Grove well (SFDPW, 2005a, Bennett Consulting, 2005). The purpose of the test filling was to raise the lake level from 33.5 feet (NGVD 29; 24.9 feet City Datum) to 40.1 feet (NGVD 29; 31.5 feet City Datum). It was anticipated that it would take up to 15 days of pumping at 400 gpm to fill the lake to the desired level to compensate for losses to groundwater. Instead, lake levels rose to 1.15 feet over the desired level with only 8 days of pumping from the Stern Grove well. The total volume of groundwater added to the lake was about 14 acre-feet. During the test period, there were additional unquantified inflows into Pine Lake from precipitation and runoff.

Based on the results of this test filling project, there was less groundwater loss resulting from lake additions than was anticipated, and it was determined that levels in Pine Lake could be maintained at 40.1 feet (NGVD 29, or 31.5 feet City Datum) by periodic additions from the Stern Grove well.

During the lake-filling test, groundwater levels in well LMMW-5SS rapidly rose about 5 to 6 feet and leveled out at 40.2 feet (NGVD 29; 31.6 feet City Datum), near the level in Pine Lake. In well LMMW-5S, groundwater levels rose less than 1 foot during the test, and were about 8 feet lower than the lake level in Pine Lake at the end of the test.

The groundwater response to the lake-filling operations indicates that Pine Lake is well-connected to the shallowest groundwater near the lake (LMMW-5SS). Based on the groundwater responses and the ability to sustain levels in Pine Lake during the test filling, it appears that the shallowest groundwater, which is monitored by LMMW-5SS, seems to be in good hydraulic communication with Pine Lake. Lower groundwater elevations measured in LMMW-5S suggest that direct hydraulic communication of deeper parts of the Shallow Aquifer with Pine Lake may be limited. This limitation may be due to a geologic restriction such as the presence of shallow clay layers that are sufficiently extensive (laterally and vertically); however, insufficient data are available to confirm this interpretation. Limited hydraulic communication with the Shallow Aquifer is consistent with observations that water from the Stern Grove well is only required a few times per year to maintain levels in Pine Lake. If good hydraulic communication were established with the portion of the Shallow Aquifer represented by the groundwater elevations monitored in LMMW-5S, it would be difficult to maintain lake levels in Pine Lake without substantially more water from the Stern Grove well than has been used historically (SFRPD, 1994, 2010). Groundwater levels in the Shallow Aquifer suggest possible groundwater mounding beneath the lake due to leakage from the overlying sediments, but this leakage appears to be rate limited, likely due to the presence of a low-permeability layer.

5.3. Pine Lake Water Balance

To help evaluate the potential effects on Pine Lake water levels resulting from SFGW Project implementation, a water balance assessment of Pine Lake was performed. The purpose of the assessment was to evaluate whether the amount of additional pumping assumed for the Stern Grove well to maintain the water level in Pine Lake at elevation 40.2 feet (NGVD 29, or 31.5 feet City Datum) during operation of the SFGW Project was adequate based on the changes in groundwater elevations from the results of the MODFLOW model.

Under the conceptual model for Pine Lake, inflows are primarily precipitation, stormwater runoff and lake additions from the Stern Grove well, while outflows are primarily evapotranspiration and groundwater outflow. Because of the sparse availability of historical data, the water balance incorporated the results of the test filling operations (SFDPW, 2005a; Bennett Consulting, 2005).

During the operation of the SFGW Project, groundwater pumping in the North Westside Groundwater Basin is expected to lower groundwater levels in the Shallow Aquifer in the Pine Lake area. The water balance provides a means for estimating the additional volume of groundwater necessary to maintain Pine Lake under these conditions. The difference between the total inflow to and total outflow from Pine Lake was considered to represent the volume of groundwater needed from the Stern Grove well to maintain lake levels. Assumptions for the volume of pumping from the Stern Grove well used for the model scenarios are based on the water balance discussed above, and are shown on Table 10.2-1. In summary, these include:

- Under the Existing Conditions and GSR-Only Scenarios (1 and 2, respectively), pumping from the Stern Grove well needed to maintain lake levels in Pine Lake is estimated at 0.0043 mgd (4.8 afy). At the given operational rate and duration of approximately 270 gpm for 24 hours to fill the lake, lake filling is expected to occur about 4 times per year on average.
- For Scenario 3a, the amount of Stern Grove well pumping needed was 0.012 mgd (13.6 afy), which represents an increase of 0.008 mgd (8.8 afy) over the results for Scenario 1.
- For Scenarios 3b and 4, Stern Grove well pumping increased to 0.013 mgd (14.8 afy), which represents 0.009 mgd (10 afy) more pumping than under Scenario 1.

For the water balance assessment, some simplifying assumptions were applied. Since all the scenarios use the same background hydrology, the water balance components for precipitation, stormwater runoff, and evapotranspiration are unchanged between scenarios. Therefore, the differences between scenarios are related solely to changes in groundwater-surface water interactions.

Under the Existing Conditions Scenario (Scenario 1), we assumed that the pumping from the Stern Grove well needed to maintain lake levels in Pine Lake would be about 0.0043 mgd (4.8 afy) based on current operations (SFRPD, 2010). From the MODFLOW model, the average groundwater elevation for LMMW-5S is 33.24 feet (NGVD 29), which is 7.0 feet below the maintained Pine Lake lake-level of 40.2 feet (NGVD 29).

To determine the groundwater outflow from Pine Lake, a Darcy’s Law approximation was applied. For this approximation, it is assumed that the hydraulic conductivity and cross sectional area of the lake are the same for all scenarios. Therefore, the change in groundwater discharge from Pine Lake is directly proportional to the change in groundwater gradient in the aquifer underneath the lake. The results of this assessment include:

- For Scenario 2, LMMW-5S had an average groundwater elevation of 35.6 feet (NGVD 29), which is 4.6 feet below the maintained Pine Lake level. Scenario 2 has higher groundwater levels in LMMW-5S than Scenario 1. Proportional to Scenario 1, Scenario 2 requires about 66% of the pumping from the Stern Grove well to maintain lake levels in Pine Lake as was required for Scenario 1. Estimated water needed to maintain lake levels is 0.0028 mgd (3.2 afy) for Scenario 2.
- For Scenario 3a, LMMW-5S had an average groundwater elevation of 20.7 feet (NGVD 29), which is 19.5 feet below the maintained Pine Lake level. Scenario 3a has lower groundwater levels in LMMW-5S than Scenario 1. Proportional to Scenario 1, Scenario 3a requires about 280% of the pumping from the Stern Grove well to maintain lake levels in Pine Lake as was required for Scenario 1. Estimated water needed to maintain lake levels is 0.0120 mgd (13.5 afy) for Scenario 3a.

- For Scenario 3b, LMMW-5S had an average groundwater elevation of 21.2 feet (NGVD 29), which is 19.0 feet below the maintained Pine Lake level. Scenario 3b has lower groundwater levels in LMMW-5S than Scenario 1. Proportional to Scenario 1, Scenario 3b requires about 270% of the pumping from the Stern Grove well to maintain lake levels in Pine Lake as was required for Scenario 1. Estimated water needed to maintain lake levels is 0.0117 mgd (13.1 afy) for Scenario 3b.
- For Scenario 4, LMMW-5S had an average groundwater elevation of 26.5 feet (NGVD 29) which is 13.7 feet below the maintained Pine Lake level. Scenario 4 has higher groundwater levels in LMMW-5S than Scenario 1. Proportional to Scenario 1, Scenario 4 requires about 200% of the pumping from the Stern Grove well to maintain lake levels in Pine Lake as was required for Scenario 1. Estimated water needed to maintain lake levels is 0.0085 mgd (9.5 afy) for Scenario 4.

Based on this analysis, the pumping assumptions used for the MODFLOW model for the Stern Grove Well are appropriate and conservative with respect to the volume of water needed to maintain lake levels at Pine Lake. The Stern Grove well is currently, and will continue to be, dedicated to maintaining the design water level in Pine Lake using groundwater pumped from the Primary Production Aquifer.

5.4. Groundwater Model Results

The Westside Basin Groundwater-Flow Model does not simulate Pine Lake as a discrete lake feature, nor does it explicitly account for the addition of groundwater pumped from the Stern Grove well to Pine Lake (HydroFocus, 2007, 2009, 2011). As discussed in Section 5.3, additional pumping from the Stern Grove well to maintain the Pine Lake water level is incorporated into the model assumptions. The Groundwater Model does simulate changes in the groundwater levels in the Shallow Aquifer beneath Pine Lake based on the effects of the GSR and SFGW Projects; however, it does not have the ability to simulate groundwater levels in the shallowest sediments (monitored by LMMW-5SS) which have been shown to be in good hydraulic communication with Pine Lake (Section 5.2). Consequently, the model cannot be used to evaluate specific changes in water levels in Pine Lake, or in seepage of lake water to the Shallow Aquifer, that might result from SFGW Project implementation.

However, it was possible to use the simulated groundwater levels for LMMW-5S to evaluate the general changes in groundwater conditions in the Shallow Aquifer during the simulation. Figure 10.2-15 shows hydrographs for the LMMW-5S location in Model Layer 1 for all five modeled scenarios. The upper figure pane shows absolute simulated groundwater levels (absolute hydrographs), whereas the lower pane depicts groundwater levels relative to Scenario 1 (relative hydrographs).

The relative hydrograph for Scenario 2 shows a general increase in groundwater levels of up to several feet at the LMMW-5S location over those of Scenario 1, until near the very end of the simulation period, when there is a very slight reduction below Scenario 1 levels after the Design Drought period. The absence of any extended periods of reduced groundwater levels illustrates that there is anticipated to be little to no effect of GSR Project pumping on groundwater levels in the Shallow Aquifer (Model Layer 1) in the portion of the Westside Basin near Pine Lake.

Implementation of the SFGW Project (Scenarios 3a and 3b) is expected to result in a relative decline in Shallow Aquifer groundwater levels near Pine Lake of about 15 to 16 feet by the end of the simulation period. For Scenario 4, the Shallow Aquifer relative decline is about 10 feet by the end of the simulation period. The higher groundwater levels under Scenario 4 than in Scenarios 3a and 3b represent the effects of the GSR Project in-lieu recharge operations in addition to increased groundwater recharge resulting from additions to Lake Merced from the Daly City Vista Grande Drainage Basin Improvements Project.

The lower groundwater levels simulated in the Shallow Aquifer during Scenarios 3a, 3b, and 4 are expected to increase the leakage rate from the shallowest sediments surrounding Pine Lake, but this would potentially be offset by the possible geologic control that limits the connection between the lake and the Shallow Aquifer (Section 5.2). Therefore, addition of groundwater from the Stern Grove well to Pine Lake is anticipated to successfully maintain water levels in Pine Lake at the desired lake level during operation of the SFGW Project and under the Cumulative Scenario.

5.5. Summary

Under the conceptual model for Pine Lake, inflows are primarily precipitation, stormwater runoff, and additions to the lake from the Stern Grove well. Outflows are primarily evapotranspiration and groundwater outflow. The nature of the interactions between the lake and the connected aquifer is principally outflow from the lake to the aquifer, as maintained lake levels are typically higher than groundwater levels. As discussed above, Pine Lake shows strong hydraulic communication with the shallowest sediments (monitored by LMMW-5SS), but does not appear to be in direct hydraulic communication with the Shallow Aquifer (monitored by LMMW-5S). However, there is evidence of groundwater mounding in the Shallow Aquifer, indicating a steady, but rate-controlled, leakage of groundwater from Pine Lake to the Shallow Aquifer via the shallowest sediments.

For the SFGW-Only and Cumulative Scenarios (3a, 3b, and 4), groundwater levels in the Shallow Aquifer beneath Pine Lake are projected to decline by approximately 10 to 16 feet relative to Scenario 1 (see Figure 10.2-15). Based on the conceptual model, these projected declines in shallow groundwater levels are anticipated to have the potential to increase groundwater leakage from Pine Lake. However, levels in Pine Lake are already maintained by additions of groundwater from the Stern Grove well, and this well is expected to continue to be dedicated to maintaining the design water level in Pine Lake in the future.

Groundwater levels in the Shallow Aquifer for the GSR-Only Scenario (2) are projected to be similar to or slightly higher than under Existing Conditions (Scenario 1). Therefore, operation of the GSR Project is not expected to affect levels in Pine Lake, or to lead to any change in lake additions operations from the Stern Grove Well.

6. Golden Gate Park Lakes

Golden Gate Park (GGP) is located along the northernmost extent of the North Westside Basin (Figure 10.2-1). Located within GGP are twelve lakes or ponds: Stow Lake, Spreckels Lake, North Lake, Lily Pond, Lloyd Lake, Elk Glen Lake, Metson Lake, Mallard Lake, South Lake, Middle Lake, Alvord Lake and Rainbow Falls Bowl. The locations of these lakes are shown on Figure 10.2-3.

6.1. Physical Setting and Lake Conditions

The GGP lakes provide a multitude of benefits, including wildlife habitat, recreation, and ornamental purposes. The largest GGP lakes are Stow, Spreckels, and North lakes, with approximate surface areas of 13, 6, and 4 acres, respectively. The other lakes range from about 0.5 to 2 acres in area (SFRPD, 1994). Alvord Lake and Rainbow Falls Bowl are both very small, with paved bottoms and containing fountains or falls, and are more properly water features than lakes.

The GGP lakes are mostly manmade or, in some cases, were drastically altered from pre-existing natural conditions. Approximately 100 years ago the man-made GGP lakes were excavated into the existing shallow soils. Elk Glen, Middle, and North lakes are believed to have originally been natural groundwater-fed ponds that were deepened, whereas the other lake locations may or may not have coincided with pre-existing natural surface water features.

The GGP lakes, with the exception of Elk Glen Lake, were constructed to be very shallow, with original depths generally less than 5 feet. As sediment has accumulated on their bottoms, the GGP lakes have become even shallower, on average by about 1 foot by 1994 (although the north portion of North Lake was deepened in 1990 to about 9 to 10 feet). The shallow GGP lakes are very susceptible to excessive algal growths that have substantial negative impacts on lake water quality (SFRPD, 1994).

It was recognized prior to construction that, with groundwater levels below the bottoms of the lakes, the lakes would likely go dry due to leakage to the aquifer. To minimize this potential leakage, most of the lakes were constructed with bottoms of gravelly clay. Lily Pond did not require this addition of material because it was an old shale quarry, and therefore possessed a natural gravelly clay bottom that already minimized leakage. The three lakes that were originally natural groundwater-fed ponds (Elk Glen, Middle, and North lakes) have been confirmed to be unlined.

A 1994 study determined that most of the GGP lakes, even those lined with clay material, do leak appreciable amounts of water. In 1994 it was estimated that the combined leakage from all of the GGP lakes was about 0.5 million gallons per day, with about 77% of the leakage occurring from the 3 unlined lakes. Some of the water lost from the GGP lakes is periodically made up by additions of groundwater pumped from wells located in GGP (SFRPD, 1994), while the rest is replenished by surface water flows (precipitation-derived runoff).

6.2. Groundwater Conditions in Golden Gate Park

Golden Gate Park is located in the northernmost part of the North Westside Basin, approximately 3 miles north of the Lake Merced area. The geology and hydrogeology of this area are somewhat different than near Lake Merced and Pine Lake. In this area, the bedrock surface slopes downward to the southwest from surface exposures in the east, and geophysical data indicate the presence of a buried bedrock valley beneath GGP. Additional discussion on the geology is presented in TM#1 (LSCE, 2010). The total thickness of sedimentary deposits on top of the bedrock thins from south to north in the North Westside Basin, from about 600 feet beneath Lake Merced to 400 feet beneath GGP (Figure 10.2-4). The “W-clay”, which forms the bottom of the Primary Production Aquifer throughout most of the basin, pinches out near the Ortega monitoring well cluster, and does not appear to exist north of this point (Figure 10.2-4). Similarly, the prominent shallower clay units present in the Lake Merced area, such as the -100-foot clay and the X-clay units, also appear to thin and pinch out near the Kirkham monitoring well cluster, just south of GGP (LSCE, 2010).

Because the -100-foot clay is not present in the GGP area, the Shallow Aquifer (as defined to the south) is not present in the GGP area. However, groundwater elevations measured in shallow wells located in GGP are typically several feet above the elevations recorded in wells screened deeper. This relationship indicates a downward vertical gradient, which implies downward vertical groundwater flow, similar to conditions seen in the Lake Merced area, where the Shallow Aquifer is prominently defined. In the GGP area, the horizontal component of groundwater flow in both the shallower and deeper portions of the Primary Production Aquifer is mostly due west, with a slight northwesterly component in some areas (SFPUC, 2009b).

Historic groundwater levels measured in wells located in GGP indicate that the groundwater surface (water table) throughout most of the park ranges from approximately 40 to 60 feet bgs, except in the western quarter of GGP, where the ground surface elevation drops fairly rapidly towards the Pacific Coast (HydroFocus 2009). At the Alvord-PW well location in the southeast corner of GGP, groundwater depths are typically about 40 to 60 feet bgs. To the west, at the Arboretum-4 well location, groundwater depths usually range from 40 to 50 feet bgs. In the central portion of GGP, near Elk Glen Lake, groundwater depths measured in the shallow USGS Elk Glen monitoring well range from about 40 to 45 feet bgs. Only at the far western edge of the GGP, right along the coast, do groundwater depths become shallower; the depth to groundwater is typically about 14 to 15 feet bgs. Additional information on groundwater levels is provided in TM-10.1, TM-10.4 and TM#1.

The average depths to groundwater within GGP noted above imply that the GGP lakes do not intersect the water table (unlike Lake Merced and Pine Lake to the south), and thus GW/SW interaction does not affect conditions in the GGP lakes. With few exceptions, the GGP lakes are very shallow, with present average depths on the order of only about 2 to 4 feet; even Elk Glen Lake, which is the deepest, is on average only about 6 feet deep. With average depths to groundwater in GGP of about 40 to 60 feet bgs, the GGP lakes are hydraulically separated from the water table.

Note that aquifer recharge provided by leakage from the GGP lakes is not considered a GW/SW interaction. The effect is only in one direction, because the water table is too far below the lake bottoms for changes in groundwater levels to affect lake levels. The water table beneath a particular lake might show evidence of mounding if the volume of seepage from the overlying lake is sufficiently high, but even then the water table remains well below the lake bottom. With implementation of the SFGW and GSR Projects, the GGP lakes are expected to continue to recharge the aquifer at the same rate because they would continue to be filled as before.

6.3. Managed Lake Levels

Some of the water lost to leakage from the GGP lakes is made up by additions from groundwater supply wells located within GGP. These wells, which are operated and maintained by SFRPD, are located east of Elk Glen Lake, at North Lake, and at the South Windmill location. Stow Lake, Elk Glen Lake, and South Lake receive water from these wells on a regular basis. The other lakes periodically receive make-up water from groundwater sources when operating engineers redirect discharges to them (SFRPD, 1994).

Historically, groundwater pumping information for the GGP wells was not maintained. However, in 2005 meters were installed in all three GGP production wells to quantify the amount of groundwater pumping in the park. In 2007, approximately 830 acre-feet of groundwater were pumped from the wells. In 2008 this amount increased to approximately 1,300 acre-feet of water (LSCE, 2010). A portion of this groundwater pumping is diverted into the Golden Gate Park lakes.

It has been recognized that water leakage from the GGP lakes recharges the underlying aquifer system. Because the water used to supplement the GGP lakes is obtained from this same aquifer system, most of the leakage from the GGP lakes is viewed as not being lost, but is instead largely considered to be circulated between the surface water and groundwater systems. The Westside Basin Groundwater-Flow Model assumes approximately 627 afy of groundwater recharge resulting from seepage from the lakes to the underlying aquifer; this rate is based on the results of a seepage investigation of the GGP lakes conducted by the San Francisco Department of Public Works (SFRPD, 1994).

6.4. Summary

The average depths to groundwater within GGP indicate that, unlike Lake Merced and Pine Lake to the south, the shallow GGP lakes do not intersect the water table and thus GW/SW interaction does not affect surface water conditions in the GGP lakes. As shown previously for other locations in the North Westside Basin, long-term operation of the GSR and SFGW Projects is expected to result in net decreases in groundwater levels in this area. This is particularly the case for the SFGW Project because the Project wells are to be installed within the North Westside Basin. Declining groundwater levels caused by operation of the SFGW wells would further reduce the likelihood of GW/SW interaction between the aquifer and the GGP lakes. Consequently, it is not expected that operation of either the SFGW Project, GSR Project, or the Cumulative Scenario would affect existing water level conditions within the GGP lakes.

7. Colma, San Bruno, and Millbrae Creeks

Three principal streams, along with their tributaries, exist in the South Westside Basin: Colma Creek, San Bruno Creek, and Millbrae Creek. Colma Creek is located in the central and southern portions of the South Westside Basin, originating near San Bruno Mountain and extending southwest and then southeast through South San Francisco before discharging into the Bay just north of the San Francisco International Airport. San Bruno Creek flows from the uplands along the west side of the Basin, and also discharges to the Bay at a location just south of the Colma Creek discharge. Millbrae Creek is in the southernmost part of the Basin, with its headwaters also located in the western uplands and with a discharge to the Bay south of the San Francisco International Airport (Figure 10.2-1).

7.1. Physical Setting and Stream Conditions

As is typical of surface water features located in heavily urbanized areas, much of the stream reaches of Colma Creek, San Bruno Creek, and Millbrae Creek have been channelized, buried, and/or lined with impervious materials. Almost the entire Colma Creek watershed is located within the Colma Creek Flood Control Zone, which was created in 1964 to construct flood control facilities in the creek to alleviate flooding in South San Francisco. Except for its upper reaches on San Bruno Mountain, all of historic Colma Creek and its tributaries have been diverted into engineered channels or underground storm drains. Similar alterations have also been made to San Bruno Creek and Millbrae Creek (Oakland Museum, 2010). These modifications have resulted in major changes to the natural hydrologic and ecologic processes that previously existed.

Colma Creek sometimes runs dry, believed to result at least in part from excessive groundwater use by non-native vegetation (e.g., eucalyptus trees) present in the headwaters of the Creek. In the upper reaches of Colma Creek, a headwaters restoration project is underway in which the non-native vegetation is being eradicated to both restore natural habitat and improve groundwater conditions (Cannon and Heath, 2005). In the lower Colma Creek watershed, along the mouth of the creek where it enters the San Francisco Bay, a habitat mitigation project is ongoing in which wetlands and native upland habitat are being constructed to restore features that were lost during construction of flood control facilities in the area.

7.2. Groundwater Conditions

In the portion of the South Westside Basin where Colma Creek is located (except for the eastern area closer to the Bay), the depth to groundwater ranges from many tens to hundreds of feet bgs, due to drawdown of the water table caused by intensive historic municipal pumping in the Daly City, South San Francisco, and San Bruno areas. Large production wells in these areas pump from the Primary Production and Deep Aquifers (the Shallow Aquifer is not present from the Daly City area southward).

Where the lower reaches of Colma Creek are located, in South San Francisco, the depth to groundwater is highly variable, depending largely on proximity to pumping wells and the depth of the aquifer being measured.

Where San Bruno and Millbrae Creeks are located, in South San Francisco and San Bruno, the groundwater in the Primary Production Aquifer is typically at elevations ranging from -100 to -200 feet (NGVD 29). However, in areas closer to the Bay, groundwater elevations are in the range of approximately 10 to -30 feet (NGVD 29), with the deeper levels corresponding to deeper monitoring wells.

7.3. Groundwater-Surface Water Interactions

Extensive modifications to Colma Creek, San Bruno Creek, and Millbrae Creek have effectively isolated almost all of the creek reaches from the underlying groundwater, precluding any substantial degree of GW/SW interaction with the creeks. Furthermore, groundwater beneath much of Colma Creek is far below ground surface, further reducing the likelihood of GW/SW interaction.

Even where groundwater levels are relatively shallow in the southernmost portion of the South Westside Basin, the heavy alteration of all three creeks (i.e., concrete lining) precludes exchanges between surface water and shallow groundwater.

Colma Creek is apparently in some degree of communication with shallow groundwater in its upper, least-altered reaches near San Bruno Mountain, because water use by stands of eucalyptus trees there is believed to deprive the Creek of some baseflow (Cannon and Heath, 2005). However, any shallow groundwater in this area exists in a highly localized system, far removed from the deeper groundwater of the Primary Production Aquifer, which exists at lower elevations in the Basin. Similar conditions are likely present for the unaltered upland portions of San Bruno Creek and Millbrae Creek.

7.4. Groundwater Model Results

The existence of thick deposits of low-permeability Bay Mud in San Bruno and portions of South San Francisco (Bay Plain area) also lessen the likelihood of GW/SW interaction in these areas (LSCE, 2010). The 2011 update to the Westside Basin Groundwater-Flow Model incorporated drain boundaries in Layer 1 of the Bay Plain area to simulate seepage to San Francisco Bay. Implementation of the drain boundaries reduced the occurrence of simulated water levels above land surface (i.e., flooding) in the Bay Plain area, but had minimal effect on simulated water levels further inland where the bulk of the major creek systems are located (HydroFocus, 2011).The simulated drainage averaged less than 120 afy, which is less than 1 percent of the volumetric budget. This equates to about 0.17 cubic feet per second (cfs) distributed among Colma, San Bruno, and Millbrae Creeks. The flow in these creeks is primarily stormwater runoff and other discharges. The total groundwater discharge is considered to be a very low percentage of the overall streamflow.

To evaluate the effects of the GSR and SFGW Projects on groundwater discharge to the creeks, the water balance for each scenario was evaluated using the data in TM10.1 Attachment TM 10.1-C. The discharge to the drains was limited to the South Westside Basin representing Colma, San Bruno and Millbrae Creeks. The average annual groundwater discharge to the creeks for Scenario 1 was 94 afy, or 0.13 cfs. For Scenarios 2 and 4, the average annual groundwater discharge to the creeks increased to 122 afy, or 0.17 cfs. This is similar to the results for the historical model (HydroFocus, 2011). For Scenarios 3a and 3b, the average annual groundwater discharge to the creeks was 93 afy, or 0.13 cfs. This is essentially the same as for Scenario 1. Based on the groundwater model results, there would be little to no change to groundwater discharge to Colma, San Bruno and Millbrae Creeks as a result of project operations.

7.5. Summary

Given the hydrogeologic conditions and substantial engineered modifications, it is unlikely that GW/SW interaction processes are present to any measureable extent for Colma, San Bruno, or Millbrae Creeks. Consequently, implementation of the SFGW Project, GSR Project, or the Cumulative Scenario is not expected to affect existing surface water conditions for Colma Creek, San Bruno Creek, or Millbrae Creek, or their respective tributaries.

8. Summary

The following discussion summarizes the results of the GW/SW interaction analysis for the principal surface water features identified in the Westside Groundwater Basin.

8.1. Lake Merced

Lake Merced is a freshwater lake located in the southwestern corner of San Francisco and is located within the North Westside Groundwater Basin, just north of the San Francisco County-San Mateo County line (Figures 10.2-1 and 10.2-2). Lake Merced consists of four inter-connected lakes - North Lake, South Lake, East Lake and Impound Lake (Figure 10.2-2).

This section summarizes the results of the evaluation based on the modeling analysis using the Lake-Level Model and the Westside Basin Groundwater-Flow Model.

Scenario 2 (GSR Project) generally results in higher lake levels than Scenario 1 for most of the simulation period. During the Design Drought (in which the extended period of pumping from SFPUC and PA wells occurs over the 7.5-year take period), the simulated Lake Merced levels are below those of Scenario 1 toward the end of the Design Drought period. The lowest lake level estimated under Scenario 2 is -2.5 feet (City Datum), which is similar to the lowest historical lake level of -3.2 (City Datum) experienced in 1993.

Scenarios 3a and 3b (SFGW Project) result in substantially lower lake levels for the entire simulation period relative to Scenario 1. Lake levels decline during the first approximately 15 years of operation of the SFGW Project. During the final approximately 30 years of the simulation, the lake levels are generally stable, remaining about 10 feet lower than the Existing Conditions Scenario. The simulated lake levels rise several feet compared to the Existing Conditions Scenario after the Design Drought period. The lowest lake levels for Scenarios 3a and 3b are about 7 feet lower than the lowest historical lake level experienced in 1993 of -3.2 feet (City Datum).

Scenario 4 (Cumulative Scenario) includes operation of the GSR and SFGW Projects using the assumptions for Scenario 2 and 3b. In addition, other reasonably foreseeable future projects such as the Daly City Vista Grande Drainage Area Improvements Project are included. This Project would augment Lake Merced with stormwater and baseflow from the Vista Grande Canal. The result of the Cumulative Scenario is that the simulated lake levels are similar to Scenario 1. They also tend to mimic the pattern from Scenario 2 (GSR Project) but at a lower elevation (by about 3 to 4 feet) as a result of SFGW Project pumping. The lowest lake level under Scenario 4 is -4.9 feet (City Datum), which is about 1.5 feet lower than the lowest historical lake level experienced in 1993.

8.2. Pine Lake

Pine Lake is a relatively shallow lake that is approximately 3 acres in area and located about 0.5 mile north-northeast of Lake Merced (Figures 10.2-1 and 10.2-2). The design water level elevation for Pine Lake is established at 40.2 feet (NGVD 1929, or 31.5 feet City Datum). Pine

Lake is already maintained by additions of groundwater from the Stern Grove well, and water additions from this well would continue to be necessary to maintain water levels in Pine Lake.

Pine Lake does not appear to be in direct hydraulic communication with the Shallow Aquifer. Rather, there is evidence of groundwater mounding in the Shallow Aquifer indicating a steady, but rate-controlled, leakage of groundwater from the shallowest sediments to the Shallow Aquifer.

For the SFGW Project and Cumulative Scenarios (Scenarios 3a, 3b and 4) groundwater levels in the Shallow Aquifer beneath Pine Lake are projected to decline by approximately 10 to 16 feet relative to the Existing Conditions (Scenario 1). However, based on the conceptual model, these projected declines in shallow groundwater levels are not considered to cause a substantial increase in groundwater leakage from Pine Lake. Therefore, proposed operations of the Stern Grove well are anticipated to maintain the design water level in Pine Lake.

Groundwater levels in the Shallow Aquifer for the GSR Project (Scenario 2) are projected to be similar to or slightly higher than the Existing Conditions. Therefore, operation of the GSR Project is not considered to affect water levels in Pine Lake or cause a change in lake additions from the Stern Grove Well during GSR Project operations.

8.3. Golden Gate Park Lakes

Golden Gate Park is located at the northernmost extent of the North Westside Basin (Figure 10.2-1). Twelve lakes or ponds -- Stow Lake, Spreckels Lake, North Lake, Lily Pond, Lloyd Lake, Elk Glen Lake, Metson Lake, Mallard Lake, South Lake, and Middle Lake, Alvord Lake and Rainbow Falls Bowl -- are located within Golden Gate Park (Figure 10.2-3).

The average depths to groundwater indicate that these shallow lakes do not intersect the water table and thus GW/SW interaction does not affect surface water conditions in the Golden Gate Park lakes. The operation of the GSR Project is not anticipated to affect this area; thus, no changes are anticipated for the Golden Gate Park lakes. The operation of the SFGW Project wells is expected to result in net groundwater decreases in this area. Declining groundwater levels caused by operation of the SFGW wells would further reduce the likelihood of GW/SW interaction processes occurring in the Golden Gate Park lakes. Consequently, it is not expected that operation of the SFGW Project, GSR Project, or the Cumulative Scenario will affect existing water level conditions within the Golden Gate Park lakes.

8.4. Colma, San Bruno, and Millbrae Creeks

Colma, San Bruno and Millbrae Creeks are located in the central and southern portions of the South Westside Basin (Figure 10.2-1). Given the hydrogeologic conditions and substantial engineered modifications made to Colma, San Bruno and Millbrae Creeks, it is unlikely that GW/SW interaction processes are present to any measureable extent for any of these creeks. The Westside Basin Groundwater-Flow Model showed no substantial effects of the operations of the GSR or SFGW Projects on the groundwater discharges to these creeks. Consequently, implementation of the SFGW Project, GSR Project, or the Cumulative Scenario is not anticipated to affect existing surface water conditions for Colma Creek, San Bruno Creek, or Millbrae Creek, or any of their respective tributaries.

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Figure List

Table List

Attachment List

Figures

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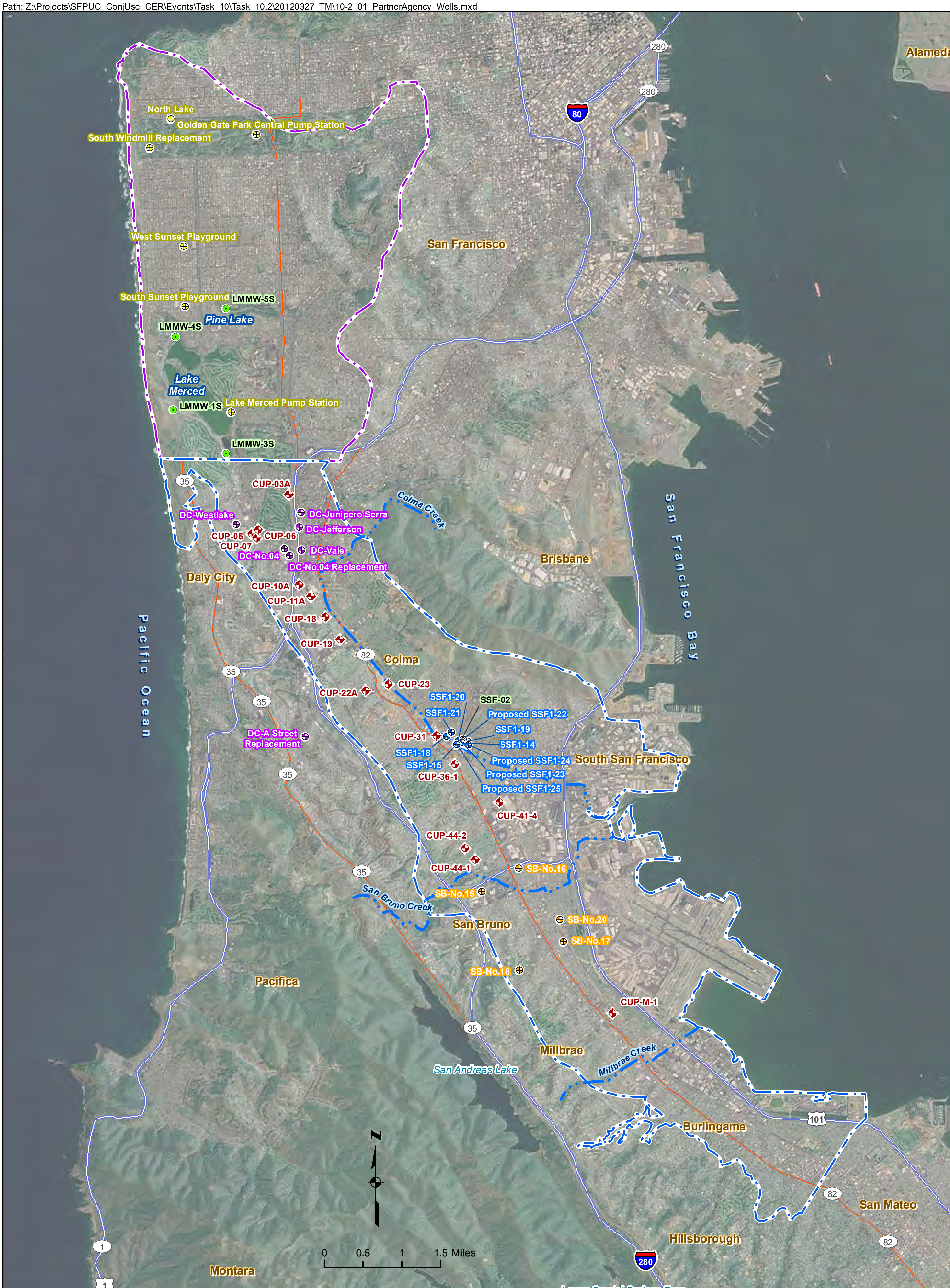

Aerial Photo Source: World Imagery from ESRI. Copyright:© 2009 ESRI, AND, TANA, UNEP-WCMC

Legend

- GSR Proposed Municipal Wells
- SFGW Proposed Municipal Wells
- Selected Representative Monitoring Wells
- Cal Water Municipal Wells
- Daly City Municipal Wells
- San Bruno Municipal Wells
- South Westside Groundwater Basin
- North Westside Groundwater Basin

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

LOCATIONS OF SURFACE WATER FEATURES, PROPOSED GSR AND SFGW PROJECT WELLS, AND MONITORING WELLS IN THE WESTSIDE GROUNDWATER BASIN

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303 Second Street, Suite 300 South
San Francisco, CA 94107

Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Figure **10.2-1**

Date May 2012

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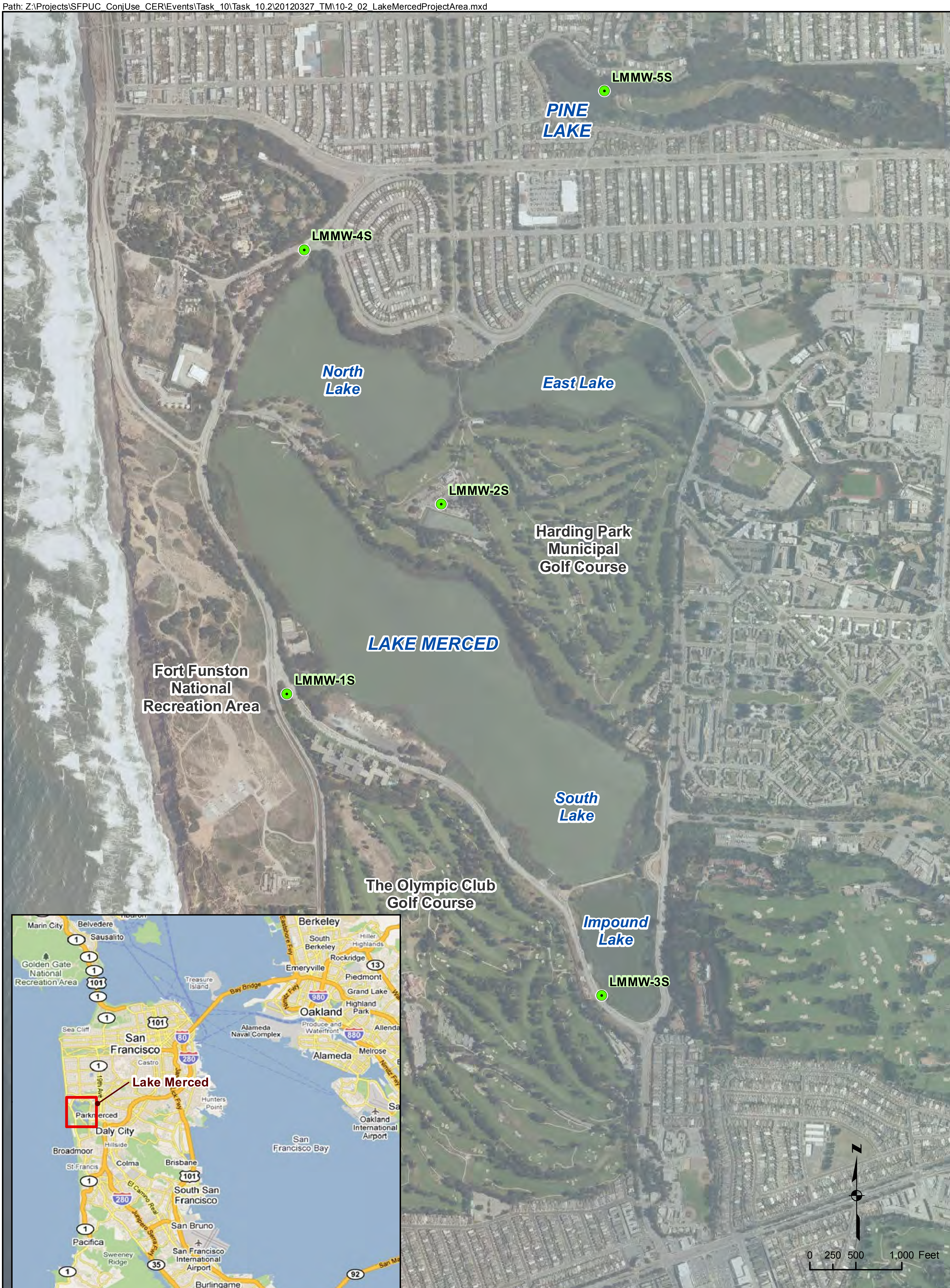

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Monitoring Wells in Lake Merced Area

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LAKE MERCED AND PINE LAKE

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San Francisco, CA 94107

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Figure **10.2-2**

Date May 2012

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Legend

North Westside Groundwater Basin

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ENGINEERING MANAGEMENT BUREAU

GOLDEN GATE PARK LAKES

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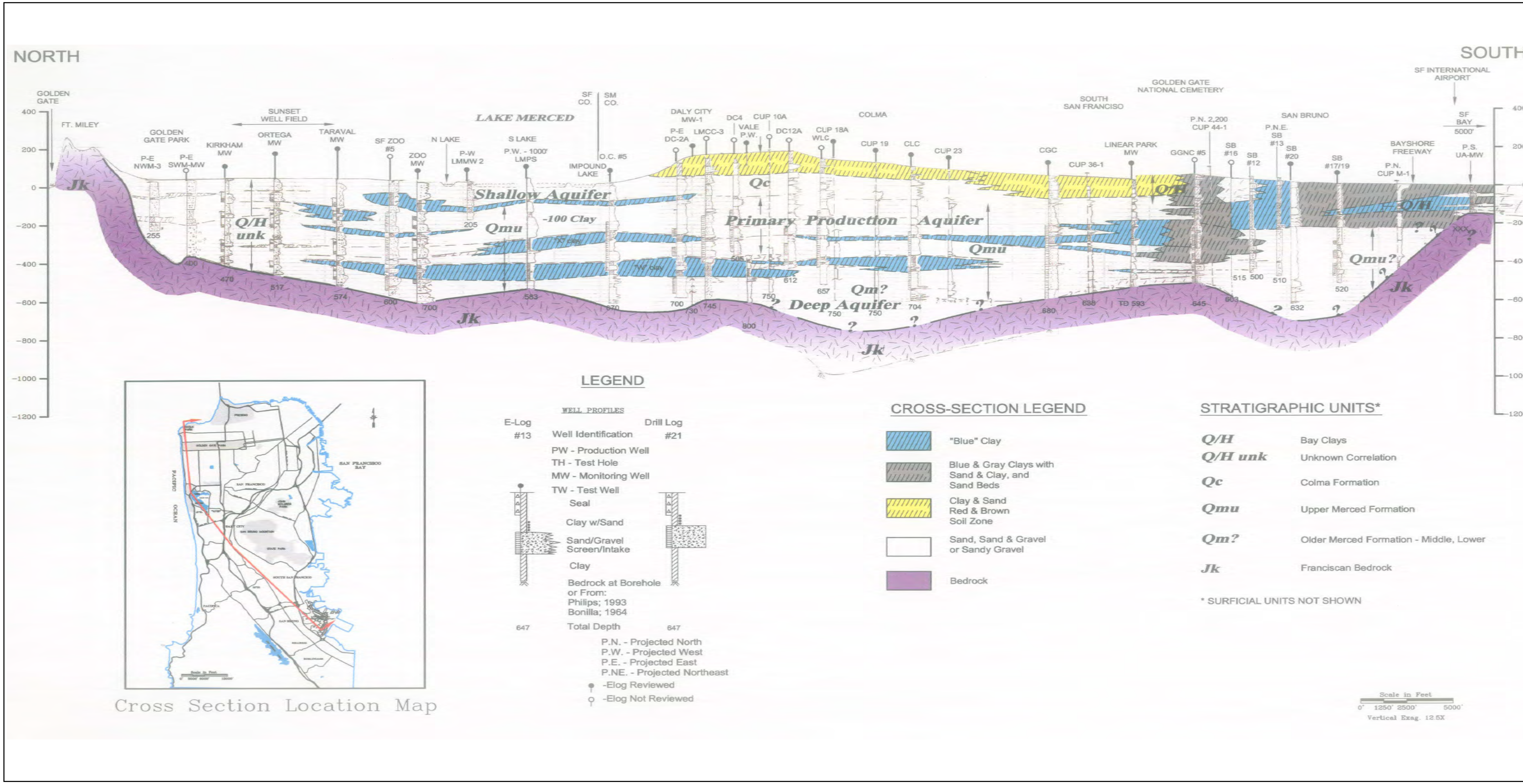
Figure
10.2-3

Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Date
May 2012



Source: Final Task 8B Technical Memorandum No.1, Hydrologic Setting of the Westside Basin, LSCE, May 2010.

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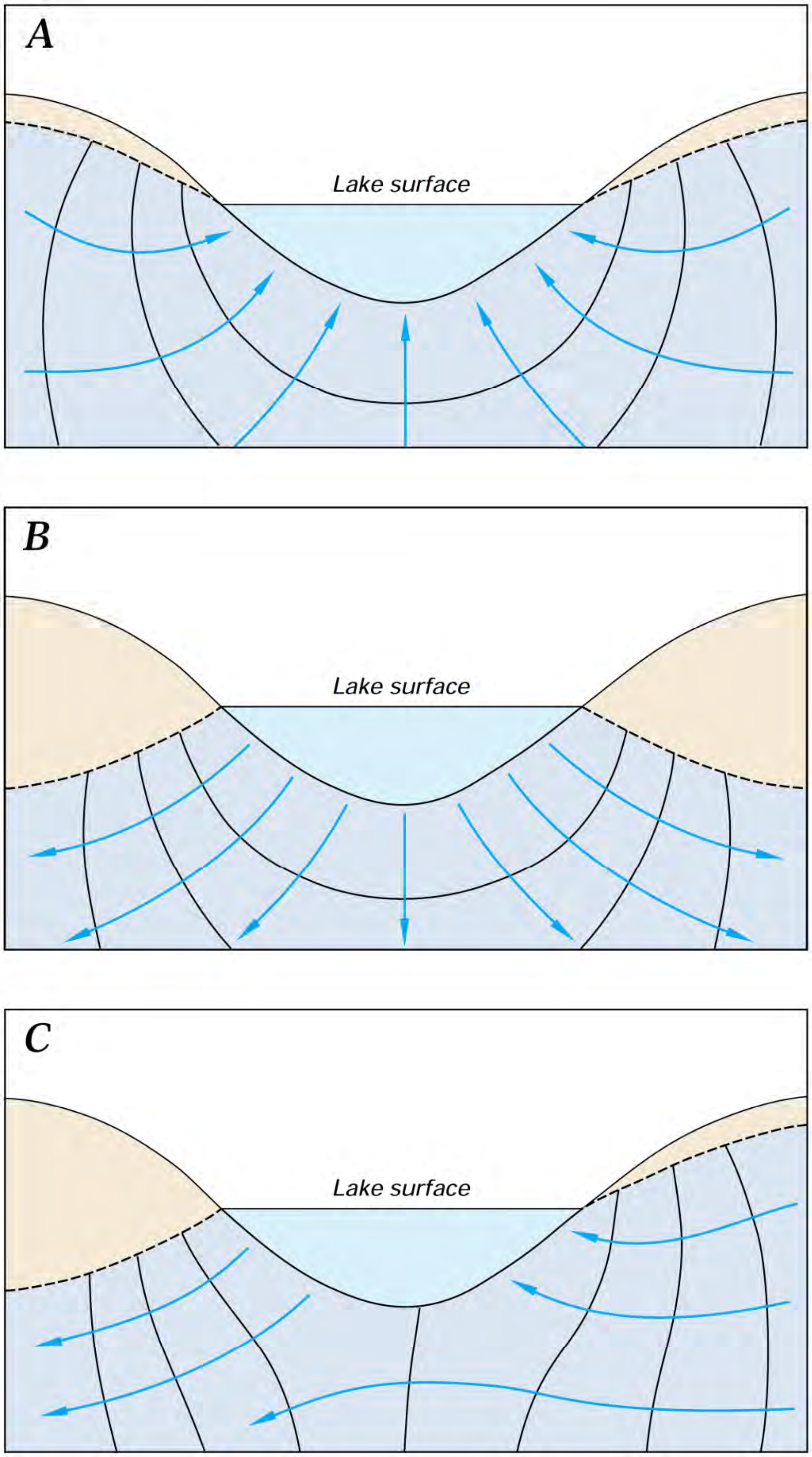
Westside Basin Regional Subsurface Hydrogeology

K/J 0864001
May 2012

Figure 10.2-4



Lakes can receive groundwater inflow (A), lose water as seepage to groundwater (B), or both (C). From Winter et al. (1998).

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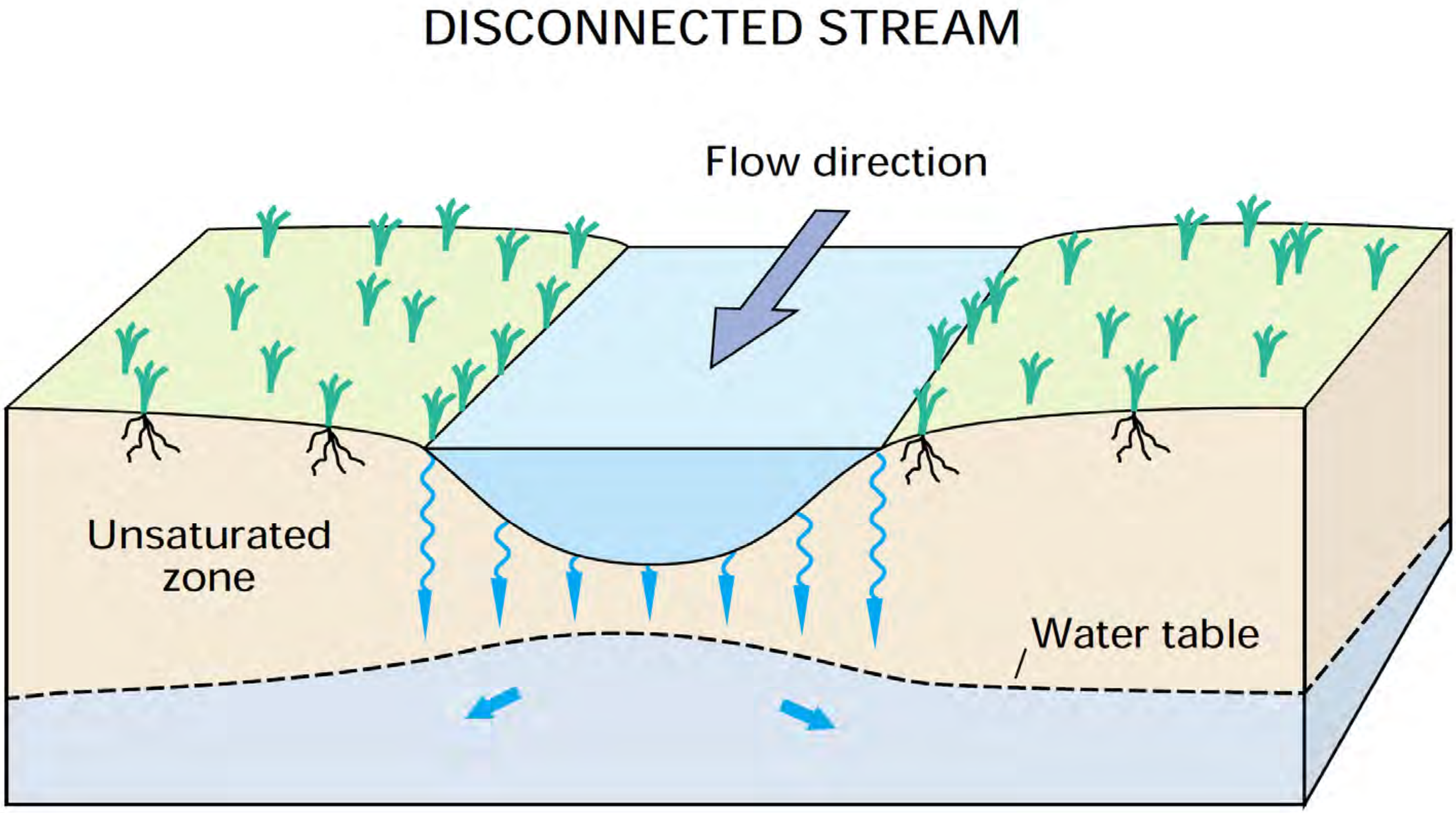
Interaction of Groundwater and Lakes

K/J 0864001
May 2012
Figure 10.2-5



Disconnected streams are separated from the groundwater system by an unsaturated zone. From Winter et al. (1998).

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Disconnected Streams

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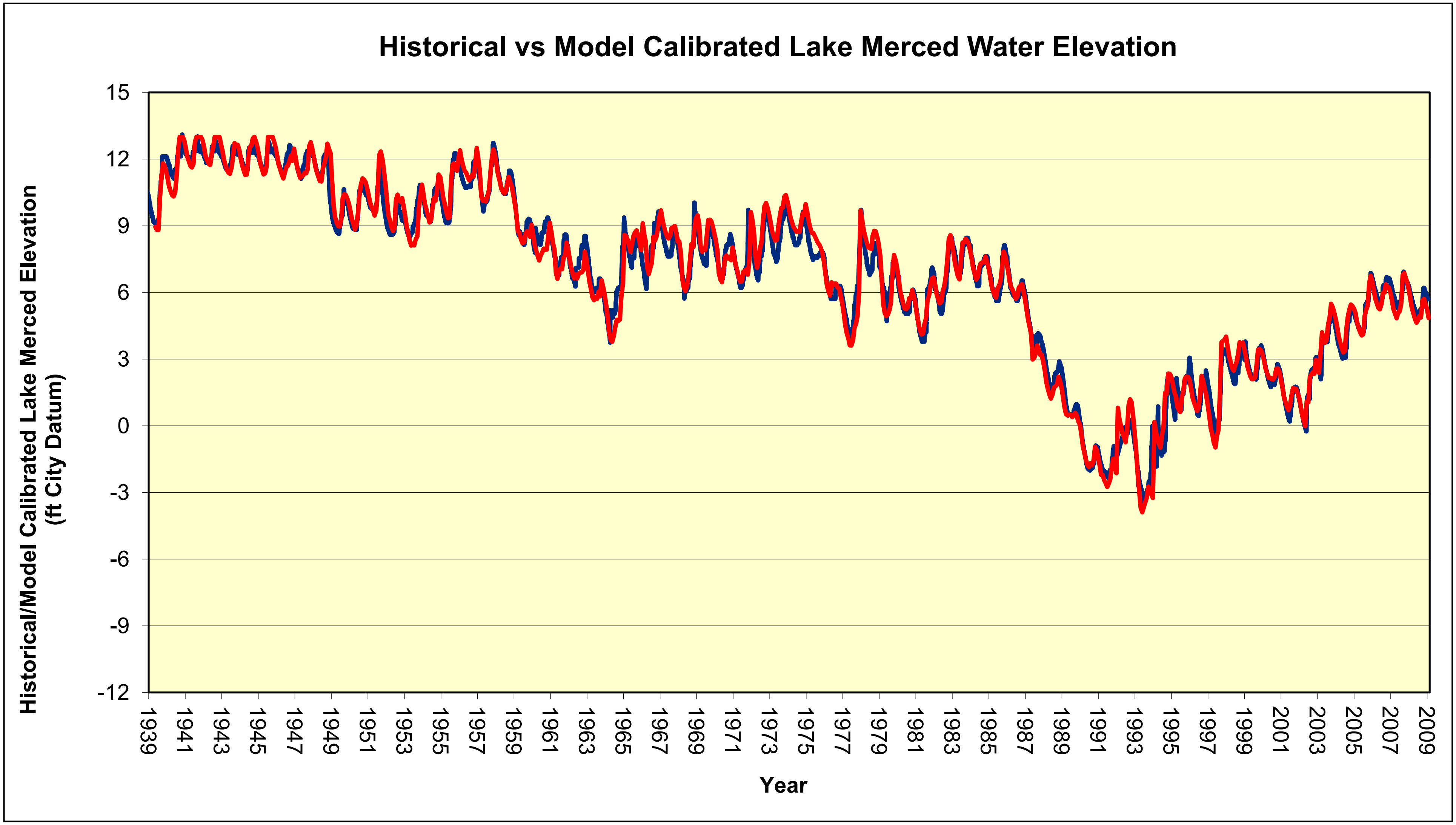
Figure 10.2-6



Source: Historical Lake Merced water elevation data from the San Francisco Public Utilities Commission
City Datum = NGVD - 8.62 feet

Legend

Historical Measured Lake Elevation (feet City Datum)

Model Calibrated Lake Elevation (feet City Datum)

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Historical Measured and Simulated Lake Merced Levels

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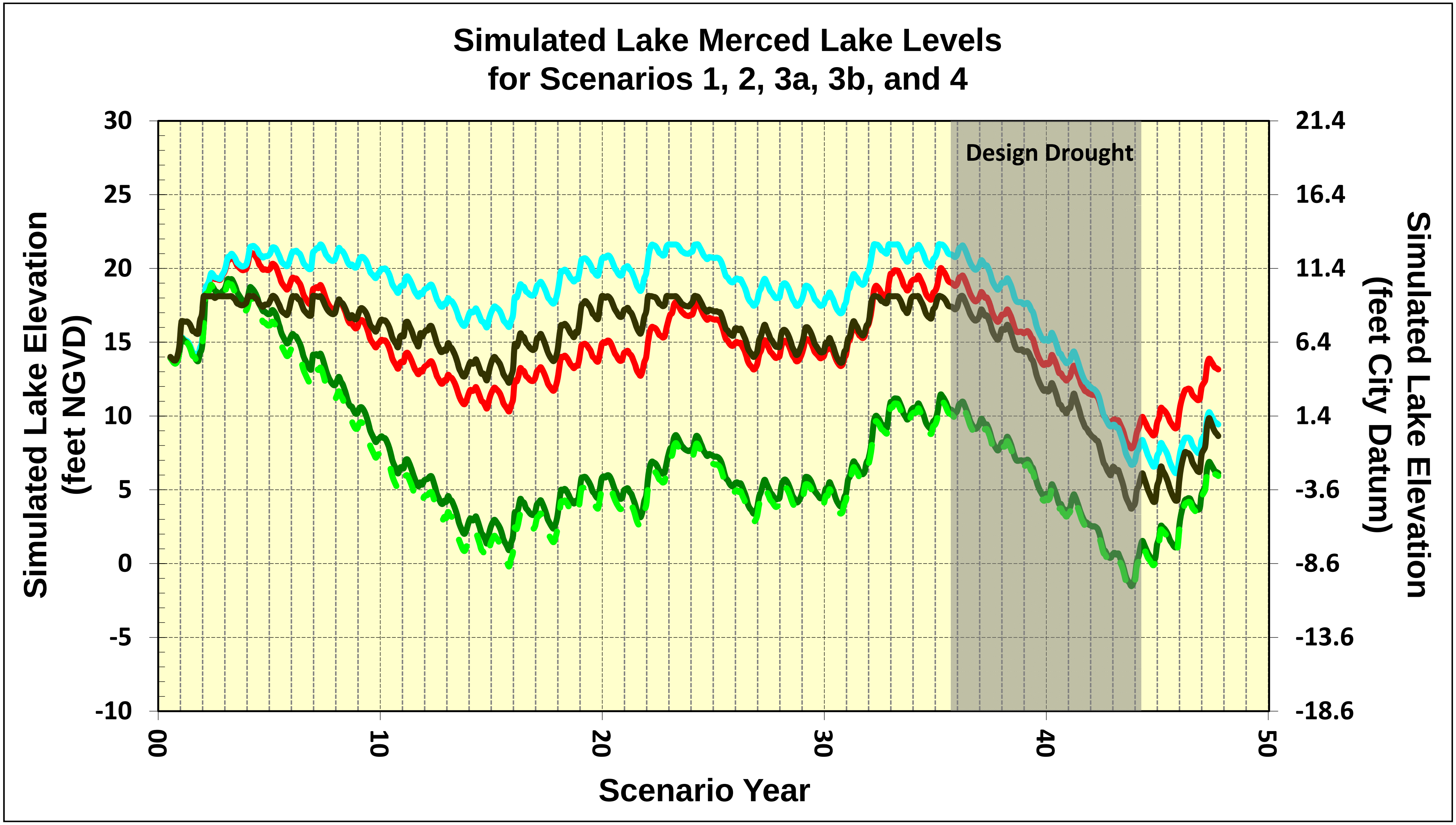
Figure 10.2-7



Note: Zero elevation NGVD is equivalent to mean sea level NGVD. City Datum = NGVD - 8.62 feet.

Lake Levels:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Simulated Lake Merced Lake-Level
Model Lake Levels

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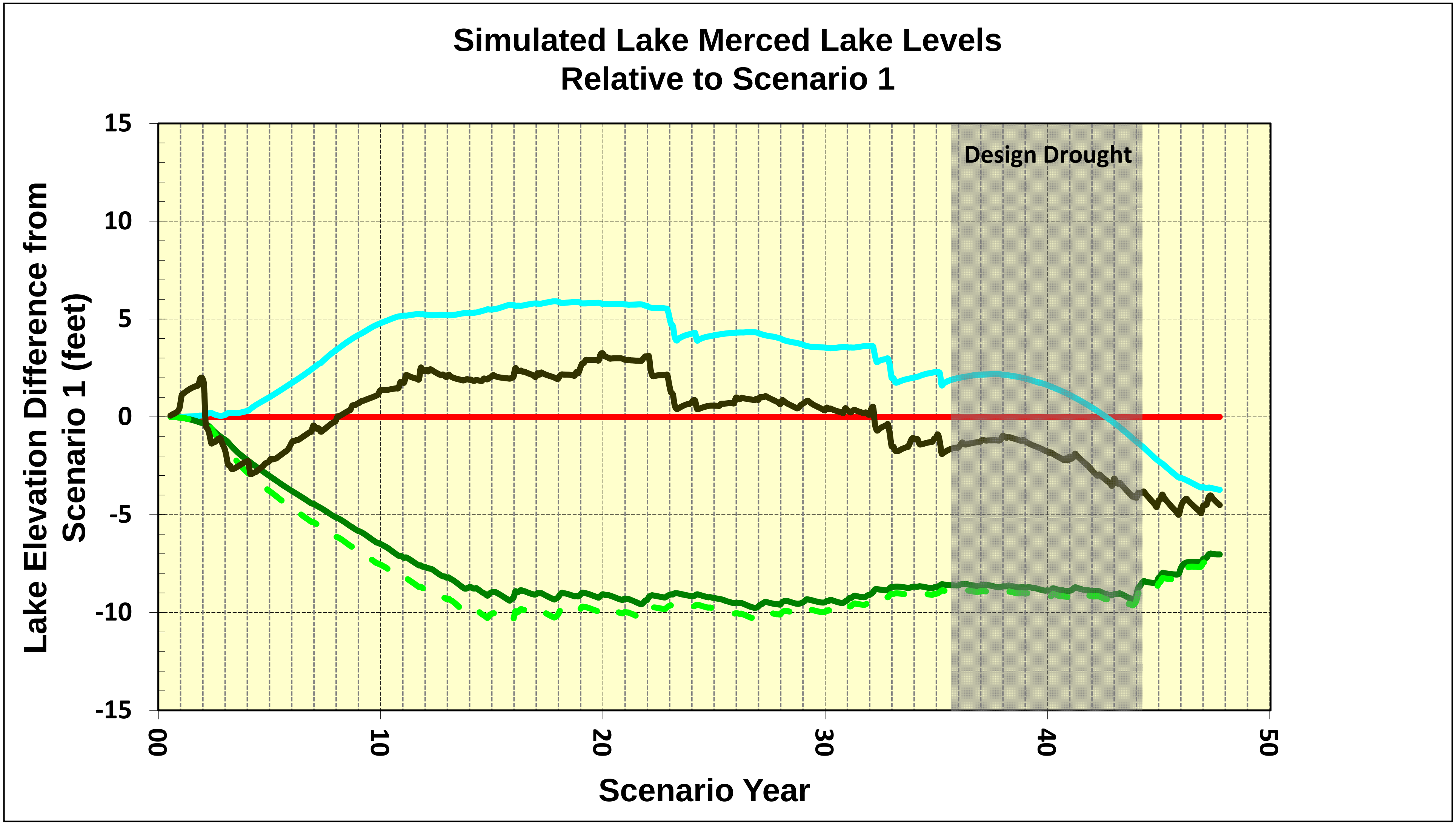
May 2012
Figure 10.2-8



Lake Levels:

Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

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Simulated Lake Merced Lake-Level Model Lake Levels Relative to Scenario 1

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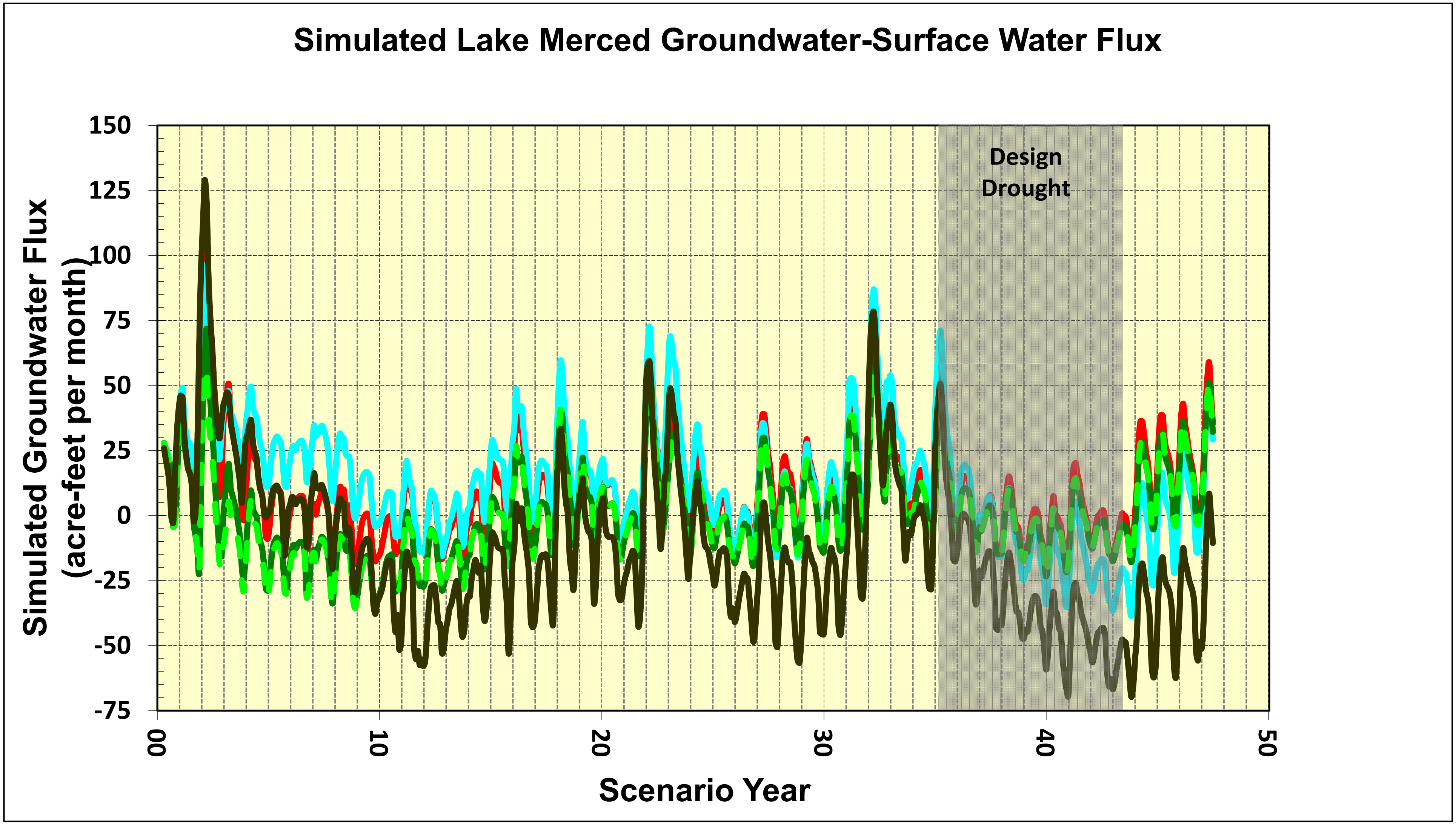
Figure 10.2-9



Model Flux:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Simulated Lake Merced Groundwater-Surface Water Flux

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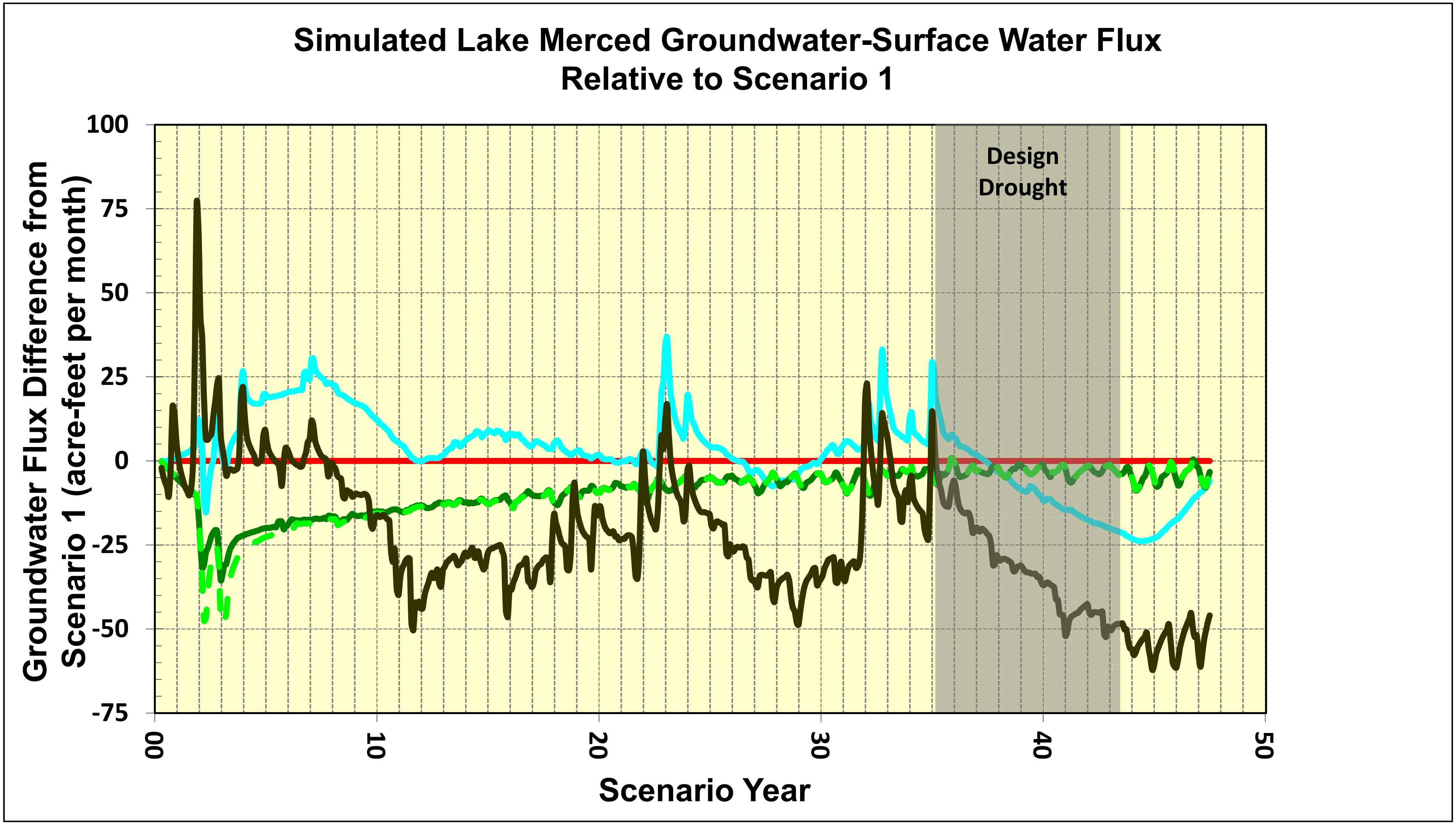
Figure 10.2-10a



Model Flux:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Simulated Lake Merced Groundwater-Surface Water Flux Relative to Scenario 1

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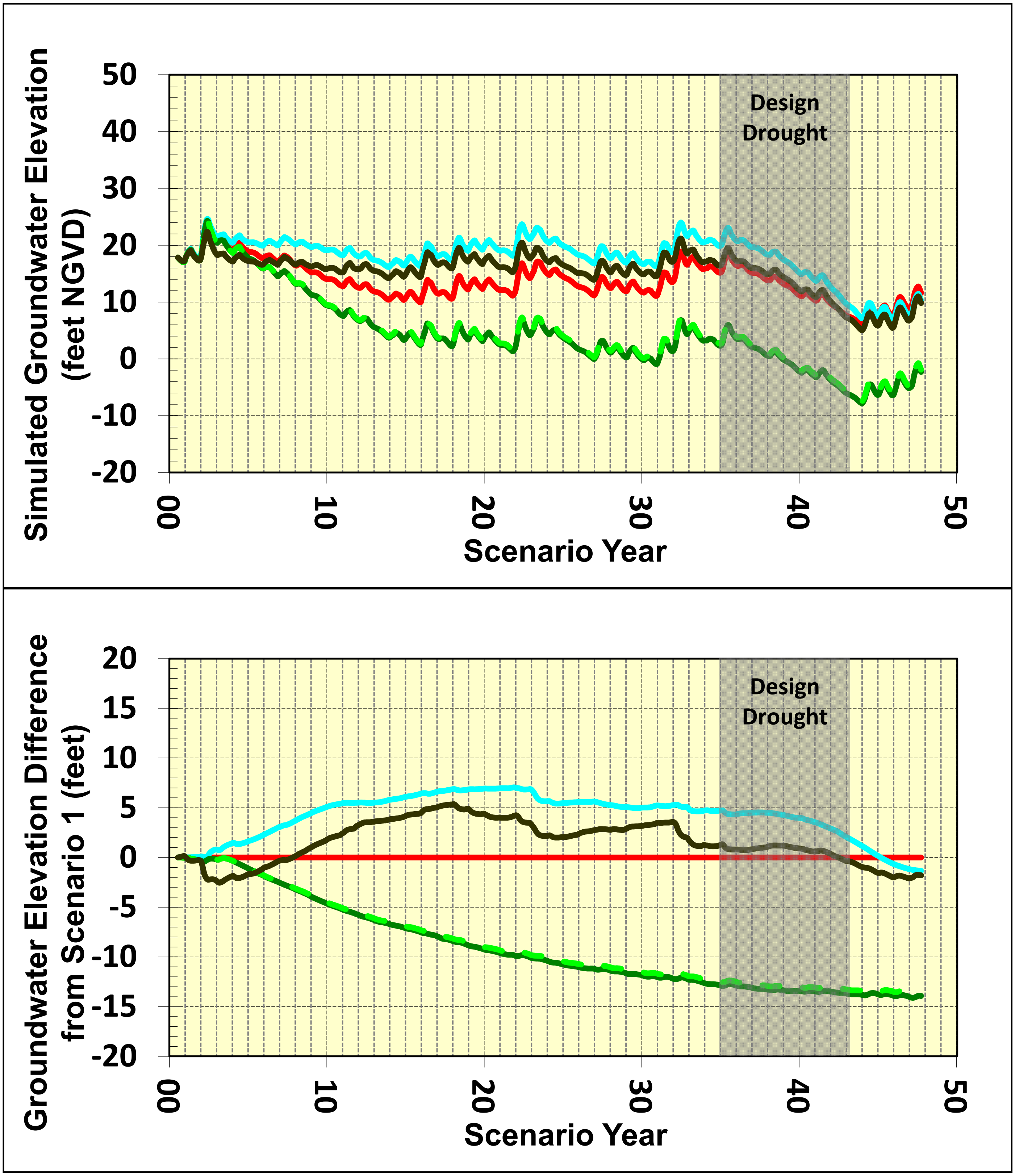
Figure 10.2-10b



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

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Model Layer 1 Hydrographs for LMMW-1

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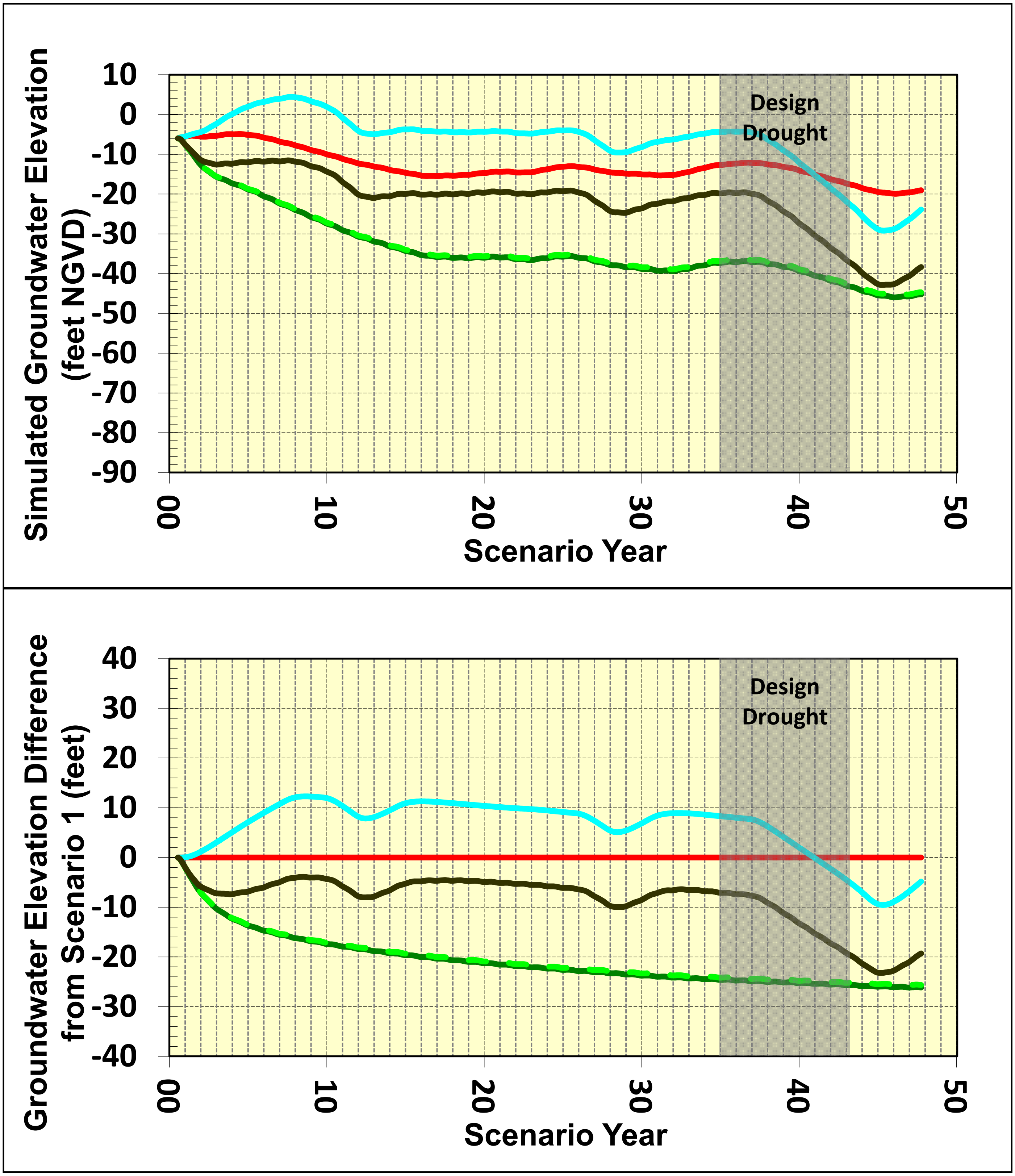
Figure 10.2-11a



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Model Layer 4 Hydrographs for LMMW-1

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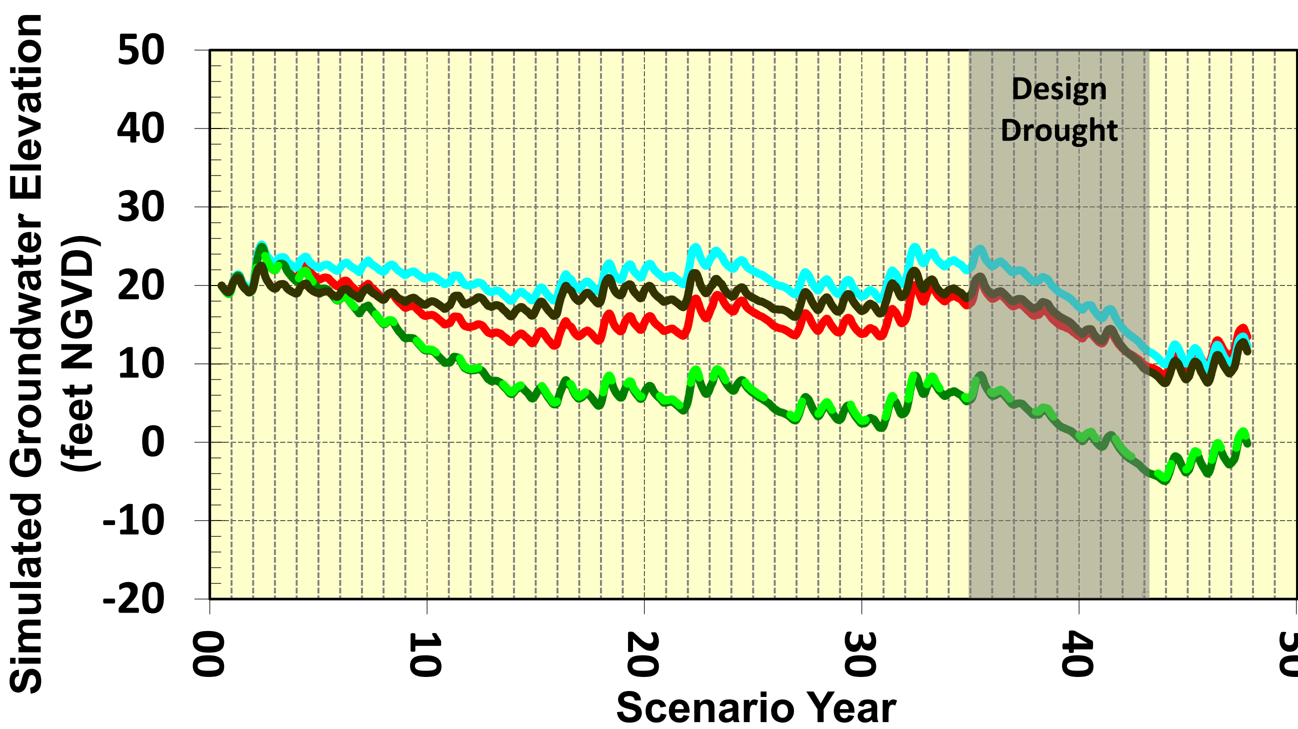
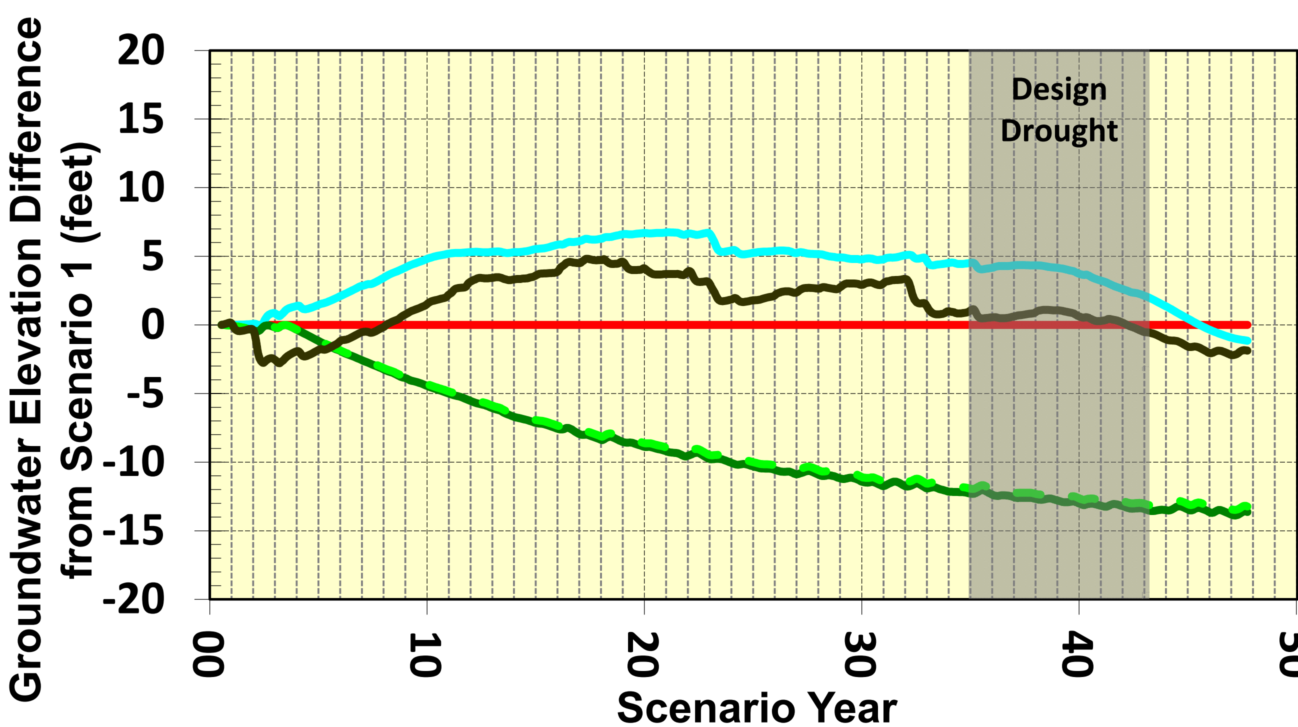
Figure 10.2-11b





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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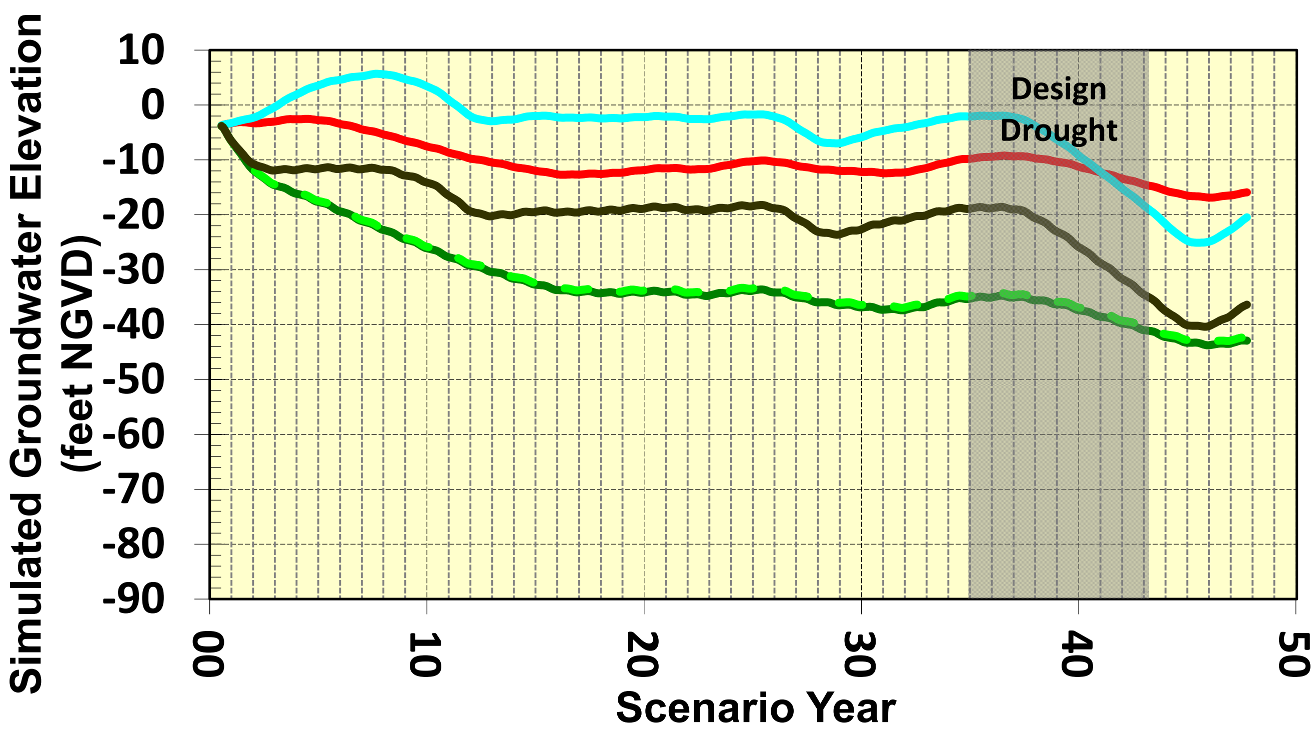
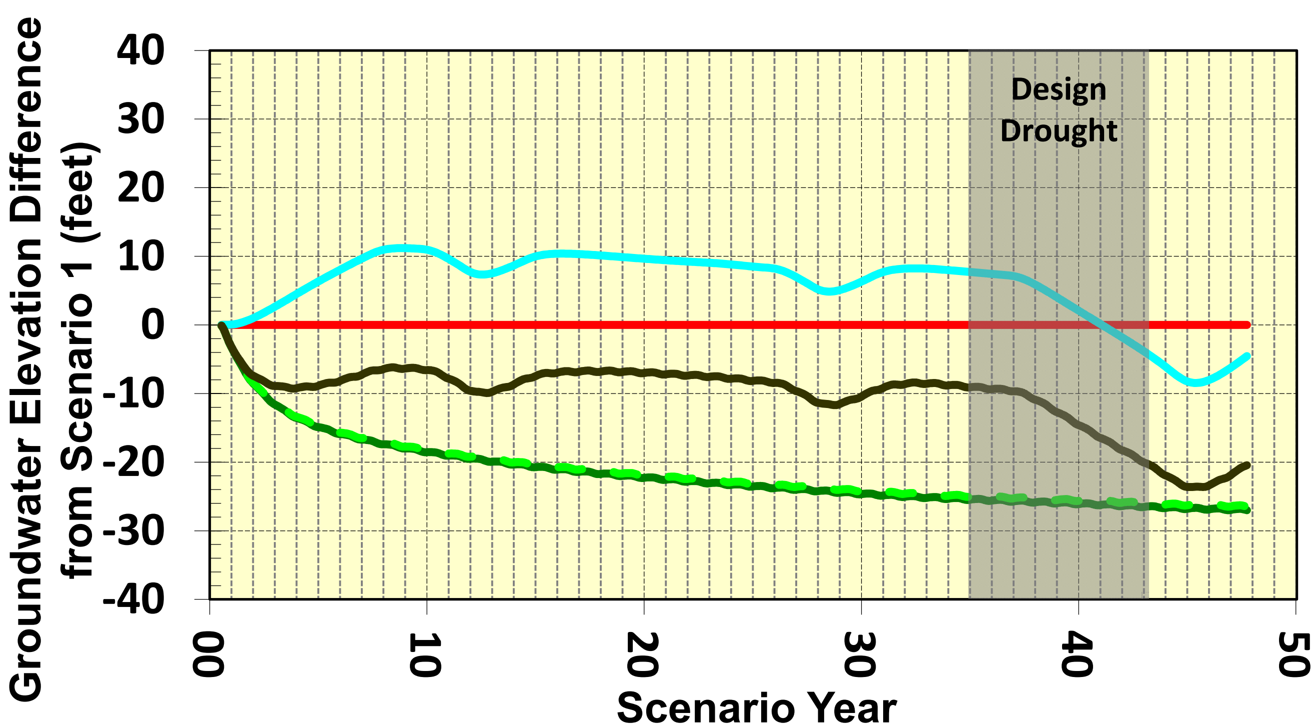
Model Layer 1 Hydrographs for LMMW-2

K/J 0864001
May 2012
Figure 10.2-12a





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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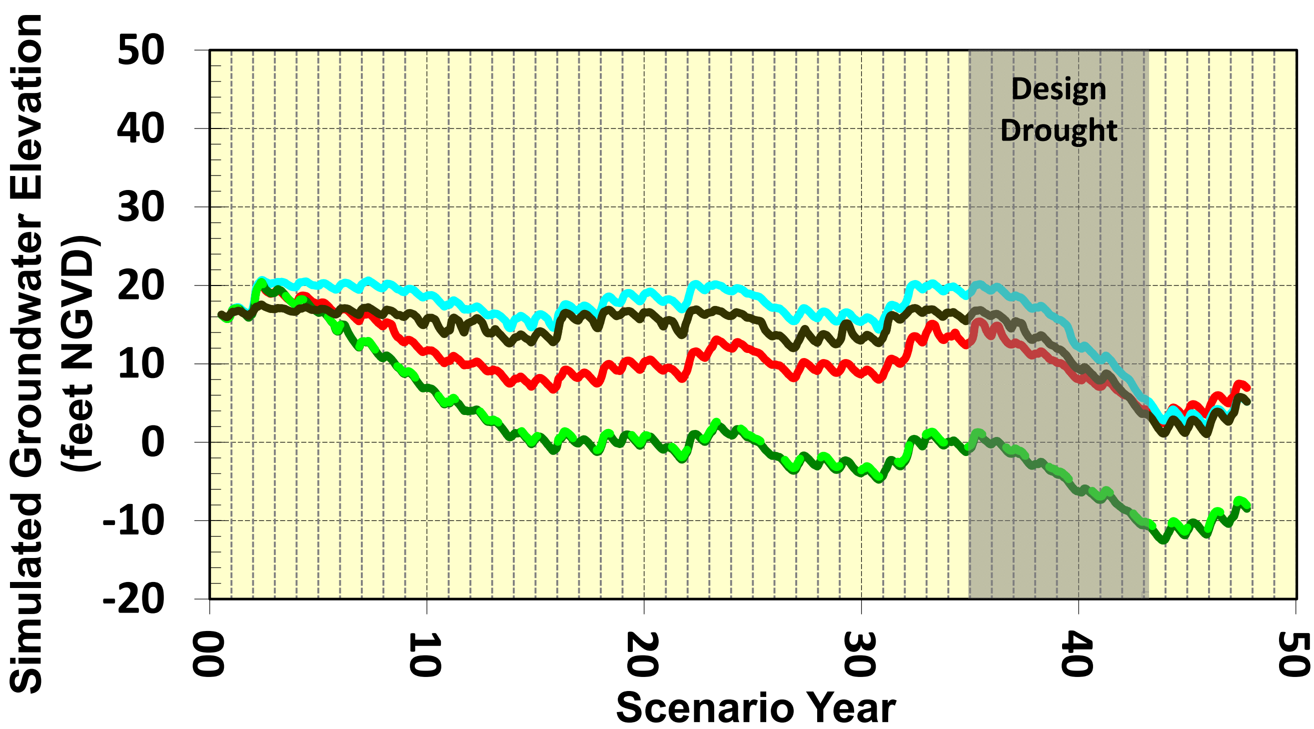
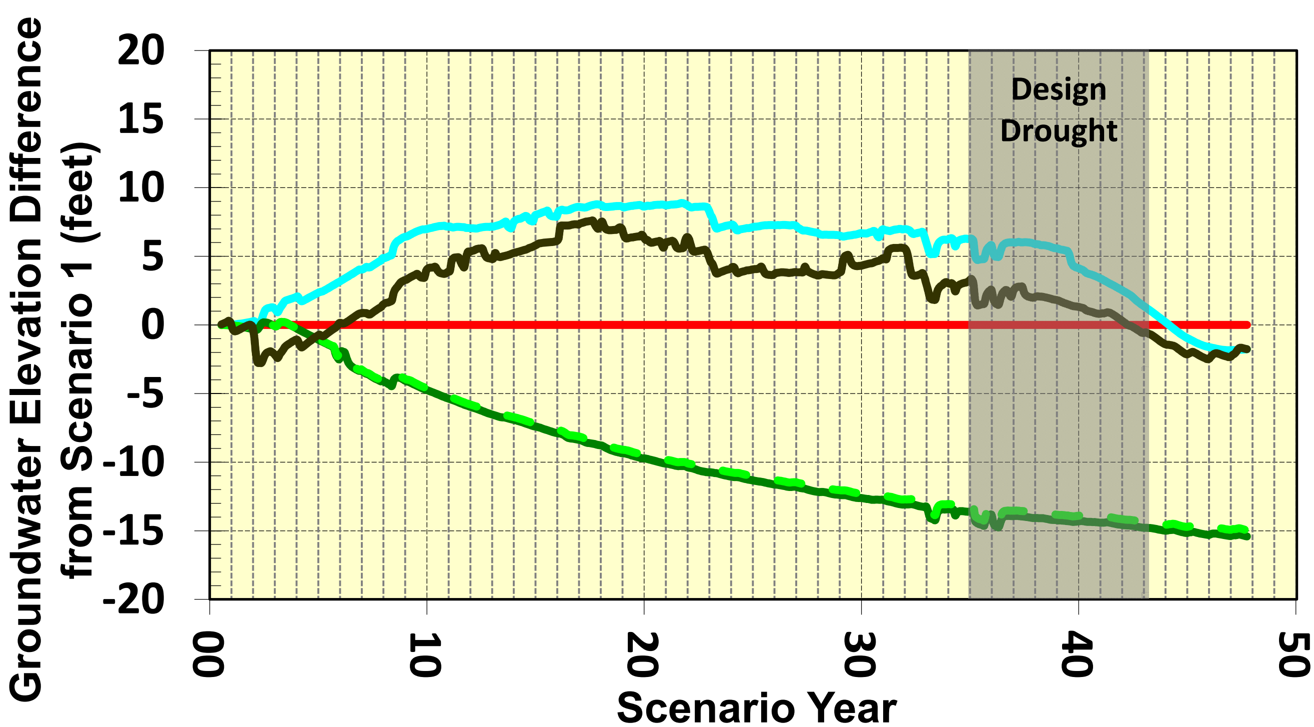
Model Layer 4 Hydrographs for LMMW-2

K/J 0864001
May 2012
Figure 10.2-12b





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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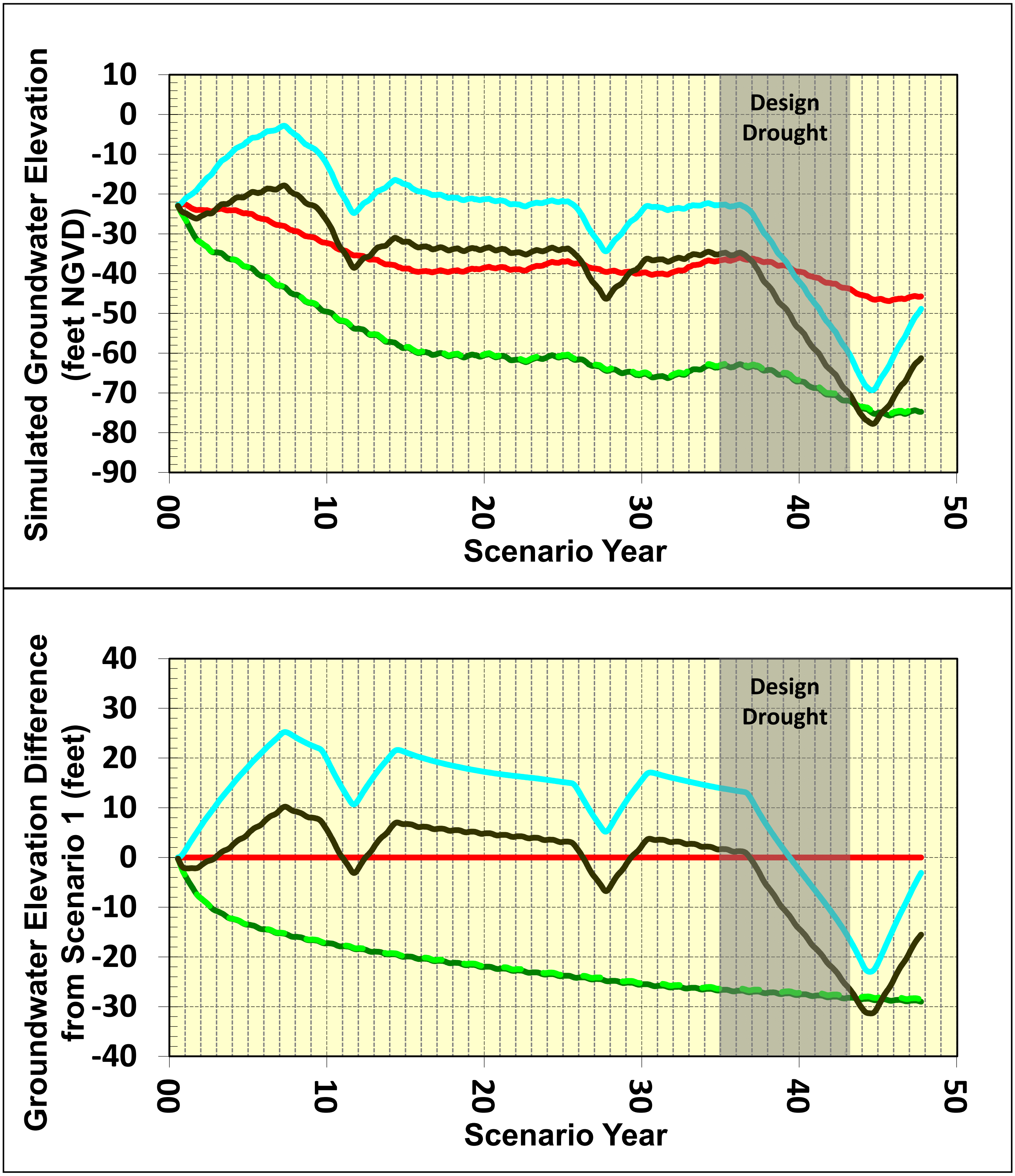
Model Layer 1 Hydrographs for LMMW-3

K/J 0864001
May 2012
Figure 10.2-13a



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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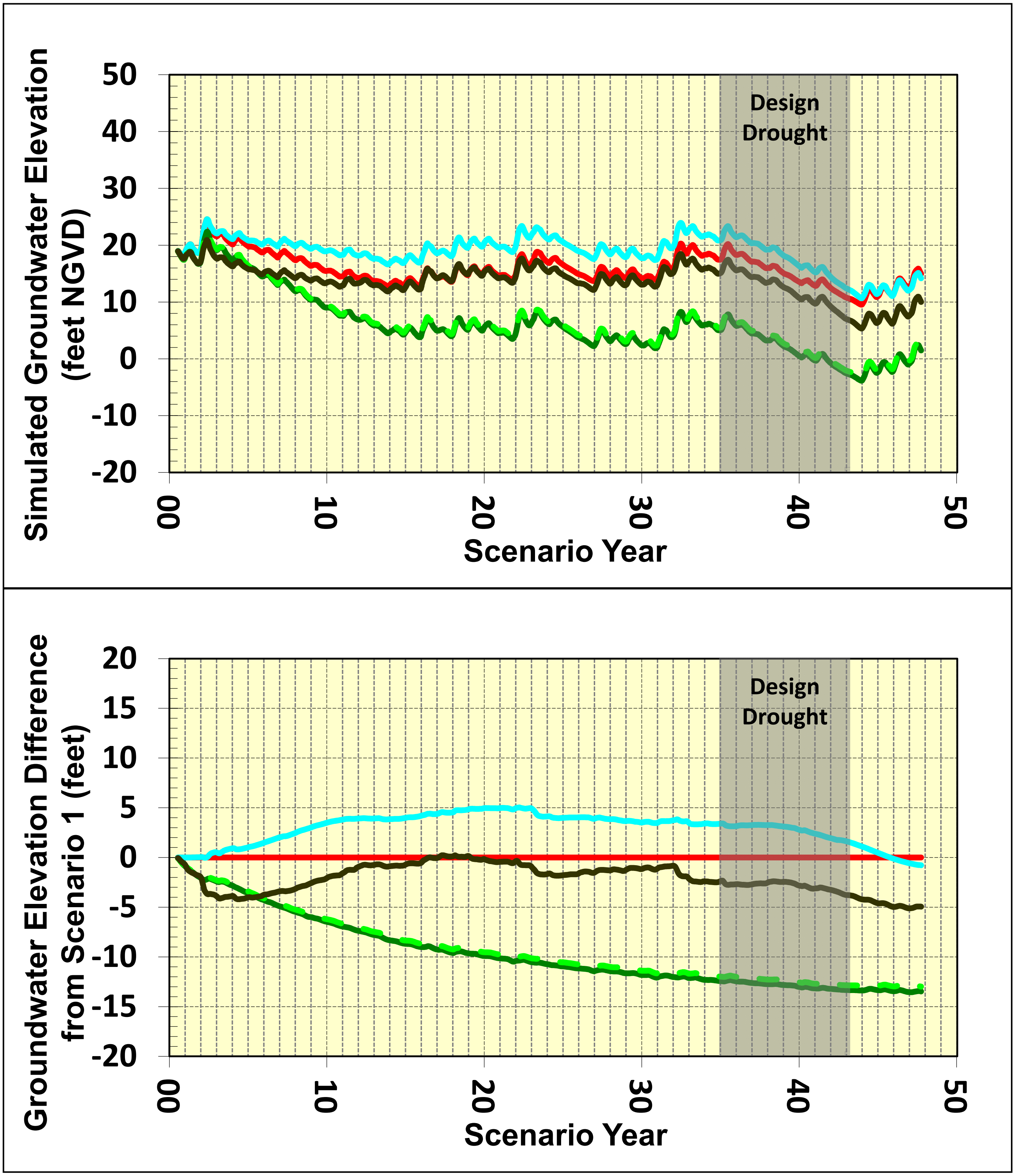
Model Layer 4 Hydrographs for LMMW-3

K/J 0864001
May 2012
Figure 10.2-13b



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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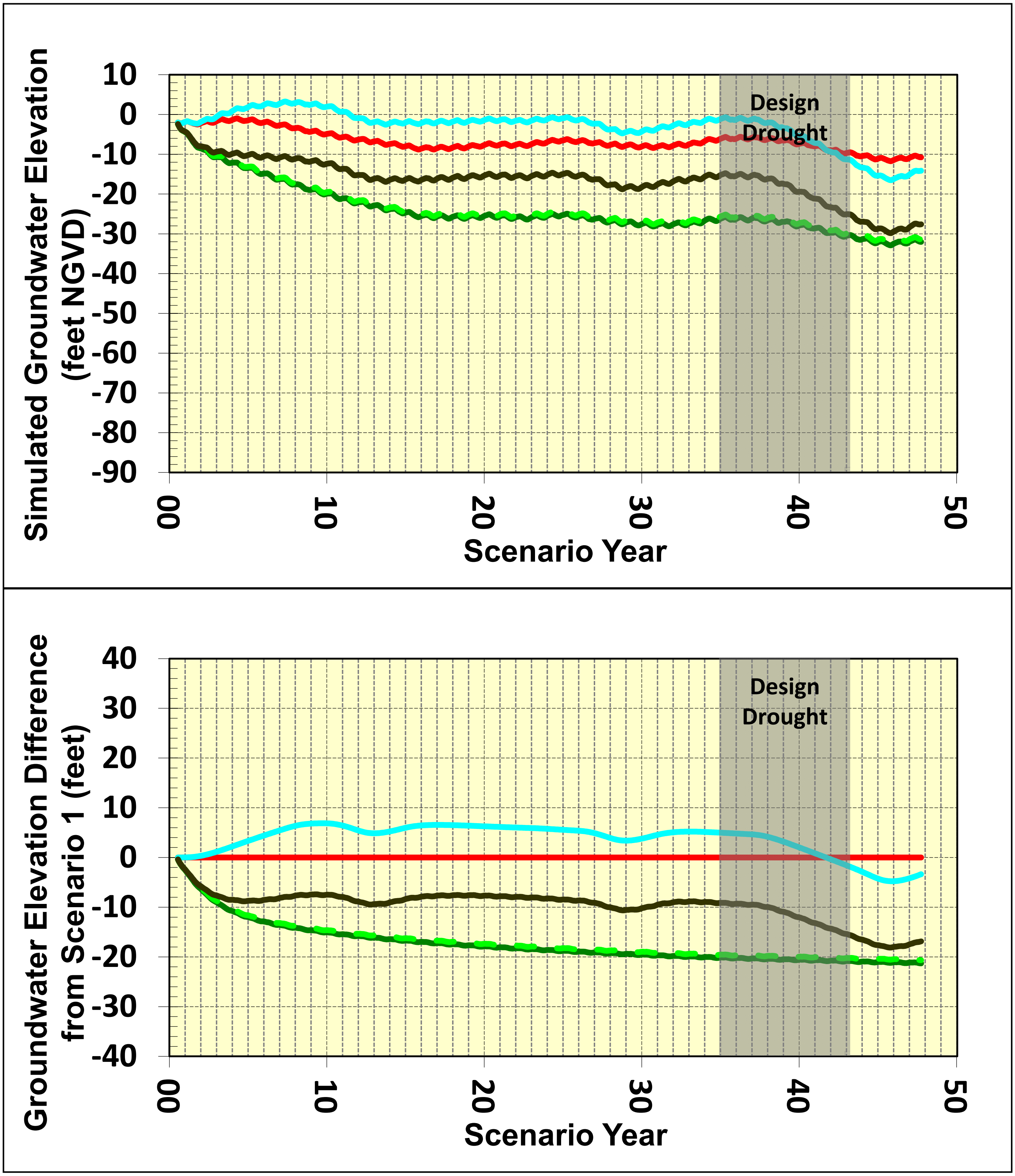
Regional Groundwater Storage and Recovery Project
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 1 Hydrographs for LMMW-4

K/J 0864001
May 2012
Figure 10.2-14a



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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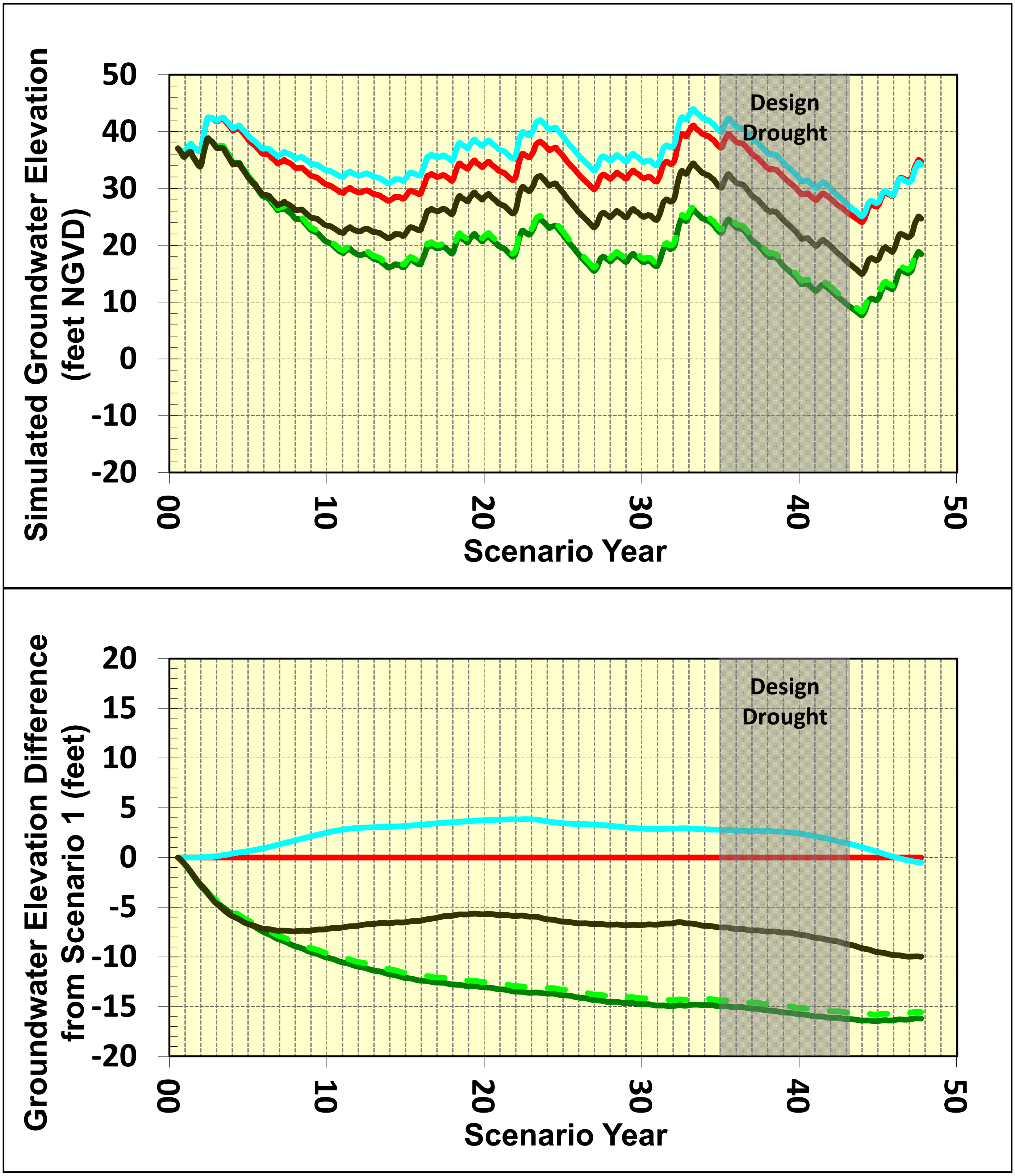
Model Layer 4 Hydrographs for LMMW-4

K/J 0864001
May 2012
Figure 10.2-14b



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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San Francisco Public Utilities Commission

Model Layer 1 Hydrographs for LMMW-5

K/J 0864001
May 2012
Figure 10.2-15

Tables

Table 10.2-1: Summary of Model Scenario Pumping Assumptions

Model Scenarios		**Scenario 1**	**Scenario 2**	**Scenario 3a**	**Scenario 3b**	**Scenario 4**
		Existing Conditions	**GSR**	**SFGW**	**SFGW**	**Cumulative**
Establish Initial Conditions		Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence
	June 2009 Condition	√	√	√	√	√
Model Scenario Simulation Period						
	47.25 years (including Design Drought) Hydrologic Sequence: July 1996 to September 2003 -> October 1958 to November 1992 -> December 1975 to June 1978 -> July 2003 - September 2006		√	√	√	√
Pumping Assumptions for Municipal Use						
PA Municipal Wells (mgd)						
	"Take" Periods	6.84	6.90	6.84	6.84	6.90
	"Put" Periods	6.84	1.38	6.84	6.84	1.38
	"Hold" Periods	6.84	6.90	6.84	6.84	6.90
GSR Project Proposed Municipal Wells (mgd)						
	"Take" Periods	0.0	7.23	0.0	0.0	7.23
	"Put" Periods	0.0	0.04	0.0	0.0	0.04
	"Hold" Periods	0.0	0.04	0.0	0.0	0.04
SFGW Project Proposed Municipal Wells (mgd)						
	Year-Round Pumping	0.0	0.0	3.0	4.0	4.0
Total Municipal Pumping (PA + GSR + SFGW)						
	"Take" Periods	***6.84***	***14.13***	***9.84***	***10.84***	***18.13***
	"Put" Periods	***6.84***	***1.42***	***9.84***	***10.84***	***5.42***
	"Hold" Periods	***6.84***	***6.94***	***9.84***	***10.84***	***10.94***
Irrigation and Other Non-Potable Pumping Assumptions (mgd)[1]						
Golden Gate Park	Elk Glen (GGP)	0.081	0.081	0.081	0.000	0.000
	South Windmill (GGP)	0.498	0.498	0.498	0.000	0.000
	North Lake (GGP)	0.563	0.563	0.563	0.000	0.000
	Sub-Total	***1.142***	***1.142***	***1.142***	***0.000***	***0.000***
Golf Courses	Burlingame Golf Club	0.150	0.150	0.150	0.150	0.150
	California Golf No. 02	0.192	0.192	0.192	0.192	0.192
	Green Hills No. 05	0.099	0.099	0.099	0.099	0.099
	Lake Merced Golf No. 01	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 02	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 03	0.010	0.010	0.010	0.010	0.010
	Olympic Club No. 09[2]	0.002	0.002	0.002	0.002	0.002
	SF Golf West	0.035	0.035	0.035	0.035	0.035
	Sub-Total	***0.495***	***0.495***	***0.495***	***0.495***	***0.495***
Cemeteries	Cypress Lawn No. 02	0.020	0.020	0.020	0.020	0.020
	Cypress Lawn No. 03	0.144	0.144	0.144	0.144	0.144
	Eternal Home	0.013	0.013	0.013	0.013	0.013
	Hills of Eternity No. 02	0.020	0.020	0.020	0.020	0.020
	Holy Cross No. 03[3]	0.190	0.190	0.190	0.190	0.230
	Home of Peace No. 02	0.039	0.039	0.039	0.039	0.039
	Italian Cemetery	0.033	0.033	0.033	0.033	0.033
	Olivet	0.098	0.098	0.098	0.098	0.098
	Woodlawn No. 02	0.085	0.085	0.085	0.085	0.085
	Sub-Total	***0.641***	***0.641***	***0.641***	***0.641***	***0.681***
Other	Hillsborough Residents No. 1-12	0.291	0.291	0.291	0.291	0.291
	Edgewood Development Ctr.	0.009	0.009	0.009	0.009	0.009
	Zoo No.05	0.321	0.321	0.321	0.321	0.321
	Stern Grove	0.004	0.004	0.012	0.013	0.013
	Sub-Total	***0.626***	***0.626***	***0.634***	***0.635***	***0.635***
Total Irrigation and Other Non-Potable Pumping		***2.90***	***2.90***	***2.91***	***1.77***	***1.81***

Key:
afy - acre-feet per year
mgd - million gallons per day
PA - Partner Agencies
GGP - Golden Gate Park
GSR - Regional Groundwater Storage and Recovery
SFGW - San Francisco Groundwater Supply
SFPUC - San Francisco Public Utilities Commission

Notes:
(1) Pumping wells that are listed identify the wells in the model scenarios whose pumping assumptions were modified compared to the 2008 No-Project Scenario by HydroFocus (May, 2011, ver. 3.1), as a result of revised Soil Moisture Budget (SMB). Pumping rates for the three wells in GGP and the California Golf No. 02, Edgewood Development Center, Zoo No. 05, and Stern Grove wells were further modified compared to the results of revised SMB.
(2) Olympic Club No. 09 values include pumping for both Olympic Golf Club wells.
(3) Holy Cross No. 3 well irrigation pumping for Scenarios 1, 2, 3a, and 3b is based on the results of revised SMB. Based on the projected future build-out at the Holy Cross cemetery, an additional pumping of 0.04 mgd (45 afy) was estimated to occur under Scenario 4 (Cumulative).

Table 10.2-2: Lake Merced Lake-Level Model Summary Statistics for Scenarios 1, 2, 3a, 3b, and 4

	Model Scenarios	Scenario 1 Existing Conditions	Scenario 2 GSR	Scenario 3a SFGW	Scenario 3b SFGW	Scenario 4 Cumulative
Lake Level\ Assessment (*percentage of simulation duration with lake levels within specified ranges*)[(1)]						
Lake Level (feet City Datum)	> 11	7%	40%	0%	0%	N/A[(4)]
	9 – 11	17%	30%	5%	4%	19%
	7 – 9	15%	10%	2%	3%	35%
	5 – 7	28%	6%	7%	5%	24%
	3 – 5	20%	2%	3%	3%	7%
	1 – 3	9%	2%	10%	9%	3%
	< 1	4%	10%	73%	76%	13%
Monthly Lake Level Statistics *(feet City Datum*)[(2)]						
	95th Percentile	11.3	12.9	9.1	8.5	9.5
	Mean	6.3	9.1	-1.3	-1.9	6.1
	5th Percentile	1.1	-0.8	-7.5	-8.1	-2.7
Annual Lake Level Range Statistics *(feet*)[(3)]						
	95th Percentile	3.2	2.8	3.6	3.8	3.1
	Mean	1.6	1.5	1.8	1.8	1.6
	5th Percentile	0.8	0.6	0.9	0.9	0.5

Key:
GSR - Regional Groundwater Storage and Recovery Project
SFGW - San Francisco Groundwater Supply Project

Notes:
Summary Statistics are from TM10.2-Attachment 10.2-A.
(1) Lake Level Assessment indicates the percentage of months in the simulation period for which lake levels in Lake Merced were within the specified range. Ranges are given in feet City Datum, which is equal to feet NGVD minus 8.62 feet.
(2) Monthly Lake Level Statistics provide the mean, 95th and 5th percentile of lake levels over the entire simulation period. The 95th Percentile value represents the level below which the Lake Merced lake level was simulated for 95% of the simulation period months. The 5th Percentile value represents the level below which the Lake Merced lake level was simulated for 5% of the simulation period months.
(3) Annual Lake Level Range is the difference between the highest and lowest lake level for a water year (October to September) and averaged over the 47 complete water years in the simulation. The 95th Percentile value represents the range below which 95% of the annual ranges in lake levels (maximum minus minimum levels over an October to September water year) fell. The 5th Percentile value represents the range below which 5% of the annual ranges in lake levels fell.
(4) Category is not applicable, because lake spillway elevation in Scenario 4 is 9.5 feet City Datum.

Attachment 10.2-A

Lake Merced Lake-Level Model Simulation Results
for Lake Merced with Summary Statistics

Explanation for TM10.2 - Attachment 10.2-A

The following sheets provide a summary of the Lake Merced Lake Model for Scenarios 1, 2, 3a, 3b and 4. These scenarios are described in more detail in TM 10.1 and the Lake Model is described in more detail in TM10.1 Attachment 10.1-H.

Summary of Lake Conditions

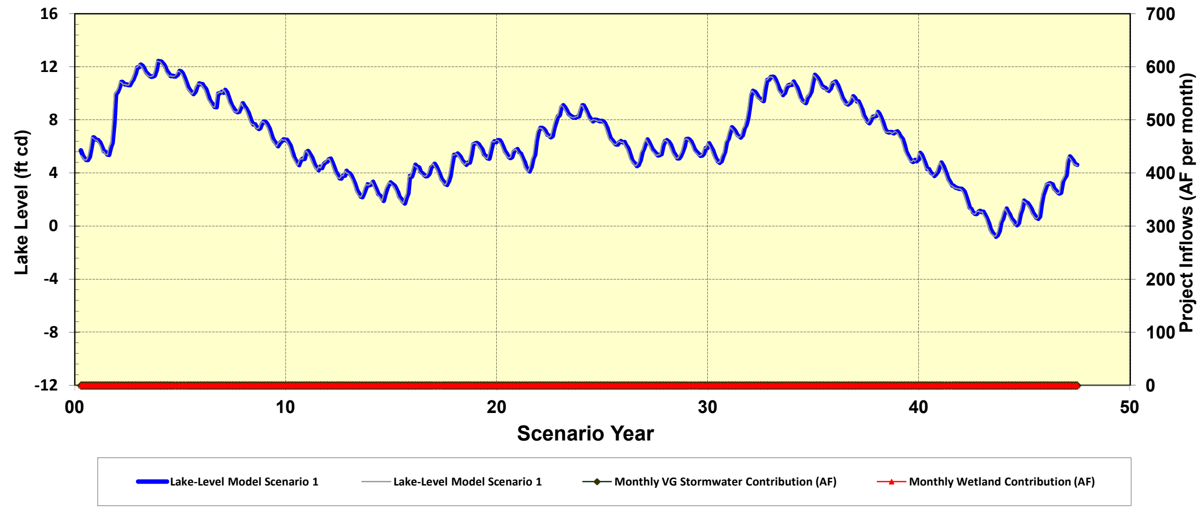
- Project Performance Summary denotes the percentage of time that the simulated lake levels occur in the specified elevation bands. The percentage of time that the lake levels occur between 1 and 13 feet (City Datum) are calculated in 2-foot bands. The percentage for lake levels less than 1 foot (City Datum) is grouped into a single band.
- Monthly Lake Level Summary provides the maximum, minimum and mean lake level for the entire simulation period. In addition, the 95th, 90th, 10th and 5th percentile lake levels are also provided to provide a basis of comparison of the lake level extremes.
- Monthly Lake Level Change Summary provides the range of month-to-month changes that occur over the entire simulation period.
- Lake Level Continuity provides the maximum length of time that lake levels remain within the specified range over the entire simulation period.
- The Average Annual Lake Elevation Summary provides the maximum, minimum and mean lake level for the 47 full water years (October to September) contained within the simulation. In addition, the 95th, 90th, 10th and 5th percentile lake levels are also provided to provide a basis of comparison of the lake level extremes.
- Annual Range of Lake Levels is the difference between the maximum and minimum lake level for each water year (October to September) for the 47 full water years included in the simulation. The range provides a method to evaluate whether the lake level fluctuations during a water year vary due to the effects of the project.

Summary of Project Flows

- Spillway flows provides the number of water years (October to September) for the 47 full water years within specific flow rate bands for lake water flow over the Lake Merced spillway.
- Wetland contribution provides the number of water years (October to September) for the 47 full water years within specific flow rate bands for inflow into Lake Merced through an engineered wetland from water diverted from the Vista Grande Canal. This only occurs in Scenario 4 as part of the Vista Grande Drainage Basin Improvements Project.
- Vista Grande (VG) Stormwater Contribution provides the number of water years (October to September) for the 47 full water years within specific flow rate bands for inflow into Lake Merced from direct diversions of stormwater from the Vista Grande Canal. This only occurs in Scenario 4 as part of the Vista Grande Drainage Basin Improvements Project.
- Project Contribution provides the number of water years (October to September) for the 47 full water years within specific flow rate bands for inflow to or outflow from Lake Merced for the sum of all spillway flows, wetland contributions and Vista Grande stormwater contributions.

Scenario 1 - SFPUC GSR and SFGW Project Technical Analysis

Assumptions:	Initial Lake Level	Wetland Source	VG Stormwater	Diversion Elevation	Spillway
	5.7	none	none	13.0	13



Lake Conditions

Project Performance Summary

Monthly Lake Elevation (ft, City Datum)	*Percent Time*
Above 11 feet	7%
between 9 and 11 feet	17%
between 7 and 9 feet	15%
between 5 and 7 feet	28%
between 3 and 5 feet	20%
between 1 and 3 feet	9%
Below 1 feet	4%
TOTAL	**100%**

Monthly Lake Level Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	12.4
95th percentile	11.3
90th percentile	10.6
Mean Lake Level	6.3
10th percentile	2.4
5th percentile	1.1
Minimum Lake Level	-0.8

Monthly Lake Level Change Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	2.14
95th percentile	0.61
90th percentile	0.42
Mean Lake Level	0.00
10th percentile	-0.32
5th percentile	-0.37
Minimum Lake Level	-0.48

Lake Level Continuity

Monthly Lake Elevation (ft, City Datum)	Consecutive months
Above 11 feet	30
between 9 and 11 feet	24
between 7 and 9 feet	18
between 5 and 7 feet	43
between 3 and 5 feet	25
between 1 and 3 feet	11
Below 1 feet	11

Average Annual Lake Elevation Summary

Percentile	*Annual Average Lake Elevation (ft, City Datum)*
Maximum Lake Level	11.8
95th percentile	11.0
90th percentile	10.4
Mean Lake Level	6.3
10th percentile	2.7
5th percentile	1.3
Minimum Lake Level	0.1

Annual Range in Lake Levels

Percentile	*Lake Level Change (ft)*
Maximum Lake Level	5.5
95th percentile	3.2
90th percentile	2.7
Mean Lake Level	1.6
10th percentile	0.9
5th percentile	0.8
Minimum Lake Level	0.2

Project Flows

Spillway Flows

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

Wetland Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

VG Stormwater Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

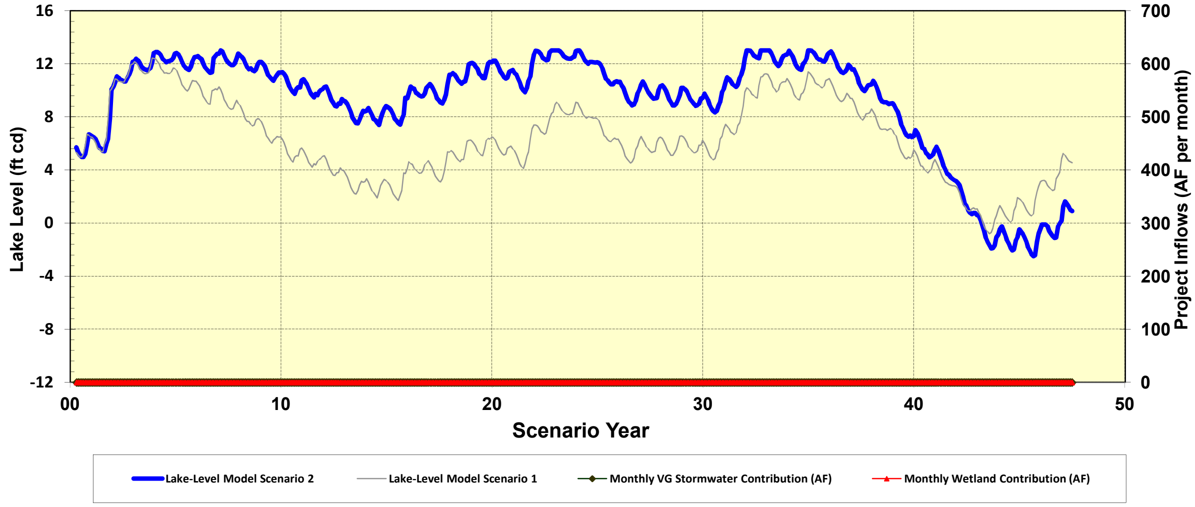
Project Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Total Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

Scenario 2 - SFPUC GSR and SFGW Project Technical Analysis

Assumptions:	Initial Lake Level	Wetland Source	VG Stormwater	Diversion Elevation	Spillway
Units - Feet City Datum	5.7	none	none	13.0	13



Lake Conditions

Project Performance Summary

Monthly Lake Elevation (ft, City Datum)	*Percent Time*
Above 11 feet	40%
between 9 and 11 feet	30%
between 7 and 9 feet	10%
between 5 and 7 feet	6%
between 3 and 5 feet	2%
between 1 and 3 feet	2%
Below 1 feet	10%
TOTAL	**100%**

Monthly Lake Level Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	13.0
95th percentile	12.9
90th percentile	12.6
Mean Lake Level	9.1
10th percentile	1.1
5th percentile	-0.8
Minimum Lake Level	-2.5

Monthly Lake Level Change Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	2.18
95th percentile	0.59
90th percentile	0.42
Mean Lake Level	0.00
10th percentile	-0.32
5th percentile	-0.36
Minimum Lake Level	-0.52

Lake Level Continuity

Monthly Lake Elevation (ft, City Datum)	Consecutive months
Above 11 feet	80
between 9 and 11 feet	27
between 7 and 9 feet	33
between 5 and 7 feet	14
between 3 and 5 feet	10
between 1 and 3 feet	5
Below 1 feet	54

Average Annual Lake Elevation Summary

Percentile	*Annual Average Lake Elevation (ft, City Datum)*
Maximum Lake Level	12.8
95th percentile	12.6
90th percentile	12.4
Mean Lake Level	9.0
10th percentile	0.8
5th percentile	-0.7
Minimum Lake Level	-1.3

Annual Range in Lake Levels

Percentile	*Lake Level Change (ft)*
Maximum Lake Level	5.6
95th percentile	2.8
90th percentile	2.7
Mean Lake Level	1.5
10th percentile	0.7
5th percentile	0.6
Minimum Lake Level	0.2

Project Flows

Spillway Flows

During operation	Volume (AFY)
Average	37
Maximum	604
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	41
0 to 100	1
100 to 200	1
200 to 300	2
300 to 500	1
>500	1
TOTAL	**47**

Wetland Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

VG Stormwater Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

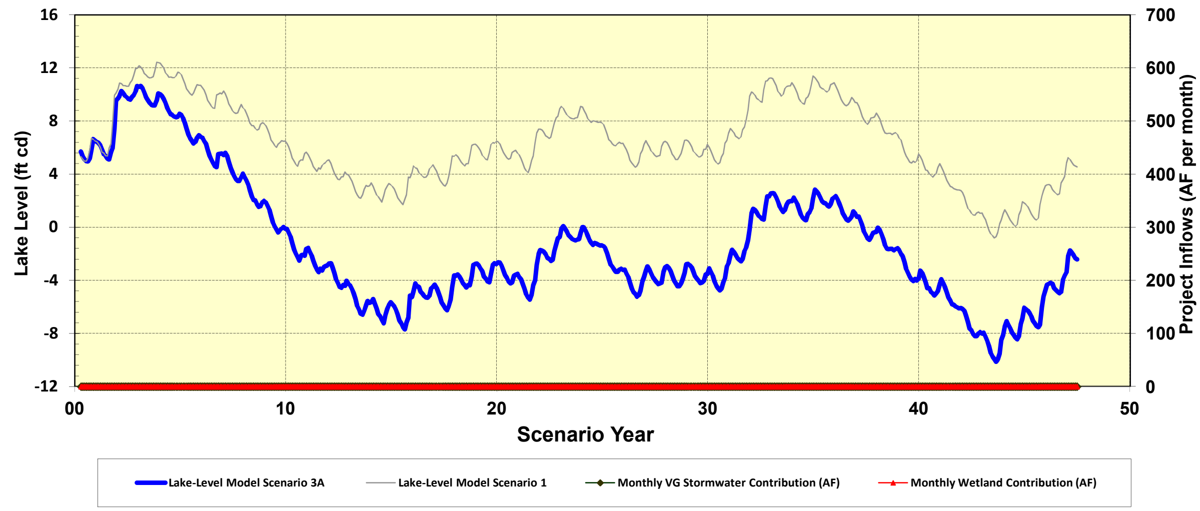
Project Contribution

During operation	Volume (AFY)
Average	37
Maximum	604
Minimum	0

Total Flow (AFY)	*Frequency (# of years)*
0	41
0 to 100	1
100 to 200	1
200 to 300	2
300 to 500	1
>500	1
TOTAL	**47**

Scenario 3A - SFPUC GSR and SFGW Project Technical Analysis

Assumptions:	Initial Lake	Wetland Source	VG Stormwater	Diversion Elevation	Spillway
Units - Feet City Datum	5.7	none	none	13.0	13



Lake Conditions

Project Performance Summary

Monthly Lake Elevation (ft, City Datum)	*Percent Time*
Above 11 feet	0%
between 9 and 11 feet	5%
between 7 and 9 feet	2%
between 5 and 7 feet	7%
between 3 and 5 feet	3%
between 1 and 3 feet	10%
Below 1 feet	73%
TOTAL	**100%**

Monthly Lake Level Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	10.7
95th percentile	9.1
90th percentile	6.2
Mean Lake Level	-1.3
10th percentile	-6.3
5th percentile	-7.5
Minimum Lake Level	-10.1

Monthly Lake Level Change Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	2.11
95th percentile	0.65
90th percentile	0.48
Mean Lake Level	-0.01
10th percentile	-0.36
5th percentile	-0.42
Minimum Lake Level	-0.51

Lake Level Continuity

Monthly Lake Elevation (ft, City Datum)	Consecutive months
Above 11 feet	0
between 9 and 11 feet	29
between 7 and 9 feet	12
between 5 and 7 feet	14
between 3 and 5 feet	12
between 1 and 3 feet	21
Below 1 feet	273

Average Annual Lake Elevation Summary

Percentile	*Annual Average Lake Elevation (ft, City Datum)*
Maximum Lake Level	10.1
95th percentile	8.0
90th percentile	6.0
Mean Lake Level	-1.3
10th percentile	-6.0
5th percentile	-6.9
Minimum Lake Level	-8.7

Annual Range in Lake Levels

Percentile	*Lake Level Change (ft)*
Maximum Lake Level	5.2
95th percentile	3.6
90th percentile	3.3
Mean Lake Level	1.8
10th percentile	0.9
5th percentile	0.9
Minimum Lake Level	0.2

Project Flows

Spillway Flows

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

Wetland Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

VG Stormwater Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

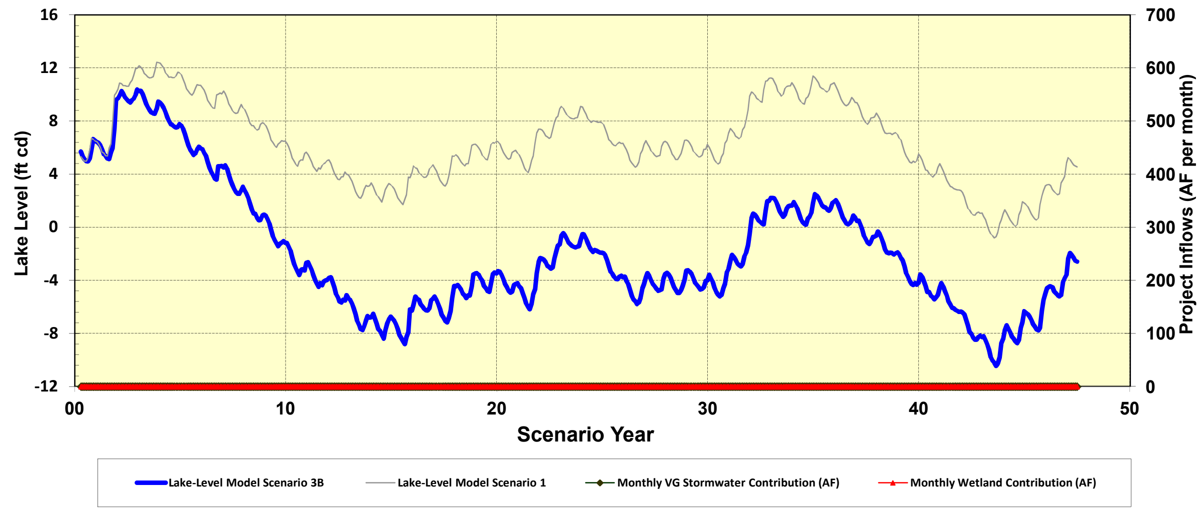
Project Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Total Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

Scenario 3B - SFPUC GSR and SFGW Project Technical Analysis

Assumptions:	Initial Lake	Wetland Source	VG Stormwater	Diversion Elevation	Spillway
Units - Feet City Datum	5.7	none	none	13.0	13



Lake Conditions

Project Performance Summary

Monthly Lake Elevation (ft, City Datum)	*Percent Time*
Above 11 feet	0%
between 9 and 11 feet	4%
between 7 and 9 feet	3%
between 5 and 7 feet	5%
between 3 and 5 feet	3%
between 1 and 3 feet	9%
Below 1 feet	76%
TOTAL	**100%**

Monthly Lake Level Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	10.4
95th percentile	8.5
90th percentile	5.7
Mean Lake Level	-1.9
10th percentile	-7.1
5th percentile	-8.1
Minimum Lake Level	-10.4

Monthly Lake Level Change Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	2.11
95th percentile	0.67
90th percentile	0.48
Mean Lake Level	-0.01
10th percentile	-0.36
5th percentile	-0.42
Minimum Lake Level	-0.52

Lake Level Continuity

Monthly Lake Elevation (ft, City Datum)	Consecutive months
Above 11 feet	0
between 9 and 11 feet	19
between 7 and 9 feet	13
between 5 and 7 feet	14
between 3 and 5 feet	15
between 1 and 3 feet	18
Below 1 feet	282

Average Annual Lake Elevation Summary

Percentile	*Annual Average Lake Elevation (ft, City Datum)*
Maximum Lake Level	9.8
95th percentile	7.5
90th percentile	5.7
Mean Lake Level	-1.9
10th percentile	-7.1
5th percentile	-7.5
Minimum Lake Level	-9.0

Annual Range in Lake Levels

Percentile	*Lake Level Change (ft)*
Maximum Lake Level	5.1
95th percentile	3.8
90th percentile	3.3
Mean Lake Level	1.8
10th percentile	1.0
5th percentile	0.9
Minimum Lake Level	0.2

Project Flows

Spillway Flows

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

Wetland Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

VG Stormwater Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

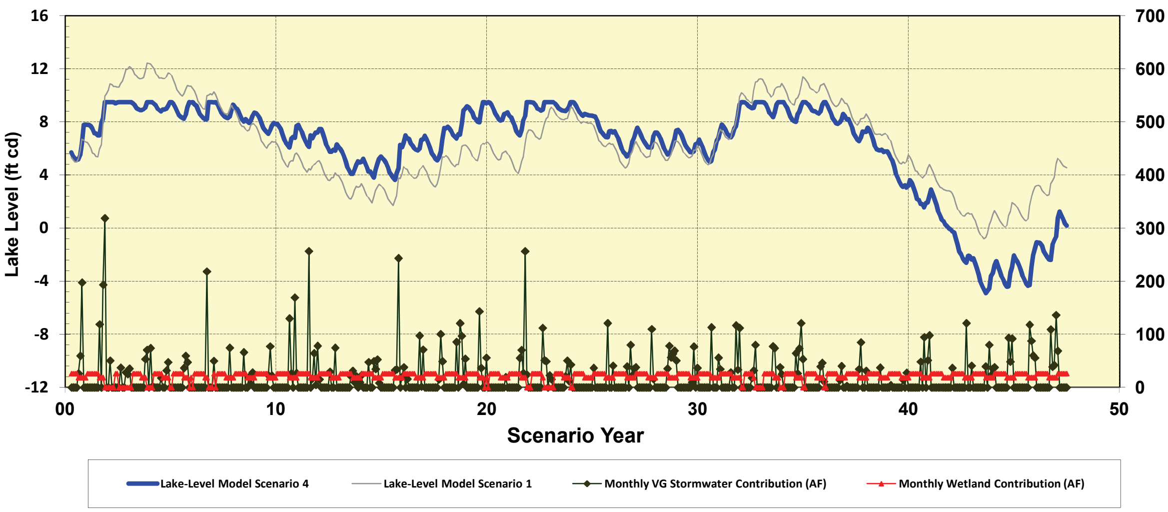
Project Contribution

During operation	Volume (AFY)
Average	0
Maximum	0
Minimum	0

Total Flow (AFY)	*Frequency (# of years)*
0	47
0 to 100	0
100 to 200	0
200 to 300	0
300 to 500	0
>500	0
TOTAL	**47**

Scenario 4 - SFPUC GSR and SFGW Project Technical Analysis

Assumptions:	Initial Lake Level	Wetland Source	VG Stormwater	Diversion Elevation	Spillway
Units - Feet City Datum	5.7	baseflow	baseflow	9.5	9.5



Lake Conditions

Project Performance Summary

Monthly Lake Elevation (ft, City Datum)	*Percent Time*
Above 11 feet	0%
between 9 and 11 feet	19%
between 7 and 9 feet	35%
between 5 and 7 feet	24%
between 3 and 5 feet	7%
between 1 and 3 feet	3%
Below 1 feet	13%
TOTAL	**100%**

Monthly Lake Level Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	9.5
95th percentile	9.5
90th percentile	9.5
Mean Lake Level	6.1
10th percentile	-0.7
5th percentile	-2.7
Minimum Lake Level	-4.9

Monthly Lake Level Change Summary

Percentile	*Lake Elevation (ft, City Datum)*
Maximum Lake Level	2.78
95th percentile	0.83
90th percentile	0.52
Mean Lake Level	0.02
10th percentile	-0.34
5th percentile	-0.39
Minimum Lake Level	-0.54

Lake Level Continuity

Monthly Lake Elevation (ft, City Datum)	Consecutive months
Above 11 feet	0
between 9 and 11 feet	19
between 7 and 9 feet	26
between 5 and 7 feet	25
between 3 and 5 feet	12
between 1 and 3 feet	14
Below 1 feet	68

Average Annual Lake Elevation Summary

Percentile	*Annual Average Lake Elevation (ft, City Datum)*
Maximum Lake Level	9.5
95th percentile	9.2
90th percentile	9.1
Mean Lake Level	6.0
10th percentile	-0.2
5th percentile	-2.6
Minimum Lake Level	-3.8

Annual Range in Lake Levels

Percentile	*Lake Level Change (ft)*
Maximum Lake Level	3.6
95th percentile	3.1
90th percentile	2.7
Mean Lake Level	1.6
10th percentile	0.7
5th percentile	0.5
Minimum Lake Level	0.2

Project Flows

Spillway Flows

During operation	Volume (AFY)
Average	128
Maximum	1547
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	32
0 to 100	4
100 to 200	2
200 to 300	1
300 to 500	4
>500	4
TOTAL	**47**

Wetland Contribution

During operation	Volume (AFY)
Average	248
Maximum	277
Minimum	78

Flow (AFY)	*Frequency (# of years)*
0	0
0 to 100	0
100 to 200	6
200 to 300	41
300 to 500	0
>500	0
TOTAL	**47**

VG Stormwater Contribution

During operation	Volume (AFY)
Average	198
Maximum	681
Minimum	0

Flow (AFY)	*Frequency (# of years)*
0	0
0 to 100	9
100 to 200	16
200 to 300	12
300 to 500	9
>500	1
TOTAL	**47**

Project Contribution

During operation	Volume (AFY)
Average	574
Maximum	2362
Minimum	78

Total Flow (AFY)	*Frequency (# of years)*
0	0
0 to 100	0
100 to 200	0
200 to 300	1
300 to 500	24
>500	22
TOTAL	**47**

Kennedy/Jenks Consultants

303 Second Street, Suite 300 South
San Francisco, California 94107
415-243-2150
FAX: 415-896-0999

Technical Memorandum 10.3

Assessment of Potential Seawater Intrusion

for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

24 April 2012

Prepared for

San Francisco Public Utilities Commission
525 Golden Gate Avenue, 10th Floor
San Francisco, CA 94102

K/J Project No. 0864001

Supplemental Explanation for Hydrographs - TM10.3

This supplemental explanation is prepared to address discrepancies on several graphs presented in TM 10.3.

First, the x-axis on several graphs showing model results was shifted. The x-axis is named Scenario Year which should correspond to a water year[1]. However, the graph template was plotted using a calendar year, so the intervals on the x-axis represent the period from January to December. The result is that the graph is shifted 3-months later relative to Scenario Year.

Second, the shaded area representing the Design Drought was added manually and because of this process, it was not presented consistently on the graphs. By definition per the PEIR, the 8.5-year Design Drought includes one Hold year before the 7.5-year Take period. In addition, the Design Drought needs to be shifted 3-months later for the x-axis issue to be consistent with the model output. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.

The following is a list of figures in TM 10.3 where the Design Drought shaded area is shown slightly different and does not match the correct display of the Design Drought. The figures should be viewed based on the correct representation of the Design Drought as explained above.

- Figures 10.3-4 through 10.3-17 (a total of 30 figures) have the shifted x-axis. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.

[1] A water year is October 1 of the previous year to September 30 of the current (named) year.

24 April 2012

Task 10.3 Technical Memorandum

San Francisco Public Utilities Commission

Assessment of Potential Seawater Intrusion for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Prepared For: Greg Bartow and Jeff Gilman, SFPUC

Prepared by: Matthew Baillie, Michael Maley and Sevim Onsoy, Kennedy/Jenks Consultants

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1. Introduction

This Technical Memorandum (TM) was prepared to document work performed by Kennedy/Jenks Consultants (Kennedy/Jenks) for the San Francisco Public Utilities Commission (SFPUC) pursuant to the amended Task Order (TO) authorizations CUW30103-TO-1.12 of the Regional Groundwater Storage and Recovery (GSR) Project and CUW30102-TO-2.7 of the San Francisco Groundwater Supply (SFGW) Project. These projects are funded by the SFPUC's Water System Improvement Program (WSIP).

1.1. GSR and SFGW Project Description

The GSR Project is a conjunctive use project that would allow for increased groundwater supplies in the southern portion of the Westside Groundwater Basin (South Westside Basin) during periods of drought when SFPUC surface water supplies might become limited (MWH, 2008). The project would be designed to provide up to 60,500 acre-feet (af) of stored water to meet SFPUC system demands during the last 7.5 years of SFPUC's Design Drought. The SFPUC plans to install 16 new production wells for the GSR Project to recover the stored groundwater. Under the Draft GSR Operating Agreement, the SFPUC would "store" water in the South Westside Basin through the mechanism of in-lieu recharge by providing supplemental surface water as a substitute for groundwater pumping by the Partner Agencies (PAs). As a result of the in-lieu deliveries, up to 60,500 af of groundwater storage or put credits could accrue to the SFPUC Storage Account. During shortages of SFPUC Regional Water System water due to drought, emergencies, or scheduled maintenance, the PAs would return to pumping from their existing wells, and SFPUC would extract groundwater from GSR Project wells as long as a positive balance exists in the SFPUC Storage Account.

The SFGW Project would provide a reliable, local source of high-quality groundwater in the northern portion of the Westside Groundwater Basin (North Westside Basin) to supplement the

San Francisco municipal water system. The SFGW Project would construct up to four wells (and convert two existing irrigation wells in Golden Gate Park for municipal supply) and associated facilities in the western part of San Francisco and extract an annual average of up to 4.0 million gallons per day (mgd) of water from the North Westside Basin (SFPUC, 2009a). The extracted groundwater, which would be used both for regular and emergency water supply purposes, would be blended in small quantities with imported surface water before entering the municipal drinking water system for distribution. The SFGW Project includes two phases. In phase one, SFPUC would build four new groundwater wells at the Lake Merced Pump Station, West Sunset Playground, South Sunset Playground, and the Golden Gate Park Central Pump Station. In phase two, SFPUC would modify two existing irrigation wells (South Windmill Replacement and North Lake) in Golden Gate Park, converting them into municipal water supply wells.

The locations of existing and proposed GSR and SFGW wells, existing PA wells, and monitoring wells are shown on Figure 10.3-1. Additional detailed discussion of the GSR and SFGW Projects is provided in Task 10.1 Technical Memorandum - Groundwater Modeling Analysis for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project (TM-10.1).

1.2. Objective

Implementation of the proposed GSR and SFGW Projects would influence groundwater heads in the Westside Groundwater Basin (Westside Basin, or Basin). Because the Westside Basin underlies both the Pacific Ocean west of San Francisco and San Francisco Bay near San Bruno, there is the potential for seawater intrusion to occur as a result of implementation of the GSR and SFGW Projects.

The purpose of this TM is to present the results of an evaluation of potential changes in groundwater head resulting from operation of each of the GSR and SFGW Projects, as well as the cumulative effects of both the GSR and SFGW Projects (along with other reasonably foreseeable future groundwater projects in the Basin), in order to assess the potential for seawater intrusion in areas that may be susceptible. The potential changes in groundwater head resulting from implementation of the GSR and SFGW Projects and other reasonably foreseeable future projects were evaluated based on groundwater model scenarios developed using the existing Westside Basin Groundwater-Flow Model (HydroFocus, 2007, 2009, and 2011). These model results were evaluated with respect to the potential to induce seawater intrusion. This TM presents information on the past, current, and future subsurface conditions that are relevant to the issue of seawater intrusion along with a conceptual discussion of the mechanisms that control seawater intrusion.

2. Approach and Conceptual Understanding of Seawater Intrusion

Before analyzing seawater intrusion in the context of the Westside Basin, a conceptual understanding of the process of seawater intrusion is presented. This section includes a description of the process, including the variables involved, the time-frame over which intrusion typically occurs, and hydrogeological factors that control intrusion.

2.1. General Approach

The general approach used to evaluate potential seawater intrusion for this TM is based on an analysis of the changes in groundwater conditions in the Basin, including groundwater heads[1] and flux, resulting from the operation of the GSR and SFGW Projects. This TM is part of a series of technical memoranda that address various aspects of the GSR and SFGW Projects. Two of these include significant data and analysis that are used for this TM. These include the following:

- Task 8B Technical Memorandum No.1 Hydrologic Setting of the Westside Basin (referred to in the text as TM#1; LSCE, 2010)
- Task 10.1 Groundwater Modeling Analysis for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project (referred to in the text as TM-10.1; Kennedy/Jenks, 2012)

The primary quantitative tools for evaluating potential future conditions are model scenarios generated using the existing Westside Basin Groundwater-Flow Model developed by HydroFocus (2007, 2009, and 2011). For this analysis, the potential for seawater intrusion is evaluated using scenarios that evaluate the proposed GSR and SFGW Projects in isolation. A Cumulative Scenario is evaluated that includes both the GSR and SFGW Projects along with other reasonably foreseeable future groundwater projects in the Basin. The development of the model scenarios is documented in TM-10.1.

This TM includes a brief conceptual understanding of the hydrogeologic processes and factors that influence seawater intrusion and a hydrogeological evaluation summarizing the current conditions with respect to seawater intrusion in the Westside Basin. Much of the information used for this analysis is discussed in detail in TM#1.

[1] As used in this TM, head is the elevation at which groundwater would rest in a piezometer completed in the referenced aquifer. In an unconfined aquifer, this is equivalent to the water table elevation; in a confined aquifer, this is equivalent to the piezometric head.

2.2. Westside Groundwater Basin

This section provides a brief overview of the physical setting and Basin hydrogeology. More detailed evaluations of the hydrogeology of the Westside Basin are presented in TM#1 and TM10.1.

Figure 10.3-2 provides a representative cross-section from north to south across the Westside Basin. There are three aquifer systems that are commonly referred to within the Westside Basin. These include:

- Shallow Aquifer: this aquifer is present in the northern part of the Basin, in the vicinity of Lake Merced and the southern portion of the Sunset district of San Francisco. The base of the Shallow Aquifer is defined as the top of the “-100 foot clay.”
- Primary Production Aquifer: this aquifer is present throughout the Basin, overlying the “W-clay” where present. Where the W-clay is not present in locations to the south (in the South San Francisco area), the Primary Production Aquifer is divided into shallow and deep units separated by a clay unit at an elevation of approximately -300 feet mean sea level (msl).
- Deep Aquifer: this aquifer underlies the W-clay, and thus its extent is limited to the generally-known extent of that clay unit (TM#1).

The three aquifer systems are separated by thick, extensive clay units (e.g., the -100 ft clay and W-clay). Because of the discontinuous nature of these clay layers, the basin is considered to be a semi-confined aquifer system with limited flow between the different aquifer systems where local geologic conditions permit (TM#1).

2.2.1. Areas Susceptible to Seawater Intrusion

The Westside Basin is bounded by bedrock highs in Golden Gate Park to the north and at Coyote Point to the south (Rogge, 2003; San Bruno, 2007; DWR, 2003). San Bruno Mountain and the San Francisco Bay form the eastern boundary of the Basin (Cal Water, 2006). The San Andreas Fault and Pacific Ocean form the Basin’s western boundary, and its southern limit is defined by a bedrock high that separates it from the San Mateo Plain Groundwater Basin (Rogge, 2003, DWR, 2003, and San Bruno, 2007). The Westside Basin opens to the Pacific Ocean on the northwest and San Francisco Bay on the southeast. Major structural features include the San Andreas Fault system and the Serra Fault.

Areas that are considered potentially susceptible must be investigated for the occurrence of seawater intrusion. Two areas of the Basin are likely to be susceptible to seawater intrusion given certain conditions (Figure 10.3-1). The first is along the Pacific Ocean, between Lincoln Park in the north and Lake Merced in the South. The second is along San Francisco Bay, from the Basin border with the Visitacion Valley Basin in the north to the border with the San Mateo

Plain Basin to the south. The susceptibility of the Westside Basin to seawater intrusion is discussed in more detail in Section 7.

2.2.2. Current Seawater-Intrusion Monitoring System

The two areas monitored for seawater intrusion (the Pacific Coast and the Bay Coast) contain a number of monitoring wells completed in the various aquifers present in the Westside Basin. The two sets of wells are known as the coastal and Bay side monitoring networks. Groundwater head in the Westside Basin is monitored in a network of production and monitoring wells as part of the semi-annual monitoring program that was initiated throughout the Basin in 2000. Results of the most recent groundwater level monitoring were reported in the 2010 Westside Basin Annual Groundwater Monitoring Report (SFPUC, 2011), prepared by SFPUC in coordination with the City of Daly City (Daly City), the City of San Bruno (San Bruno), and the California Water Service Company (Cal Water). Annual monitoring reports have been published by the SFPUC since 2006 (LSCE, 2006 and SFPUC, 2007, 2008a, 2009b, 2010, and 2011); these reports are summarized in TM#1 and TM10.1.

The coastal monitoring network consists of a series of wells stretching along the Pacific Coast from the west end of Golden Gate Park south to Thornton Beach in Daly City (SFPUC, 2009b). The three well clusters (nested wells) along the Old Great Highway (near Kirkham, Ortega, and Taraval Streets) and the well cluster at the San Francisco Zoo were installed specifically for the purpose of monitoring seawater intrusion, and were completed by 2004. Head in some of these wells is monitored continuously using pressure transducers, while in others it is measured quarterly by hand. The results of these monitoring activities are presented as hydrographs in Appendix B of TM#1.

Nested wells or well clusters are present at the South Windmill (57 and 140 feet below land surface; ft bls), Kirkham (130, 255, 385, and 435 ft bls), Ortega (125, 265, 400, and 475 ft bls), Taraval (145, 240, 400, and 530 ft bls), Zoo (275, 450, and 565 ft bls), and Thornton Beach (225, 360, and 670 ft bls) locations. Additional monitoring wells in the coastal monitoring network are present at Lake Merced (LMMW-9SS, LMMW-1D, LMMW-1S) and Fort Funston (S and M).

The Bay side monitoring network is less extensive. Head data were provided to SFPUC for two monitoring wells by the San Francisco Airport (UAL MW13C, constructed to a depth of 146 ft bls, and MW13D, constructed to a depth of 41.5 ft bls) from late 2003 to 2006, and since then SFPUC has been collecting data. Two additional clusters of wells were installed in the Bay side area by San Bruno in 2006 (WRIME, 2007) at the San Francisco Airport (SFO-S, 74 ft bls, and SFO-D, 146 ft bls) and in Burlingame (Burlingame-S, 98 ft bls, Burlingame-M, 166 ft bls, and Burlingame-D, 280 ft bls). These wells have been monitored for groundwater elevation and various chemical constituents since November 2006.

The groundwater elevation and water quality data collected to date from these monitoring wells are provided in TM#1, and the monitoring results are discussed in Sections 7.2 and 7.3.

2.3. Conceptual Understanding of Seawater Intrusion

Seawater intrusion is the movement of saline water from an ocean or bay into freshwater aquifers. Some degree of seawater intrusion occurs in virtually all coastal aquifers, as long as they are hydraulically connected with seawater. Seawater intrusion usually occurs when coastal freshwater aquifers begin to be developed as sources of water supply. Pumping of freshwater from an aquifer reduces the groundwater head and gradient towards the seawater-freshwater interface, drawing seawater into the freshwater aquifer. The increase in chloride and other constituents that accompanies seawater intrusion can cause the freshwater aquifer to become unfit for beneficial uses such as drinking or irrigation.

The intrusion of seawater into a freshwater aquifer is an effect of the respective heads in the ocean and the freshwater aquifer and the difference in densities of the two fluids (the standard value of density for freshwater is 1.0 grams per cubic centimeter, g/cm^3, and a typical value of seawater density is 1.026 g/cm^3). Because freshwater is less dense than seawater, it actually floats on top of the saline water when both are present in an aquifer. The depth of the interface between the saline and freshwater depends on the freshwater head in the aquifer, with a higher head leading to a greater depth to the salt water. Under a simplified aquifer system with groundwater flowing toward the ocean, the freshwater head declines closer to the ocean, so the seawater-freshwater interface gets progressively closer to the ground surface moving from inland toward the ocean; this has led to the seawater intrusion into the aquifer being termed a "wedge" (Figure 10.3-3).

As discussed above, due to its high salt content seawater has a density about 2.6% higher than does freshwater. Based on this difference in densities, the Ghyben-Herzberg principle states that, for every foot of freshwater head in an unconfined aquifer above sea level, there will be 38 feet of fresh water in the aquifer below sea level at equilibrium (Badon-Ghyben, 1888; Herzberg, 1901).

When freshwater heads drop, the seawater-freshwater interface can migrate inland, and over time the interface may eventually reach coastal wells. If the groundwater head were to rise again, the seawater-freshwater interface would migrate back seaward. Movement of the seawater-freshwater interface is a slow process. Seawater intrusion may not reach a production well for a number of years, and only when the conditions leading to seawater intrusion are sustained for an extended period of time.

It is important to note that the freshwater head does not need to be lowered below sea level for seawater intrusion to occur, although a groundwater head below sea level certainly increases the potential rate and extent of seawater intrusion. Instead, the groundwater head must simply be dropped to a level lower than 1/38 the depth below sea level of the bottom of the aquifer. If this occurs, the thickness of freshwater is no longer great enough to exclude seawater from intruding along the base of the aquifer. The presence of freshwater head above this level represents what in this TM is termed a hydrologic control.

In addition, seawater intrusion does not necessarily need to follow the typical conceptual route of intruding from the location of freshwater discharge to the seawater body, as shown in Figure 10.3-3; instead, an aquifer can be intruded via another, bounding aquifer. To illustrate this, we can consider an unconfined aquifer in direct contact with the ocean overlying a semi-confined aquifer that is not in direct contact with the ocean, and is separated from the unconfined aquifer by a discontinuous low-permeability confining layer. If head in the unconfined aquifer is lowered far enough to allow it, seawater would intrude along the base of the aquifer. If the intruding wedge encounters a gap in the low-permeability base of the unconfined aquifer, its density, higher than that of freshwater, dictates that it would sink and intrude into the lower semi-confined aquifer.

The seawater-freshwater interface is not actually a sharp interface because of the action of dispersion and diffusion, instead it forms a transition zone where chloride concentrations range from values typical of freshwater to those of seawater (Bear and Cheng, 1999). The movement of the transition zone within the aquifer is due to changing of the groundwater conditions on the freshwater side of the interface. As the seaward flow of freshwater and/or the groundwater elevations near the interface decline, the interface can move landward. If freshwater flow and groundwater head later increase, the interface would move back toward the ocean; however, some of the salt can remain in the freshwater aquifer even after the interface moves away. Once salt water enters a part of the freshwater aquifer, it is very difficult to expunge, demonstrating that it is important to prevent the movement of the interface into the freshwater aquifer to the extent possible (Bear and Cheng, 1999).

Geologic features can limit communication between the freshwater aquifer and ocean water. In order for seawater to intrude into a freshwater aquifer, that aquifer must be in contact with the ocean in some way, usually by being exposed on the ocean floor. Other geologic configurations can limit or prevent seawater intrusion. These can include tilted beds, impermeable bedrock, gradational changes in aquifer permeability (i.e., the freshwater aquifer grading from sand inland into mud offshore), or fault zones. If one or more of these physical controls exists between the freshwater aquifer and the ocean, and is sufficiently low in permeability, it can serve as an effective barrier to the intrusion of seawater into the aquifer. If this is the case, less care would be required to prevent seawater intrusion, as long as the barrier (or barriers) is known to be sound and continuous. Of course, no natural barrier is truly impervious to flow, but its hydraulic conductivity may be so low that the flux of seawater through it would not have a substantial effect on the quality of water in bounding freshwater aquifers. These structural controls, referred to herein as physical controls, are, for all intents and purposes, permanent.

The two types of controls noted above (hydrologic and physical) are discussed further throughout this TM, and can be used to consider the vulnerability of a given freshwater aquifer to seawater intrusion. As is implied by the above discussion, either a hydrologic control or a physical control can prevent seawater intrusion; therefore, both must be absent for seawater intrusion to occur. In locations where physical controls on seawater intrusion (such as a low-permeability clay layer or fault zone) are absent, hydrologic controls are necessary to limit intrusion. For locations where physical controls do exist, freshwater head below the level dictated by the Ghyben-Herzberg relationship may be possible without leading to any intrusion, depending on the nature of the physical control.

3. Groundwater Model Analysis

Groundwater models are useful tools that can help quantify the changes in groundwater conditions due to future activities. This section summarizes previous modeling studies of seawater intrusion along the Pacific Coast of the Westside Basin and documents the results of the current modeling conducted for this study using the existing Westside Basin Groundwater-Flow Model (HydroFocus, 2007, 2009 and 2011).

3.1. Previous Seawater Intrusion Model

CH2M HILL (1995) performed a numerical modeling exercise to determine the effect that proposed increases in groundwater extraction would have on the intrusion of seawater into the freshwater aquifers of the North Westside Basin. Although focused in the same area, their model does not deal with the same changes in pumping as would be entailed in the SFGW Project.

There are important differences between the CH2M HILL seawater intrusion model (SIM) and the numerical model for the Westside Basin discussed here. The most important difference is that the SIM was constructed as a steady-state model, unlike the transient Westside Basin model; this means that the results of the model indicate the seawater intrusion that would eventually happen if a given pumping rate was maintained indefinitely, and cannot deal with changes in pumping rate or climatic conditions (e.g., an extended drought). The SIM does not simulate the connection between Lake Merced and the North Westside Basin, instead assuming a general head boundary to be present just north of Lake Merced that imposes head values that are constant in time and assumed to be uniform vertically throughout the aquifer. This rigid assumption does not allow head in the aquifer in the Lake Merced area to vary, meaning that the North Westside Basin cannot be dynamically linked to the South Westside Basin using this model, and therefore does not have the capacity to simulate changes to the groundwater system in the North Westside Basin due to changes in hydrologic conditions in the South Westside Basin, a key component of this analysis. In particular, the head in the Deep Aquifer along this boundary is assumed to be the same as the head in the Shallow Aquifer, which does not conform to measurements (see TM#1). Finally, the model assumes that the gradient across the entire model domain is the same as in Golden Gate Park, while the gradient across the southern Sunset District has been shown to be lower than in Golden Gate Park (see, for example, HydroFocus, 2009). Unlike the Westside Basin model, the SIM is explicitly designed to handle the problems of dual-density fluids and the movement of seawater onshore. The SIM used a combination of the finite-element code MicroFem and a seawater migration routine developed by CH2M HILL.

The SIM simulated the intrusion of seawater into the North Westside Basin under various pumping conditions (total of 9 scenarios). These scenarios dealt with the installation of three wells, and increased pumping in one previously-existing well. The new wells, located between Golden Gate Park and Lake Merced: one at the location of the currently proposed West Sunset Playground well, one at the Francis Scott Key Elementary School, and one at Noriega Early

Education School. The previously existing well was the Elk Glen well in Golden Gate Park. All other pumping in the study area was set equal to values estimated for water year 1988. The total pumping under their calibration scenario was 1.02 mgd.

Total additional pumping in the four wells mentioned varied from 0.54 to 0.94 mgd in the nine model scenarios. For all of these scenarios, the greatest pumping occurred at the Elk Glen well, due to the fact that the freshwater flux through Golden Gate Park is assumed to be greater than it is to the south of the Park. The pumping was generally assumed to be equal in the three proposed Sunset wells.

The results of this modeling exercise indicate that the North Westside Basin can handle an additional pumping load of about 0.9 mgd above the rates of water year 1988, as long as the pumping is properly configured. Rates between 0.91 and 0.94 mgd did induce seawater intrusion into the proposed Sunset wells, which are well inland (some 2,000 feet or more) from the coast. This implies that smaller amounts of pumping in the Sunset area would induce substantial seawater intrusion some way inland of the coast. The baseline scenario of the CH2M HILL model (which involved no changes from existing pumping) calculated the top of the freshwater-seawater interface (i.e., the point where the freshwater discharges from the seafloor) as being about 1,400 feet offshore. Figure 10 in CH2M HILL (1995) shows the calculated location of the interface along a cross-section perpendicular to the coast that runs through their proposed well at the Francis Scott Key School; at this location, the toe of the interface wedge stretches inland from the shore by about 2,200 feet, while the well is about 2,600 feet inland. Under one pumping scenario shown, the toe of the wedge stretches inland for more than 4,600 feet, although the interface does not actually intersect the well since it is not screened across the entire model thickness. The results of the CH2M HILL model indicate that, at least in the North Westside Basin, pumping of about 2 mgd may result in the landward shift of the seawater-freshwater interface.

As stated above, the CH2M HILL model has certain limitations that make it less than ideal for analyzing seawater intrusion into the North Westside Basin along the Pacific Coast. The first is that the model is a steady-state model, meaning that it simulates seawater intrusion at equilibrium. Thus, it does not have the capacity to model seawater intrusion in the context of changing conditions, whether these changes are in the amount and location of pumping, or in the climatic conditions that act as inputs to the model (such as wet years and droughts). Second, the SIM does not have the capacity to allow conditions from Lake Merced south to change dynamically, meaning that it cannot simulate how the North Westside Basin would respond to changes in the South Westside Basin. Therefore, the HydroFocus Westside Basin model is considered a better tool to assess the dynamic vulnerability of the North Westside Basin to seawater intrusion.

3.2. MODFLOW Model

The existing Westside Basin Groundwater-Flow Model (HydroFocus, 2007, 2009, and 2011) was used as a tool to provide the level of analysis necessary to evaluate the potential for seawater intrusion as a result of the GSR and SFGW Projects. The setup and results of the model are documented in TM-10.1. A limitation of this model is the handling of the boundary conditions representing the Pacific Ocean and San Francisco Bay. These boundary conditions are set to a constant head of zero elevation. This usage is overly rigid, limiting the ability of the near-Ocean head in the aquifer to behave dynamically. HydroFocus (2007) states that "model results should be interpreted with caution near constant head boundaries like the Pacific Ocean or San Francisco Bay."

The model does not simulate dual-density flow. Therefore, the application of the model results to the problem of seawater intrusion is accomplished in this TM chiefly by analyzing how hydrologic controls are affected by the conditions simulated by the various scenarios, rather than by any direct simulation of seawater flow and transport. The two important hydrologic controls that will be examined here are the flux toward the Ocean or Bay and the groundwater (freshwater) head elevation. The more the oceanward flux is reduced, or the lower the groundwater head drops, the less effective would be the hydrologic controls preventing seawater intrusion (as discussed above, a lack of hydrologic control on seawater intrusion does not automatically imply actual intrusion, as physical controls may still exist that effectively prevent intrusion).

3.3. Model Scenario Summary

Five model scenarios were constructed and simulated to evaluate potential groundwater and related hydrological effects from the GSR and SFGW Projects and from the Cumulative Scenario that includes the GSR and SFGW Projects and other reasonably foreseeable future projects. The following is a summary of the five scenarios used for the groundwater model analysis:

- Scenario 1, Existing Conditions: Scenario 1 represents the continuation of the Existing Conditions into the future and does not include the SFPUC Projects (either GSR or SFGW Project). Groundwater pumping by the PAs and irrigation pumping are representative of the existing pumping conditions (as of June 2009). The PA pumping was established based on the historical pumping rates, using the median of the 1959-2009 pumping data for individual agencies.
- Scenario 2, GSR Project Only: Scenario 2 represents implementation of the GSR Project operations including put periods when groundwater pumping by SFPUC and the PAs does not occur and groundwater is placed into storage using in-lieu recharge; hold periods when the PAs are pumping and no in-lieu recharge is occurring because the SFPUC Storage Account is full, and take periods which represent periods when both SFPUC and the PAs are pumping from the South Westside Basin.

- Scenario 3a, SFGW Project Only (3 mgd): For Scenario 3a, the four new wells constructed for the SFGW Project would pump an annual average of 3.0 mgd; however, the two existing irrigation wells in Golden Gate Park would remain irrigation wells, and their pumping rates would be the same as in Scenario 1.
- Scenario 3b, SFGW Project Only (4 mgd): For Scenario 3b, the four news wells constructed for the SFGW Project and the two modified irrigation wells in Golden Gate Park would pump an annual average of 4.0 mgd. Irrigation in Golden Gate Park is assumed to be replaced by the WestsideRecycled Water Project. Total combined pumping in the Westside Basin for Scenario 3b is slightly less than Scenario 3a, because the total SFGW Project pumping in Scenario 3b would increase by 1.0 mgd, whereas the irrigation pumping that is replaced would be slightly more than 1.0 mgd.
- Scenario 4, Cumulative Scenario: Scenario 4 represents implementation of both the GSR and SFGW Projects (Scenarios 2 and 3b) along with other reasonably foreseeable future projects. The other foreseeable projects are discussed in more detail in TM-10.1 but primarily include the Daly City Vista Grande Drainage Area Improvements Project, which increases stormwater diversions into Lake Merced, and a minor increase in irrigation pumping based on the planned build-out of the Holy Cross cemetery.

As discussed in TM-10.1, the strongest predictive capability of the existing model is to forecast relative changes over time, rather than absolute predictions of head. Therefore, analyzing differences in head relative to a base case rather than the actual groundwater elevation output by the model is the more appropriate method to evaluate the results of the groundwater model. However, in the case of seawater intrusion, the important relationship is between groundwater head in the model and sea level, so absolute head must be considered in this analysis as well. Scenario 1 (the Existing Conditions scenario) forms a basis of comparison for evaluating the results of the GSR-only, SFGW-only, and Cumulative Project scenarios.

To allow for the model scenarios to be directly comparable, all five model scenarios are set up using similar sets of assumptions regarding initial conditions and background hydrology. All of the modeled scenarios have the same projected simulation period of 47.25 years and use initial groundwater conditions representing June 2009 conditions.

All five model scenarios use the same hydrologic sequence and include the 8.5-year Design Drought period included in the Water System Improvement Program Environmental Impact Report PEIR (SFPUC, 2008b and 2009c). The 8.5-year Design Drought repeats the December 1975 to March 1978 drought period following the dry hydrologic conditions of July 1987 to November 1992. To incorporate the Design Drought, the historical hydrological sequence was rearranged. A more detailed discussion of the development of the background hydrology is presented in TM-10.1.

Table 10.3-1 presents a summary of the estimated Basin-wide average pumping rates corresponding to each of the model scenarios. Note that, in addition to the anticipated GSR and

SFGW Project wells, average pumping rates are also provided for the PA wells and for irrigation wells in Golden Gate Park.

3.4. Use of Model Results

As stated above, HydroFocus (2007) suggests that the strongest predictive capability of the MODFLOW model is to forecast relative changes over time, rather than absolute predictions of head. Therefore, the model analysis for the different scenarios will consider differences in head and flux relative to the Existing Conditions Scenario (Scenario 1). However, because seawater intrusion is dependent on the relationship between elevations of the seawater and the freshwater aquifers, it is necessary to evaluate the simulated groundwater elevations as well as the relative changes, to evaluate the potential for seawater intrusion.

For the evaluation of the model scenarios, the results of the MODFLOW model are applied to seawater intrusion by considering the flux of water across the coastal boundary conditions and the head just landward of the coastal boundaries. These quantities will be analyzed for each of the five model scenarios listed at the beginning of this section.

3.4.1. Head Results

The numerical model includes the capability of monitoring head at 87 different monitoring points, included to track head in the aquifer. Of these, this section examines the results for 9 monitoring points along the Pacific Coast and 3 monitoring points along the Bay Coast. Hydrograph representations for each of the monitoring points are presented as Figures 10.3-4 through 10.3-15. In each of these figures, the upper panel includes the absolute simulated head for each of the five scenarios; the lower panel is the difference between the results of each scenario and those of Scenario 1. Each figure presents results for Model Layer 1, 4, or 5 as representative of conditions in the Shallow, Primary Production, or Deep Aquifer, respectively. The exclusion heads plotted on these figures represent a theoretical freshwater head that must be maintained at the well location to prevent seawater intrusion to reach that location; see Section 3.5. Selected statistics (average, maximum and minimum as calculated from the 47.25 years of model simulation) were compiled for the difference between the head results of the four Project scenarios and Scenario 1 (Table 10.3-2).

Along the Pacific coast, 9 monitoring locations were set in the numerical model. All of these except for North Windmill correspond to locations of an actual monitoring well or well cluster, which correspond to the seawater intrusion monitoring network already existing along the Pacific Coast (Figure 10.3-1). The North Windmill location corresponds to a historical well location, but not an active monitoring well. These locations include:

- North Windmill
- South Windmill
- Kirkham
- Ortega
- West Sunset Playground

- Taraval
- Zoo
- Fort Funston
- Thornton Beach

Along the Bay Coast, monitoring locations were set in the numerical model at the locations of actual monitoring well clusters (UAL, SFO, and Burlingame). These locations correspond to the seawater intrusion monitoring network already existing in the South Westside Basin (Figure 10.3-1). The UAL cluster consists of pre-existing monitoring wells, but the SFO and Burlingame clusters were installed as part of work conducted under Assembly Bill 303[2] specifically to track the occurrence of seawater intrusion (WRIME, 2007).

In addition to the absolute and relative heads depicted in the hydrographs (Figures 10.3-4 through 10.3-15), seasonal fluctuations in absolute head were computed for each of the model scenarios. These values were determined by calculating the average annual difference in head values under each scenario for May (generally representing the highest annual heads) and November (generally representing the lowest annual heads). These values were analyzed to determine whether the aquifer experiences annual head declines sufficient to leave it substantially more susceptible to seawater intrusion during the dry parts of the year.

3.4.2. Flux Results

The flux of groundwater out to the Ocean or Bay from the coast is a convenient variable for tracking the occurrence of seawater intrusion in the model domain because it tracks the amount of water passing through the boundary conditions placed along the coastlines. The fluxes are presented as total fluxes for the entire North Westside Basin (Pacific Coast) (Figure 10.3-16) and South Westside Basin (Bay Coast) (Figure 10.3-17). This means that these flux values indicate whether or not each of the coasts is, as a whole, experiencing seawater intrusion on average. Seawater intrusion is expected to occur locally during its initial stages, and this would not be captured in this analysis. However, in the context of the strengths and limitations of the numerical model discussed above, this approach is considered a sufficiently comprehensive, conservative, and scientifically-sound evaluation that properly addresses seawater intrusion.

A positive freshwater flux toward the Ocean or Bay does not necessarily preclude seawater intrusion, because the seawater wedge would enter into the lowest part of the freshwater aquifer. Therefore, the use of modeled freshwater flux as a proxy for seawater intrusion is a way to indicate when intrusion is predicted to be a major problem, rather than when it might begin to occur.

As with the head analysis, this analysis of the flux calculated by the numerical model is not able to give accurate quantification of the intrusion of seawater into the freshwater aquifer. This is

[2] Passed by the California Legislature in 2000, Assembly Bill 303 created the Local Groundwater Assistance Grant Program, providing funding to local public agencies for the performance of groundwater studies or to carry out groundwater monitoring and management activities.

due to several factors: the flux numbers are totals of flux along the entire coastline; the boundary condition along the coastline does not accurately reflect the dynamic conditions at the land-Ocean interface; and the real occurrence of seawater intrusion is a complex process involving aquifer heterogeneity, tidal fluctuations, diffusive transport, and dual-density fluid flow, which are not captured in the existing model.

3.4.3. Groundwater Contour Map Analysis

Under Scenario 1, the model-simulated groundwater elevations for the Shallow Aquifer (Model Layer 1) are above sea level throughout the North Westside Basin (Figure 10.3-18). The water table gradient was highest through Golden Gate Park and along the fronts of the elevated bedrock areas, and lowest just north of Lake Merced. Water table elevations were predicted to be between five and ten feet above sea level in the direct vicinity of the Coast, with higher elevations along the northern part of the Coast. This indicates that the existing conditions are not anticipated to induce seawater intrusion along the Pacific Coast.

3.5. Application of Analytical Method Along the Pacific Coast

As mentioned, the Westside Basin model does not have the capability to evaluate seawater intrusion using the density differences between freshwater and saline water. Therefore, an analytical evaluation is included with the groundwater model results to incorporate the density driven components of seawater intrusion while evaluating the MODFLOW output.

3.5.1. Methodology

The movement of the seawater-freshwater interface is a dynamic process that is dependent upon the relative difference in the freshwater and seawater groundwater head, flux and density. The analytical method discussed in Attachment A was used to evaluate the freshwater head, based on the Ghyben-Herzberg relationship, necessary to maintain hydrologic control, keeping seawater from intruding into freshwater aquifers (a function of the depth below sea level of the bottom of the aquifer). This value is termed the “exclusion head” and it represents a conservative analysis for maintaining freshwater aquifer conditions (see Section A.5).

The freshwater head results from the numerical model were compared to the exclusion head at the various monitoring points; it is assumed that groundwater head at a location equal to or greater than its exclusion head indicates that the location would not experience seawater intrusion.

For locations where the groundwater head stays above the exclusion head, the pressure of the freshwater aquifer is sufficient that seawater would not intrude to this location based on the Ghyben-Herzberg relationship for the aquifer thickness at a given location.

For locations where groundwater head falls below the exclusion head, there is the potential that seawater could intrude to this location. However, there are other factors that control seawater intrusion, so groundwater head below the exclusion head does not necessarily imply that seawater intrusion may reach this location, but rather that the hydrologic potential exists for the landward migration of the seawater-freshwater interface. Therefore, this is a conservative analysis of the potential for seawater intrusion.

If groundwater head moves back above the exclusion head, the interface could be expected to slow or reverse its movement toward land. It should be noted that sustained, repeated fluctuations in head, even when they remain above the exclusion head, would result in a widening of the transition zone between seawater and freshwater.

Movement of the seawater-freshwater interface is a slow process. Seawater intrusion may not manifest in a production well for a number of years, and only when the conditions leading to seawater intrusion are continuously sustained for an extended period of time, depending on aquifer conditions. Additionally, physical controls, where present, can prevent seawater intrusion even if head conditions are maintained below the exclusion head long-term.

Uncertainty in these results is due mostly to uncertainties in the prediction of the input parameter, *b* (aquifer thickness below sea level). However, uncertainties in the estimate of *b* must be very large to create substantial errors in the estimate of the exclusion head, due to the fact that the exclusion head is only a fraction of the aquifer thickness. Additionally, the analytical method assumes that the individual aquifers are single bodies; if aquifers are divided up into several discrete sections separated by continuous low-permeability layers, seawater intrusion would be less extensive than indicated by this method because the exclusion head is higher in the thicker, composite aquifer than in the thinner, separate aquifers.

It is important to note that the analytical analysis presented here assumes that the aquifer is near horizontal. As the analytical method shows (Attachment A), this has some effect on the length of intrusion. The aquifers present in the North Westside Basin are actually sloped toward the Ocean, and so the intrusion length could be expected to be somewhat smaller than shown by the analytical method, thus making the analysis more conservative with relation to the potential for seawater intrusion.

3.5.2. Definition of Parameters

For this analysis, the elevation of the base of the aquifer is the only variable that must be known. Because the offshore structure of the coastal aquifers (e.g., the continuity of low-permeability layers between aquifers, which is key to the movement of intruding seawater) is not precisely known, two approaches were taken to compute the exclusion head. The thicknesses were then input into the Ghyben-Herzberg equation to determine the exclusion head. These levels are indicated on Figures10.3-4 through 10.3-15, and given in Table 10.3-3.

Along the Pacific Coast, the sediment thickness is considered to include several aquifers (multiple-aquifer case). The thicknesses of the individual aquifers were determined using the cross-sections of LSCE (2010) by estimating (to the nearest 10 feet) the elevations of the bottom of each aquifer below sea level. It should be noted that extensive clay layers present within an aquifer (e.g., the Y clay within the Primary Production Aquifer at the Taraval and Zoo clusters) are not removed from the aquifer thickness, so that these clay layers are counted as part of the aquifer. This is a conservative assumption, as excluding them would reduce the thickness of the aquifer, thereby reducing the exclusion head. Because the Primary Production Aquifer is thicker than the other two aquifers, the values of exclusion head in this aquifer are higher than in the others.

3.5.3. Use of the Analytical Evaluation

As discussed, the results are a conservative estimate of the potential for seawater intrusion along the Coast, but do provide a point of reference for evaluating the MODFLOW results with respect to the density aspects of seawater intrusion. The analysis can identify areas where seawater intrusion would not occur, or where there is the potential that seawater intrusion may occur. Other factors have to be considered. A major limitation to evaluation of seawater intrusion is that the seawater-freshwater interface has not been located along the Pacific Coast.

The results of this analysis for the Pacific Coast are discussed for the SFGW-Only and Cumulative Scenarios. The GSR-Only Scenarios are not presented, because the MODFLOW model analysis showed little variation from Scenario 1.

4. GSR Only Scenario Analysis

The GSR-Only Scenario analysis evaluates the potential for seawater intrusion from the operation of the GSR Project. The GSR Project is a conjunctive use project that would allow for increased groundwater supplies in the Westside Basin during periods of drought (MWH, 2008). The GSR Project is sponsored by the SFPUC in coordination with its PAs: Cal Water, Daly City, and San Bruno. The GSR Project is located within San Mateo County in the South Westside Basin. This Project is discussed in more detail in Section 1.1 of this TM, and in TM-10.1. In summary, the PAs would reduce pumping during normal and wetter than normal times (put periods) to naturally replenish groundwater in the South Westside Basin, and both SFPUC and the PAs would extract groundwater during drier than normal times (take periods). The total pumping capacity to be developed by the Project would be about 7.2 mgd, and the maximum amount of groundwater that would be placed in a storage account via this in-lieu recharge would be 60,500 af (MWH, 2008). If surface water is available, but the storage account is full (hold periods), the PAs would pump as during a take period, but SFPUC would not extract groundwater, aside from a small amount to exercise the Project wells[3].

4.1. Conceptual Analysis

The GSR Project consists primarily of using excess surface water instead (or “in-lieu”) of pumping groundwater from the Westside Basin. The Project is planned to have up to 60,500 af of in-lieu recharge capacity. During the take cycle, both SFPUC and the PAs would be pumping groundwater; however, SFPUC would not take more than the amount of in-lieu recharge available in the SFPUC Storage Account.

In addition, the GSR Project would be operated in the South Westside Basin, where groundwater head has been substantially below sea level for decades. This portion of the Basin appears to be isolated from sources of saline water from the Pacific Ocean and San Francisco Bay.

Because of this mode of operation, the GSR Project would typically produce groundwater head similar to or higher than Scenario 1 in the South Westside Basin. Higher groundwater head would typically have the effect of reducing the potential for seawater intrusion due to the higher freshwater head and flux towards the Ocean and the Bay. Therefore, in general, the likelihood of seawater intrusion resulting from the GSR Project is considered to be low.

4.2. Model Results along the Pacific Coast

The GSR-only Scenario (2) does not include any additional pumping in the North Westside Basin, so large changes in head are not anticipated in this area. Hydrographs (Figures 10.3-4 through 10.3-12) present the model-derived head for this scenario, as well as the differences in

[3] Exercising the production wells would entail pumping for a few hours approximately monthly, with an anticipated average monthly total production rate for all of the wells of 0.04 mgd.

head between this scenario and Scenario 1. Table 10.3-2 presents the maximum, average, and minimum differences between the results for this scenario and those of Scenario 1.

4.2.1. Head

In Model Layer 1, head at the various monitoring locations is generally slightly higher than under Scenario 1 throughout most of the simulation duration, dropping slightly below Scenario 1 levels at the end of the simulation. The maximum increase over Scenario 1 (Table 10.3-2a) is less than a foot at all of the monitoring locations except the West Sunset Playground well (1.3 ft; Figure 10.3-8) and the Zoo cluster (2.7 ft; Figure 10.3-10). The maximum decrease compared to Scenario 1 at the end of the simulation reaches a maximum of 0.4 ft at the Zoo cluster, and is 0.2 ft or less at all other locations.

In Model Layer 4, the difference in head from Scenario 1 follows a similar pattern to that of Model Layer 1, but the changes tend to be more pronounced, especially in the southern part of the North Westside Basin. The maximum increase over Scenario 1 (Table 10.3-2b) varies from 0.1 ft at the South Windmill cluster (Figure 10.3-5) to 6.1 ft at the Zoo cluster. In almost all monitoring locations, the head results from Scenario 2 are above those of Scenario 1 except during and after the Design Drought, except at the Thornton Beach cluster (Figure 10.3-12), where head drops below the Scenario 1 results around Scenario Year 28. The maximum decrease compared to Scenario 1 near the end of the simulation varies from 0.1 ft at the South Windmill cluster to 4.3 ft at the Zoo cluster. This Model Layer is not present at the North Windmill location.

In Model Layer 5, the difference in head from Scenario 1 follows a similar pattern to that of the other Model Layers, with still more pronounced changes. The Scenario 2 heads are below those of Scenario 1 during the take periods (as shown by large downward deflections in relative head difference) at many locations. The maximum increase over Scenario 1 (Table 10.3-2c) varies from 0.3 ft at the Kirkham cluster (Figure 10.3-6) to 12.2 ft at the Zoo cluster. The greatest relative decrease at all locations occurs just after the Design Drought, and varies from 0.2 ft at the Kirkham cluster to 14.4 ft at the Zoo cluster. Head values recover to levels similar to or above those of Scenario 1 throughout the North Westside Basin by the end of the simulation period. This Model Layer is not present at the North Windmill location or the South Windmill cluster.

The average differences presented here indicate that the GSR Project would not have a substantial effect on the occurrence of seawater intrusion in the North Westside Basin within the Shallow Aquifer. There would also not be much of an effect north of the Zoo cluster in the Primary Production Aquifer. In the southern part of the North Westside Basin, head dips during take periods, particularly the Design Drought. The effect is smallest in Model Layer 1, greater in Model Layer 4, and largest in Model Layer 5 (Figures 10.3-4 through 10.3-12). The magnitude of the dips in head is indicated by the maximum relative decrease compared to the results of Scenario 1 (“minimum difference” in Table 10.3-2). Although the declines in head during the take periods are locally substantial (greatest during the Design Drought in the southern part of the North Westside Basin in the Deep Aquifer; see results for the Zoo cluster above), the aquifer returns to conditions similar to Scenario 1 by the end of the simulation period, indicating that the situation of lowered head is fairly short-lived.

Simulated seasonal fluctuations in head (defined in Section 3.5.1; Table 10.3-4) varied in Model Layer 1 from 0.5 ft at the Taraval cluster to 1.7 ft at the North Windmill location, from -0.7 ft (South Windmill cluster) to 0.3 ft (Kirkham, Ortega, and Taraval clusters and West Sunset Playground well) in Model Layer 4, and from -0.5 ft (Zoo cluster) to 0.3 ft (Kirkham and Ortega clusters) in Model Layer 5; it should be noted that negative values of seasonal fluctuation indicate that head is generally higher in the summer than in the winter. The greatest fluctuations are in Model Layer 1 at every location, as the Shallow Aquifer (represented by Model Layer 1) directly receives recharge from precipitation, the root cause of the seasonal fluctuations. These results indicate that seasonal changes in head are not very large, and would not substantially affect the occurrence of seawater intrusion in the North Westside Basin.

4.2.2. Groundwater Flux

Freshwater flux leaving the model domain through the Pacific Coast is the result of recharge in the upper reaches of the North Westside Basin that flows through the aquifers in this Basin toward the Ocean. A reduction in this freshwater flux indicates an increasing chance of seawater intrusion occurring along this coast. Figure 10.3-16 shows the fluxes predicted for the North Westside Basin by the numerical model, as well as the difference between the results of each scenario and Scenario 1. Table 10.3-5 gives the maximum, minimum, and average monthly freshwater fluxes and fluxes relative to Scenario 1 for each scenario.

As discussed above, the GSR Project pumping conditions included in Scenario 2 are not expected to have a large effect on head in the North Westside Basin. Therefore, the freshwater flux into the Pacific Ocean is not expected to change very much. Indeed, Figure 10.3-16 indicates very minor differences between Scenario 1 and this scenario. For most of the duration of the model simulation, the freshwater flux out of the Pacific Coast remains above the Scenario 1 conditions, up to 30 acre-feet per month (afm). Toward the end of the simulation, during the Design Drought, the freshwater flux dips slightly below the Scenario 1 conditions, by up to about 10 afm. The minimum freshwater flux for this scenario was about 150 afm, the same as for Scenario 1. Compared to the absolute flux values (an average of about 270 afm for Scenario 2 versus an average of about 260 afm for Scenario 1), the differences in flux values indicate, as do the head results, that the GSR Project pumping conditions are not expected to have a substantial effect on the occurrence of seawater intrusion in this part of the Basin.

4.2.3. Groundwater Contour Map Analysis

Under Scenario 2, the model-simulated groundwater elevation map for the Shallow Aquifer at the end of the simulation period (Figure 10.3-19) is almost identical to that simulated under Scenario 1 (Figure 10.3-18), with slightly lower groundwater elevations (by approximately 5 feet or less) in the southern part of the North Westside Basin; almost no difference is visible north of

Lake Merced. This confirms that the operation of the GSR Project by itself would have little effect on the water table in the North Westside Basin. This indicates that the GSR Project is not anticipated to induce seawater intrusion along the Pacific Coast.

4.2.4. Evaluation

Pumping in the South Westside Basin for the GSR-only Scenario (2) would have only a minor effect on groundwater head in the North Westside Basin. These conditions are anticipated to lead to minimal landward movement of the seawater-freshwater interface due to operation of the GSR Project.

None of the monitoring points in Model Layer 1 show head falling below sea level, although some of the heads do approach sea level. In Model Layer 4, the head drops below sea level at the Zoo and Taraval clusters and the West Sunset Playground well. In Model Layer 5, the head drops below sea level at the Ortega, Taraval, Zoo, and Fort Funston clusters and the West Sunset Playground well. In fact, head is largely below sea level throughout the simulation period in the southern half of the North Westside Basin in Model Layers 4 and 5, indicating that the hydrologic conditions would be conducive to seawater intrusion; however, as noted above, these layers are likely to have physical controls that would prevent intrusion from happening. In addition, at no location does head drop below sea level in the Scenario 2 results without also dropping below sea level in the Scenario 1 results. The differences between this scenario and Scenario 1 are not great, with generally higher head through most of the simulation except the take periods (Section 4.2.1), indicating that the changes in the pumping regime included in the GSR Project would not substantially alter the likelihood of seawater intrusion along the Coast. The drops in head seen during the take periods may lead to conditions more favorable for seawater intrusion along the Pacific Coast, but the drops do not persist for more than a few years after the end of each take period, indicating that any such increase in the possibility of seawater intrusion due to the operation of the GSR Project would be temporary. Similarly, seasonal declines in freshwater head throughout the North Westside Basin are unlikely to substantially alter the likelihood of seawater intrusion along the Pacific Coast, as the declines are temporary and compensated for by seasonal increases. In much of the North Westside Basin, the differences between Scenarios 2 and 1 are not great, indicating that the GSR Project is not responsible for any substantial decreases in head.

4.3. Model Results along the San Francisco Bay Coast

The GSR-only scenario (Scenario 2) focuses on changes in the pumping regime in the South Westside Basin, so substantial changes in head may occur in this area. Figures 10.3-13 through 10.3-15 show heads for this scenario, as well as the differences in head versus Scenario 1 (note that the results for this Scenario are nearly identical to those of Scenario 4, so their lines overlap on the hydrograph figures). Table 10.3-2 presents the maximum, average, and minimum differences between the results for this scenario and those of Scenario 1.

4.3.1. Head

Under GSR-only conditions, the heads in the Bay monitoring system react similarly to the Scenario 1 conditions. Compared to Scenario 1, the head results of Scenario 2 at the Burlingame cluster are mostly higher than under Scenario 1 (up to maximums of 1.3 ft in Model Layer 1 and 2.3 ft in Model Layer 4), although at the end of the simulation period the head in Model Layer 4 is lower, by up to 0.6 ft (Figure 10.3-13, Table 10.3-2b). At both the SFO (Figure 10.3-14) and UAL (Figure 10.3-15) clusters, the Scenario 2 results are higher (up to 3.1 ft at the SFO cluster and 2.4 ft at the UAL cluster) in Model Layer 1 than in Scenario 1. Model Layer 4 is not present at the SFO and UAL clusters, and Model Layer 5 is not present at any of the three well clusters along the Bay coast.

To understand the implications of the Scenario 2 results, it is helpful to note how groundwater head behaves in this area under Scenario 1. The Burlingame cluster is projected to see a substantial decline in head during Scenario 1, approaching sea level in Model Layer 1 (Figure 10.3-13), while in Model Layer 4, head at the Burlingame cluster begins just above sea level, and declines throughout the scenario. These results indicate that, if there is a route for seawater intrusion, intrusion would become more rapid over the simulation period in both Model Layers. Because Scenario 2 head results are mostly higher than under Scenario 1 throughout the simulation, the potential rate of seawater intrusion over time would actually be lower than in Scenario 1. At the SFO (Figure 10.3-14) and UAL (Figure 10.3-15) clusters, head under Scenario 2 rises throughout most of the simulation period, indicating that, if seawater intrusion were occurring in this area, its pace may decline or even reverse.

Whether heads are higher or lower under Scenario 2, the results are not very different from those of Scenario 1. This indicates that the GSR Project pumping rates would not have a substantial effect on the occurrence of seawater intrusion in this part of the Basin because groundwater head is mostly higher than under Scenario 1.

Seasonal fluctuations along the Bay Coast are very small, and all between +0.1 ft and -0.1 ft for this scenario (Table 10.3-4). These results indicate that seasonal fluctuations in head would not have a substantial effect on seawater intrusion in this area.

4.3.2. Groundwater Flux

Freshwater flux into the San Francisco Bay is expected to be substantially lower than flux into the Pacific Ocean. The exposed coastline is somewhat shorter, the Bay Mud presents a low-permeability barrier between the freshwater aquifer and the saline water, the aquifer is thinner, and heads on land are lower. As discussed in Section 7.3, this area may or may not be physically susceptible to seawater intrusion. Table 10.3-5 gives the maximum, minimum, and average monthly freshwater fluxes and fluxes relative to Scenario 1 for these scenarios.

Scenario 2 adds the pumping entailed in the GSR Project. The maximum freshwater flux is about 110 afm, while the minimum is about 70 afm (Figure 10.3-17); these maximum and minimum numbers are similar to those of Scenario 1. The freshwater flux is slightly higher than in Scenario 1 through most of the simulation before dropping below Scenario 1 conditions around Scenario Year 40, during the Design Drought. Because the freshwater flux is generally higher than under Scenario 1 conditions, GSR Project pumping is not anticipated to have a substantial effect on seawater intrusion along the Bay Coast.

4.3.3. Evaluation

In general, the changes to groundwater pumping for the GSR-only Scenario (2) would not have a substantial effect on the potential for seawater intrusion compared to Scenario 1 conditions. The freshwater flux out of the aquifer into the San Francisco Bay is quite low, and is not modified to any great degree by the pumping configurations simulated in the numerical model.

The modeling results suggest that the Bay Coast is not especially vulnerable to seawater intrusion, at least under the conditions simulated by the model (Figure 10.3-17). The presence of the Bay Mud is considered to represent a physical barrier that limits the potential for seawater intrusion along the San Francisco Bay Coast, even when groundwater head is lowered.

5. SFGW Only Scenario Analysis

The SFGW Project would provide a local source of high-quality groundwater within the North Westside Basin. The SFGW Project is discussed further in Section 1.1 and TM-10.1.

The SFGW Project Scenarios (3a and 3b) simulate increased pumping in the North Westside Basin, and so the model predicts a much greater change in head in this area under these scenarios than under the GSR Project Scenario (2). Scenario 3a assumes that irrigation in Golden Gate Park would continue as in the past. Scenario 3b assumes that irrigation would be provided largely by a recycled water project, so that two of the existing irrigation wells can be converted for use as a municipal supply. These two scenarios begin with June 2009 initial head conditions.

5.1. Conceptual Analysis

Because operation of the SFGW Project includes substantial pumping of groundwater, and the wells to be utilized are located relatively close to the Pacific Coast, there is the potential for seawater intrusion in this area. Therefore, additional analysis is necessary to characterize the potential for seawater intrusion in the North Westside Basin. However, because of the distance from the pumping wells to the San Francisco Bay Coast, the potential of seawater intrusion induced by the SFGW Project in the South Westside Basin is low.

5.2. Pacific Coast

The SFGW-only Scenarios (3a and 3b) include substantial additional pumping in the North Westside Basin (3.0 mgd and 2.9 mgd, respectively; see Table 10.3-1), so changes in head would be expected to occur in this area. Figures 10.3-4 through 10.3-12 show head results for these scenarios, as well as the differences in head between these scenarios and Scenario 1. Table 10.3-2 presents the maximum, average, and minimum differences between the results for these scenarios and those of Scenario 1.

5.2.1. Head

Scenario 3a: In general, heads in the North Westside Basin under Scenario 3a decline quickly over the first approximately 10 years of the simulation period, eventually leveling out at a fairly constant offset from Scenario 1 results (Figures 10.3-4 through 10.3-12). This fairly constant offset (as represented by the average difference between the scenario results and those of Scenario 1 from Scenario Years 37 to 47) varies from well to well. In Model Layer 1 (Table 10.3-2a), the average offset varies from 0.1 ft at the Fort Funston cluster to 23.0 ft at the West Sunset Playground well. In Model Layer 4 (Table 10.3-2b), the average offsets varied from 0.3 ft at the Thornton Beach cluster to 18.5 ft at the Zoo cluster. In Model Layer 5 (Table 10.3-2c), the average offsets varied from 0.3 ft at the Thornton Beach cluster to 6.9 ft at the West Sunset well cluster. Note that head decreases more at the West Sunset Playground well because its location is close to a proposed SFGW Project production well. Additionally, it is important to note that this well is about 3,000 feet inland, so results at this location should not be considered typical of head along the coast.

At the North Windmill location and the Fort Funston and Thornton Beach clusters (Figures 10.3-4, 10.3-11, and 10.3-12), the head in all present Model Layers remains at least a bit above sea level at all times during the model simulations. Elsewhere, head drops to sea level and below, up to -11.4 ft msl at the West Sunset Playground well (Figure 10.3-8a) in Model Layer 1, -31.3 ft msl at the Zoo cluster (Figure 10.3-10b) in Model Layer 4, and -32.1 ft msl at the Zoo cluster in Model Layer 5 (Figure 10.3-10c). After head declines slow between Scenario Years 10 and 15, heads are mainly above sea level at all Model Layer 1 locations aside from the West Sunset Playground well, only dropping below sea level at isolated times (particularly during the Design Drought). In Model Layer 4, head hovers around sea level at the South Windmill and Kirkham clusters, and remain below sea level through most of the simulation period at the Ortega, Taraval, and Zoo clusters and the West Sunset Playground well. In Model Layer 5, head is around sea level at the Kirkham cluster, and below sea level at the Ortega, Taraval, and Zoo clusters and the West Sunset Playground well.

Scenario 3b: Scenario 3b is similar to Scenario 3a, except that it includes the assumed recycled water delivered to Golden Gate Park; this means that total groundwater extraction in Golden Gate Park is slightly lower in Scenario 3b than in Scenario 3a, and also slightly lower in the South Sunset Playground and West Sunset Playground wells.

The difference between the results of Scenario 3b and Scenario 3a is generally not large. As might be expected by the scenario construction, head in the Golden Gate Park wells resulting from Scenario 3b is slightly lower at the North Windmill location (Figure 10.3-4a) and the South Windmill cluster (Figure 10.3-5) in Model Layer 1. In Model Layer 4, head at the South Windmill cluster is generally higher than in Scenario 3a, and with much larger seasonal fluctuations. At the Kirkham cluster (Figure 10.3-6b), head is generally slightly higher, with larger seasonal fluctuation, than in Scenario 3a. At the Ortega (Figure 10.3-7b), Taraval (Figure 10.3-9b), and Zoo (Figure 10.3-10b) clusters and the West Sunset Playground well (Figure 10.3-8b), head results for Scenario 3b are slightly higher than those for Scenario 3a. Finally, heads at the Fort Funston (Figure 10.3-11) and Thornton Beach (Figure 10.3-12) clusters are almost equal under Scenarios 3b and 3a.

Seasonal Fluctuations: Seasonal fluctuations are generally somewhat smaller than under Scenario 1 (Table 10.3-4). For Scenario 3a, values range from about 0.5 ft (West Sunset Playground well and Taraval cluster) to 1.6 ft (North Windmill location) in Model Layer 1, from -0.8 ft (South Windmill cluster) to 0.3 ft (Kirkham, Ortega, and Taraval clusters and West Sunset Playground well) in Model Layer 4, and from -0.6 ft (Zoo cluster) to 0.2 ft (Kirkham and Ortega clusters) in Model Layer 5. For Scenario 3b, seasonal fluctuations vary from 0.5 ft (West Sunset Playground well and Taraval cluster) to 1.3 ft (Fort Funston cluster) in Model Layer 1, from 0.0 ft (Fort Funston and Thornton Beach clusters) to 0.3 ft (South Windmill, Kirkham, and Taraval) in Model Layer 4, and from -0.6 ft (Zoo cluster) to 0.2 ft (Kirkham and Ortega clusters) in Model Layer 5. These results indicate that seasonal fluctuations in head would not have a substantial effect on the occurrence of seawater intrusion in this area.

5.2.2. Groundwater Flux

Scenario 3a includes increased pumping in the North Westside Basin envisioned as part of the SFGW Project. As discussed in Section 5.2.1, the general reaction of the aquifers in this part of the Basin is a decline in head, although it is not uniform throughout the area studied. This decline in head indicates that the oceanward freshwater flux could be expected to decrease. Figure 10.3-16 shows the freshwater flux predicted by the numerical model for this scenario. Table 10.3-5 gives the maximum, minimum, and average monthly freshwater fluxes and fluxes relative to Scenario 1 for these scenarios.

Although flux still responds strongly to climatic variation, the fluxes predicted for this scenario are much lower than those of Scenario 1, varying from a maximum of about 370 afm to a minimum of about 10 afm. Additionally, the variance of flux is higher (standard deviation of about 70 afm versus about 50 afm under Scenario 1).

As discussed above, the flux values presented in this analysis represent the total flux for the entire coast, and so can only be used to discuss average conditions along the coast. However, it is probable that, at the extremely low flux totals seen in this scenario, flux is either zero or negative (i.e., inland from the Ocean) at certain locations. Therefore, this analysis indicates that the increased pumping entailed by the SFGW Project would create conditions conducive to the potential inducement of seawater intrusion in localized areas along the coast.

Scenario 3b is identical to Scenario 3a, except as noted above. The results for this scenario are very similar to those of Scenario 3a: a maximum freshwater flux of about 350 afm, and a minimum of about 10 afm. The change in pumping conditions does not have a substantial effect on the flux out of this stretch of coastline compared to Scenario 3a, although the head results (Section 5.2.1) do show some spatial variability in the North Westside Basin. This indicates that the freshwater flux may be decreased in some places and increased in others compared to Scenario 3a, something that this analysis of total flux would not capture. These results indicate that the pumping rates and distribution of pumping under Scenario 3b would not have a substantial effect on seawater intrusion in the North Westside Basin compared to Scenario 3a, although the location and timing of intrusion may be affected.

These results indicate that there is no major difference between Scenarios 3a and 3b in terms of seawater intrusion, except on the coastline directly west of Golden Gate Park, where heads are projected to be slightly higher under Scenario 3b, possibly reducing the rate of intrusion along this part of the coast.

5.2.3. Groundwater Contour Map Analysis

Under Scenario 3a, the model-simulated groundwater head elevations for the Shallow Aquifer at the end of the simulation period (Figure 10.3-19) were lower than under Scenario 1

(Figure 10.3-18). This reflects the effect of the SFGW Project operations in the North Westside Basin. The head was just below sea level in the immediate area around West Sunset Playground and in central Golden Gate Park, representing the drawdown cones around production wells. Head was above sea level through most of the rest of the North Westside Basin, other than the southernmost parts (where head was below sea level in Scenario 1 as well).

Scenario 3b was similar to Scenario 3a, except as noted above. The model-simulated water table elevations in the North Westside Basin under this scenario (Figure 10.3-20) were mostly similar to those of Scenario 3a. The water table was very slightly higher at the western end of Golden Gate Park. The area of the North Westside Basin with groundwater heads below sea level under this scenario was slightly smaller than under Scenario 3a, as the cone of depression in central Golden Gate Park does not reach below sea level.

The map distributions for Scenarios 3a and 3b suggest that the area between the West and South Sunset Playgrounds would have an increased potential for landward migration of the seawater-freshwater interface resulting from groundwater pumping (as noted in Section 2, the groundwater elevation does not have to drop below sea level for seawater intrusion to occur). Areas along the northern part of the Coast are predicted to have higher groundwater head even with the pumping, suggesting a lesser potential for the landward migration of the seawater-freshwater interface in this area compared to the southern part of the Coast.

5.2.4. Evaluation of Analytical Results

Comparing the exclusion heads calculated by the analytical method (see Section 3.5.1) to the head results from the numerical model suggests that conditions near the Pacific Coast of the North Westside Basin under Scenarios 3a and 3b have the potential for seawater intrusion, particularly during periods of drought. Table 10.3-6 provides the percentage of each scenario duration during which head is below the applicable exclusion heads.

- At the North Windmill location (Figure 10.3-4), head in Model Layer 1 is below the single-aquifer exclusion head[4] for much of the simulation after about Scenario Year 10 (57% of the simulation duration for Scenario 3a, 60% for Scenario 3b), and is below the Shallow Aquifer exclusion head during the Design Drought and Scenario Year 27 (5% of the simulation duration for Scenario 3a, 4% for Scenario 3b).

- At the South Windmill cluster (Figure 10.3-5), head in Model Layer 1 is below the single-aquifer exclusion head for the entire simulation duration after about Scenario Year 4 (95% of the Scenario 3a simulation duration, 98% for Scenario 3b), and varies around the Shallow Aquifer exclusion head throughout most of the simulation duration (below the exclusion head for 73% of the simulation duration under Scenario 3a, 85% for

[4] As discussed in Section 3.5.1, this represents the exclusion head for the entire subsurface taken as a single aquifer, rather than discretized into multiple aquifers.

Scenario 3b). In Model Layer 4, head is below the single-aquifer and Primary Production Aquifer exclusion heads for the entire simulation.

- At the Kirkham cluster (Figure 10.3-6), head in Model Layer 1 is below the single-aquifer exclusion head for the entire simulation duration, and is mostly below the Shallow Aquifer exclusion head for most of the simulation after about Scenario Year 8 (77% of the Scenario 3a simulation duration, 75% for Scenario 3b). In Model Layers 4 and 5, head is below both exclusion heads for the entire simulation, although this is also true of Scenario 1.

- At the Ortega cluster (Figure 10.3-7), head in Model Layer 1 is below the single-aquifer exclusion head for the entire simulation duration (as is true of Scenario 1), and below the Shallow Aquifer exclusion head for the bulk of the simulation duration after about Scenario Year 6 (89% of the total simulation duration for both scenarios). In Model Layers 4 and 5, head is below both exclusion heads for the entire simulation, as is true for Scenario 1.

- At the West Sunset Playground Well (Figure 10.3-8), head in Model Layer 1 is below the single-aquifer exclusion head for the entire simulation duration after about Scenario Year 1 (99% of the simulation duration for both scenarios), and below the Shallow Aquifer exclusion head after about Scenario Year 6 (90% of the simulation duration for both scenarios). In Model Layers 4 and 5, head is below both exclusion heads throughout the simulation duration, as is the case for Scenario 1.

- At the Taraval cluster (Figure 10.3-9), head in Model Layer 1 is below the single-aquifer exclusion head throughout the simulation (as is the case for Scenario 1), and below the Shallow Aquifer exclusion head for the entire simulation duration after about Scenario Year 5 (91% of the simulation duration for both scenarios). Head in Model Layers 4 and 5 is below both exclusion heads for the entire simulation period, as is the case for Scenario 1.

- At the Zoo cluster (Figure 10.3-10), head in Model Layer 1 is below the single-aquifer exclusion head throughout the simulation duration (as is the case for Scenario 1), and varies around the Shallow Aquifer exclusion head for the entire simulation duration after about Scenario Year 14 (below for 35% of the simulation duration for Scenario 3a, 30% for Scenario 3b). Head in Model Layers 4 and 5 is below both exclusion heads for the entire simulation, as is the case for Scenario 1.

- At the Fort Funston cluster (Figure 10.3-11), head in Model Layers 1, 4 and 5 is below the single-aquifer exclusion heads for the model simulation, as is the case for Scenario 1. Note that the units at this cluster and at the Thornton Beach cluster do not correlate to the individual aquifers present east of the Serra Fault, so only the single-aquifer exclusion head is considered and presented on the hydrographs.
- At the Thornton Beach cluster (Figure 10.3-12), head in Model Layer 1 varies around the single-aquifer exclusion head throughout the simulation duration (below the exclusion head for 64% of the simulation duration for both scenarios, compared to 63% of the simulation duration for Scenario 1). Head is below the single-aquifer exclusion head for the entire simulation duration for Model Layers 4 and 5, as is true of Scenario 1.

These results indicate that there is the potential for the landward migration of the seawater-freshwater interface under the pumping conditions proposed for the SFGW Project along some parts of the Pacific Coast, but not others. The exclusion head is a way to evaluate the long-term potential for seawater intrusion. It is important to note that groundwater heads below the exclusion head at a location do not necessarily imply that seawater intrusion will reach that location, because there are other hydrogeologic factors that may influence the location of the seawater-freshwater interface. In particular, physical controls may exist, such as low-permeability layers or offshore fault zones, as discussed earlier. Rather, the analytical model indicates that there is an increased potential for the landward migration of the seawater-freshwater interface. Also, seawater intrusion is typically a slow process that may take years to manifest in a production well, and only if the conditions favorable for seawater intrusion are sustained continuously for an extended period of time.

Varying groundwater heads over the year can have a substantial effect on the movement of the seawater-freshwater interface. If groundwater head rises and falls within a similar range from year to year, then the seawater-freshwater interface would move back and forth in a similar fashion. If this were the case, the interface would not continue to advance landward over time, but would establish a new transition zone and remain at that new location over time. If groundwater head declines over a period but become stable at some lower level, then the seawater-freshwater interface would shift to a new equilibrium location, which may still be offshore.

For the most part, seasonal fluctuations in head in Model Layer 1 are not great enough to lower head below exclusion head values during dry parts of the year (Table 10.3-4). In general, seasonal fluctuations, even when they repeatedly cross the exclusion head, are not likely to substantially affect the occurrence of seawater intrusion, because intrusion occurs on a much greater time scale than these annual fluctuations. Therefore, the small inward interface migration that would occur during the low summer heads would be offset by the outward migration that would occur during the higher winter heads. In this conceptual scenario, the seasonal fluctuations would approximately cancel each other out, indicating that the average annual head is the most important factor that relates to the potential for seawater intrusion.

5.2.5. Evaluation

Groundwater head, especially in the southern half of the North Westside Basin, is projected by the model to be below sea level (and the calculated exclusion heads) for some or most of the simulation period. During the operation of the SFGW Project, the model results show lower groundwater heads throughout the northern half of the North Westside Basin. For Scenarios 3a and 3b, the groundwater heads along the Pacific Coast would be depressed and hydrologic conditions may allow for the landward migration of the seawater-freshwater interface in the aquifer in areas where no physical controls exist to prevent intrusion. Based on the groundwater elevation contour maps from the model, these areas would be limited to an area along the Coast. It is unclear how far landward the seawater-freshwater interface may move or at what rate.

Groundwater head responds similarly during drought periods compared to the same drought periods under Scenario 1, except that they are offset by fairly uniform amounts, so the change in head appears to be due almost entirely to the increase in pumping in this area; head also does not rebound to Scenario 1 levels during wet periods, indicating that the extra pumping in the North Westside Basin would have a uniform effect on head in both wet and dry times.

The results of this analysis indicate that the increase in pumping in the North Westside Basin entailed in the SFGW Project would result in the landward migration of the seawater-freshwater interface in the aquifer beyond that which would occur naturally due to climatic fluctuations. Although the flux results quantified by the numerical model are not expected to accurately represent the actual flux everywhere along the coast, the relative changes resulting from the various scenarios are informative for understanding the possible timing of seawater intrusion.

5.3. San Francisco Bay Coast

The SFGW-only Scenarios (3a and 3b) do not include any additional pumping in the South Westside Basin, so large changes in head are not anticipated in this area. Figures 10.3-13 through 10.3-15 show the difference in head for these scenarios versus Scenario 1 (note that the results of these scenarios are nearly identical to those of Scenario 1, so the Scenario 1 results are generally not visible on the hydrographs). Table 10.3-2 presents the maximum, average, and minimum differences between the results for these scenarios and those of Scenario 1.

5.3.1. Head

Scenario 3a: This scenario includes additional pumping in the North Westside Basin, which is far from the Bay monitoring well locations. Therefore, minimal change is expected in these wells. Indeed, the average differences in head in these wells compared to Scenario 1 are all between -0.01 and -0.03 ft (Table 10.3-2). This indicates that the SFGW Project pumping conditions would not have a substantial effect on the occurrence of seawater intrusion in this part of the Basin.

Seasonal fluctuations under this scenario are all between +0.1 ft and -0.1 ft (Table 10.3-4), indicating that seasonal head fluctuations would not have a substantial effect on the occurrence of seawater intrusion in this part of the Basin.

Scenario 3b: As with Scenario 3a, the situation simulated in this scenario is not expected to affect this area greatly. The average differences in head compared to Scenario 1 are all between -0.01 and -0.03 ft (Table 10.3-2). As such, the Scenario 3b conditions are not expected to have a substantial effect on the occurrence of seawater intrusion in this part of the Basin.

Seasonal fluctuations in head under this scenario are all between +0.1 ft and -0.1 ft (Table 10.3-4), indicating that seasonal head fluctuations would not have a substantial effect on the occurrence of seawater intrusion in this part of the Basin.

5.3.2. Groundwater Flux

Scenario 3a: This scenario simulates the pumping entailed in the SFGW Project, which increases groundwater extraction in the North Westside Basin. Even though pumping is not modified in the South Westside Basin, the inclusion of the SFGW Project seems to have a slight effect on the freshwater flux along the Bay coast, decreasing it slightly compared to Scenario 1 throughout the simulation period (Figure 10.3-17 and Table 10.3-5). This decrease is not reflected in the heads. The minimum freshwater flux is about 80 afm, a decline of only 2 afm compared to Scenario 1. These results indicate that this configuration of the SFGW Project would not have a substantial effect on the occurrence of seawater intrusion in the South Westside Basin.

Scenario 3b: This scenario is identical to Scenario 3a, except as noted above. Because of the distance to the North Westside Basin and the relatively small change in pumping involved from Scenario 3a, conditions along the Bay Coast are expected to show only minimal changes. The minimum freshwater flux is still about 80 afm (Table 10.3-5). These results indicate that the changes between Scenarios 3a and 3b do not have a substantial effect on the occurrence of seawater intrusion along the Bay coast.

5.3.3. Evaluation

In general, the modeling results suggest that the Bay Coast would not be vulnerable to seawater intrusion due to the operation of the SFGW Project. The freshwater flux out of the aquifer into San Francisco Bay is quite low, and would not be modified to a great degree by the pumping configurations simulated in the numerical model (Figure 10.3-17). As noted previously, the hydrogeological framework in this part of the Basin is not well-known, so these results are considered to be fairly qualitative.

6. Cumulative Scenario Analysis

The Cumulative Scenario (4) includes the assumed operation of both the GSR and SFGW Projects, projected pumping for the PAs and third party pumpers, and other reasonably foreseeable future projects. Reasonably foreseeable projects that are considered under the cumulative scenario include the Daly City Vista Grande Drainage Basin Improvements Project and the Holy Cross cemetery future build-out with its anticipated increase in irrigation pumping.

6.1. Scenario Conditions

Scenario 4 assumes the operations of the GSR (as per Scenario 2) and SFGW Projects with total SFGW Project pumping of 4 mgd (as per Scenario 3b). The model assumptions used for Scenario 4 are summarized in TM-10.1.

The Daly City Vista Grande Drainage Basin Improvements Project is assumed to be a reasonably foreseeable future project under the cumulative scenario. It is assumed that supplemental water to the Lake would be supplied by Daly City storm water from the Vista Grande canal with baseflows being maintained via a wetland (see TM-10.1 for details).

Based on the future land use development projections in the Holy Cross cemetery, irrigation pumping in this cemetery is anticipated to increase under the cumulative scenario by 0.04 mgd, and the associated recharge to groundwater has also been adjusted (see TM-10.1).

6.2. Conceptual Analysis

The Cumulative Scenario includes both the GSR and SFGW Projects. However, since the GSR Project is located in the South Westside Basin, and the SFGW Project is located in the North Westside Basin, it is not anticipated that there would be much interaction between the two projects with respect to seawater intrusion. Scenario 2 showed that the GSR Project conditions did not have a large effect on conditions in the North Westside Basin, while Scenarios 3a and 3b showed that the SFGW Project conditions did not have a large effect on conditions in the South Westside Basin. Therefore, in terms of the potential for seawater intrusion, it is anticipated that the Cumulative Scenario would produce results in the South Westside Basin similar to those of the GSR-only Scenario (2), and in the North Westside Basin similar to those of the SFGW-only Scenarios (3a and 3b).

As shown in TM-10.1, diversion of water from the Vista Grande Canal into Lake Merced would have the effect of raising groundwater head in the Lake Merced area as a result of leakage from the Lake to the aquifer. This localized increase in head may decrease the potential for seawater intrusion along the coast near Lake Merced, but this effect diminishes with distance from the Lake.

The changes to pumping associated with the Cumulative Scenario (such as the pumping increase at the Holy Cross cemetery) are located in the South Westside Basin and are too far from either coast to have a substantial effect on seawater intrusion.

6.3. Pacific Coast

The results of the Cumulative Scenario (4) are shown on Figures 10.3-4 through 10.3-12. These figures show predicted head at the various Pacific Coast monitoring locations as well as the difference in head between this scenario and Scenario 1. Table 10.3-2 presents the maximum, average, and minimum differences between the results for this scenario and those of Scenario 1.

6.3.1. Head

Scenario 4 combines the GSR Project pumping of Scenario 2 with the SFGW Project pumping of Scenario 3b. Because the GSR Project pumping is concentrated in the South Westside Basin, the results of this scenario in the Pacific Coast area are very similar to those of Scenario 3b (Figures 10.3-4 through 10.3-12). At the North Windmill location, and the South Windmill and Kirkham clusters, the average difference between the results of Scenario 3b and those of this scenario in Model Layer 1 is minimal (Table 10.3-2a).

Further to the south, head is slightly higher in this scenario versus Scenario 3b. This reflects the operation of the GSR Project, which is shown (under Scenario 2; see Section 4.2.1) to increase head slightly in this area compared to Scenario 1. At the Ortega Cluster, head in Model Layer 1 (Table 10.3-2a) is on average less than a foot higher than under Scenario 3b. This average difference increases to the south to about 0.8 ft at the Taraval cluster and 4 ft at the Zoo cluster. At the West Sunset Playground well (Figure 10.3-8), head is about 2 ft higher than under Scenario 3b. Head is nearly unchanged at the Fort Funston (Figure 10.3-11) and Thornton Beach (Figure 10.3-12) clusters.

In Model Layer 4 (Table 10.3-2b), the results are similar. At the West Sunset Playground well, the average difference from Scenario 1 is about 3 fthigher than under Scenario 3b, about 3 ft higher at the Taraval cluster, and 6 ft higher at the Zoo cluster.

In Model Layer 5 (Table 10.3-2c), results are similar to those of Model Layer 1, except that the average difference is about 2 ft higher at the Taraval cluster than under Scenario 3b.

Seasonal fluctuations in this area are mostly smaller than under Scenario 1 for the Cumulative Scenario, and similar to those of Scenario 3b (Table 10.3-4). Values for Scenario 4 range from about 0.5 ft (West Sunset Playground well and Taraval cluster) to 1.3 ft (Zoo and Fort Funston clusters) in Model Layer 1, from about 0 ft (Fort Funston and Thornton Beach clusters) to 0.3 ft (South Windmill, Kirkham, and Taraval clusters and West Sunset Playground well) in Model Layer 4, and from -0.5 ft (Zoo cluster) to 0.2 ft (Kirkham and Ortega clusters) in Model Layer 5. These results indicate that seasonal fluctuations in head would not have a substantial effect on the occurrence of seawater intrusion in this part of the Basin.

6.3.2. Groundwater Flux

Scenario 4 combines the pumping changes of the GSR and SFGW Projects simulated in Scenarios 2 and 3b. The average flux (and head) conditions are higher than under the SFGW Project Scenarios (3a and 3b), although by only a small amount relative to the total flux (Figure 10.3-16 and Table 10.3-5).

The maximum freshwater flux for this simulation is about 350 afm, while the minimum is about 15 afm. The minimum flux is slightly higher than under Scenarios 3a and 3b, but the difference is not large compared to the total range of fluxes from maximum to minimum. Therefore, the results of this scenario indicate that the combination of the SFGW and GSR Project pumping regimes would not have a substantial effect in the North Westside Basin compared to the SFGW Project alone.

6.3.3. Groundwater Contour Map Analysis

Under Scenario 4, the model-simulated groundwater elevations for the Shallow Aquifer at the end of the simulation period (Figure 10.3-20) are very similar to those of Scenario 3b. The lack of difference between the results of Scenarios 3b and 4 indicate again that the GSR Project would have only a minor effect on groundwater head in the North Westside Basin. The cone of depression around the West Sunset Playground well is very slightly smaller, and areas north of this well see very slightly higher groundwater elevations. South of the West Sunset Playground well, areas of below-sea-level groundwater elevations around Lake Merced disappear, and groundwater elevations just north of Lake Merced are generally around five feet higher, a likely result of the modeled additions of the Daly City Vista Grande Drainage Basin Improvement Project under the Cumulative Scenario.

Compared to Scenario 1, the map distribution for Scenario 4 suggests that the area of the West Sunset Playground well would have an increased potential for landward migration of the seawater-freshwater interface resulting from groundwater pumping, similar to the results of Scenarios 3a and 3b. Areas to the south would have a much smaller extent of decreased groundwater head, suggesting a lesser potential for the landward migration of the seawater-freshwater interface.

6.3.4. Evaluation of Analytical Results

From the Ortega cluster (Figure 10.3-7) south, head is actually higher than predicted for Scenario 3b in Model Layers 1 and 4, likely the result of the Vista Grande additions to Lake Merced. However, the differences are generally quite small, and would only slightly change the degree and rate of seawater intrusion, not its occurrence. Therefore, combined operation of the GSR and SFGW Projects is considered to have the same effect on seawater intrusion as does the SFGW Project alone. The exception to this is in Model Layer 1 at the Zoo cluster (Figure 10.3-10a), where heads are about four feet higher under this simulation and above the Shallow Aquifer exclusion head throughout the simulation duration (compared to Scenario 3b, during which head was below the Shallow Aquifer exclusion head for 30% of the simulation duration).

Seasonal head fluctuations in Model Layer 1 (Table 10.3-4) are similar to those of Scenario 3b, and the same conclusions apply (Section 5.2.4). Even in the southern part of the North Westside Basin, where there is some slight difference between the head values for this scenario and those of Scenario 3b, the seasonal fluctuations are not markedly different.

6.3.5. Evaluation

The Scenario 4 results indicate that some of the groundwater heads in the North Westside Basin for the Cumulative Scenario would be higher than those for the SFGW-only Scenarios (3a and 3b), while other groundwater heads would be similar to Scenarios 3a and 3b. Exceptions are seen in Model Layer 5 in the southern part of the North Westside Basin (from the West Sunset Playground well south). Head values under Scenario 4 drop below the results of Scenarios 3a and 3b during take periods, with the largest declines seen during the Design Drought; these declines follow similar patterns as the Scenario 2 results, indicating that they result from the operation of the GSR Project. As noted in Section 4.2.4, the declines in head seen during the take periods are temporary, and would not have a significant effect on the occurrence of seawater intrusion along this Coast. Taken as a whole, the results of Scenario 4 indicate that the combined effects of the Projects would create conditions less favorable for the landward migration of the seawater-freshwater interface than those seen in Scenarios 3a and 3b.

6.4. San Francisco Bay Coast

The results of the Cumulative Scenario (4) for the Bay side monitoring network locations are shown on Figures 10.3-13 through 10.3-15, which depict the head predictions for this scenario as well as the differences in head between this scenario and Scenario 1. Table 10.3-2 presents the maximum, average, and minimum differences between the results for this scenario and those of Scenario 1.

6.4.1. Head

Scenario 4 combines the pumping changes entailed in the GSR and SFGW Projects. Because neither of these projects would have much of an effect on head in this part of the Basin (see Sections 4.3.3 and 5.3.3), the Cumulative Scenario pumping would not have a large effect either. Indeed, the hydrograph results for the three well clusters in the area (Figures 10.3-13 through 10.3-15) show minimal differences compared to the results of Scenario 2. This finding is confirmed by the statistical evaluation of head (Table 10.3-2). This indicates that the operation of the combined Projects would not have a substantial effect on seawater intrusion in this part of the Basin.

Seasonal fluctuations in head under Scenario 4 are between about -0.1 ft and +0.1 ft (Table 10.3-4). This indicates that seasonal fluctuations in head would not have a substantial effect on the occurrence of seawater intrusion in this part of the Basin.

6.4.2. Groundwater Flux

Scenario 4 combines the pumping conditions of the GSR and SFGW Projects. The average freshwater flux results of this scenario fall below those of the other scenarios (Figure 10.3-17 and Table 10.3-5), with a maximum flux of about 110 afm and a minimum flux of about 50 afm. This minimum flux is substantially lower than under Scenario 2 (minimum flux of 70 afm), indicating that the combined operation of the Projects may have an increased effect on freshwater flux, but the flux remains well above zero throughout the simulation period, and the fine-grained nature of the aquifer deposits may represent a physical control preventing seawater intruson.

6.4.3. Evaluation

In general, the changes to groundwater pumping entailed in the GSR and SFGW Projects would not have a substantial effect on seawater intrusion along the San Francisco Bay Coast compared to what may occur under Scenario 1 conditions. The Burlingame cluster is projected to see a decline in head during Scenario 1, approaching sea level in Model Layer 1 (Figure 10.3-13a). In Model Layer 4 (Figure 10.3-13b), head at the Burlingame cluster begin slightly above sea level, and decline throughout the scenario. At the SFO (Figure 10.3-14) and UAL (Figure 10.3-15) clusters, the head rises throughout the simulation period.

7. Assessment of Areas Susceptible to Seawater Intrusion

The occurrence of seawater intrusion into a freshwater aquifer depends greatly on the connection between the ocean and the aquifers. If the aquifer is isolated from seawater, there is no potential for intrusion, while freshwater aquifers in direct communication with seawater may have no physical barrier preventing the intrusion of seawater. To understand the susceptibility of the various aquifers in the study area to seawater intrusion, it is necessary to understand the configuration of the aquifers offshore. In general, studies suggest that the aquifers present in the North Westside Basin do stretch offshore to some distance, but how far, and whether these aquifers are in direct communication with the ocean, are questions that have not to date been fully resolved.

7.1. Potential Rate of Intrusion

The rate of seawater intrusion into an aquifer can be widely variable, depending on the values of the various parameters that control it. Because groundwater head in the coastal areas of the Westside Basin is not as far below sea level as in some of the examples presented in Section 8.2, the rate of seawater intrusion that would be seen in this basin may be on the low end of the rates determined by other studies.

The timing of seawater intrusion depends on a number of variables. A large inland gradient or high horizontal hydraulic conductivity would hasten seawater intrusion. Seawater intrusion would also occur more quickly if the seawater front is already close to land due to lower onshore head or freshwater flux. Although the thickness of the aquifer does not analytically have an effect on the rate at which seawater intrudes into a freshwater aquifer, a seawater wedge would form earlier in a thicker aquifer because the thicker aquifer requires a larger freshwater head to keep seawater out. An analytical equation can be developed that gives a first approximation of the potential rate of seawater intrusion under various conditions; this is described in Attachment A.

A simplified aquifer was constructed to apply this analytical solution, and the various parameters were chosen to reflect approximate actual values at the South Windmill cluster in Golden Gate Park. The parameter values, and the sources from which they were derived, are given in Table 10.3-7. These values were used to calculate the change in seawater intrusion length over various periods of time (0.25, 0.5, 1, 2, 5, 10, 20, and 50 years) at pumping rates varying from zero to equal to the freshwater flux rate determined by Yates et al. (1990) for the Golden Gate Park area. It should be noted that the aquifer at this location was assumed to be continuous from the top of the sediments to the bedrock surface, due to the lack of large aquifer-bounding clay layers here (LSCE, 2010).

The results of this analysis indicate that the rate of intrusion would be quite low (Figure 10.3-21; note that the vertical axis is logarithmic). The dotted line on this figure represents the equilibrium change in intrusion length (i.e., the equilibrium intrusion length, L_{eq}, minus the pre-pumping intrusion length, L_0) based on the new freshwater flux rate (i.e., the original freshwater flux rate,

Q'_0, minus the pumping rate, Q'_w); this is the intrusion length that would eventually be reached at steady state. The blue dashed line indicates the percentage of the original freshwater flux rate that is left after pumping is increased. The three solid lines indicate the change in intrusion length (i.e., the transient intrusion length, L(t), minus the pre-pumping intrusion length, L_0) at three different values of t: 1, 10, and 50 years. The change in intrusion length, read off the left-hand axis, represents how far the toe of the intrusion wedge would have advanced in the period of time corresponding to each line; for example, at a pumping rate of 5,000 cubic feet per year per foot of shoreline (cfy/ft of shoreline), the intruding wedge would have moved 3 feet in 1 year, 13 feet in 10 years, and 39 feet in 50 years. When a solid line intersects with or is above the red dotted curve representing the equilibrium change in intrusion length, the system would be at equilibrium, and the interface would not progress past L_{eq}.

These results indicate that the rate of seawater intrusion is lower than has been seen in other settings (see Section 8.2). Even if pumping in the Basin were equal to the pre-pumping freshwater flux (an extreme scenario that is not expected to occur), the change in the intrusion length would be 7 feet after 1 year, 33 feet after 10 years, and 96 feet after 50 years (note that the method assumes that the freshwater pumping is small compared to the initial freshwater flux, so these results should be considered approximate). An equilibrium change in intrusion length of 12,600 feet for this pumping rate indicates that it would take many decades for this system to reach equilibrium.

This method can be applied to the pumping rates from the various modeling scenarios. Scenario 1 utilizes an average pumping rate of about 4,830 cfy/ft of shoreline. The proposed total pumping in the North Westside Basin is about 13,640 cfy/ft of shoreline in Scenario 3a, which represents an increase of about 8,810 cfy/ft of shoreline. The analytical method indicates that the change in intrusion length would be 4 feet over the first year, 19 feet over 10 years, and 57 feet over 50 years. The proposed total pumping of 14,050 cfy/ft of shoreline in Scenario 3b represents an increase of about 9,220 cfy/ft of shoreline. At this rate, the change in intrusion length would be 4 feet over 1 year, 20 feet over 10 years, and 59 feet over 50 years. It should be noted that the increased pumping entailed by the SFGW Project represents about 45% of the initial freshwater flux under Scenario 3a and 47% under Scenario 3b, which indicates that one of the assumptions of the analytical method (that pumping be small compared to the initial freshwater flux) is not completely valid. Because of this, these results should be considered approximate. However, the results are still instructive of the general magnitude of the potential seawater intrusion rate, and are useful in providing an independent line of evidence that pertains to the seawater intrusion analysis.

As with the analysis of flux predicted by the numerical model, it should be noted that this rate analysis assumes that the fluxes can be applied in average across the entire Pacific coast. The actual rate of intrusion at Golden Gate Park may be greater or less than that implied by this analysis, depending on how flux in the area is actually modified.

7.2. Physical Conditions Along the Pacific Coast

Previous reports (LSCE, 2002; LSCE, 2010; SFPUC, 2005; SFPUC, 2006) discussed the coastal topography and stratigraphy in relation to the problem of seawater intrusion. These reports considered pre-existing information on the onshore geology (e.g., Clifton and Hunter, 1987) coupled with the results of a study of offshore seismic reflection (Bruns et al., 2002). The information in these reports is summarized in this section. Because no control studies have been performed (i.e., coring offshore to confirm stratigraphy), this discussion of offshore stratigraphy is somewhat speculative.

7.2.1. Offshore Geology

The upper surface of sediments continues offshore at a very gentle slope for a large distance. The water depth in the Ocean is only 60 feet about 2 miles offshore, 100 feet 8 miles offshore, and 300 feet 25 miles offshore, at the edge of the continental shelf; the Ocean bottom drops off steeply further offshore. This indicates that the onshore sedimentary units, if they stretch continuously offshore, may not outcrop on the Ocean floor for some distance. The intersection of the top of each aquifer with the Ocean bottom (i.e., its highest outcrop) is important to the problem of seawater intrusion because this is, theoretically, where freshwater exits the aquifer, and is the location where the uppermost part of the seawater wedge exists within the aquifer (Figure 10.3-3).

Because of the structural complications that exist offshore, the slope of the aquifer boundaries that exist onshore and the depth to the Ocean floor cannot be used to predict the depths of the units offshore and where the aquifers are connected to the Ocean. The San Andreas Fault is present offshore from around Mussel Rock north to Bolinas Lagoon. Further to the west, the San Gregorio Fault Zone also sits offshore. Between these faults exists the extensional San Gregorio Basin, a down-dropped area that results from the structure of the two bounding fault zones. This extensional basin has filled with more than 3,000 feet of sediment that is presumed to correlate to the Merced and Colma Formation sediments further inland (Bruns et al., 2002). However, no control points exist to confirm this. The extensional regime that led to the deepening of this basin likely made this a somewhat different depositional environment from the areas east of the San Andreas Fault, so there may be some differences even between units that correlate exactly in time across the San Andreas Fault. West of the San Gregorio Fault Zone, the stratigraphic sequence revealed by the seismic profiling resembles the units seen in the Santa Cruz Mountains to the southeast, indicating that these units have been translated by strike-slip motion along the San Andreas and San Gregorio Fault Zones (Bruns et al., 2002), and the aquifers that exist in the North Westside Basin therefore cannot be correlated to units west of the San Gregorio Basin. As long as the individual onshore aquifer units do not intersect the Ocean floor before reaching the San Andreas Fault, this fault zone may act as a physical barrier preventing seawater intrusion. The Shallow Aquifer, which is not covered by a confining clay layer, is in direct communication with the Ocean all along the coast.

Faults may represent hydrologic barriers in other parts of the Basin. The Serra Fault makes the Daly City area non-susceptible to seawater intrusion from the Ocean (see Section 7.2.3), and the same might be true of the lower aquifers in the North Westside Basin north of Lake Merced due to the presence of the San Andreas Fault, although no direct evidence of this exists.

An additional factor that may aid in reducing the likelihood of seawater intrusion is the presence of freshwater in offshore sediments (LSCE, 2010). During the Pleistocene glaciations, Ocean levels were about 300 to 400 feet lower, exposing the coastal plain to the atmosphere. During that time, the Sacramento-San Joaquin River system flowed across the coastal plain, depositing river sediments. The presence of this river and the exposure to the atmosphere for a relatively long period of time likely allowed fresh water to flush through most or all of the present-day offshore aquifer system. Provided the fine-grained units that exist between the aquifer layers are continuous offshore, these offshore units may still be filled with fresh water. If this is the case, then even head below sea level in the Primary Production and Deep Aquifers may not lead to seawater intrusion on any near-term time frame (SFPUC, 2006); it may take years to decades of continuously below-sea level onshore freshwater head for seawater to intrude through the miles of aquifer potentially occupied by fresh water. Indeed, about 5.5 mgd of groundwater was pumped from the North Westside Basin from 1930 to 1935, immediately prior to the completion of the Hetch Hetchy aqueduct, without inducing any noticeable degradation of water quality in the production wells (Gilman, 2010; SFPUC, 2006). LSCE (2010) also notes that the boreholes at the Fort Funston and Thornton Beach clusters, both located in deformed Merced Formation sediments west of the Serra Fault, did not encounter any saline water to their total depths of 1,500 feet.

7.2.2. Pacific Coast Northeast of the Serra Fault

The western boundary of the North Westside Basin is the Pacific Ocean. This stretch of the Pacific Coast is considered potentially susceptible to seawater intrusion due to its direct connection to the Pacific Ocean; however, it does not seem to be currently affected by seawater intrusion. Chloride levels in the monitoring wells along the coast have remained steady and fairly low. The shallow well at the South Windmill monitoring well cluster shows relatively high chloride concentrations, up to 154 milligrams per liter (mg/L) in the most recent (2011) samples (J. Gilman, personal communication, April 22, 2012). The California secondary maximum contaminant level (MCL) for chloride is 250 mg/L recommended and 500 mg/L upper limit.

As noted above, three aquifers exist in this part of the Basin, the Shallow, Primary Production, and Deep Aquifers, although the Deep Aquifer pinches out between the Kirkham and South Windmill well clusters (LSCE, 2010). The boundaries between these units tend to dip slightly toward the Ocean, especially in the deepest sediments as noted in TM#1.

The onshore hydrogeology presented in Appendix A of LSCE (2010) provides insights into the structure of the aquifers. Cross-sections J-J', Z-Z', and Y-Y' stretch through this area. According to these cross-sections, the Shallow Aquifer is in direct contact with the Ocean, and so there are no physical controls to prevent the intrusion of seawater should currently-existing hydrologic controls change.

The cross-sections do not stretch far enough off the coast to show where the Primary Production and Deep Aquifers may be in direct contact with seawater. SFPUC (2006) notes that the structural and depositional features that exist in the offshore sediments preclude the intrusion of seawater into the Primary Production and Deep Aquifers north of Lake Merced, but the physical barriers implied by this are not yet proven to exist. Rather, they are suggested by offshore seismic studies (Bruns et al., 2002) and the presence of offshore fault zones.

Cross-section J-J' is located along an west-east transect from the Ocean through Golden Gate Park to Strawberry Hill. In this area, the Shallow and Primary Production Aquifers are present. At the coast, the Shallow Aquifer is about 100 feet thick, while the Primary Production Aquifer may be about 350 feet thick. There is no fine-grained layer between the two aquifers at this location, meaning that they are hydraulically connected, and they can effectively be considered to be one thick aquifer. According to the cross-section, no physical barrier exists here that would prevent intrusion of seawater into the Primary Production Aquifer via the Shallow Aquifer above. As noted above, these cross-sections do not stretch far offshore; the absence of an intervening fine-grained layer onshore does not necessarily imply that no such layer separates the different aquifers offshore.

Cross-section Z-Z' runs from the Ortega cluster approximately east through the West Sunset Playground to the Sunset Reservoir. Along this cross-section, all three aquifers are present, and they are divided by at least some thickness of fine-grained units, although these lenses are fairly thin and could be discontinuous between the existing wells. At the coast, the Shallow Aquifer is about 120 feet thick, while the Primary Production Aquifer is about 310 feet thick and the Deep Aquifer is about 60 feet thick. If the clay layers between the aquifers are continuous as indicated on the cross-section, and if they continue offshore to some physical barrier (e.g., the San Andreas Fault), the Primary Production and Deep Aquifers at this location may be physically protected from seawater intrusion.

Cross-section Y-Y' runs from the San Francisco Zoo area east to Pine Lake Park and beyond. This cross-section, like Z-Z', indicates that there are continuous clay layers present between (and, in some cases, within) the aquifers here. The Shallow Aquifer is about 40 feet thick at the coast, while the Primary Production Aquifer is about 300 feet thick and the Deep Aquifer is about 130 feet thick. As with cross-section Z-Z', the Primary Production and Deep Aquifers may be isolated from the Ocean. It should be noted that the thick clay present between the Shallow and Primary Production Aquifers at the coast (the "-100 clay") is indicated to be possibly discontinuous about 2,000 feet inland of the coast.

From the information summarized above, a conceptual model of the potential route of seawater intrusion can be constructed for the North Westside Basin. The Shallow Aquifer is connected directly to the Ocean everywhere along the coast, indicating that seawater intrusion would occur in this aquifer anywhere that the on-shore freshwater head is low enough that seawater is not excluded from the aquifer. From the Kirkham cluster north, there are no continuous confining layers present that separate the aquifers, indicating that all three aquifers are open to intrusion along this stretch of the coast should head levels permit it.

South of the Kirkham cluster, clay layers are present between the three aquifers. To the extent that these layers are laterally continuous, they present a barrier to seawater intruding into the lower two aquifers from the Shallow Aquifer above. Cross-section D-D' in LSCE (2010) indicates that the W clay is continuous from the Kirkham cluster south to the Serra Fault, separating the Primary Production Aquifer from the Deep Aquifer below. This indicates that, should seawater enter the Primary Production Aquifer, it would not intrude into the Deep Aquifer except at the rate allowed by the W clay. The -100 clay, which separates the Shallow from the Primary Production Aquifer, is not fully continuous south of the Ortega cluster, and there is a gap in this layer between the Taraval and Zoo clusters. Should seawater intrusion occur in the Shallow Aquifer along the coast in locations where the -100 clay is not present, the Primary Production Aquifer would also be susceptible to seawater intrusion. The -100 clay is continuous from north of the Zoo cluster to the Serra Fault (to the south).

7.2.3. Pacific Coast Southwest of the Serra Fault

The southwestern boundary of the South Westside Basin is made up of the San Andreas Fault, which juxtaposes Merced Formation sediments against the Franciscan bedrock southwest of the Basin. This barrier likely prevents the part of the Basin bounding it from experiencing any ill effects in terms of seawater intrusion due to groundwater development. As with the bedrock high sections along the eastern edge of the North Westside Basin, it is always somewhat possible that connate water (seawater trapped in a formation when the sediments are deposited) could be mobilized out of marine sediments by changes in the head distribution, but this is considered unlikely. Therefore, the areas of the Basin bounded by the San Andreas Fault, from San Andreas Lake to the Pacific Ocean, are considered non-susceptible to seawater intrusion.

The Serra Fault, which runs sub-parallel to the San Andreas Fault, has unknown hydraulic characteristics. While the San Andreas Fault to the south has placed low-permeability bedrock against the sediments of the Merced Formation, the Serra Fault separates Merced Formation sediments from those of the Colma Formation, implying that, if a physical barrier to groundwater flow exists, it must be the fault zone itself rather than the rocks bounding it. LSCE (2002) suggest that, due to their "presence and configuration," the deformed Merced Formation sediments present along the Serra Fault could act as a barrier to seawater intrusion as far north as Fort Funston, where the fault heads offshore, but no corroborating evidence for this has been found elsewhere. The well cluster at Thornton Beach shows very different groundwater head trends from the other wells in the coastal monitoring network, indicating that this cluster, which is located between the San Andreas and Serra Faults, may be hydraulically disconnected by the Serra Fault from the rest of the Westside Basin. For the purposes of this TM, the portion of the Basin along the Pacific Ocean southwest of the Serra Fault between the San Andreas Fault and Lake Merced is considered to be non-susceptible to seawater intrusion based on the assumption that the Serra Fault represents an effective physical barrier to intrusion.

7.2.4. Pacific Coast Head Monitoring

The coastal monitoring wells are screened in the Shallow, Primary Production, and Deep Aquifers (hydrographs for the wells discussed in this section are presented as Appendix B of TM#1). Within the Shallow Aquifer, head has generally not changed much since monitoring began (2004) at the Ortega (120 ft bls) and Taraval (145 ft bls) well clusters. At the Kirkham cluster, head in the well screened within the Shallow Aquifer (130 ft bls) fluctuates quite a bit on a seasonal basis, and LSCE (2010) suggest that this is due to irrigation cycles in Golden Gate Park. The average head in this well dropped by about 4 feet around the spring of 2006; this drop could be related to a change in the irrigation practices. All available heads in the Shallow Aquifer remain above sea level, currently averaging about +10 ft mean sea level (msl) in the Ortega and Taraval wells and about +8 ft msl in the Kirkham wells.

The recent head trends in the Primary Production Aquifer have shown more spatial variability, although they have generally been fairly steady and above sea level. The South Windmill well (140 ft bls) has seen head dip below sea level repeatedly during the irrigation season, by as much as 20 feet. Of the three wells screened in this aquifer at the Kirkham cluster, head in the upper one (255 ft bls) has fluctuated around an average of about +11 ft msl, that in the middle one (385 ft bls) has fluctuated around an average of +8 ft msl, and has not dropped below sea level, and head in the deeper one (435 ft bls) has generally been about +5 ft msl, and dipped below sea level in September of 2007; at the same time, head in the upper (255 ft bls) and middle (385 ft bls) wells dropped below +3 ft msl for the only time over the period of record. The Ortega cluster also has three wells screened within the Primary Production Aquifer. The upper two (265 and 400 ft bls) show very similar trends in head over time, with little change and values hovering around +12 ft msl for most of the period of record. Head in the lowest well (475 ft bls) has fluctuated quite a bit, with two major excursions below sea level in 2006 and 2007. Two wells screened in the Primary Production Aquifer at the Taraval cluster (240 and 400 ft bls) have had heads averaging around +10 to +13 ft msl, with fairly steady heads and no major trends up or down. At the West Sunset Playground well, head has been fairly steady over the period of record at between +17 and +18 ft msl. At the Zoo cluster, two wells are screened within the Primary Production Aquifer. The upper one (275 ft bls) has shown a generally rising head since 2004, staying consistently above sea level; recent head measurements have ranged between about +6 and +7 ft msl. The lower well (450 ft bls) head has also been highly variable, although it has seen at least three drops slightly below sea level, in 2004, 2006, and 2007. Finally, the Thornton Beach cluster has two wells screened within the Primary Production Aquifer. The upper one (225 ft bls) shows head between +82 and +85 ft msl, with the most recent heads about a foot above the earliest heads. The lower one (360 ft bls) shows head between +13 and +15 feet msl, with no appreciable trend over time.

Head in the Deep Aquifer has generally stayed steady on average, with large seasonal fluctuations. The deepest wells at the Taraval (530 ft bls) and Zoo (565 ft bls) clusters are screened in this aquifer. Head in the Taraval well varies between 4 and -9 ft msl, with the lowest heads recorded during the autumn of 2007. The Zoo well varies between +1 and -14 ft msl, with the timing of the deepest head coincident with that in the Taraval well. Neither of these wells shows an identifiable upward or downward groundwater head elevation trend over the period of record.

7.2.5. Pacific Coast Chemical Monitoring

Within the coastal monitoring network, the clusters at South Windmill, Kirkham, Ortega, and Taraval are sampled for chloride, total dissolved solids (TDS), and specific conductance, while the Zoo cluster and the West Sunset Playground well are measured for nitrate and general minerals (which includes chloride and TDS). Chloride concentrations for selected wells are included on the hydrographs of TM#1, and average concentrations for selected chemical constituents are given in Table 10.3-8.

The wells in the monitoring network are sampled for chloride semi-annually. At the Kirkham, Ortega, and Taraval wells, chloride has varied between about 20 and 40 mg/L, and each well has seen fairly steady concentrations since monitoring began in 2004. The three wells in the Zoo cluster have higher chloride, varying from about 70 mg/L (275 ft bls) to 45 mg/L (450 ft bls) to 50 mg/L (565 ft bls). These wells have shown no appreciable upward or downward trend in concentrations over time. Limited data exist for the cluster at South Windmill, with the shallower well (57 ft bls) concentrations varying from 115 to 193 mg/L, and the deeper well (140 ft bls) concentrations varying between 48 and 70 mg/L. The concentrations in this shallower well increased with every measurement from when monitoring began in 2006 through 2009, but have since decreased to 154 mg/L in November 2011.

The highest chloride concentrations measured in the North Westside basin have been at LMMW-1S, screened in the Shallow Aquifer and located between Lake Merced and the Pacific Ocean along the west side of John Muir Drive (data are available for April and November of 2009 and 2010). The highest chloride concentration measured was 393 mg/L in November 2009, with the lowest concentration being 129 mg/L in April 2010 (SFPUC, 2011). The ultimate cause of these high chloride concentrations is unknown. The co-located well LMMW-1D, screened in the Primary Production Aquifer, yielded samples with chloride concentrations of 104 and 106 mg/L in April and November of 2010. The proximity of these wells to the Pacific Ocean (approximately 1,300 feet to the west) indicates that the Ocean is a potential source for elevated chloride; however, LMMW-1S is separated from the Ocean by the Serra Fault, which is interpreted to be a barrier to groundwater flow and seawater intrusion in this area, as discussed further in TM#1. In addition, some other chemical constituents are not typical of Ocean water; in particular, the pH (average of 6.8) is well below the average pH of seawater (about 7.8 to 8.4; see, for example, Krauskopf and Bird, 1995) and below the values seen in the other wells within the North Westside Basin (averages for wells monitored by SFPUC vary from 7.2 to 8.6), perhaps indicating that some other source is affecting the chemistry of groundwater at LMMW-1S. These observations indicate that the elevated chloride concentrations seen in LMMW-1S likely result from a source other than seawater intrusion.

Other previous studies have also presented chloride data in the North Westside Basin that could potentially provide useful information on the occurrence of seawater intrusion along the Pacific coast. AGS (1994) presented results of production well sampling in November and December of 1993 at various wells around the North Westside Basin. Chloride varied from 21 to 68 mg/L, with the highest value at the Oceanside Water Pollution Control Plant (just south of the Zoo cluster and LMMW-4S on Figure 10.3-1); outside of this sample, the highest chloride concentration was 42 mg/L at Sunset Well #7. Samples were obtained from a few locations studied in detail in this TM: North Windmill, South Windmill, and the San Francisco Zoo. At these production wells, chloride concentrations varied from 37 to 39 mg/L. High capacity, deep production wells have been pumping at the west end of Golden Gate Park since the 1920s and at the San Francisco Zoo since the 1930s.

Yates et al. (1990) and Phillips et al. (1993) provided the results of sampling for various constituents (including chloride) at several wells, mostly in the North Westside Basin. Chloride concentrations in all of the wells sampled varied from 21 to 210 mg/L (this highest value was seen at the Elk Glen-S monitoring well in central Golden Gate Park; the highest value along the coast was 130 mg/L at HLA E). Samples from the North Windmill, South Windmill, and Zoo locations (including both production and monitoring wells) had chloride concentrations of 35 to 54 mg/L, except a sample from the shallowest monitoring well at South Windmill, which had a chloride concentration of 100 mg/L. Yates et al. (1990) offered the following explanation for the chloride concentrations in shallow groundwater: “Most of the chloride in shallow ground water is probably derived from near-surface sources. For example, the average concentration of chloride during 1987 in sewage flowing out of the Richmond-Sunset Water Pollution Control Plant was 145 mg/L.” Phillips et al. (1993) offered the following explanation for the elevated chloride concentrations seen at the Elk Glen-S and the South Windmill-S (now known as MW57) monitoring wells: “The apparent saltwater contamination in shallow wells at Golden Gate Park probably is a result of leakage of seawater used at Steinhart Aquarium, either from the supply pipe or exfiltration of saltwater discharge to the sewer system.”

The data presented in the reports discussed above indicate that there have not been appreciable trends over time in the coastal chloride concentrations in the North Westside Basin. Further, the recent sample results have been in line with historical data. The generally stable chloride concentrations along the Pacific Coast indicate that substantial seawater intrusion has not occurred to date, despite long-operating irrigation wells in the areas of Golden Gate Park and the San Francisco Zoo.

Additional groundwater chemistry monitoring has been performed on a short-term basis as part of construction projects in the North Westside Basin. An important and instructive example occurred during dewatering associated with construction at the Oceanside Water Pollution Control Plan (WPCP) from 1989 to 1994 (dewatering started in May of 1990, and continued until April 1991). Oceanside WPCP is located south of the San Francisco Zoo, between the Pacific Ocean and Lake Merced. ESA (1994) presented monitoring data collected in the Oceanside WPCP area during the construction activities. Observation wells were installed surrounding the site, including along the Great Highway along the Pacific Coast (OB-3, OB-6, and OB-7), along the northern end of the site (OB-1, OB-2, and OB-5), and along the eastern boundary of the site where it borders Lake Merced (OB-4). Well OB-3, screened in the Shallow Aquifer, was directly west of the field of dewatering wells, and saw 19 feet of water table decline during dewatering operations, but rebounded to pre-pumping levels within a month of the cessation of dewatering. Water quality was also monitored during construction activities; chloride in OB-3 rose quickly from background concentrations, eventually reaching a maximum of 10,500 mg/L. Monitoring of chloride continued after the cessation of dewatering, and the groundwater in OB-3 remained brackish throughout the period of post-dewatering monitoring, at least to 1994 when ESA reported these results. The monitoring results indicate several important things relevant to this TM:

- Based on the speed with which seawater reached OB-3 after dewatering began, the freshwater-seawater interface in the Shallow Aquifer must be located just offshore in this aquifer, and the Shallow Aquifer is in direct contact with the Ocean here.
- Seawater intrusion can affect coastal monitoring wells within a span of just a few months.
- Once seawater intrusion does occur, it is difficult to reverse the process and return aquifer water quality to its pre-intrusion state, even when head has rebounded to this pre-intrusion state.
- Intrusion, especially when it is caused by highly localized pumping in the vicinity of the coast, can be localized (none of the other monitoring wells saw any decline in water quality during dewatering operations) and temporary (SFPUC, 2005).

The results of the dewatering operations are not expected to exemplify the reaction of the aquifer system to pumping associated with either the GSR or SFGW Projects, which would involve pumping further away from the Coast, and would derive groundwater from deeper, confined aquifers that are not expected to experience seawater intrusion on the short timescales demonstrated for the Shallow Aquifer by ESA (1994).

7.3. Physical Conditions Along the San Francisco Bay Coast

The portion of the Westside Basin along the San Francisco Bay is the easternmost part of the South Westside Basin. This is another area potentially susceptible to seawater intrusion, and may in fact currently be affected by seawater intrusion. Chloride concentrations in this area vary from 42 to 13,000 mg/L, with the highest values seen in the shallowest wells. The chloride-bromide ratios for the sampling events in November 2006 and April 2007 (WRIME, 2007) are fairly similar to that of water collected from a nearby location in the San Francisco Bay (Cl:Br = 327), also in April 2007.

As noted in WRIME (2007), both the Bay Mud and the artificial fill were emplaced in the environment of the saline Bay, meaning that these deposits likely contain substantial connate water. While the similarity of chloride concentrations and chloride-bromide ratios to those of Bay water may seem indicative of seawater intrusion into this area, similar concentrations could be due to the presence of connate Bay water in the sediments of the area, which may be expected to be fairly similar chemically to today's Bay water and would therefore have a similar effect on aquifer water quality as would intruding seawater. Because the available reservoir of connate water is determined by the porosity of the Bay Mud, this reservoir can be assumed to be much smaller than the effectively infinitely large reservoir of Bay water nearby; therefore, the flux of connate water into the freshwater aquifer would likely be lower than would be the flux of seawater intrusion from the Bay if the aquifer were in direct communication with the Bay.

7.3.1. San Francisco Bay Geology

In the San Bruno area, the deposits closest to the Bay are made up of Bay Mud overlain by artificial fill deposited into the Bay (WRIME, 2007). LSCE (2010) produced two cross-sections that stretch through the South Westside Basin toward the Bay, although neither provides a representation of the sediments at the Bay Coast. These cross-sections (N-N' and O-O' in Appendix A of LSCE, 2010) show Colma Formation deposits on the surface inland, interfingering with Bay deposits closer to the Bay. A subsurface bedrock ridge is also shown that provides some protection to the southern portion of the South Westside Basin from potential seawater intrusion from San Francisco Bay.

Cross-section O-O' runs from San Andreas Lake northeast towards San Francisco Bay. Based on the inferred geologic correlations, the Colma Formation sediments that are present on this cross-section inland are not continuous to the Bay, being separated from it by deposits of low-permeability Bay Mud that likely stretch from the land surface to the bedrock surface below. If true, this would present a physical barrier, likely precluding seawater intrusion in this area. The Bay deposits are very fine-grained, and are considered by some to be a physical control on seawater intrusion into the freshwater aquifers. However, TM#1 notes the presence of some sands within this unit that could be conduits for seawater intrusion. The properties of the artificial fill deposited over the Bay Mud are not noted in WRIME (2007), although it is likely that it contains a wide variety of grain sizes.

7.3.2. San Francisco Bay Head Monitoring

Head in the Bay side monitoring well network is available for the Shallow and Primary Production Aquifers (hydrographs for the wells discussed in this section are presented as Appendix B of TM#1). At the UAL site, one well (MW13D) is screened within the Shallow Aquifer (SFPUC, 2010). Head in this well hovered around +2.5 ft msl from late 2003 to early 2006, after which head dropped to around -0.5 ft msl through at least late 2009. At the SFO and Burlingame sites, the shallowest wells (SFO-S and Burlingame-S) are both screened within the Shallow Aquifer; these two wells show very similar head results (with fairly sparse data). Each well shows a seasonal variation, with high values (around +2.3 ft msl at SFO and +3.5 ft msl at Burlingame) in the winter and low values (around +1.9 ft msl at SFO and +1.8 ft msl at Burlingame) in the summer.

At the UAL site, one well (MW13C) is screened within the Primary Production Aquifer. This well shows head varying between -29 and -33 ft msl from 2004 to 2009. At the SFO and

Burlingame sites, the deepest wells (SFO-D and Burlingame-D) are both screened within the Primary Production Aquifer. These wells show a similar seasonal fluctuation to the co-located wells screened within the Shallow Aquifer. SFO-D head varies from about -30 ft msl in the summer to about -29 ft msl in the winter. Burlingame-D head varies from about -5 ft msl in the summer to about -4 ft msl in the winter.

7.3.3. San Francisco Bay Chemical Monitoring

The wells in the Bay side monitoring network are sampled for general minerals, nitrate, bromide, boron, and orthophosphate (see Table 10.3-8 for average concentrations of selected constituents for each well). The Burlingame cluster contains three wells. Samples from the shallowest (Burlingame-S) well have chloride concentrations varying from 110 to 518 mg/L, with the highest values measured in February, 2009. The middle well (Burlingame-M) has shown concentrations ranging from 63 to 140 mg/L, while the deep well (Burlingame-D) has shown concentrations between 41 and 140 mg/L; these two wells have both shown a decreasing trend in chloride concentration over the sampling period. In the SFO cluster, the shallow well (SFO-S) has shown the most elevated values of chloride, between 8,400 and 12,400 mg/L, with increasing chloride over time. The deep well (SFO-D) has shown chloride values between 240 and 2,210 mg/L, with highly variable concentrations that don’t seem to have a specific trend. Chloride results from the UAL cluster indicate that concentrations in the deeper well (MW-13C) are slightly over 500 mg/L, while one sample in the shallower well (MW-13D) shows a chloride concentration of 13,000 mg/L (WRIME, 2007). Bay water near the site was reported to have a chloride concentration of 17,000 mg/L. The high chloride concentrations observed in the Bay side monitoring network wells may result from the mobilization of or mixing with connate water with high salt concentrations (see Section 7.3).

Bromide results are also available for the Burlingame and SFO clusters from two sampling events (WRIME, 2007). At Burlingame, bromide concentrations were 0.22 and 0.36 mg/L in Burlingame-D, 0.24 and 0.38 mg/L in Burlingame-M, and 0.26 and 0.66 mg/L in Burlingame-S. At SFO, bromide concentrations were 0.79 and 1.7 mg/L in SFO-D and 27 and 32 mg/L in SFO-S. Bay water near the site was reported to have a bromide concentration of 52 mg/L.

Chloride:bromide ratios represent a better method for detecting seawater intrusion than simple chloride concentrations. In the Burlingame well cluster, this ratio was 389 and 427 in Burlingame-D, 368 and 458 in Burlingame-M, and 333 and 423 in Burlingame-S. At the SFO cluster, the ratio was 259 and 342 in SFO-D and 291 and 311 in SFO-S (WRIME, 2007). The ratio in Bay water near the site was reported to be 327. Salinity in the southern Bay changes on a seasonal basis due to changes in the inflows, reaching a maximum in October and a minimum in February (Figure 10.3-22). Because this salinity change is the result of the mixing of two very different waters, the chloride:bromide ratio may be expected to change seasonally as well, so a single measurement should not be taken as the definitive representation of Bay water.

8. Seawater Intrusion Monitoring and Management

In addition to evaluating the conceptual model and the results of the analytical and MODFLOW models, other evaluations were conducted to add insight into potential seawater intrusion issues.

8.1. Drinking Water Standards

For the purpose of managing water resources to minimize the occurrence of seawater intrusion, a set of performance measures must be defined. Although this is a complex issue, it is helpful to put the problem in terms that are easily understood. CH2M HILL (1995) defined seawater intrusion as "significant migration (based upon an intermediate composition of fresh water and salt water) of salt water into the potable aquifer and/or extraction of salt water by production wells." However, this definition is fairly subjective, and represents a definition of seawater intrusion that is reactionary, rather than preventative, in nature.

For effects on the freshwater aquifer, it is useful to define some level of chloride (and other constituents) that represents degradation of the groundwater resource. Although various levels can be defined, management agencies generally use pre-existing maximum contaminant level (MCL) values. The Environmental Protection Agency (EPA) publishes a secondary drinking water standard of 250 milligrams per liter (mg/L) for chloride (EPA, 2009); there is no primary MCL for chloride as high chloride levels are not dangerous to health, but rather cause aesthetic degradation (e.g., taste or odor). This level has been used as a threshold for defining seawater intrusion in other basins, including Soquel Creek in California (Hydrometrics, 2009) and those around the City of Honolulu in Hawaii (Todd, 2004). Performance measures could be defined for other constituents based on EPA MCL values, but chloride is the most commonly utilized one for seawater intrusion.

8.2. Summary of Seawater Intrusion Rate Studies

The rate at which the seawater-freshwater interface enters the aquifer depends on a number of parameters, and is difficult to determine except by direct measurement or numerical simulation. This section summarizes the results of previous studies in other parts of the world, where geophysical, chemical, or modeling techniques were used to estimate a rate of seawater intrusion.

Izbicki (1996) summarized the occurrence of seawater intrusion into the Oxnard and Mugu aquifers of southern California. Seawater intrusion into these aquifers occurred as the result of extended groundwater overdraft in the coastal zone, with head levels dropping to below sea level in large parts of the aquifer system. Seawater began intruding into the coastal freshwater aquifers as early as the mid-1950's. Using a time-series of chloride measurements, Izbicki (1996) was able to estimate the total extent of seawater intrusion from 1955 to 1992 as being 2.7 miles in the Oxnard aquifer and 1.9 miles in the Mugu aquifer, implying rates of 375 and 264 feet per year (ft/yr), respectively.

Yakirevich et al. (1998) used the SUTRA computer model code to predict the rate of seawater intrusion in the coastal aquifer along the Gaza Strip. Seawater intrusion is currently occurring in this aquifer, where groundwater is heavily over-used. Yakirevich et al. (1998) predicted that seawater intrusion over the ten-year period from 1997 to 2006 would occur at a rate of 66 to 148 ft/yr.

Kennedy/Jenks (2004) studied the intrusion of seawater into the Salinas Valley groundwater basin by constructing a three-dimensional hydrogeologic conceptual model to assess the susceptibility of the different aquifers to seawater intrusion. An analysis of the movement of chloride fronts was based on a time-series of chloride concentration from a system of monitoring wells. It was concluded that the rate of intrusion into the coastal aquifer varied between 202 and 673 ft/yr, depending on location in the aquifer.

8.3. Typical Monitoring Procedures

To monitor whether seawater intrusion is occurring, an extensive monitoring system is typically employed. A network of groundwater monitoring wells is typically employed that monitors groundwater head and water quality at different depth intervals within the aquifer (or aquifers). Monitoring different depth ranges is necessary because, since seawater intrusion occurs as a wedge, the presence of vertical variations in water quality is important to understanding the extent of intrusion. Also, aquifer heterogeneity may cause seawater intrusion to find preferential pathways through the aquifer that a single well screen might miss.

The primary parameter that is monitored is groundwater head, as this represents the driving mechanism for seawater intrusion. Based on the Ghyben-Herzberg ratio, seawater is kept out of the freshwater aquifer if the groundwater elevation above sea level is at least about 1/38th of the thickness of the aquifer. For example, if the aquifer is 380 feet thick, a freshwater head of 10 feet is required to keep the aquifer at that location free of seawater at the bottom of that aquifer. Therefore, at each location an aquifer thickness must be defined, and then divided by 38 to determine the threshold above which freshwater head should be maintained.

Water quality parameters are also monitored, primarily chloride (Cl) and total dissolved solid (TDS) concentrations. Because of the contrast in marine and typical continental anion matrices, the clearest indication of possible seawater intrusion is an increase in Cl concentration as a proxy for salinity (although other processes may lead to a similar phenomenon; see below). In those coastal aquifers where continuous over-exploitation causes a reduction of groundwater head levels, intrusion of seawater would result in an increase in salinity. Thus, a time-series of chloride concentrations can help provide early indications of seawater intrusion.

In addition to the lateral infiltration of seawater through aquifers that communicate directly with the ocean, there are several possible sources of increased salinity of freshwater aquifers (DWR, 1958). The best way to differentiate intruding seawater from degradation through some other cause is to employ an extensive monitoring network to track the spatial and temporal variability in groundwater chemistry. If saline water can be observed progressing steadily inland and upward in the formerly freshwater aquifer, causes other than seawater intrusion can be discounted. In situations where salinity increases are observed in a monitoring network, more intensive monitoring may be initiated, using other ionic constituent concentrations or stable isotope values to identify seawater intrusion and differentiate it from other potential sources of increased salinity. These approaches exploit the differences in geochemistry and transport processes between seawater intrusion and other sources of salinity. In summary, these include (modified from Jones et al., 1999):

- **Chloride-bromide (Cl/Br) ratios:** These ratios can be used as a reliable tracer as both constituents usually behave conservatively (i.e., they are not particularly subject to retardation through reaction or sorption, and therefore are transported almost entirely by advection alone). Seawater is distinguished from anthropogenic sources like sewage effluents (which have higher Cl/Br ratios) or agriculture-return flows (which have lower Cl/Br ratios). This and the other geochemical methods listed here rely on the fact that seawater chemistry is quite uniform in time and space.
- **Sodium-chloride (Na/Cl) ratios:** Na/Cl ratios of intruding seawater are usually lower than the values in ocean water due to the fact that sodium interacts with aquifer sediments more strongly than does chloride. The low Na/Cl ratio of seawater intrusion is distinguishable from the higher Na/Cl ratios typical of anthropogenic sources like domestic wastewaters.
- **Calcium-anion (Ca/X) ratios:** One of the most conspicuous features of seawater intrusion is the enrichment of Ca over its concentration in seawater. High Calcium-Magnesium (Ca/Mg) and Calcium-Bicarbonate-Sulfate ($Ca/(HCO_3 + SO_4)$) ratios are further indicators of seawater intrusion.
- **Oxygen and hydrogen stable isotopes:** Linear correlations are expected from mixing of seawater with ^{18}O-depleted groundwater when comparing $\delta^{18}O$[5] to $\delta^{2}H$ or Cl because all three behave conservatively (so a straightforward mixture of seawater and freshwater would fall along a line between the seawater and freshwater end-members). Salinity introduced to an aquifer by sources enriched by evaporative processes (e.g., agriculture-return flows) would result in mixing lines with different slopes from the seawater-freshwater mixing line, which could generally be expected to follow a meteoric water line.
- **Boron isotopes:** The boron isotopic composition of groundwater can be useful in distinguishing seawater intrusion from anthropogenic salinity sources such as domestic wastewater or non-seawater salinity sources such as hydrothermal fluids (Vengosh and Spivack, 1999). The $\delta^{11}B$ value of seawater is about 39‰, distinctly different from the more depleted values in sewage effluents (0-10‰) and non-marine hydrothermal fluids (-10-5‰). Because of the significant differences between seawater and other potential

[5] Stable isotope measurements are expressed in delta (δ) notation, calculated as the difference between the abundance of a specific isotope to that in a reference standard divided by the abundance in the reference standard. This is a much more accurate measure than the actual abundance. See Clark and Fritz, 1997.

salinity sources, boron isotopes may be one of the most useful constituents to include in a monitoring program.

- **Residence time tracers:** The above constituents are measured to monitor for the intrusion of saline water, and to differentiate intruding seawater from domestic effluents and evaporatively enriched groundwater. Radioactive and other residence time tracers can be used to differentiate between recently-intruded seawater and connate water (seawater trapped in a formation when the sediments are deposited) that may have been present in the sediments for thousands of years. The specific tracer chosen would depend on the expected residence time of the connate water.

8.4. Potential Control Measures for Seawater Intrusion

Various control methods can be utilized to prevent, slow, or reverse seawater intrusion into coastal aquifers. These methods have been developed in areas that have experienced significant intrusion. Control measures have been summarized elsewhere (e.g., DWR, 1975; van Dam, 1999), and will only be briefly discussed here. Two categories of control methods exist, corresponding to two types of controls on seawater intrusion discussed in Section 2.3: physical and hydrological methods.

Physical controls entail the installation of actual physical barriers in the subsurface to block the flow of ocean water. These barriers are only useful when intrusion occurs on a fairly small scale, where the area of intrusion is limited. Barriers can be constructed of grout, slurry, or some kind of membrane, anything that is low enough in permeability to effectively exclude seawater. In thick or complex aquifer systems, physical barriers would have to be very long and extend very deep into the aquifer to prevent seawater intrusion, making them impractical.

Hydrologic controls are more widely employed, and are better suited to large aquifers. As discussed in Section 2.3, the two important factors for preventing seawater intrusion are freshwater flux into the ocean and the freshwater head just landward of the coast. Hydrologic methods of control consist of enhancing one or both of these. The simplest method is conservation, where extraction of groundwater is reduced. This can be considered a “natural” approach to control, as it seeks to prevent intrusion by returning the hydrologic system closer to its “natural” (or pre-development) state. However, this method may not be practical in systems where the groundwater extraction is necessary. Similarly, active management of groundwater extraction, where pumping is shifted around in the basin so that individual locations are not pumped too heavily, is used to allow the aquifer to recover when not pumped; this requires the installation of extra wells, and could greatly increase the cost required to build a groundwater extraction network.

Seawater intrusion can also be controlled hydrologically through artificial means. Attempts to limit or prevent seawater intrusion through engineering often focus on creating a head barrier near the shoreline through injection of freshwater. Commonly, this involves the injection of freshwater into the aquifer landward of the intrusion wedge, and seaward of production wells.

The injected freshwater can be locally-sourced groundwater, imported surface water, or reclaimed wastewater. The goal of this method is to build up a mound of freshwater with sufficient head to prevent seawater from intruding into the base of the aquifer.

A similar effect can be achieved by pumping groundwater on the seaward side of the seawater intrusion wedge, although this is necessarily temporary (since the goal is to get the wedge to move toward, and eventually past, these extraction wells), and the produced water must be disposed of somehow; as the wedge is moved back toward the pumping wells, much of the extracted water would be made up of useful freshwater that is mixed with the saline water, and this freshwater may have to be wasted by simply discharging it to an appropriate location.

The control method (or methods) used depends on the exact conditions under which seawater intrusion occurs. This would require an analysis to be made before seawater intrudes into the freshwater aquifer, through the investigation of various mitigation alternatives.

9. Summary

This section summarizes the results of the conceptual model, empirical data, numerical modeling, and analytical approaches with respect to seawater intrusion.

9.1. Assessment of Susceptible Areas

The two areas of the Westside Basin that were determined to be susceptible to seawater intrusion are (1) the Pacific Coast from the south side of Lincoln Park to Lake Merced, and (2) the San Francisco Bay Coast from the Visitacion Valley Basin to the San Mateo Plain Basin (Figure 10.3-1).

Along the Pacific Coast, sediments are more permeable, and reductions in head along the Coast could move the seawater wedge inland. There is no physical barrier to seawater intrusion into the Shallow Aquifer because the sediments here are fairly coarse-grained and in direct communication with the Ocean offshore. The offshore San Andreas Fault may represent a physical control on seawater intrusion into the Primary Production and Deep Aquifers, although discontinuities in the -100-foot clay may serve as locations where seawater could intrude into the Primary Production Aquifer from the Shallow Aquifer above.

In general, the San Francisco Bay Coast is not particularly susceptible to seawater intrusion due to the presence of the Bay Mud and a subsurface bedrock ridge that provides some protection to the southern portion of the South Westside Basin from potential seawater intrusion from San Francisco Bay. Chloride levels in the Shallow Aquifer at the SFO cluster are very high, near those of Bay water. However, this could be due to the presence of connate water in the Bay Mud itself, which may be easier to mobilize locally than it would be for seawater to intrude from the Bay to the freshwater aquifer through the Bay Mud. It should be noted that the chloride concentrations in the Primary Production Aquifer, where head levels are well below sea level and seawater intrusion would occur more quickly, are much lower than in the Shallow Aquifer.

Non-susceptible parts of the basin are areas where some sort of physical control precludes the current and future intrusion of seawater into the Basin. The inland parts of the basin, separated from the coast by the mountain ranges located on the northeastern and southwestern boundaries of the basin, are not susceptible to seawater intrusion. Parts of the North Westside Basin where the bedrock surface is above sea level are also not susceptible. The southern part of the Basin's Pacific Coast, where the Serra Fault represents a barrier between the Ocean and inland areas, seems to not be susceptible to seawater intrusion.

9.2. GSR-Only Scenario

The GSR Project is a conjunctive use project that would allow for increased groundwater supplies in the Westside Basin during periods of drought and emergencies (MWH, 2008). The conjunctive use project is based on the concept of providing available surplus surface water from the SFPUC Regional Water System to the Partner Agencies (PAs). This water would be used by the PAs instead (or “in-lieu”) of pumping groundwater from the Westside Basin.

The project is planned to provide up to 60,500 af of in-lieu recharge. During the take cycle, both SFPUC and the PAs would be pumping groundwater; however, SFPUC would not take more than the amount of in-lieu recharge available in the SFPUC Storage Account.

Pumping in the South Westside Basin for the GSR-only Scenario (2) would have a minimal effect on head in the North Westside Basin. South of Lake Merced the Serra Fault likely presents a physical barrier to seawater intrusion. The operation of the GSR Project would not change the potential for seawater intrusion relative to Scenario 1 because groundwater head at wells in the North Westside Basin along the Pacific Coast would not substantially change.

Along the San Francisco Bay Coast, the changes to groundwater pumping do not show a substantial effect on seawater intrusion compared to what may occur under Scenario 1 conditions. The freshwater flux out of the aquifer into the San Francisco Bay is quite low under existing conditions, and is not modified to any great degree by the pumping configurations simulated in the MODFLOW model.

Based on this analysis, the likelihood of seawater intrusion resulting from the GSR Project would be considered low along either the Pacific Coast or the San Francisco Bay Coast.

9.3. SFGW-Only Scenarios

The SFGW Project would construct up to four wells (along with conversion of two irrigation wells) and associated facilities in the western part of San Francisco and extract an annual average of up to 4 mgd of water from the North Westside Basin (SFPUC, 2009a). The SFGW wells would pump at this rate on a near-continuous basis over periods of many years.

Two model scenarios incorporate the pumping of the SFGW Project (3a and 3b). The results of these scenarios indicate that there is the potential for the landward migration of the seawater-freshwater interface along the Pacific Coast as a result of increased groundwater pumping from the SFGW Project. Many of the heads, especially in the southern half of the North Westside Basin, are projected by the numerical model to be below sea level for some to most of the simulation period; even in the northern half of the North Westside Basin, head would drop everywhere near and along the Pacific coast, possibly low enough to induce seawater intrusion.

It is important to note that the groundwater head in the Deep Aquifer at the Zoo monitoring well cluster has been almost uniformly below sea level since monitoring began in 2003. Despite this, and despite the fact that the cluster is only about 300 feet from the Ocean, the chloride concentration has remained steady between 50 and 60 mg/L over the same time period, indicating that this location has not yet been affected by seawater intrusion. This indicates one or more of the following: 1) that conditions ideal for seawater intrusion (i.e., groundwater head below sea level) must be present for some time (in this case more than at least 9 years) before the intrusion actually occurs; 2) the assumption of a coastal location for the discharge point is not applicable for these aquifers (i.e., the discharge point is further offshore); and 3) the Deep Aquifer is separated from the Ocean by a physical barrier, such as the W-clay. Without more knowledge of offshore geologic structures and their ability to act as physical controls, and the locations where freshwater discharges from the different aquifers, the exact reason that seawater has not shown itself to be intruding into the freshwater aquifer is unknown.

Similarly, measured head elevations in wells along the west end of Golden Gate Park have repeatedly dipped below the single-aquifer and Shallow Aquifer exclusion heads in the recent past (TM#1), and this area has been subject to relatively continuous groundwater pumping for irrigation since the 1920's. Despite this, there has been no appreciable increase in chloride concentrations in the production wells at the North Windmill and South Windmill locations over many years of monitoring. Unlike the Deep Aquifer at the Zoo monitoring well cluster (see above), the aquifers along the west end of Golden Gate Park seem to be in fairly direct contact with seawater (see Figure 10.3-2), so there does not seem to be a specific physical control that would prevent seawater intrusion. The fact that seawater intrusion does not seem to have had an effect on chloride concentrations in this area may indicate that the seasonal rebound in head that occurs in the winter (when head in the Shallow Aquifer is above the single-aquifer and Shallow Aquifer exclusion heads) effectively compensates for seasonal excursions below the exclusion heads, or that the small fine-grained layers present in the area break the sediments into multiple thin aquifers, which are theoretically less susceptible to seawater intrusion than would be a single thick aquifer.

Along the San Francisco Bay coast, the freshwater aquifer would not be vulnerable to seawater intrusion due to the operation of the SFGW Project primarily because of the distance from the SFGW groundwater pumping to the San Francisco Bay. The freshwater flux out of the aquifer into the San Francisco Bay is quite low, and would not be modified to any great degree by the pumping configurations for the SFGW Project. Therefore, the model results indicate that there is not a substantial change in the potential for seawater intrusion along the San Francisco Bay as a result of the SFGW Project.

9.4. Cumulative Scenario

The cumulative scenario (4) assumes the operations of the GSR and SFGW Projects at the same time. The cumulative scenarios also include other reasonably foreseeable future projects, such as the Daly City Vista Grande Drainage Basin Improvements Project and Holy Cross cemetery future build-out.

The Daly City Vista Grande Drainage Basin Improvements Project involves diverting stormwater from the Vista Grande Canal into Lake Merced with baseflow to Lake Merced being maintained via a wetland. The addition of water to Lake Merced to maintain lake levels would have the net effect of recharging the groundwater system locally.

Because the GSR Project pumping is concentrated in the South Westside Basin, the results of cumulative Scenario 4 are very similar to those of Scenario 3b.

Similar to both the GSR and SFGW Projects, the changes to groundwater pumping under the Cumulative Scenario do not show a substantial effect on seawater intrusion along the San Francisco Bay Coast compared to what may occur under Scenario 1 conditions. The freshwater flux out of the aquifer into the San Francisco Bay is quite low, and is not modified to any great degree by the pumping configurations simulated in the MODFLOW model.

These results indicate that there is the potential for the landward migration of the seawater-freshwater interface along the Pacific Coast as a result of increased groundwater pumping from the SFGW Project under the cumulative scenario. In addition,, the results of the Cumulative Scenario generally do not indicate an increased risk of seawater intrusion along the San Francisco Bay Coast.

9.5. Analytical Evaluation Along the Pacific Coast

The exclusion head analysis was performed to evaluate the potential for the landward migration of the seawater-freshwater interface under the Westside Basin Groundwater-Flow Model Results for Scenarios 3a, 3b, and 4. The results suggest that the lowering of groundwater head along the coast would increase the potential for the landward migration of the seawater-freshwater interface along several portions of the Pacific Coast. However, the rate analysis suggests that any seawater intrusion would occur at rates on the order of feet per year. It should be noted that the analytical method employed assumes a horizontal aquifer base, and that the actual intrusion into the sloped aquifers of the North Westside Basin would be slightly smaller than shown by the method.

The potential rate of seawater intrusion was estimated for the North Westside Basin using analytical equations. These results indicate that the rate of possible seawater intrusion would be on the order of 4 feet after 1 year, about 20 feet after 10 years, and about 60 feet after 50 years under implementation of the SFGW Project, a very slow rate of intrusion. Therefore, careful groundwater monitoring would be able to indicate the potential for seawater intrusion to occur with sufficient time to take proper actions to correct the situation.

Therefore, seawater intrusion along the Pacific Coast would occur slowly and would be recognizable in the Coastal Groundwater Monitoring Network before it could affect the beneficial use of pumping wells in the North Westside Basin. Historical data have shown that chloride levels along the Pacific Coast have remained low, even when there have been periods of relatively substantial groundwater pumping in the North Westside Basin in the past (5.5 mgd from 1930 to 1935; note that this rate is higher than the 3.0 to 4.0 mgd of municipal pumping proposed for the SFGW Project). This confirms that, although the potential for seawater intrusion exists, there may be other geologic factors that are limiting both the occurrence and rate of seawater intrusion along the Pacific Coast.

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Figure List

Table List

Attachment List

Figures

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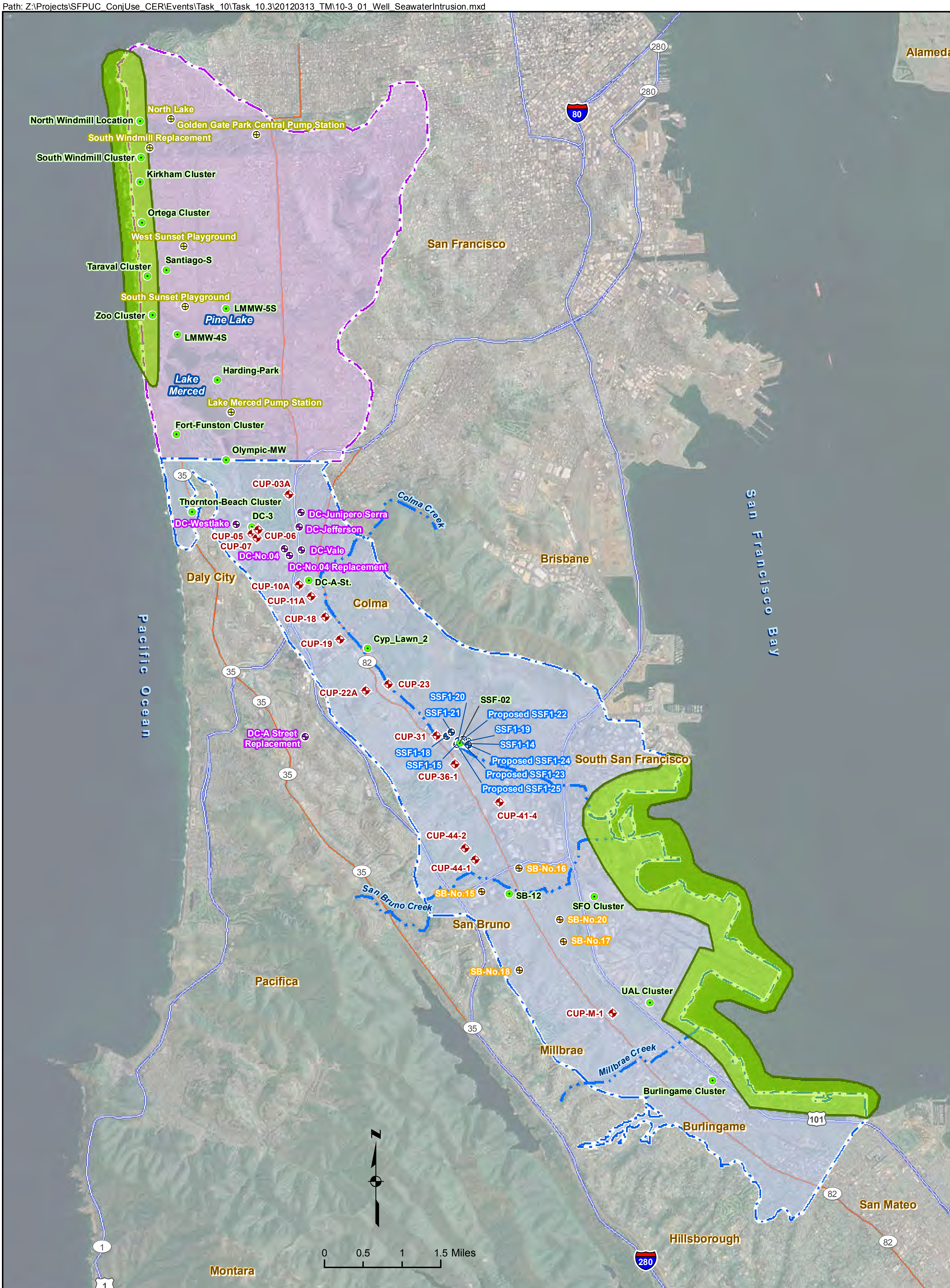


Aerial Photo Source: World Imagery from ESRI. Copyright:© 2009 ESRI, AND, TANA, UNEP-WCMC

Note:
The North Windmill Location is a location used by the Westside Basin Groundwater-Flow Model to track the model-simulated groundwater head. It represents a historical well location, but is not the current location of an active monitoring well.

Legend

- GSR Proposed Municipal Wells
- SFGW Proposed Municipal Wells
- Selected Representative Monitoring Location
- Cal Water Municipal Wells
- Daly City Municipal Wells
- San Bruno Municipal Wells
- North Westside Groundwater Basin
- South Westside Groundwater Basin
- Approximate Areas Susceptible to Seawater Intrusion

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

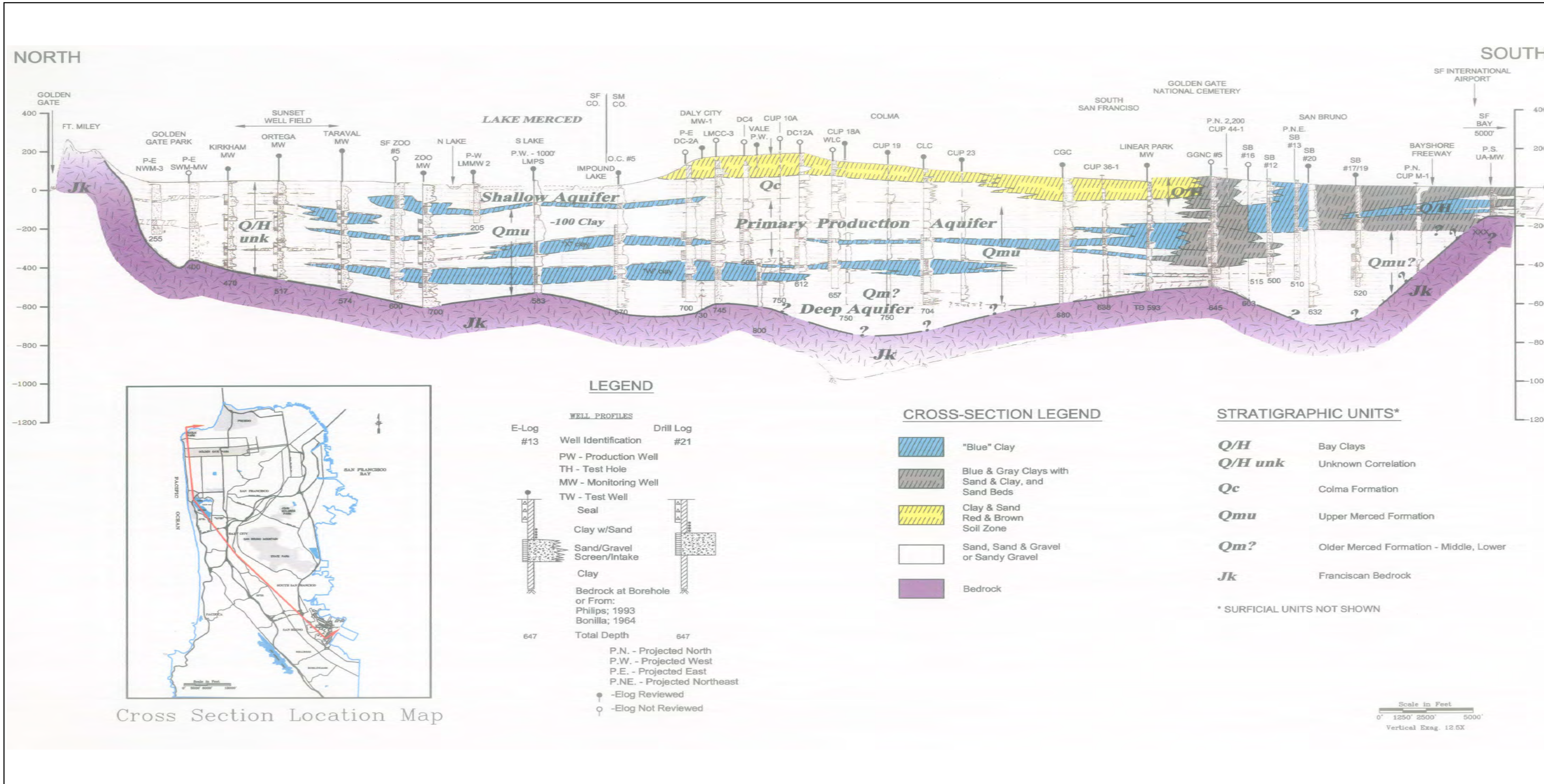
WELL LOCATIONS AND AREAS POTENTIALLY SUSCEPTIBLE TO SEAWATER INTRUSION

Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Figure 10.3-1

Date April 2012



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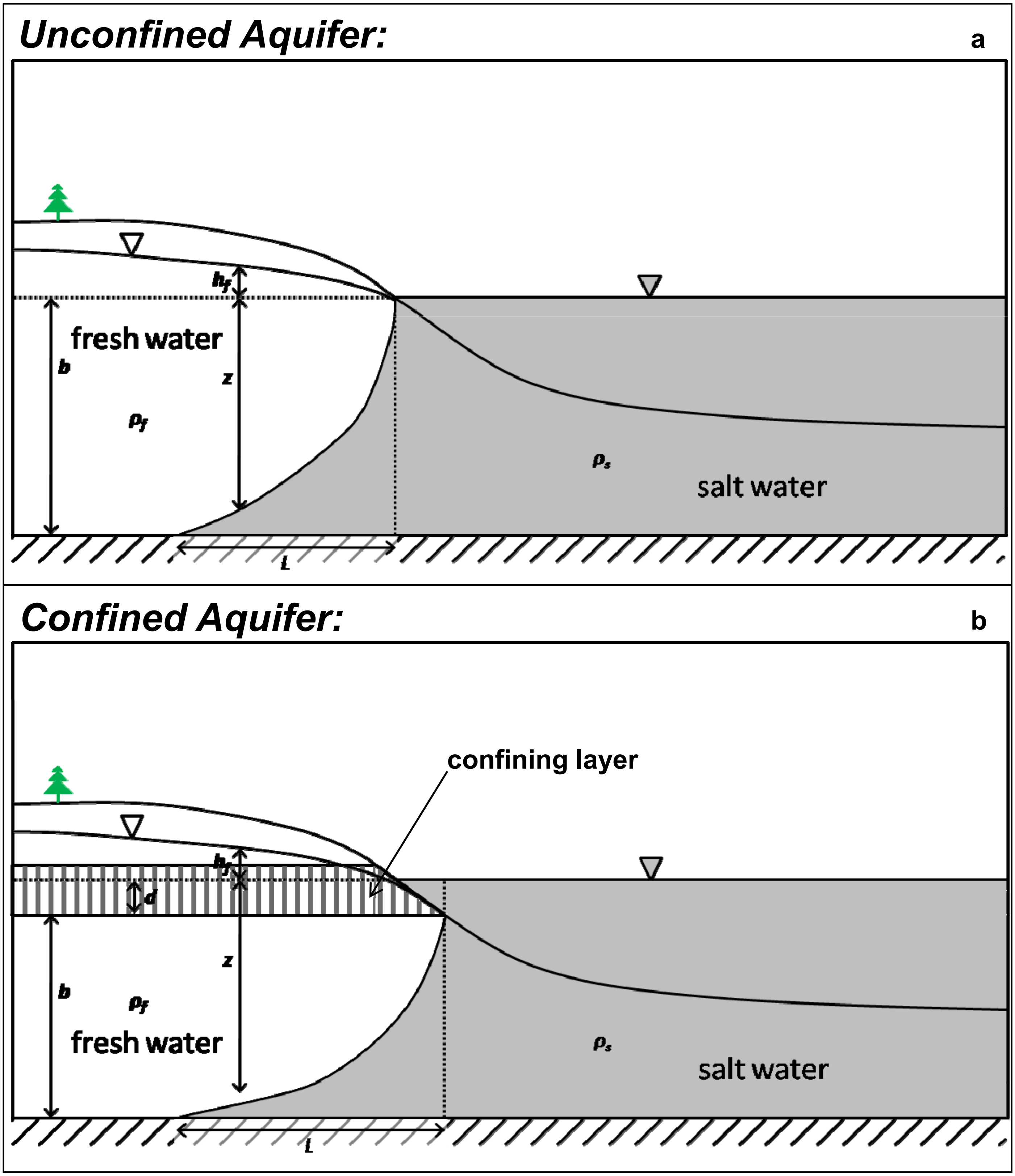
San Francisco Public Utilities Commission
Westside Basin Regional Subsurface Hydrogeology
K/J 0864001
April 2012
Figure 10.3-2



Explanation of Variables:

- ρ_f = density of freshwater (mass/volume)
- ρ_s = density of seawater (mass/volume)
- z = depth of freshwater-seawater interface below sea level (length)
- h_f = freshwater head above sea level (length)
- b = depth below sea level to aquifer base (length); unconfined conditions
- b = aquifer thickness (length); confined conditions
- d = depth below sea level of base of confining layer (length)
- L = length of intruding wedge (length)

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Seawater Intrusion Schematics for Unconfined and Confined Aquifers

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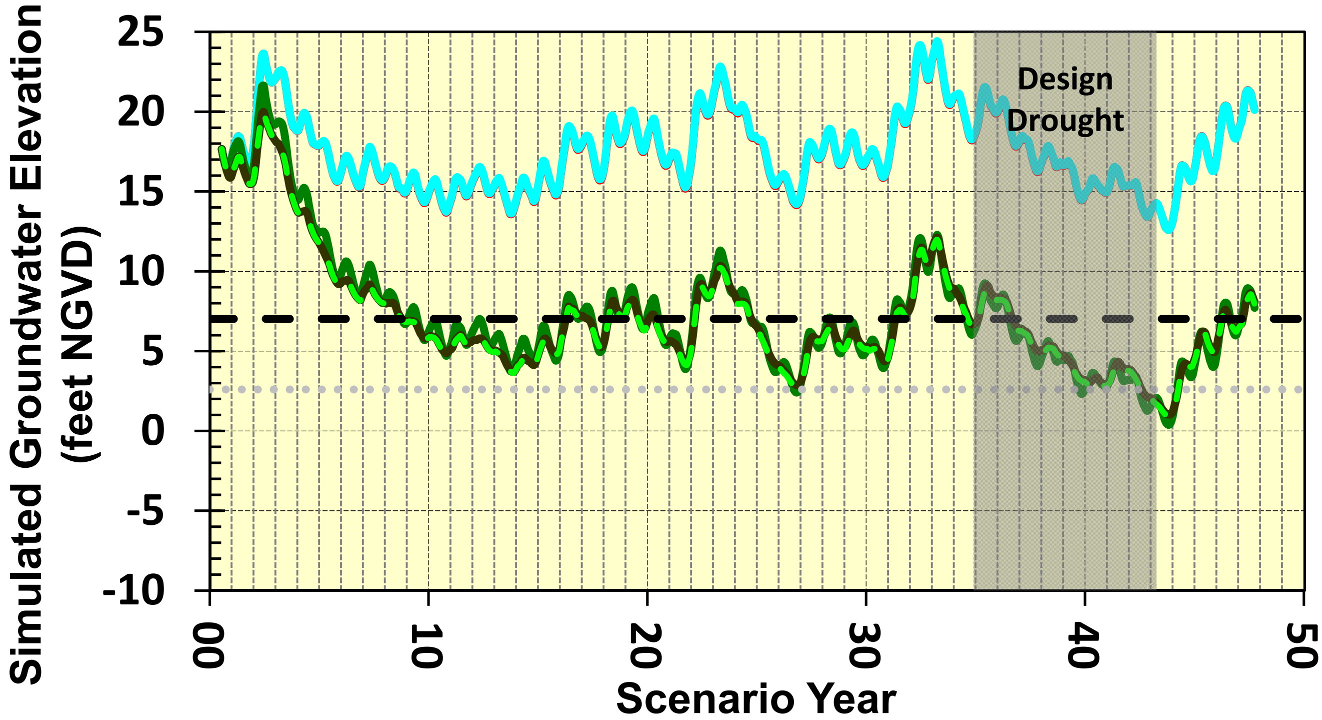
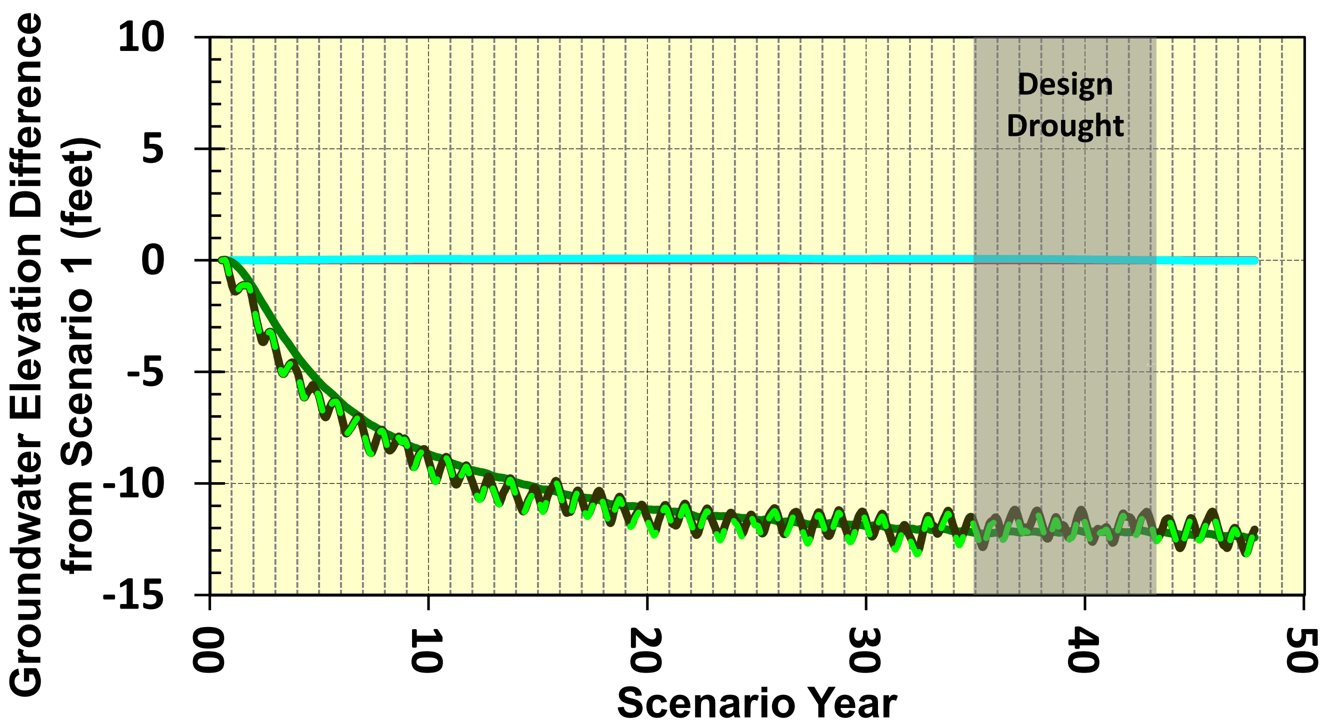
April 2012

Figure 10.3-3





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

Scenario 1 — Scenario 2

Scenario 3a — Scenario 3b

Scenario 4

Exclusion Heads:

Single-Aquifer — Shallow Aquifer

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Model Layer 1 Hydrographs for North Windmill Location

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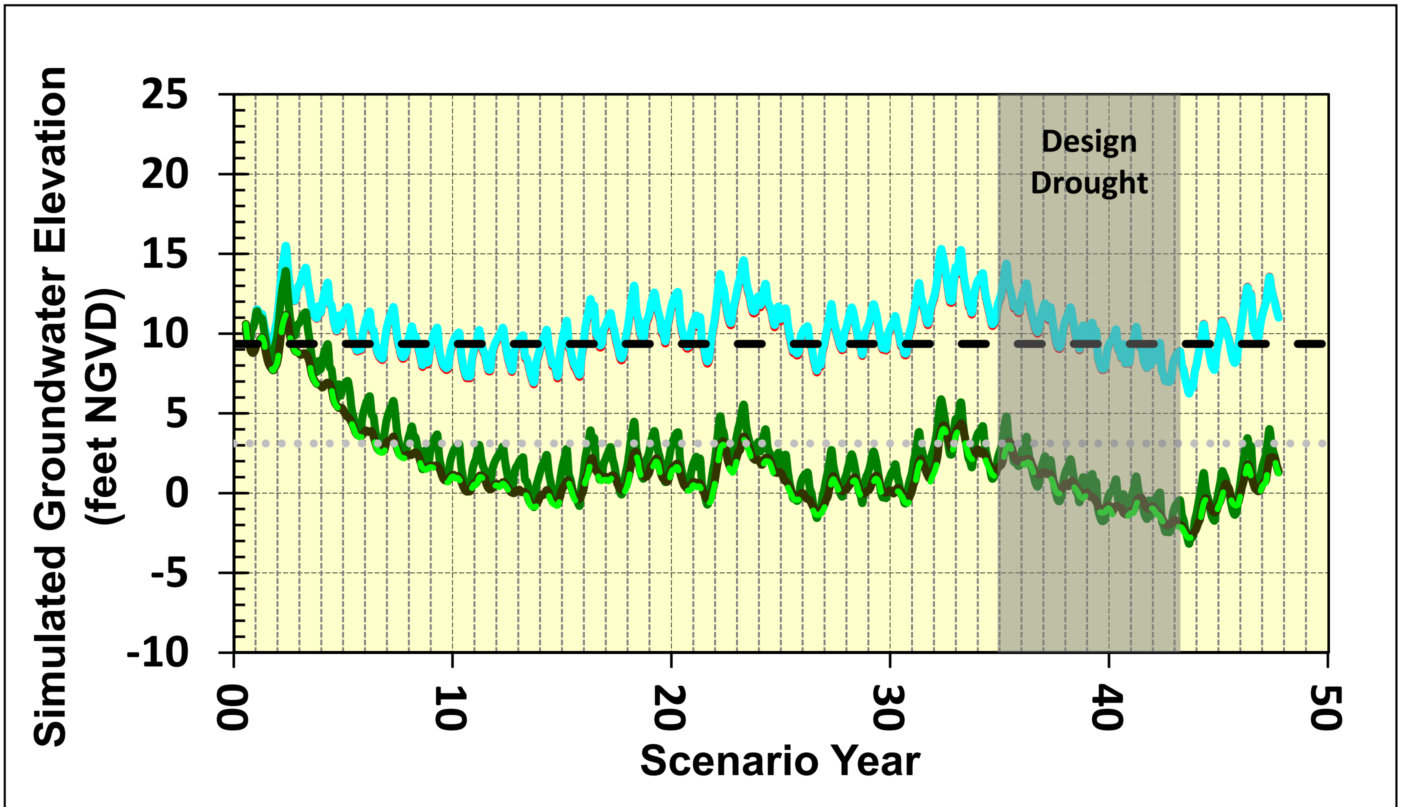
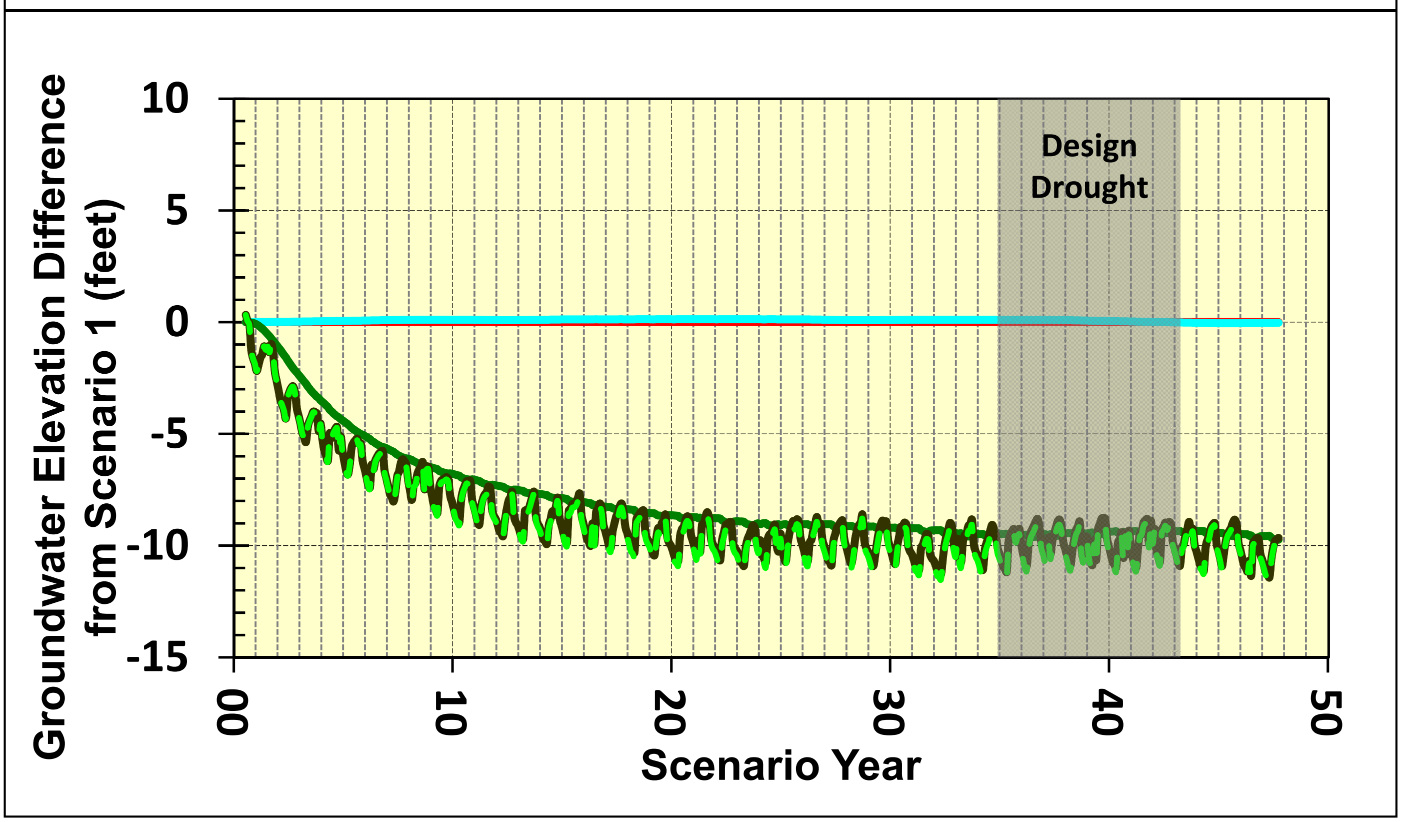
Figure 10.3-4





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- **Scenario 1**
- **Scenario 2**
- **Scenario 3a**
- **Scenario 3b**
- **Scenario 4**

Exclusion Heads:
- **Single-Aquifer**
- **Shallow Aquifer**

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Model Layer 1 Hydrographs for South Windmill Cluster

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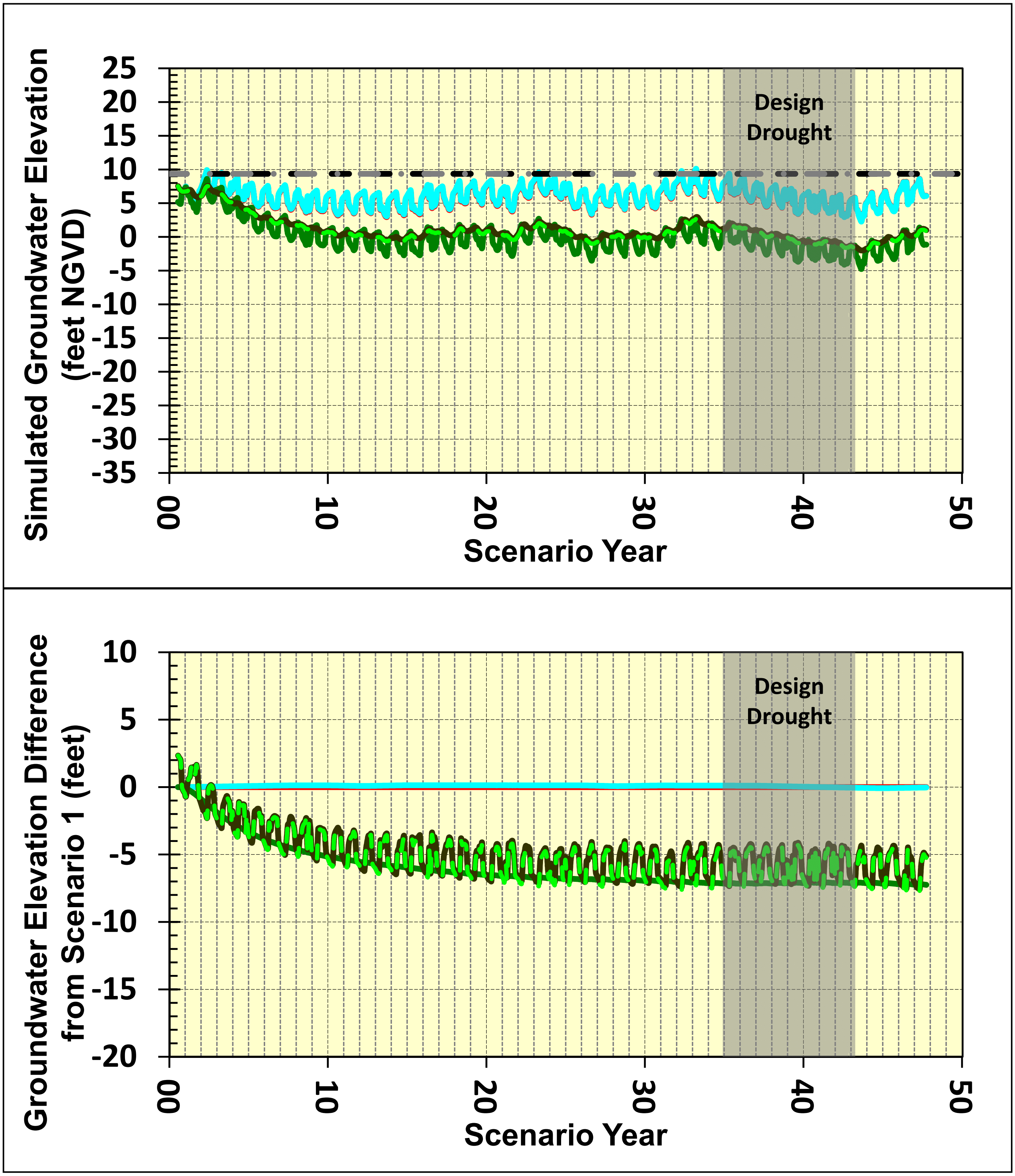
Figure 10.3-5a



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Primary Production Aquifer

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Model Layer 4 Hydrographs for South Windmill Cluster

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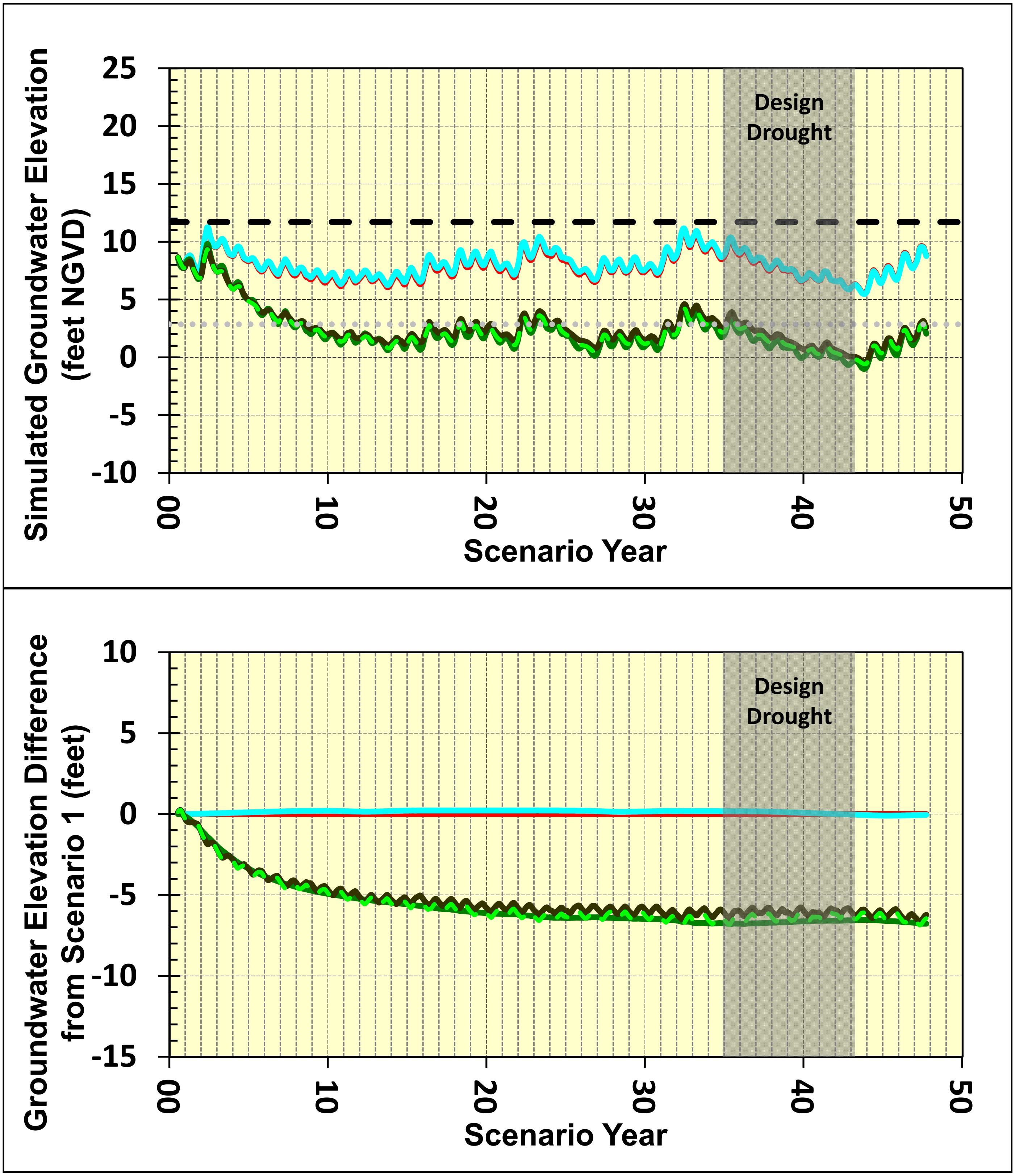
Figure 10.3-5b



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:
- Single-Aquifer
- Shallow Aquifer

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Model Layer 1 Hydrographs for Kirkham Cluster

K/J 0864001
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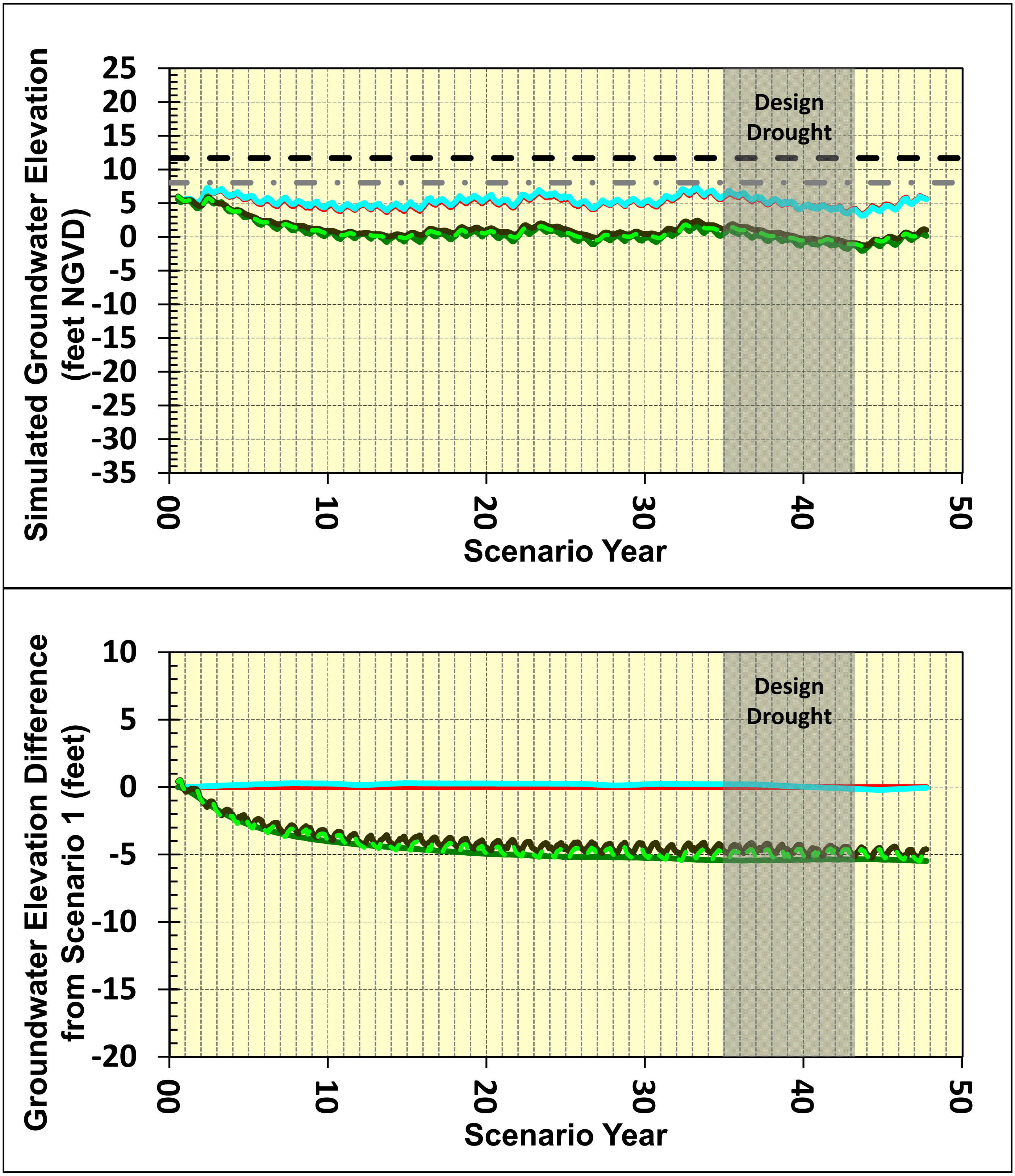
Figure 10.3-6a



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

Scenario 1

Scenario 2

Scenario 3a

Scenario 3b

Scenario 4

Exclusion Heads:

Single-Aquifer

Primary Production Aquifer

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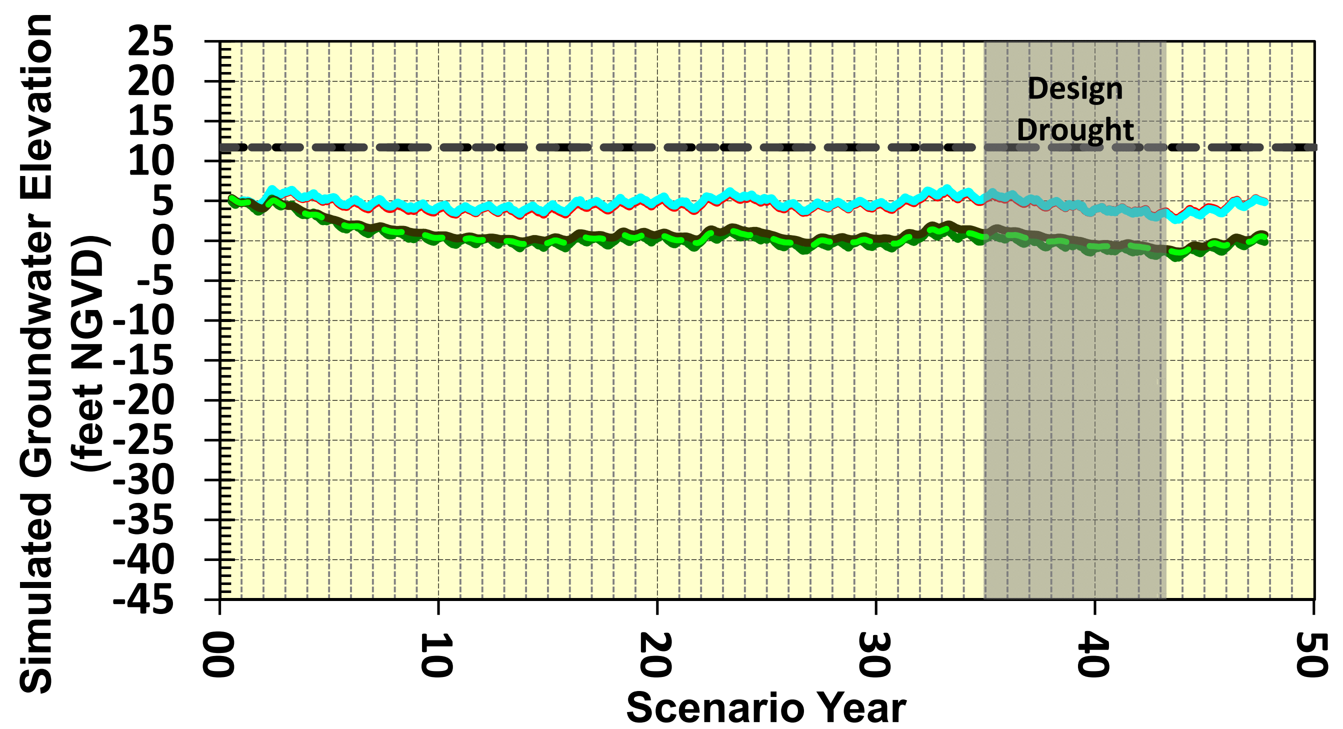
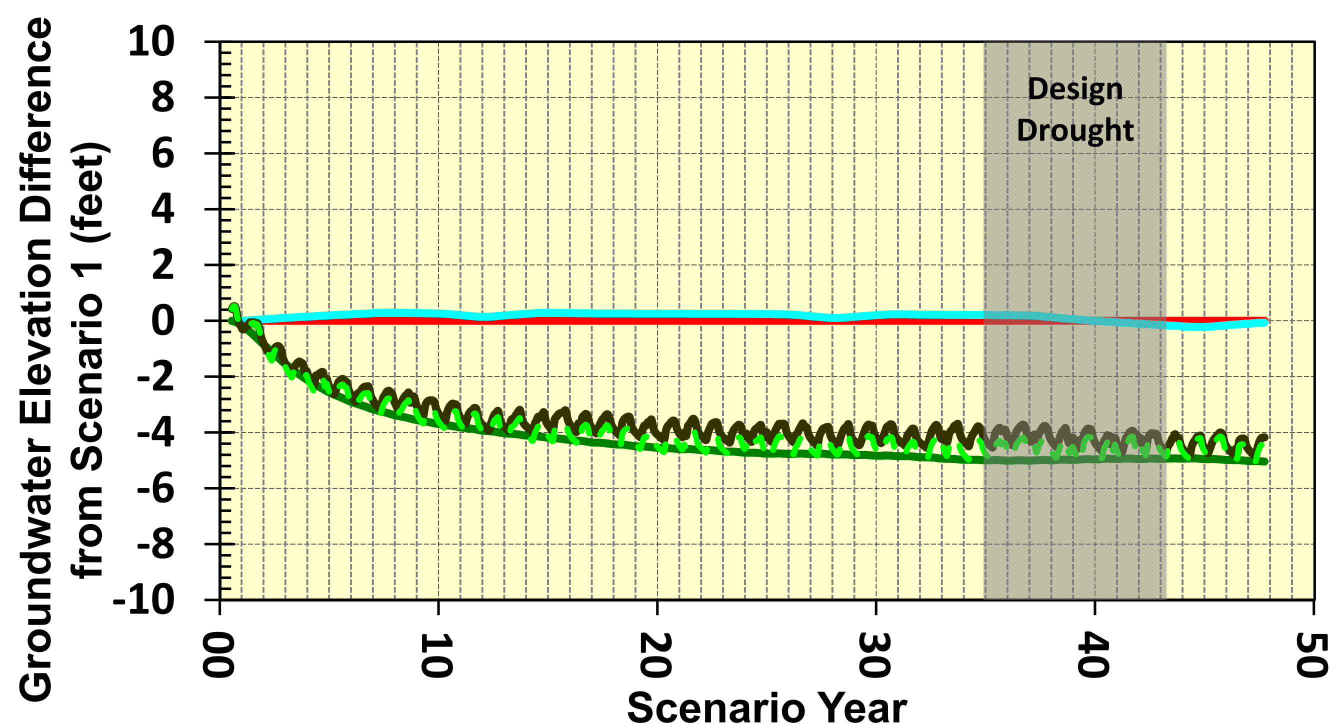
Model Layer 4 Hydrographs for Kirkham Cluster

K/J 0864001

April 2012

Figure 10.3-6b





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

Exclusion Heads:
Single-Aquifer
Deep Aquifer

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Model Layer 5 Hydrographs for Kirkham Cluster

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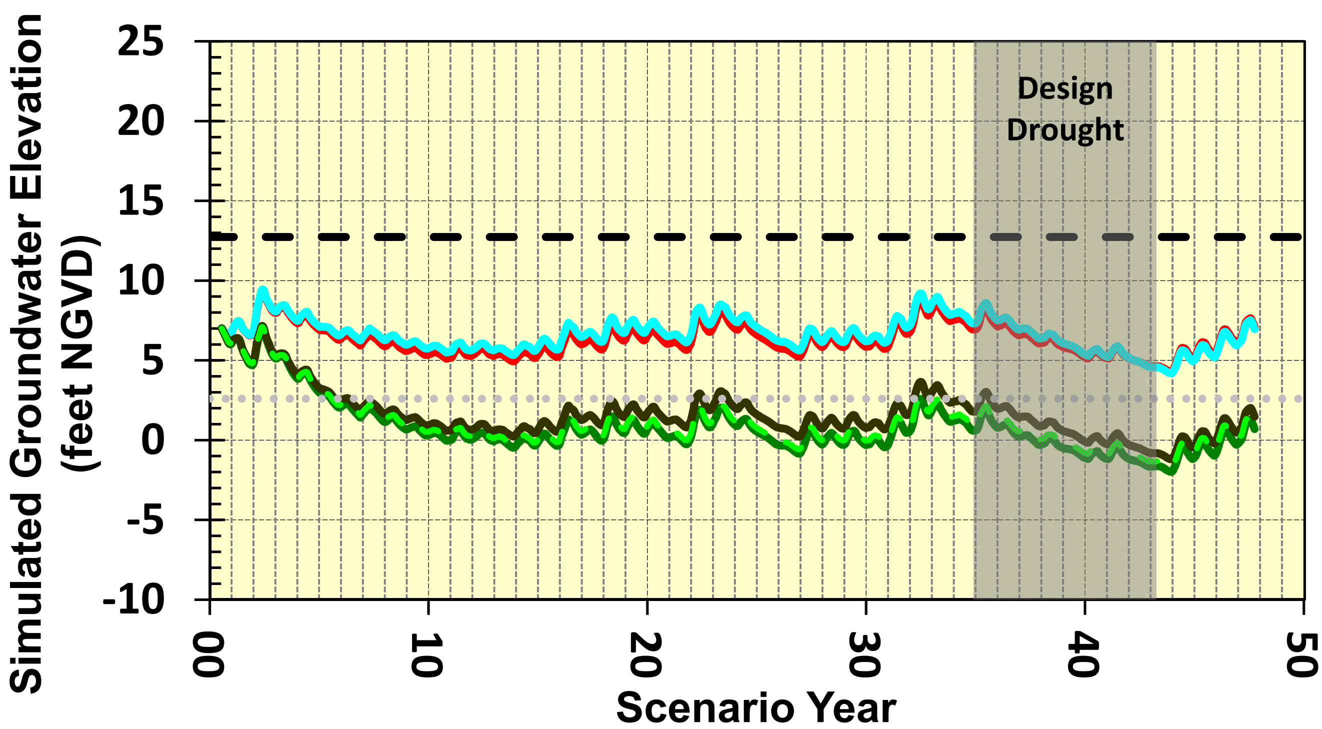
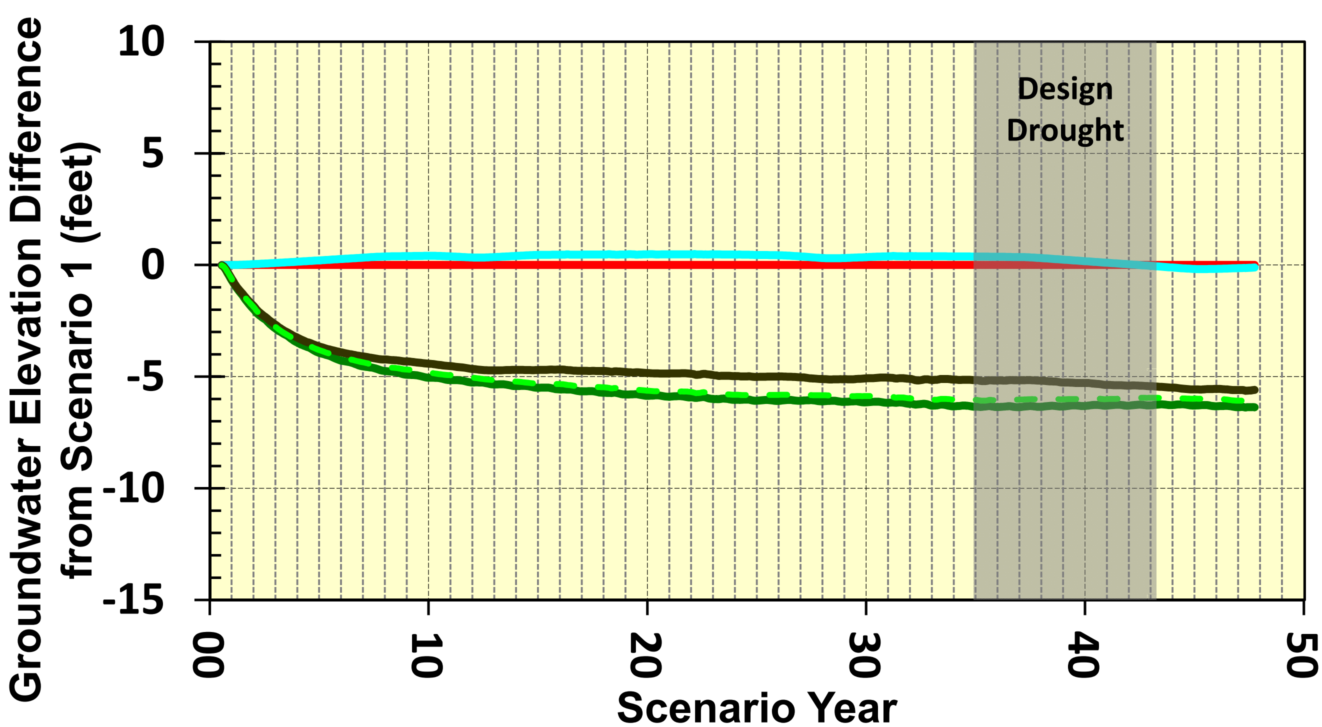
April 2012
Figure 10.3-6c





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Shallow Aquifer

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Model Layer 1 Hydrographs for Ortega Cluster

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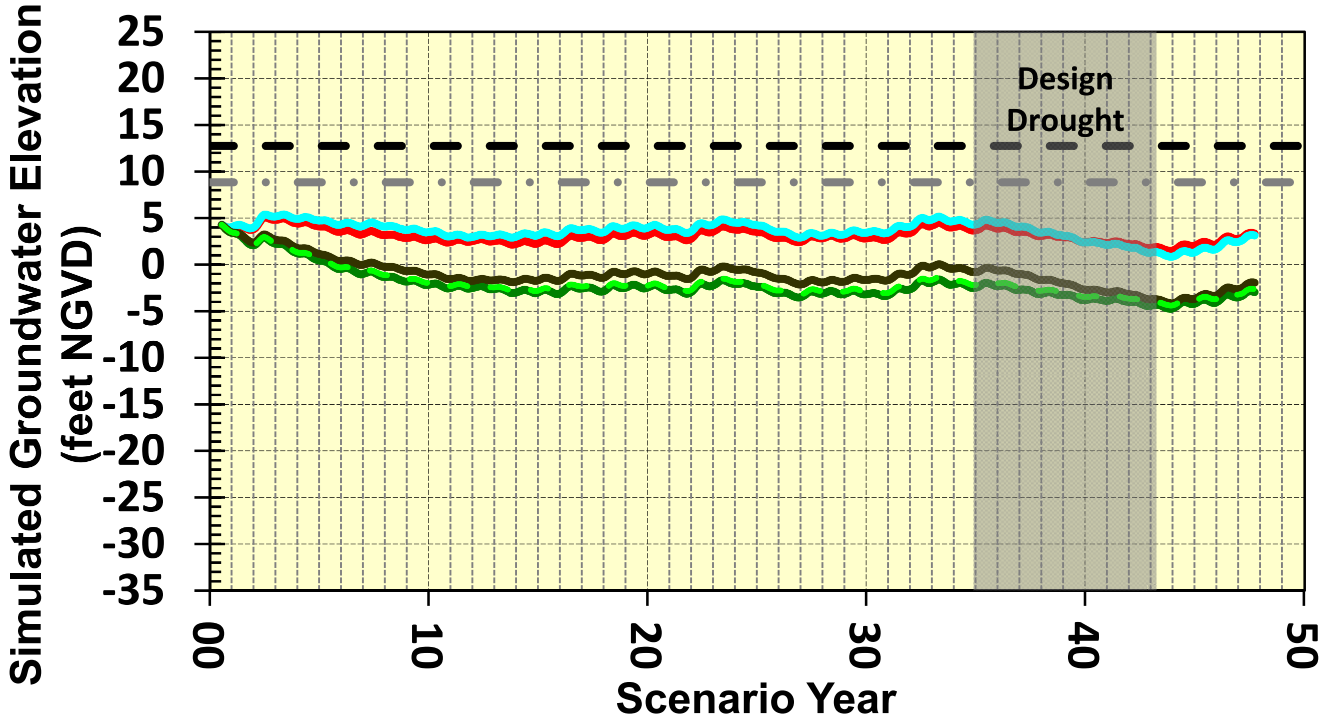
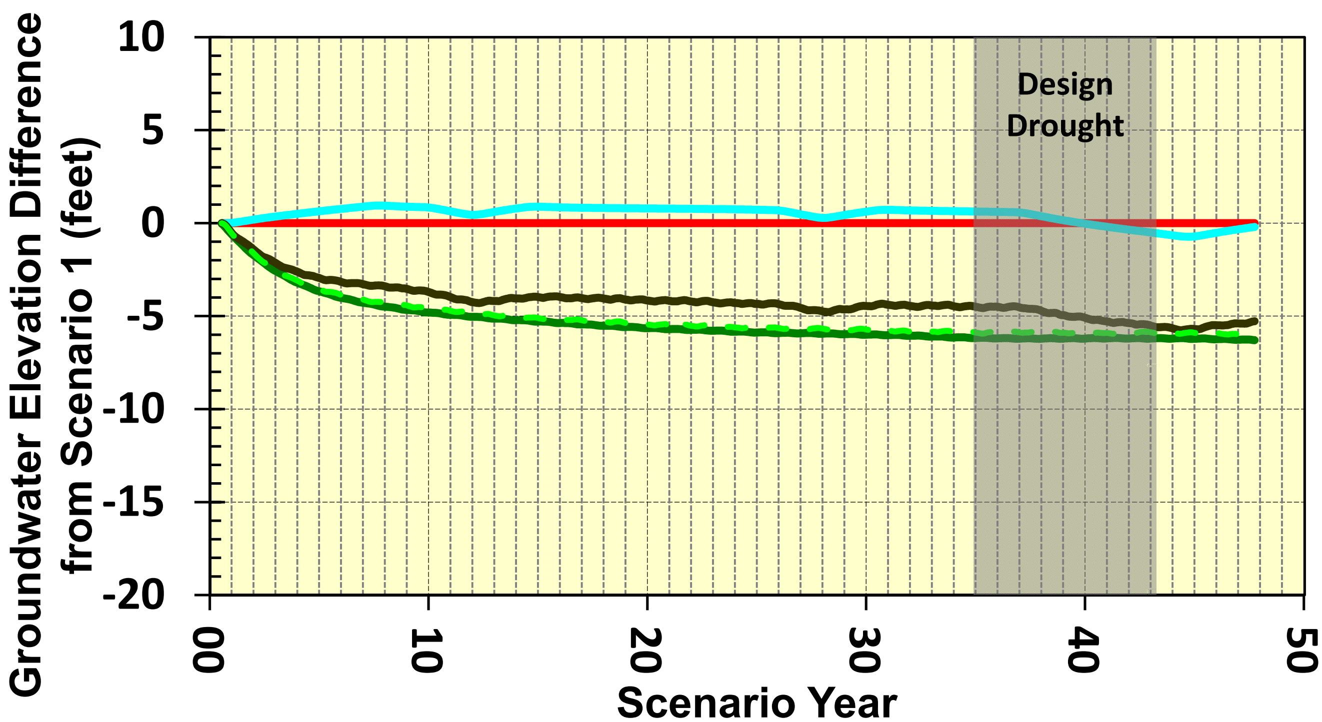
Figure 10.3-7a





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Primary Production Aquifer

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Model Layer 4 Hydrographs for Ortega Cluster

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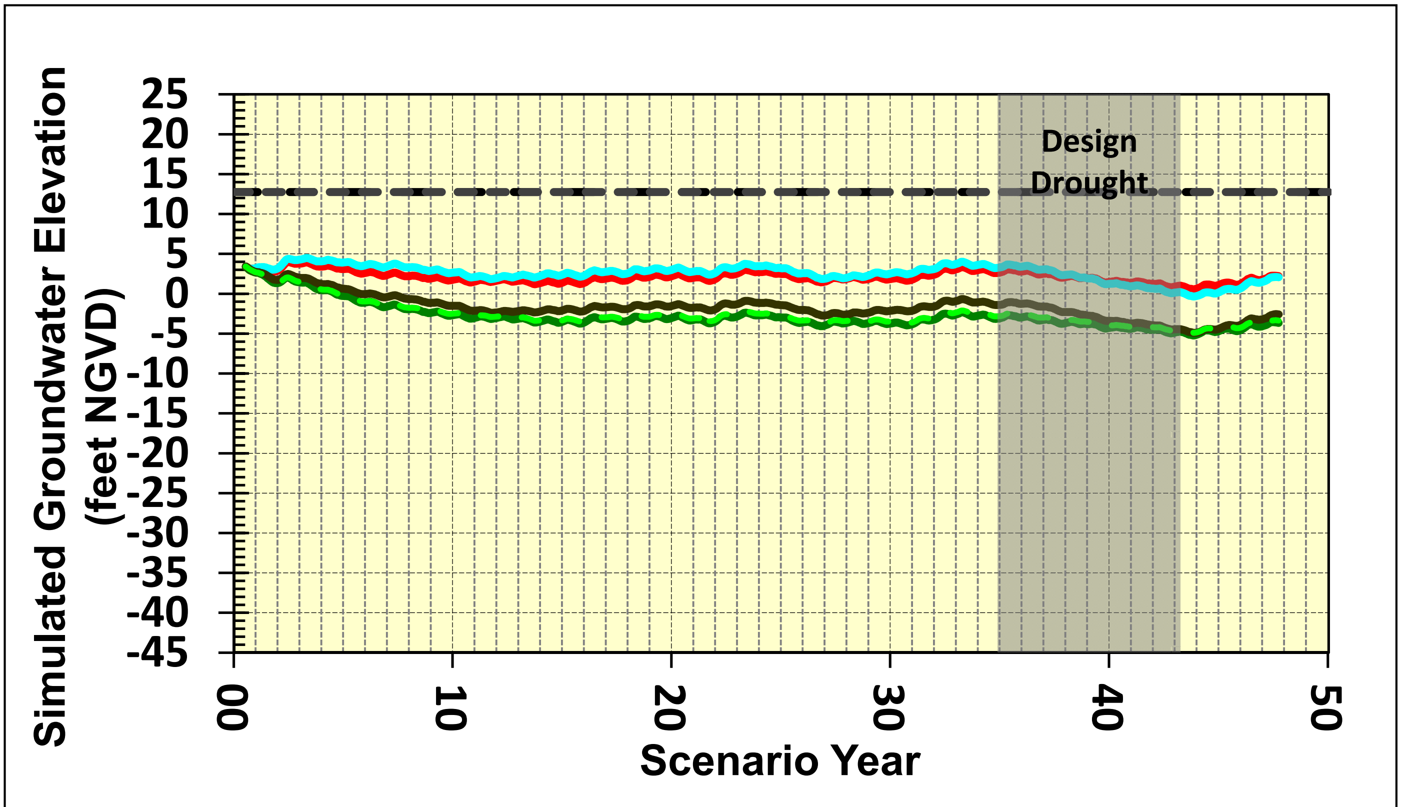
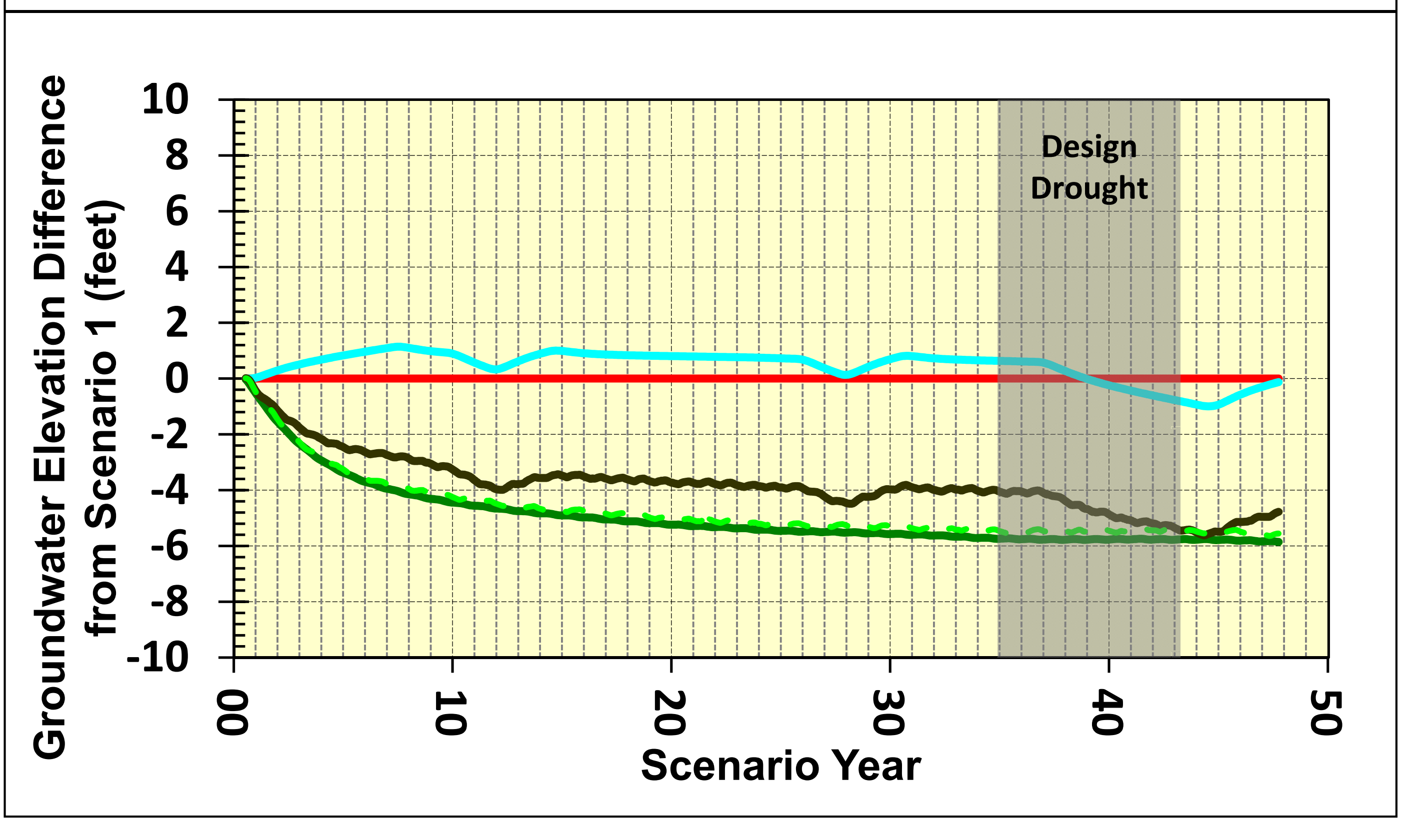
Figure 10.3-7b





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Deep Aquifer

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Model Layer 5 Hydrographs for Ortega Cluster

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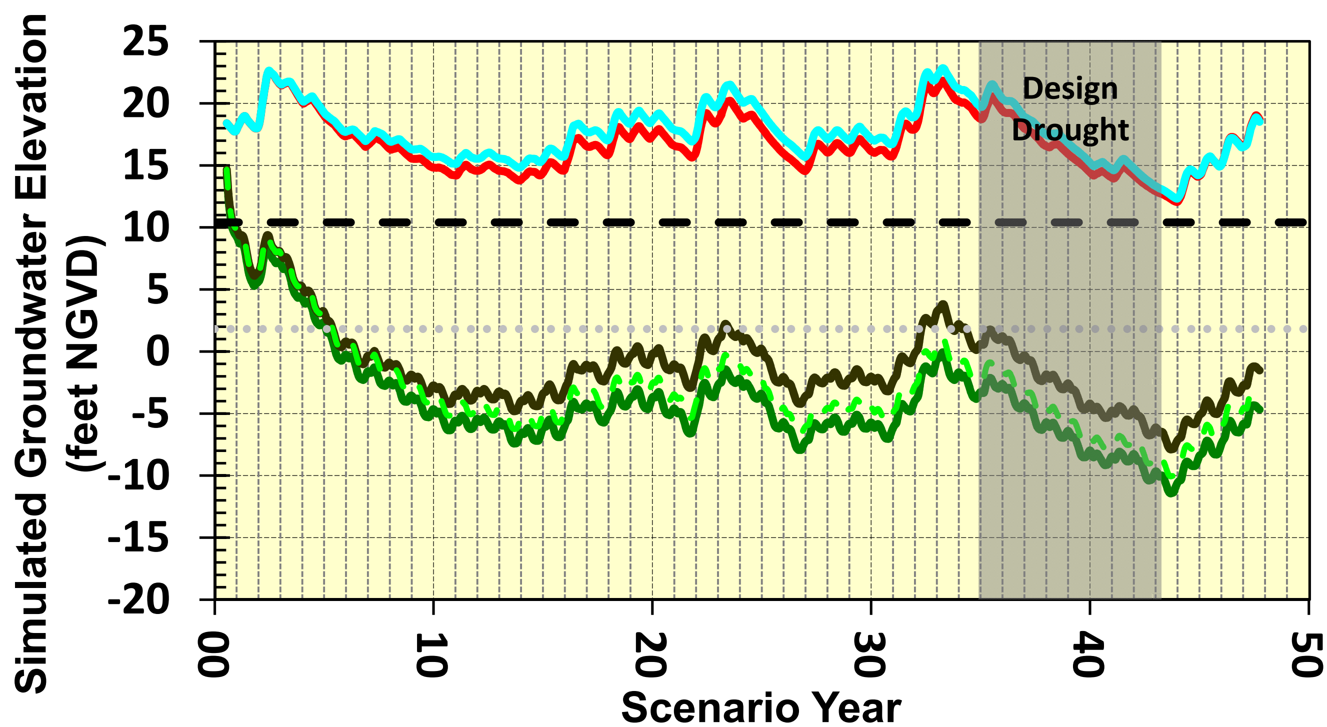
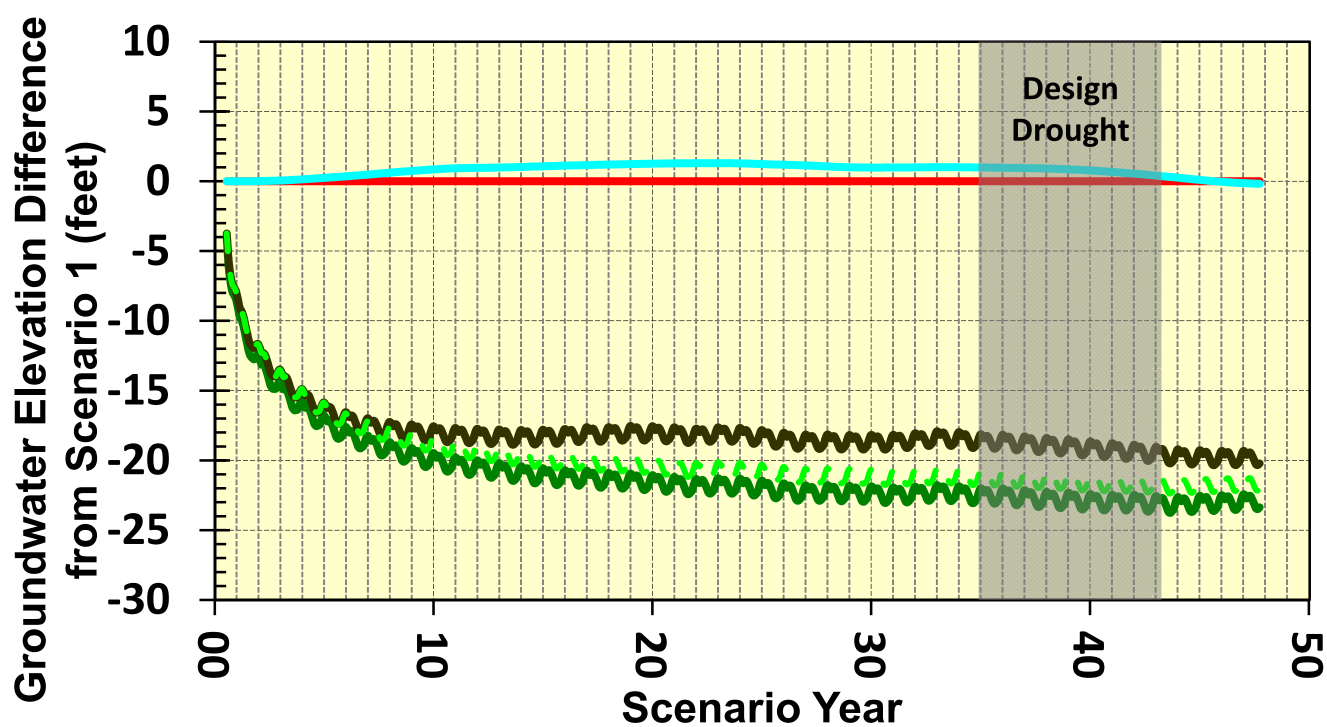
Figure 10.3-7c





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Shallow Aquifer

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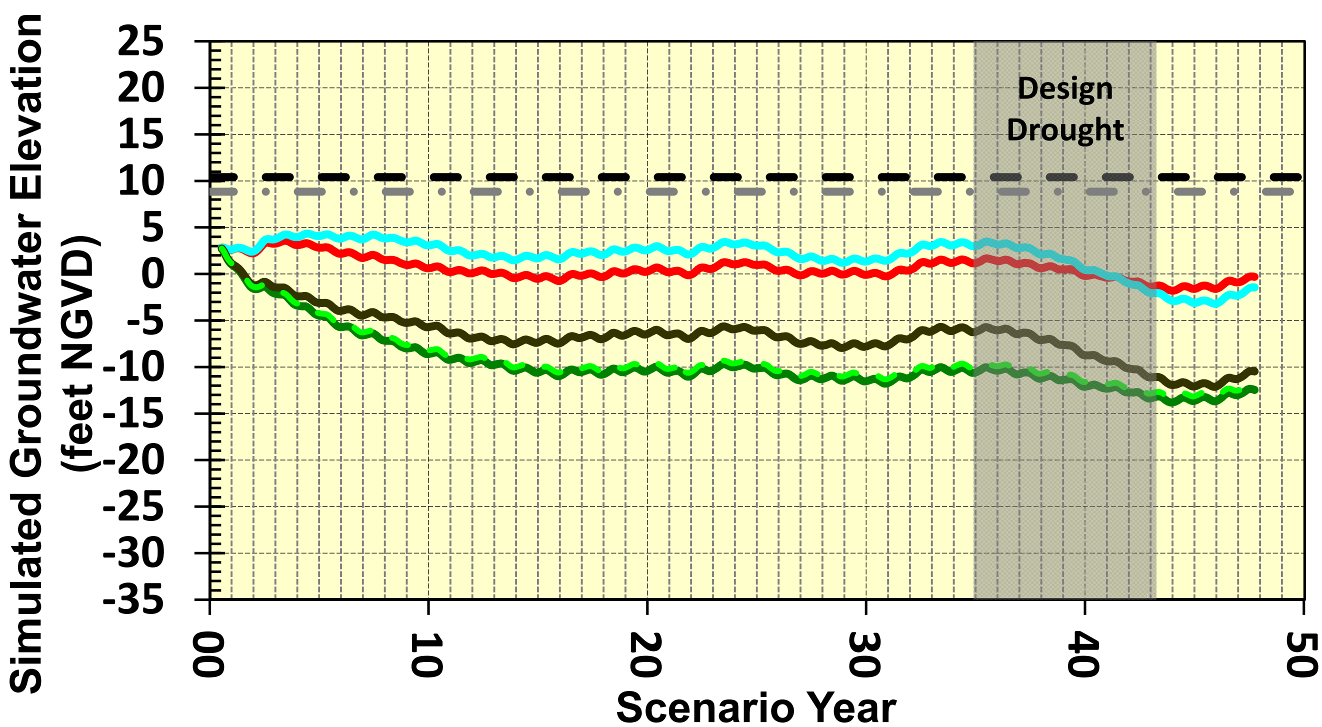
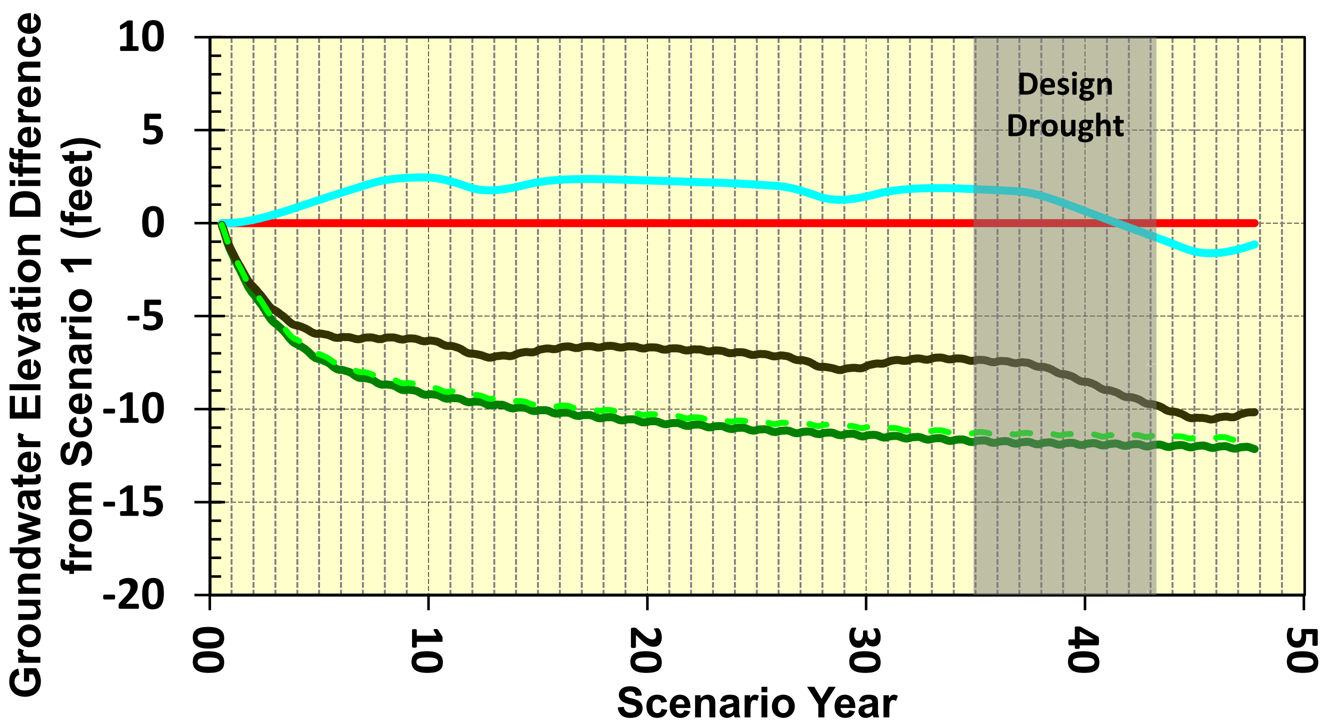
Model Layer 1 Hydrographs for West Sunset Playground Well

K/J 0864001
April 2012
Figure 10.3-8a





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Primary Production Aquifer

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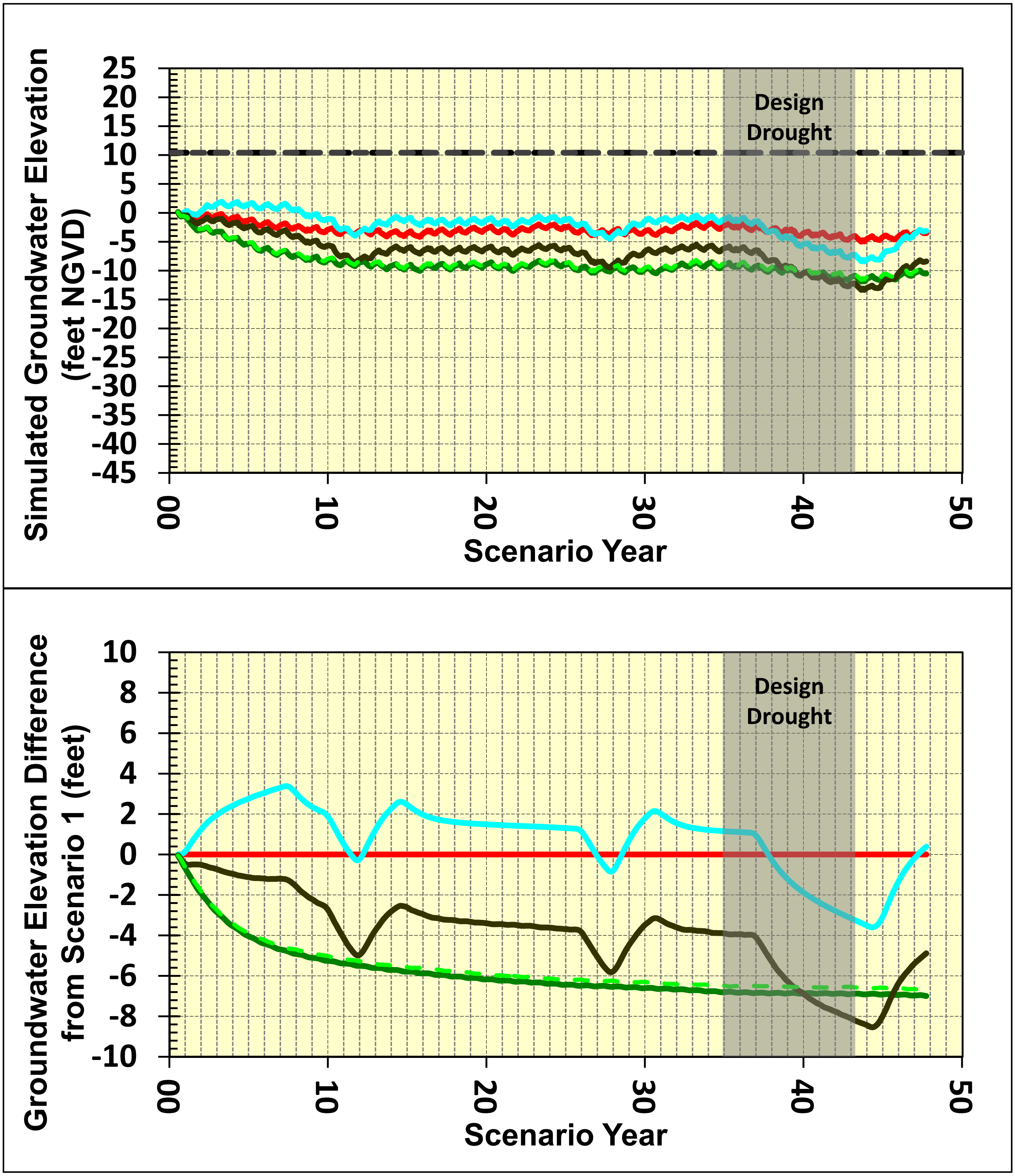
Regional Groundwater Storage and Recovery Project
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 4 Hydrographs for West Sunset Playground Well

K/J 0864001
April 2012

Figure 10.3-8b



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Deep Aquifer

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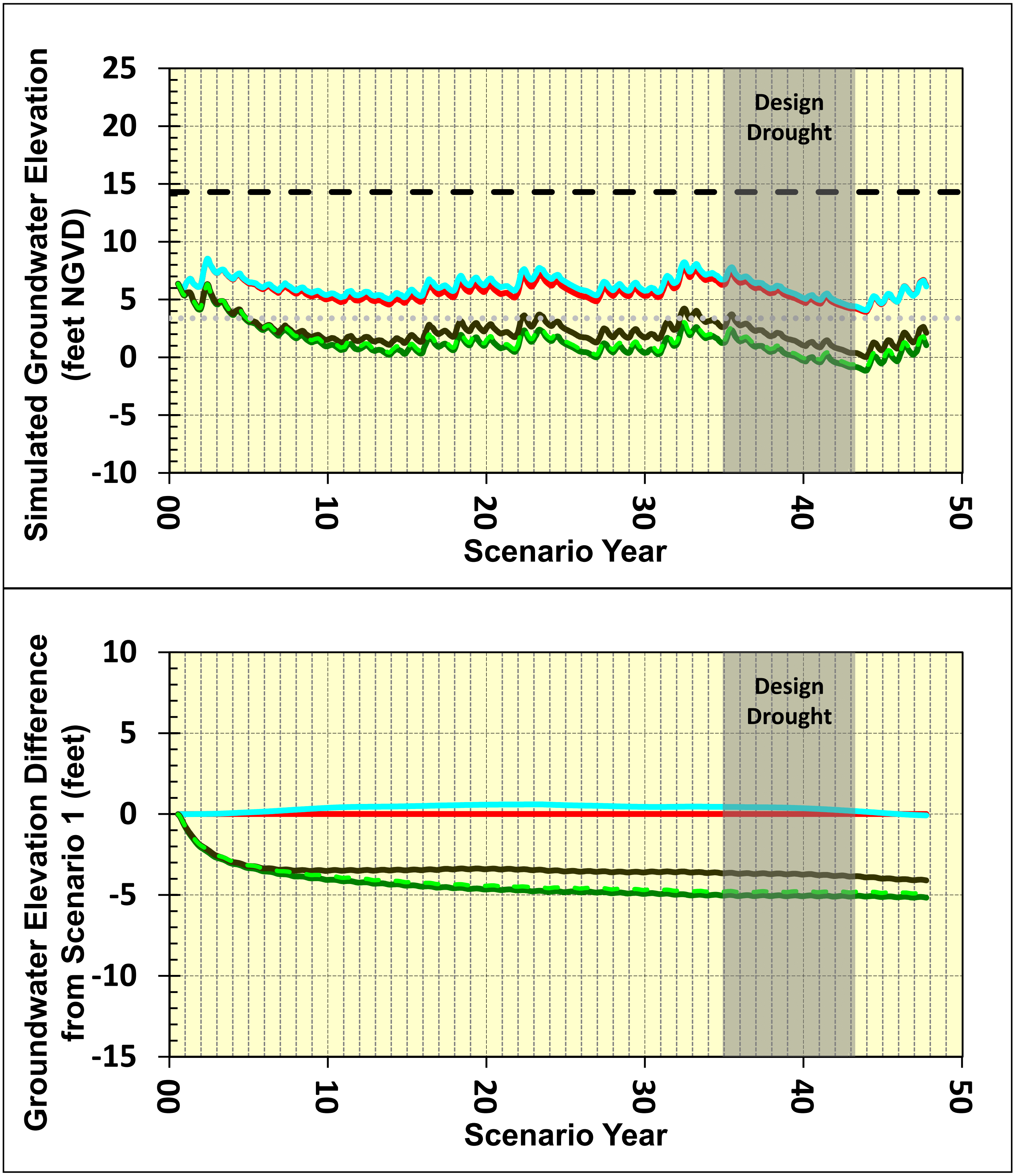
San Francisco Public Utilities Commission

Model Layer 5 Hydrographs for West Sunset Playground Well

K/J 0864001
April 2012
Figure 10.3-8c



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

Exclusion Heads:
Single-Aquifer
Shallow Aquifer

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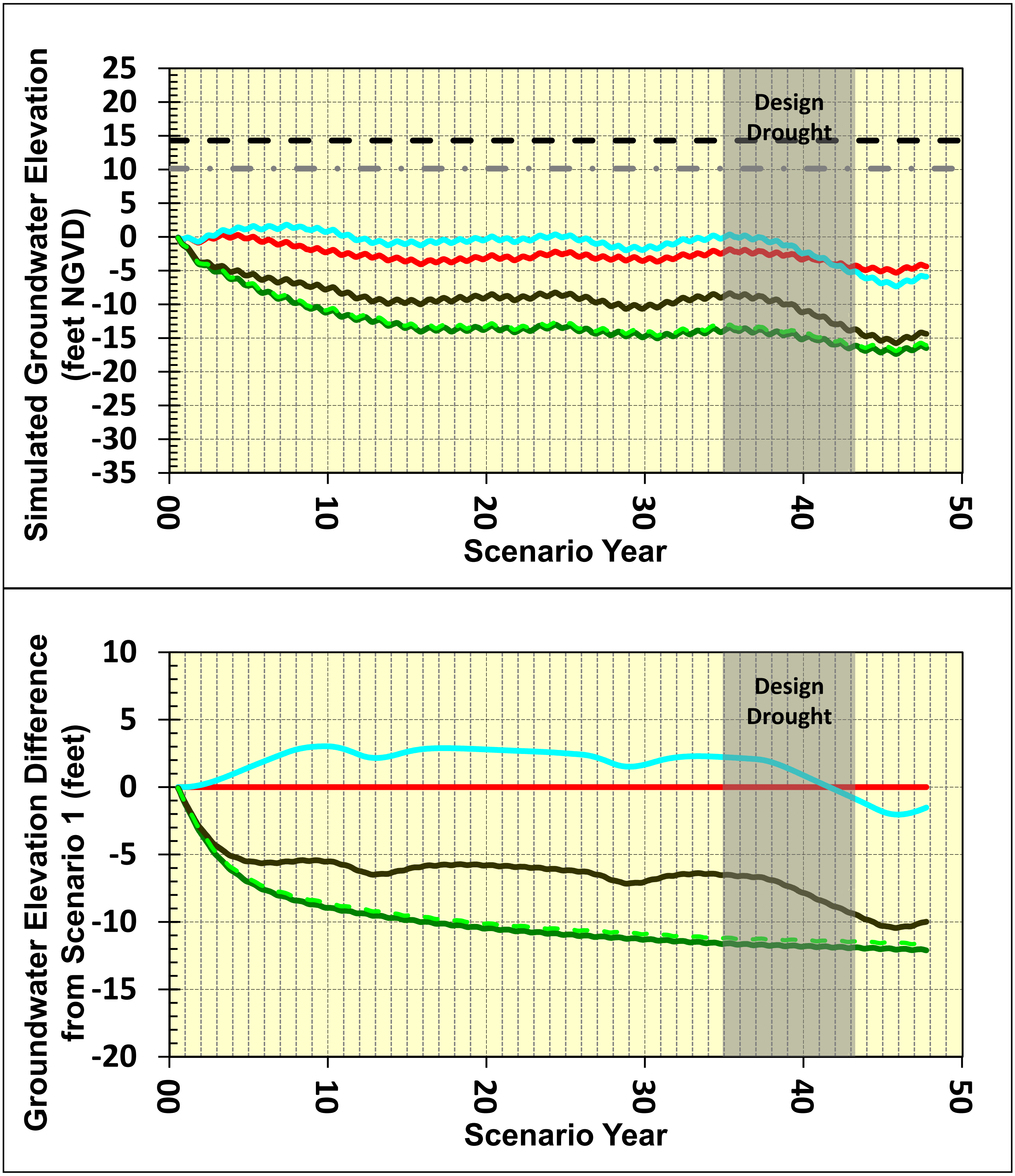
Regional Groundwater Storage and Recovery Project
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 1 Hydrographs for Taraval Cluster

K/J 0864001
April 2012
Figure 10.3-9a



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

Scenario 1 **Scenario 2**
Scenario 3a **Scenario 3b**
Scenario 4

Exclusion Heads:

Single-Aquifer **Primary Production Aquifer**

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Model Layer 4 Hydrographs for Taraval Cluster

K/J 0864001
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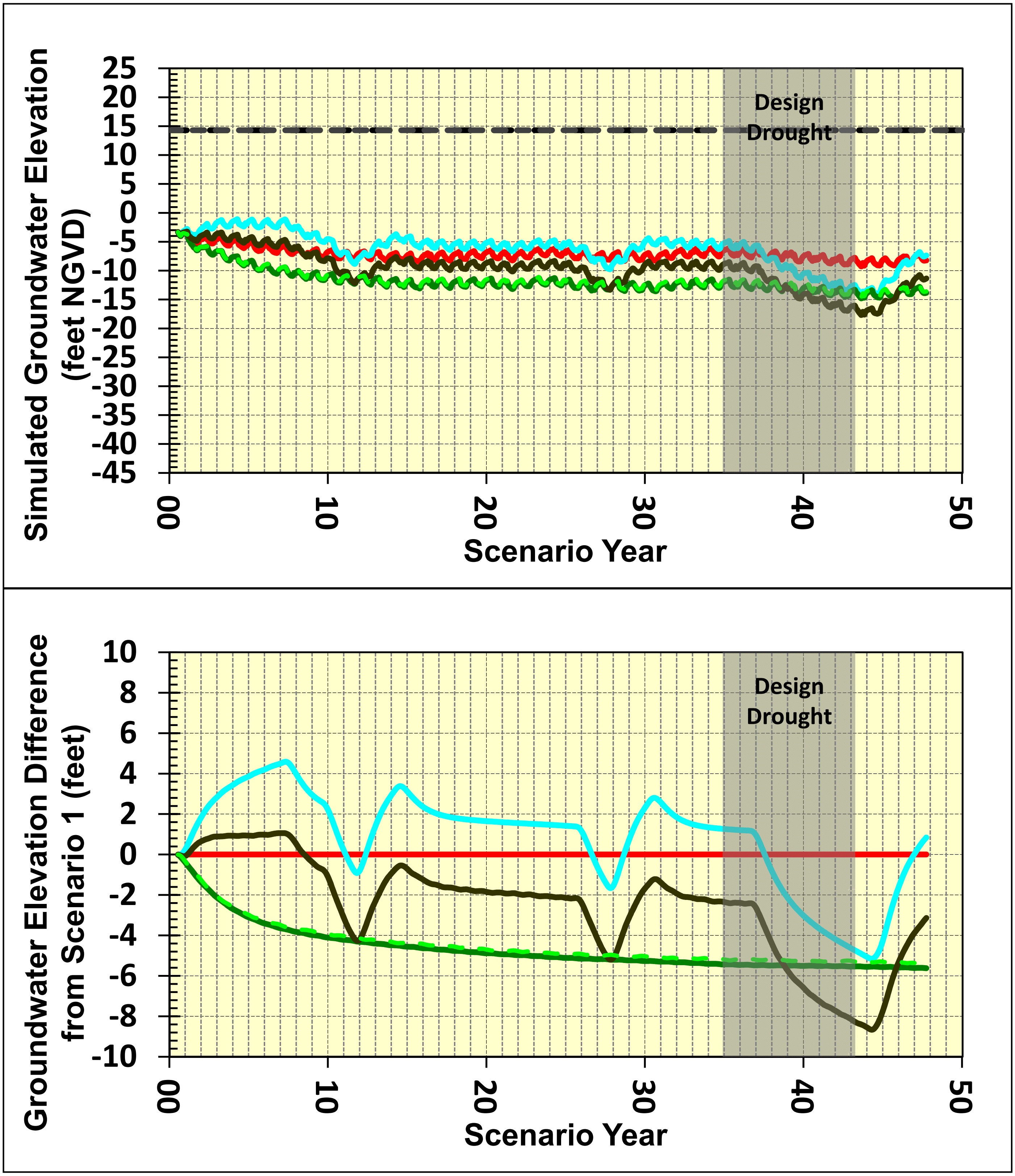
Figure 10.3-9b



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:
- Single-Aquifer
- Deep Aquifer

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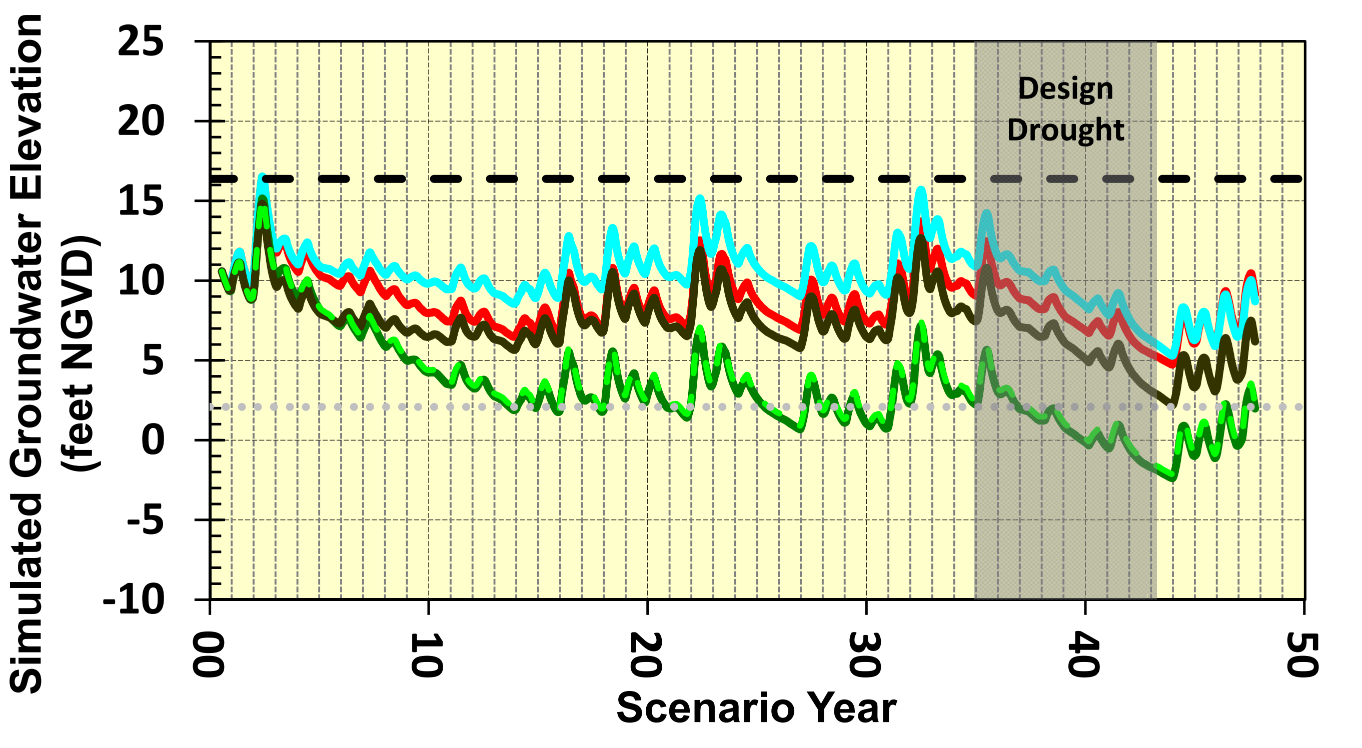
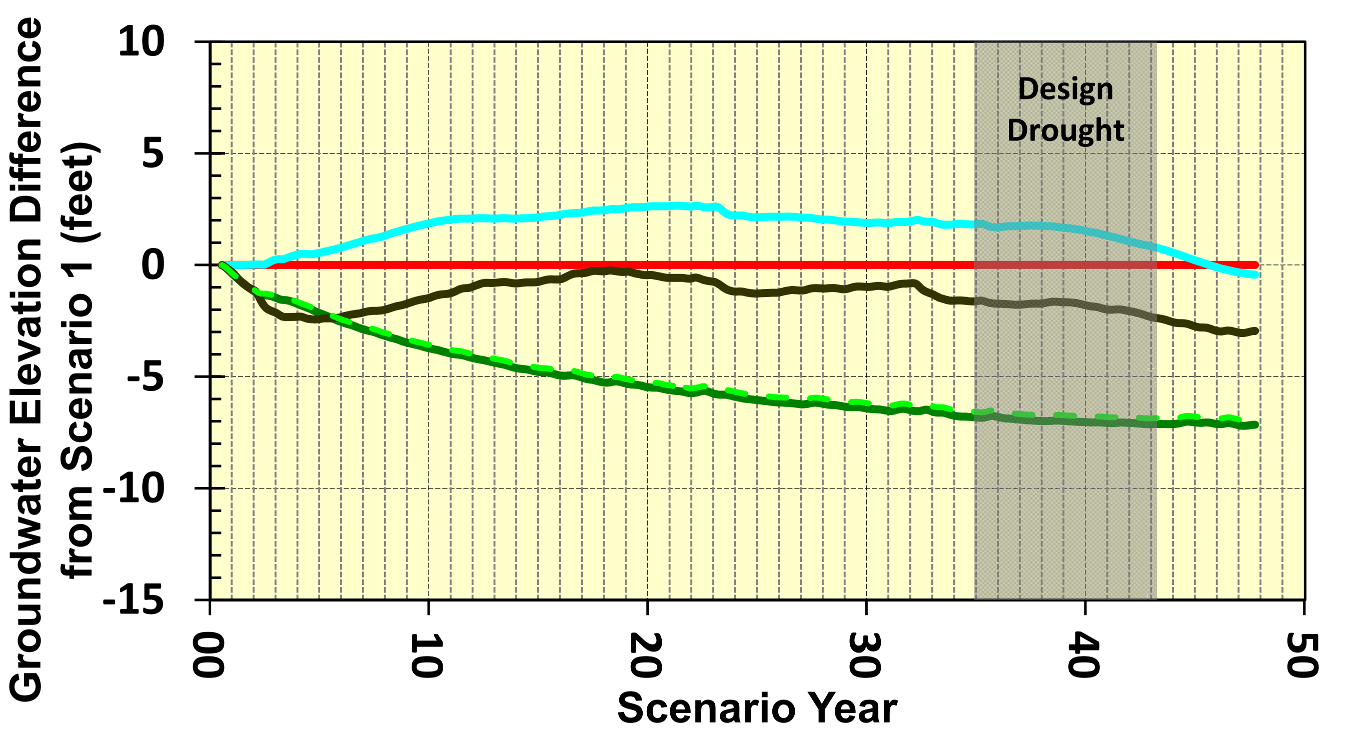
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 5 Hydrographs for Taraval Cluster

K/J 0864001
April 2012
Figure 10.3-9c





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Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Shallow Aquifer

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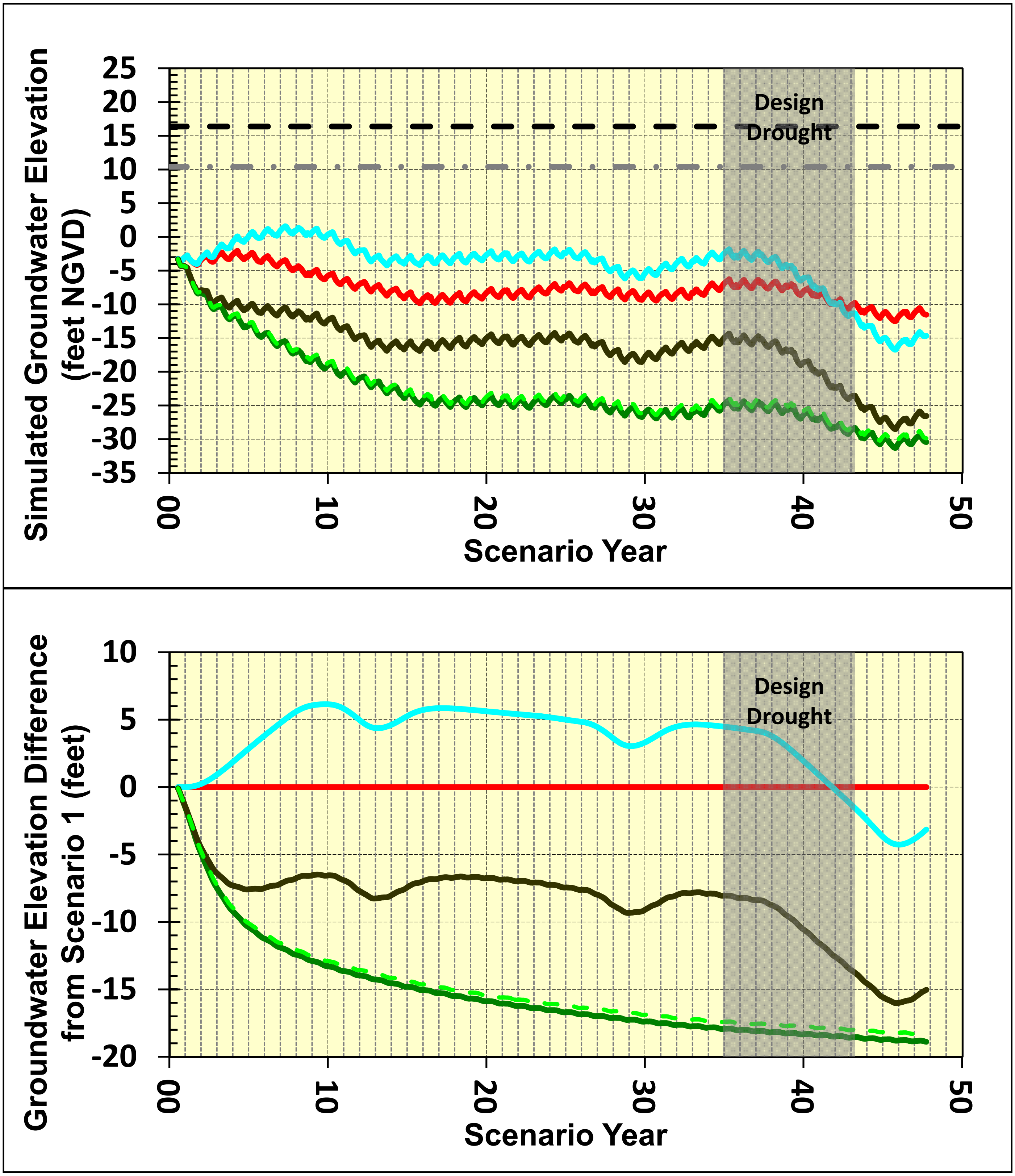
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 1 Hydrographs for Zoo Cluster

K/J 0864001
April 2012
Figure 10.3-10a



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer
- Primary Production Aquifer

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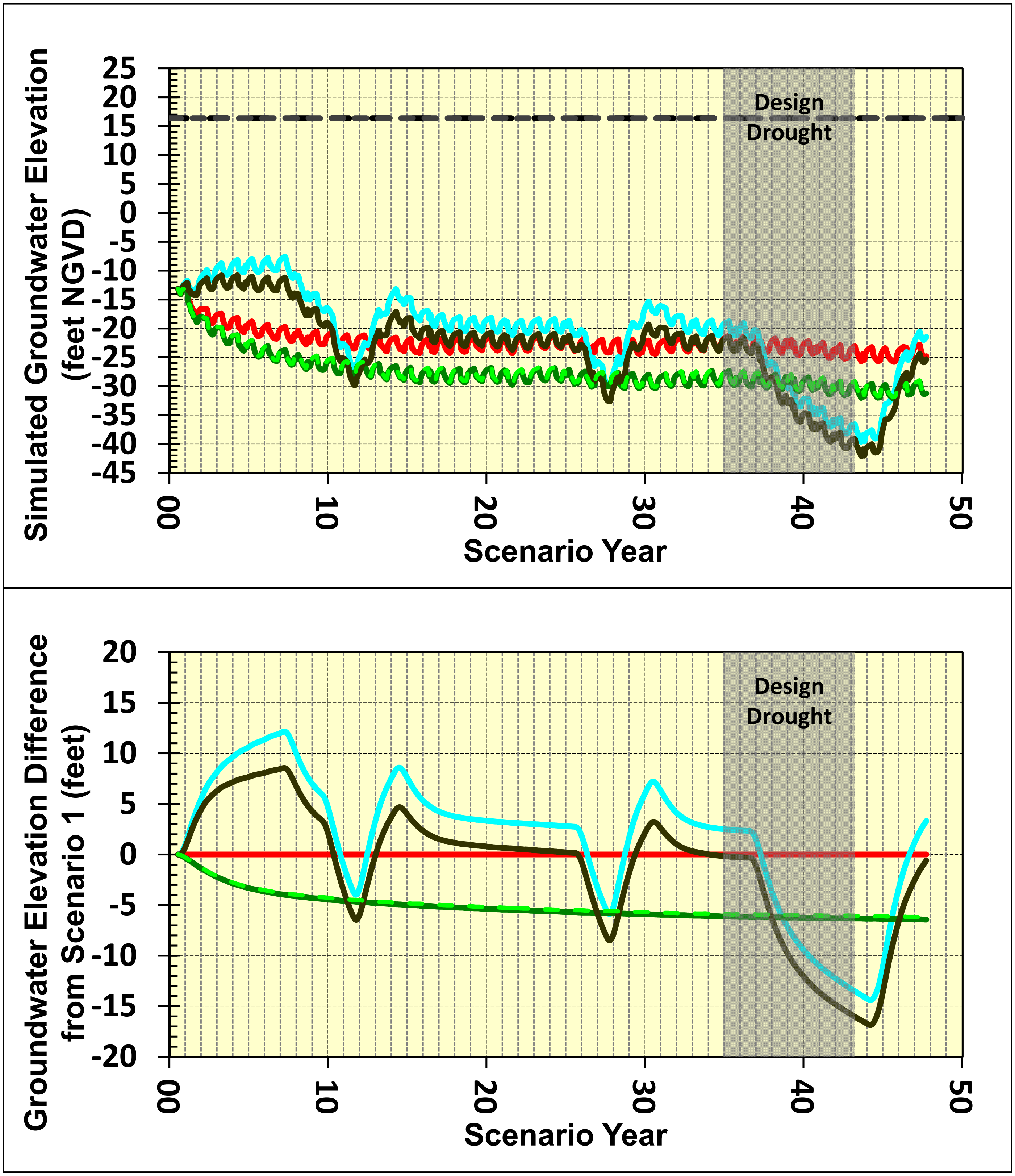
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 4 Hydrographs for Zoo Cluster

K/J 0864001
April 2012
Figure 10.3-10b



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:
- Single-Aquifer
- Deep Aquifer

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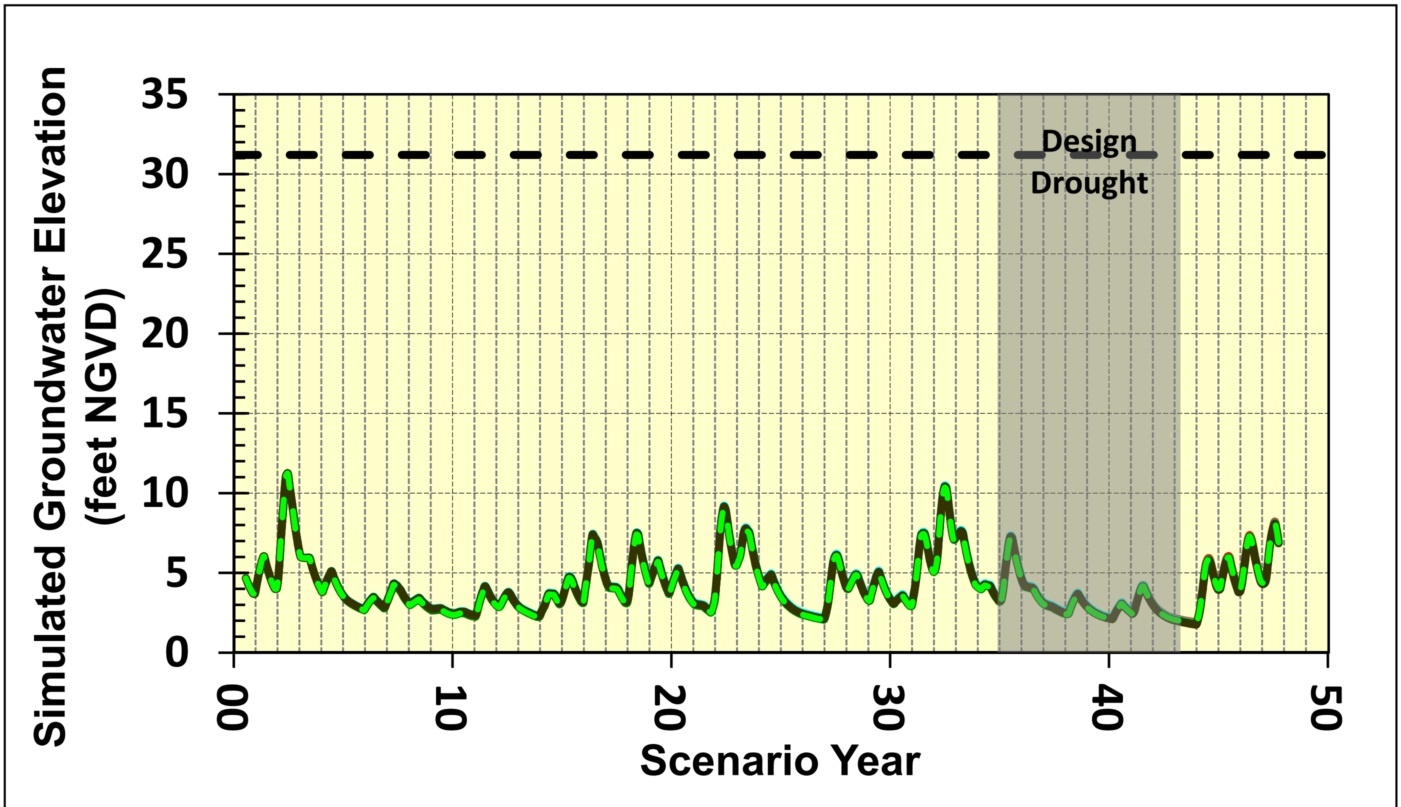
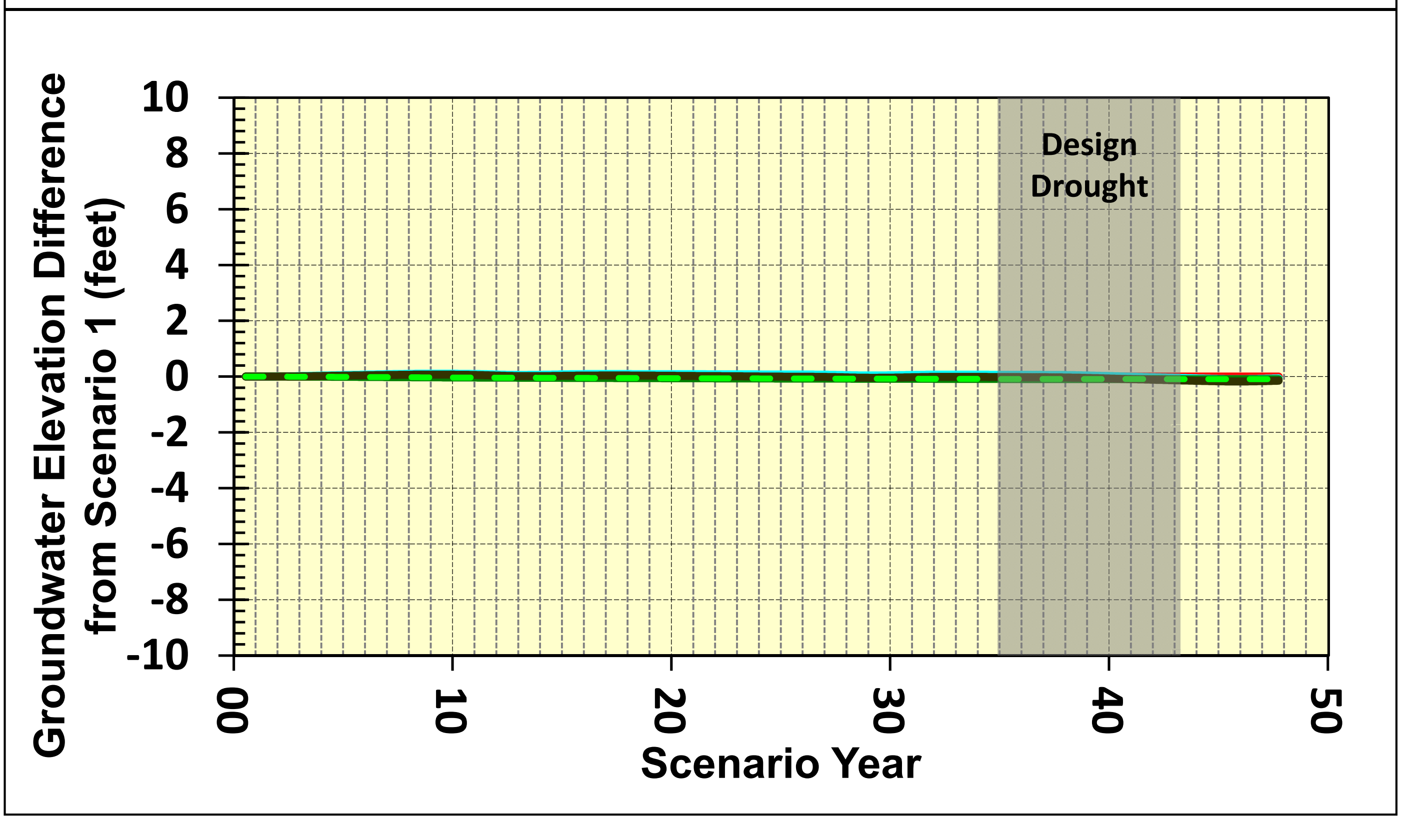
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 5 Hydrographs for Zoo Cluster

K/J 0864001
April 2012
Figure 10.3-10c





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer

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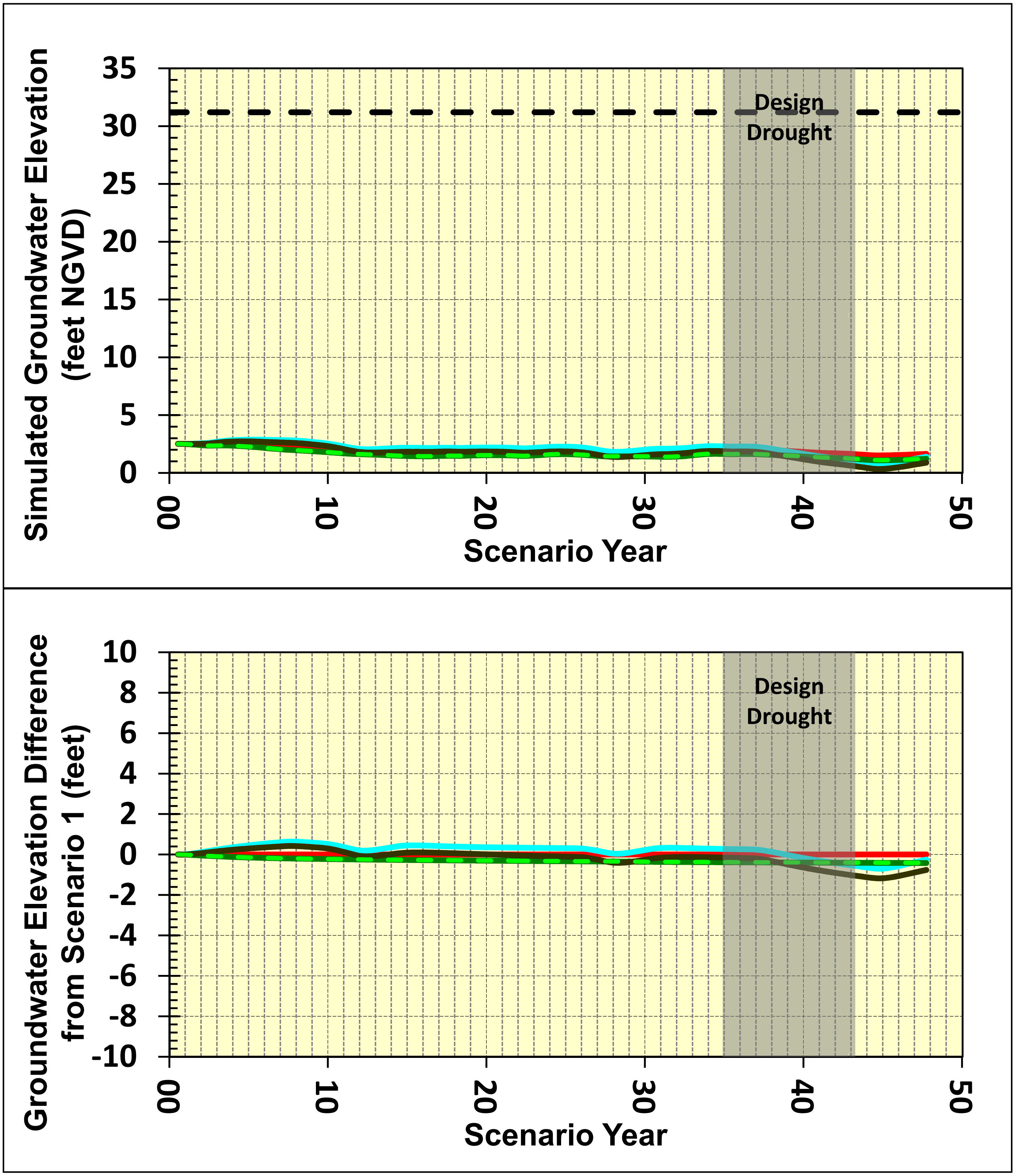
Model Layer 1 Hydrographs for Fort Funston Cluster

K/J 0864001
April 2012
Figure 10.3-11a



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:
- Single-Aquifer

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Model Layer 4 Hydrographs for Fort Funston Cluster

K/J 0864001
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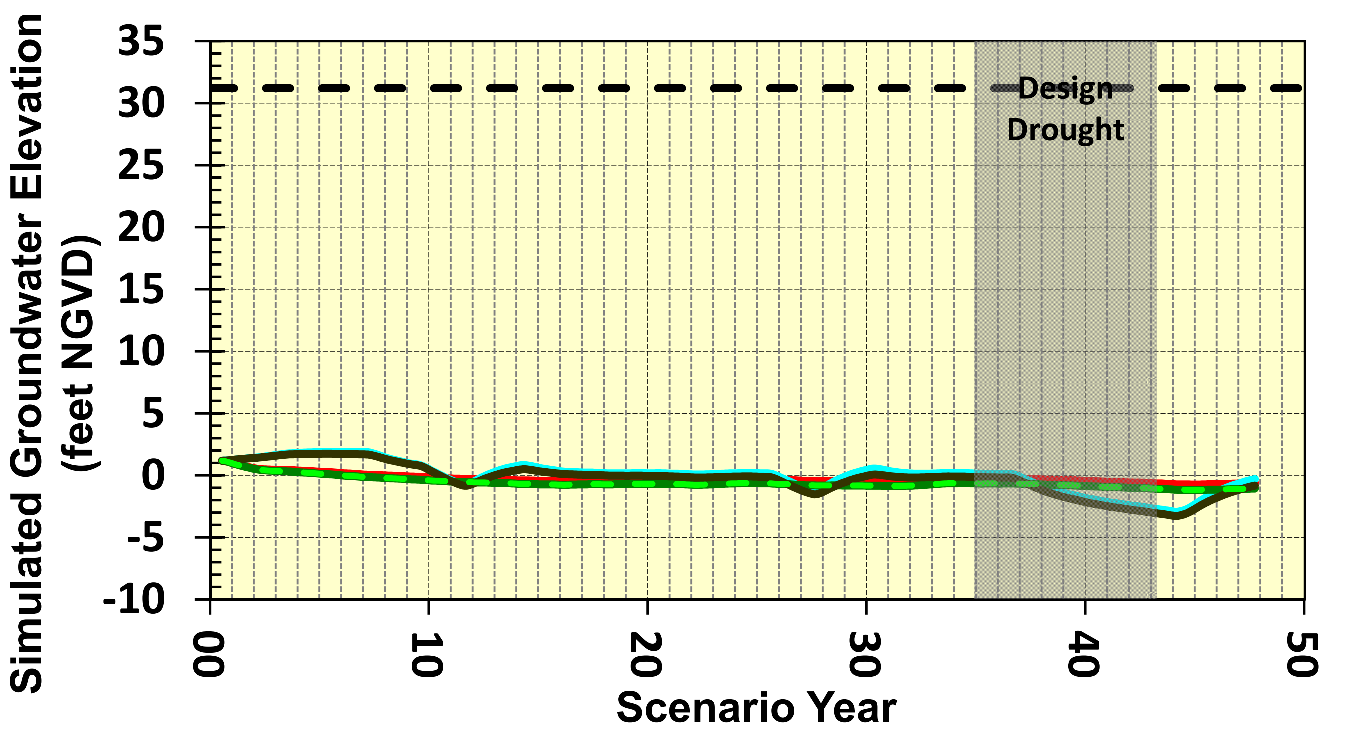
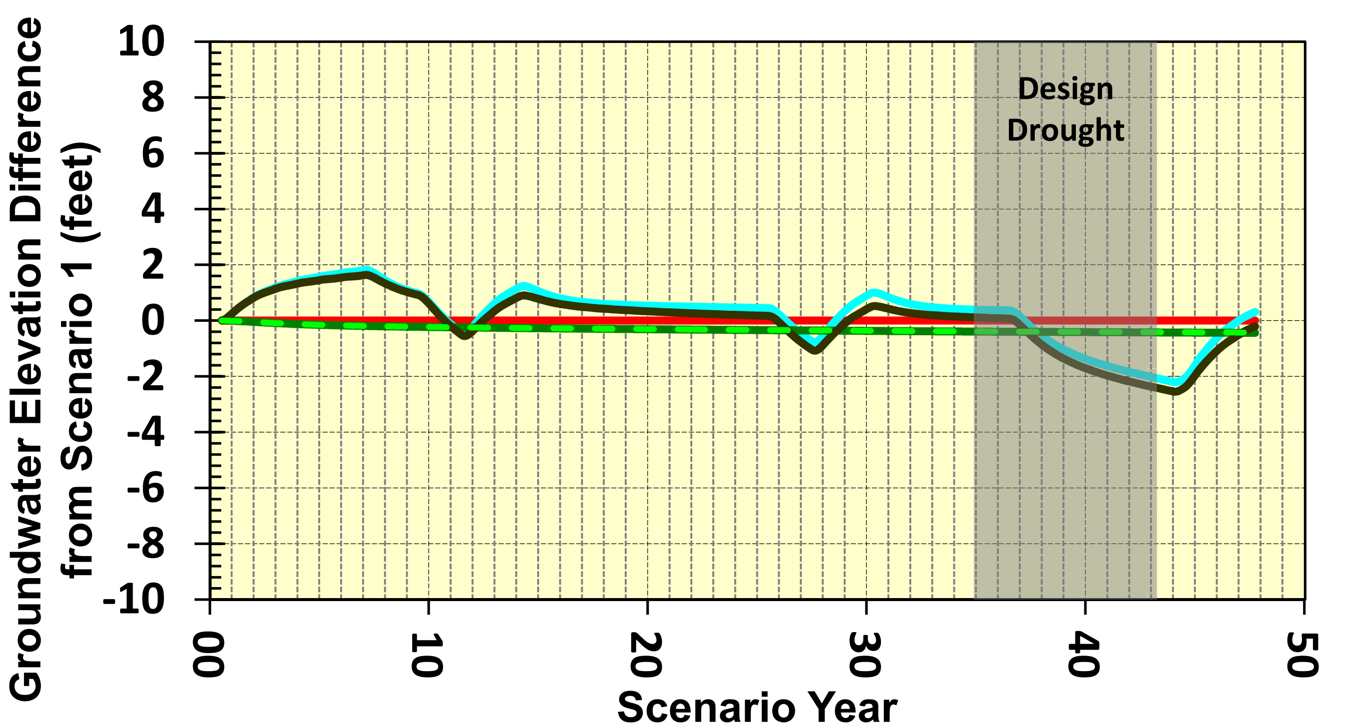
Figure 10.3-11b





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer

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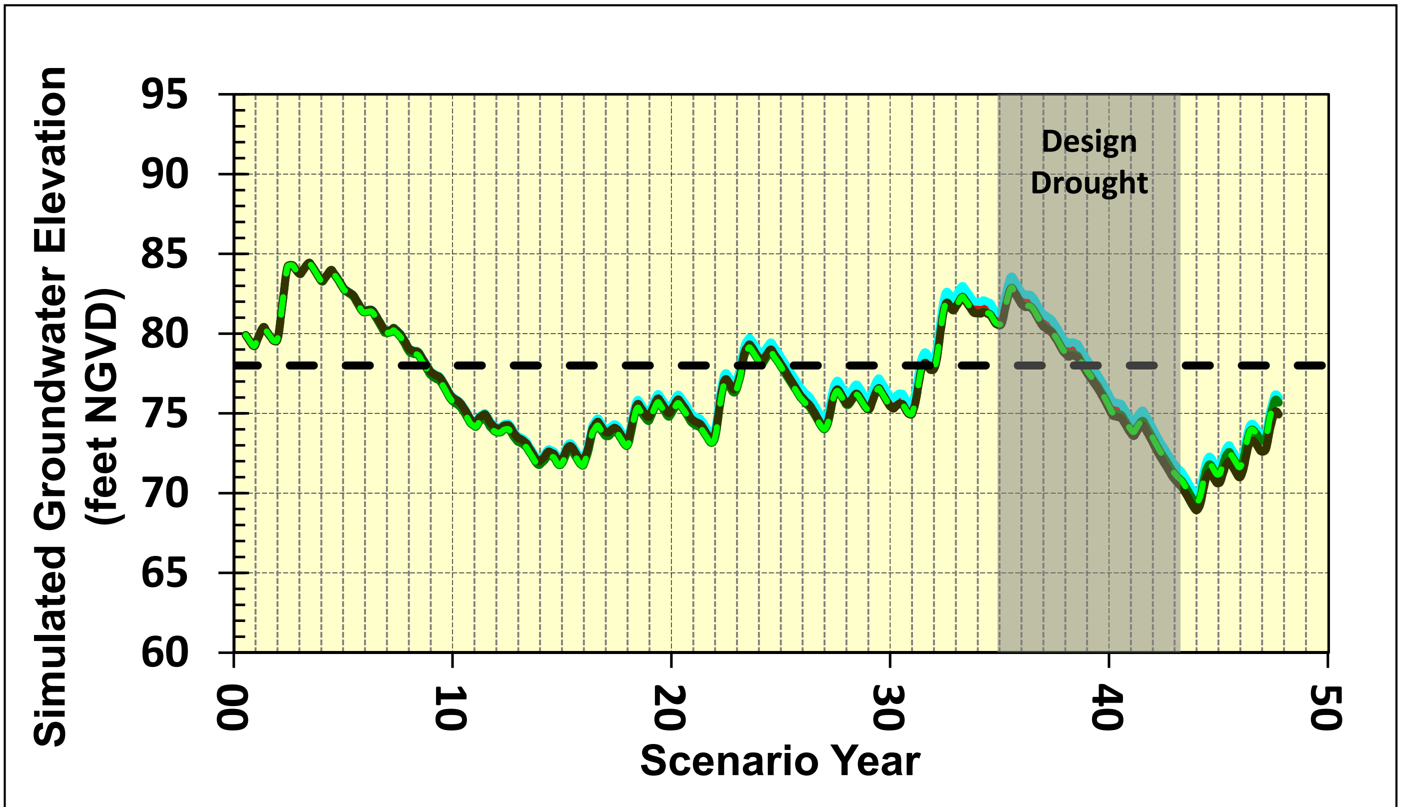
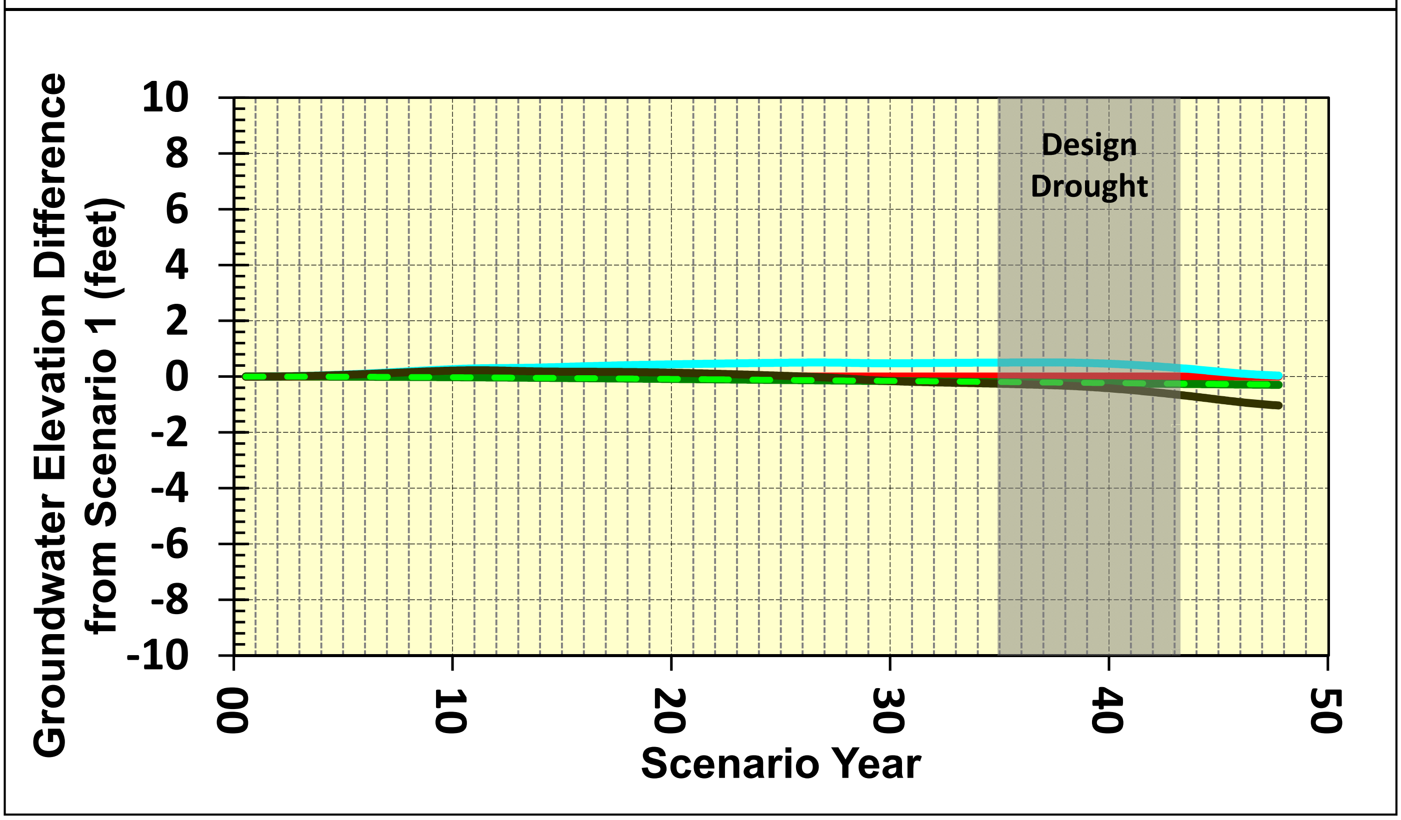
Model Layer 5 Hydrographs for Fort Funston Cluster

K/J 0864001
April 2012

Figure 10.3-11c





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer

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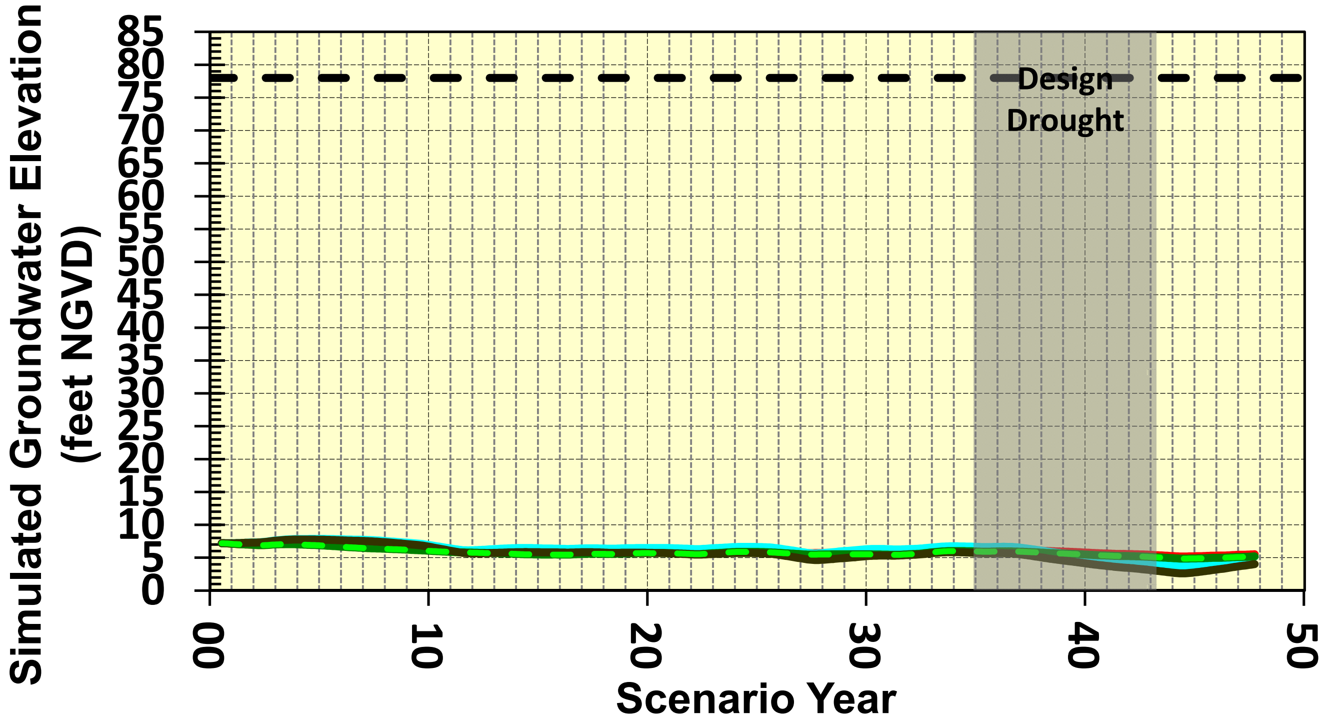
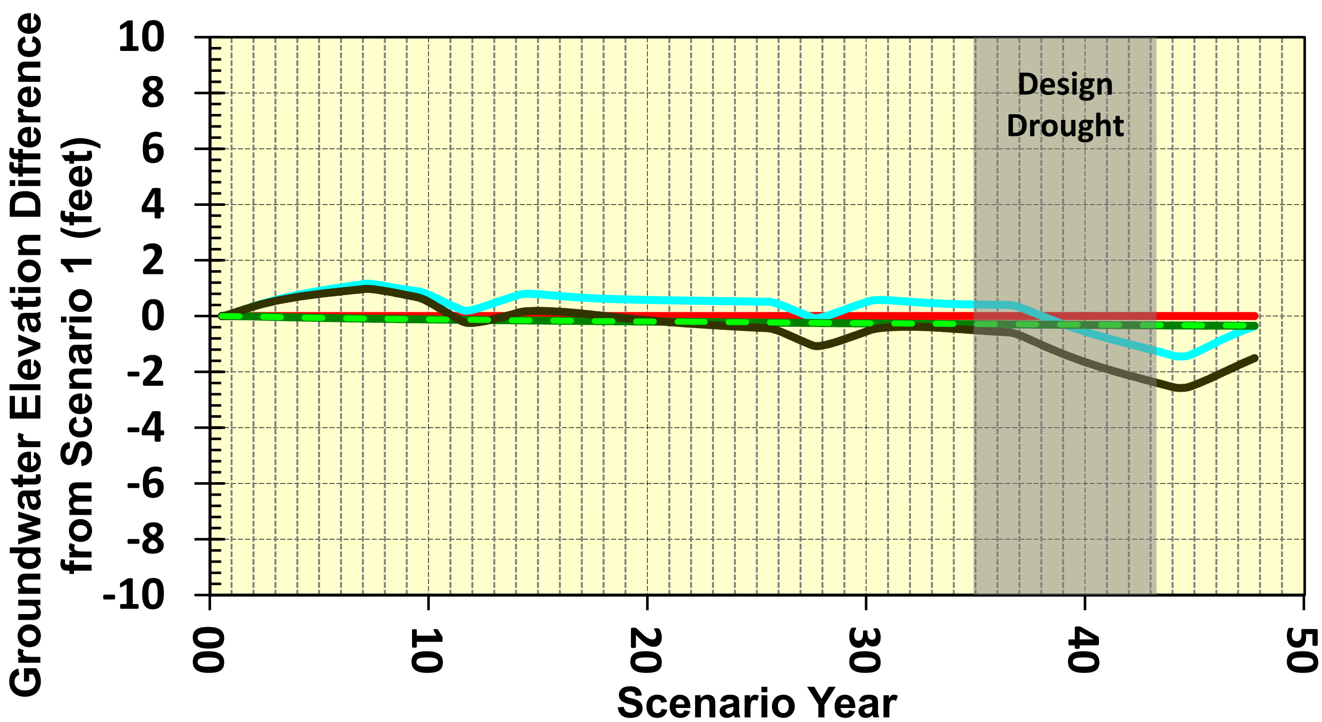
Model Layer 1 Hydrographs for Thornton Beach Cluster

K/J 0864001
April 2012
Figure 10.3-12a





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

Scenario 1 — Scenario 2

Scenario 3a — Scenario 3b

Scenario 4

Exclusion Heads:

Single-Aquifer

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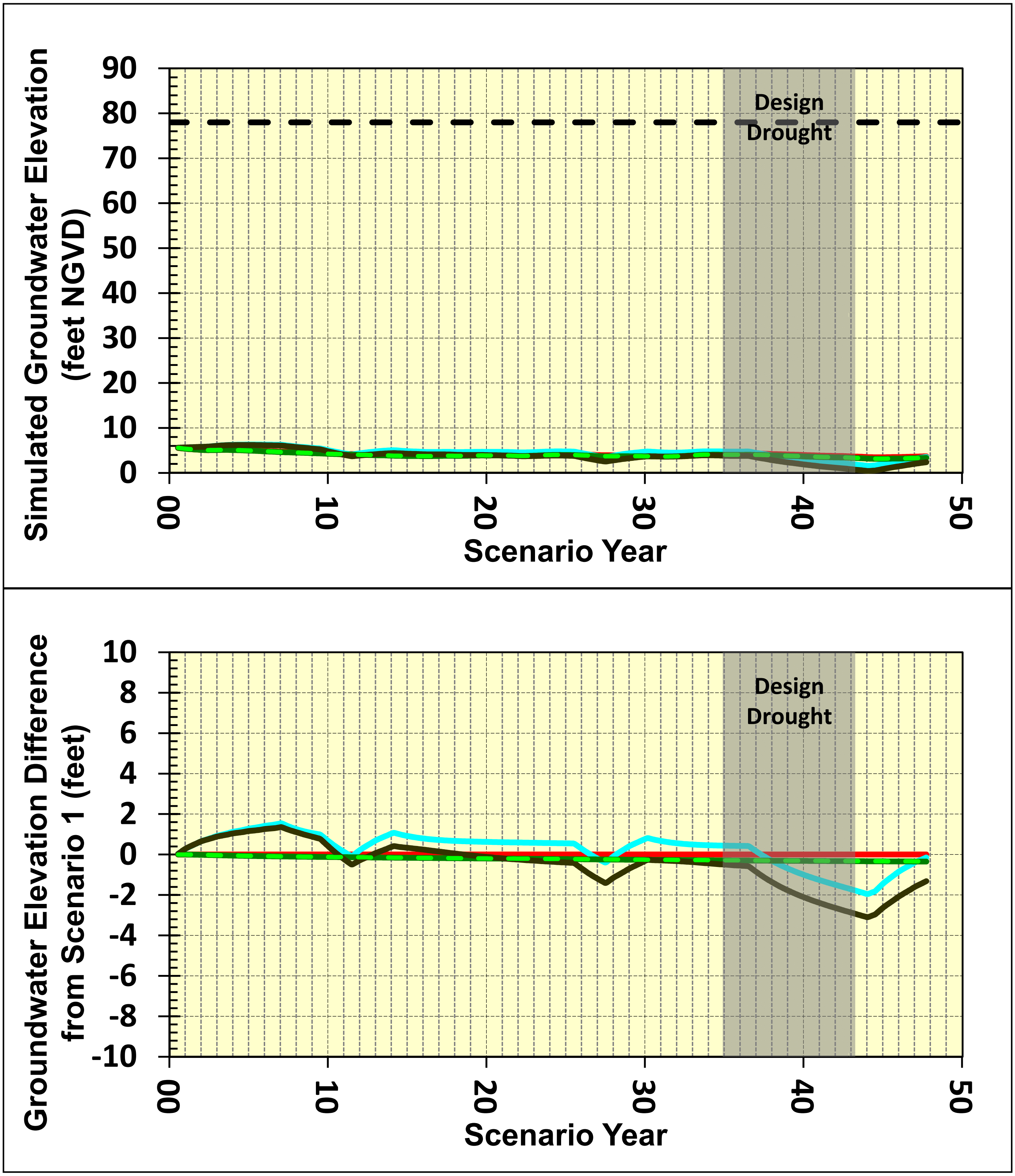
Model Layer 4 Hydrographs for Thornton Beach Cluster

K/J 0864001
April 2012

Figure 10.3-12b



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer

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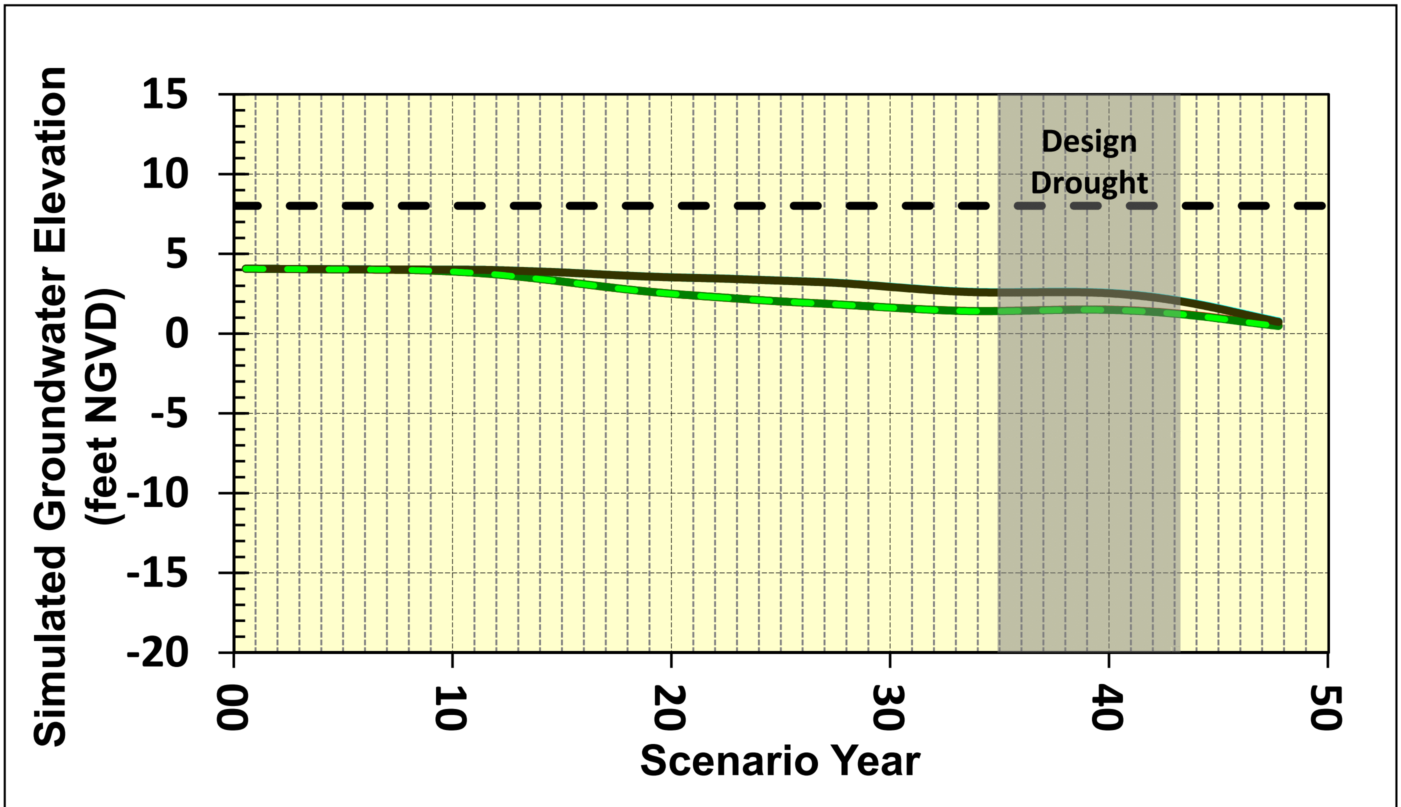
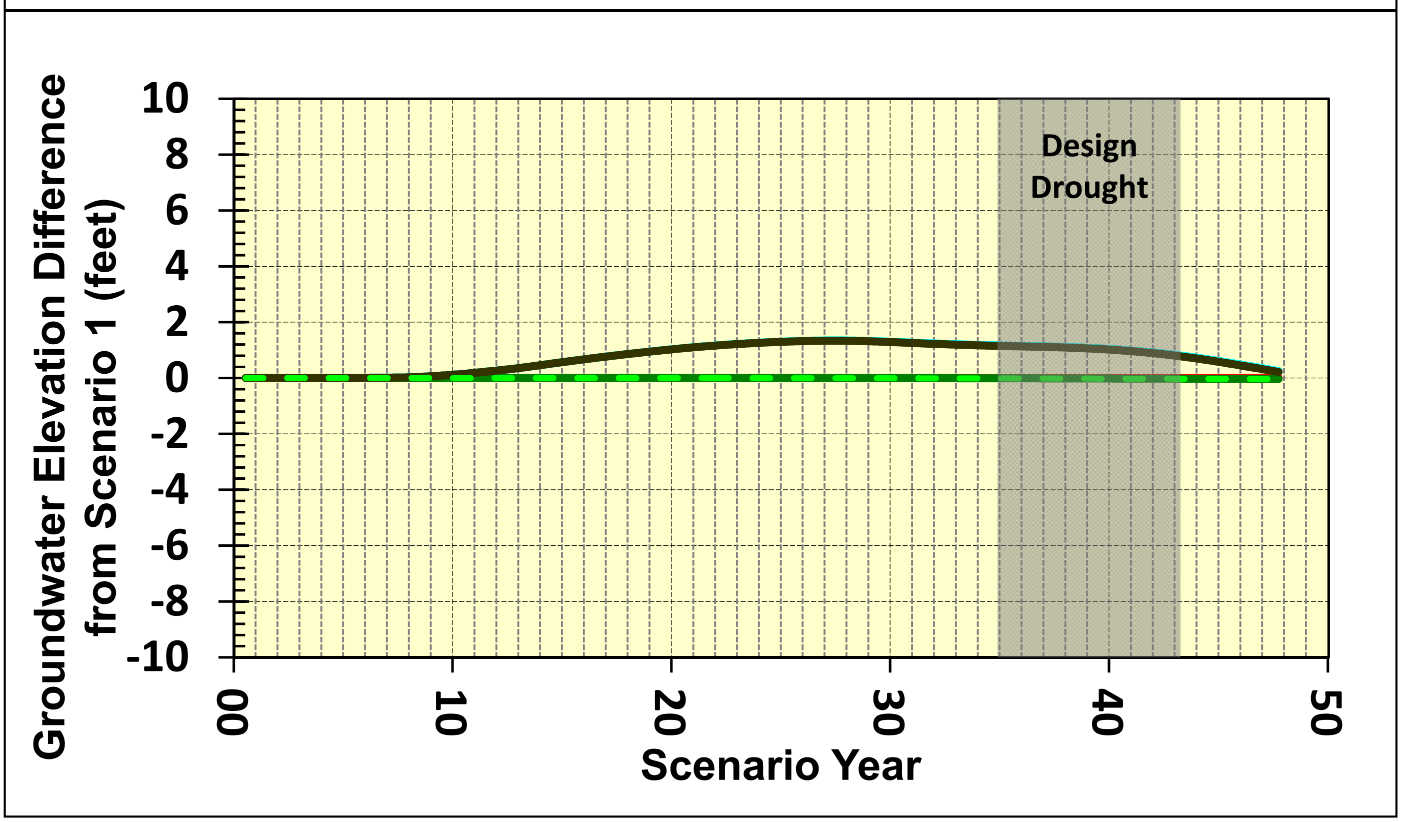
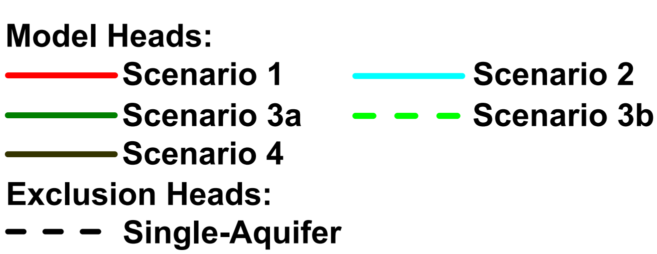
Model Layer 5 Hydrographs for Thornton Beach Cluster

K/J 0864001
April 2012
Figure 10.3-12c





Note: Zero elevation is equivalent to mean sea level NGVD.



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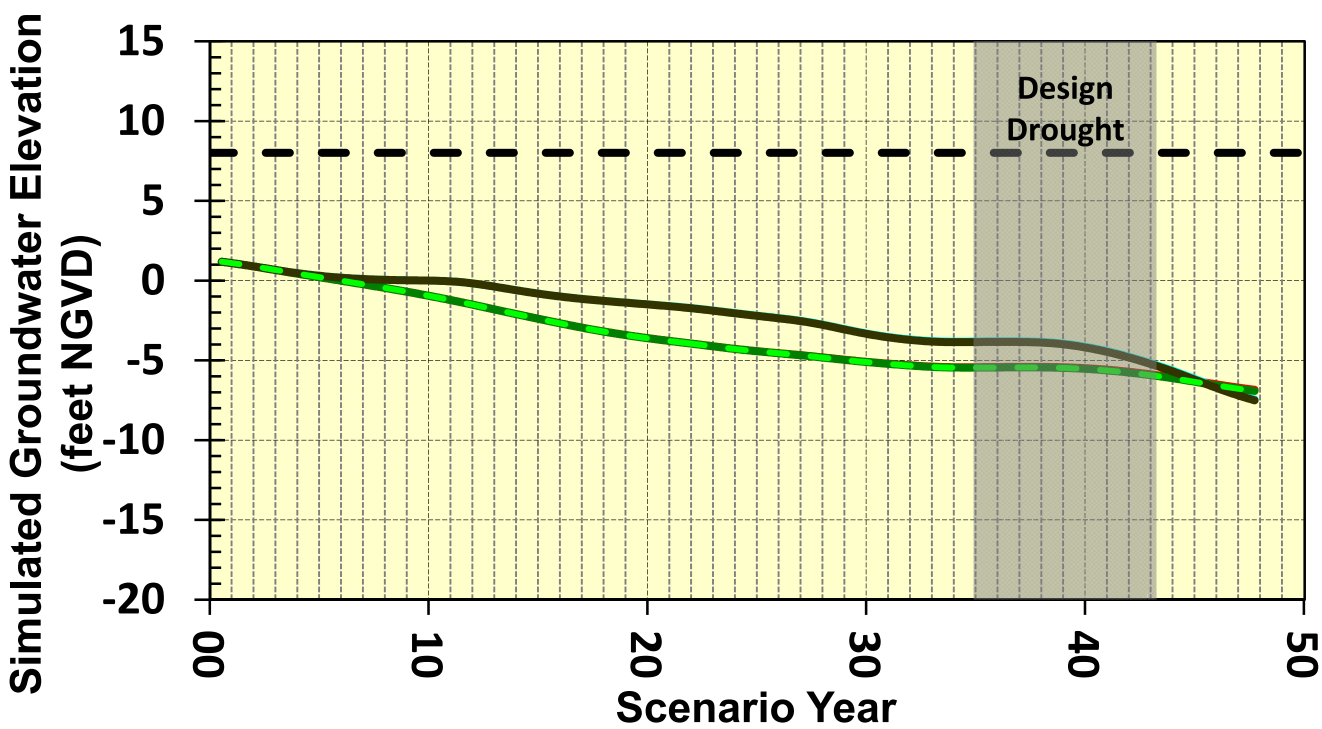
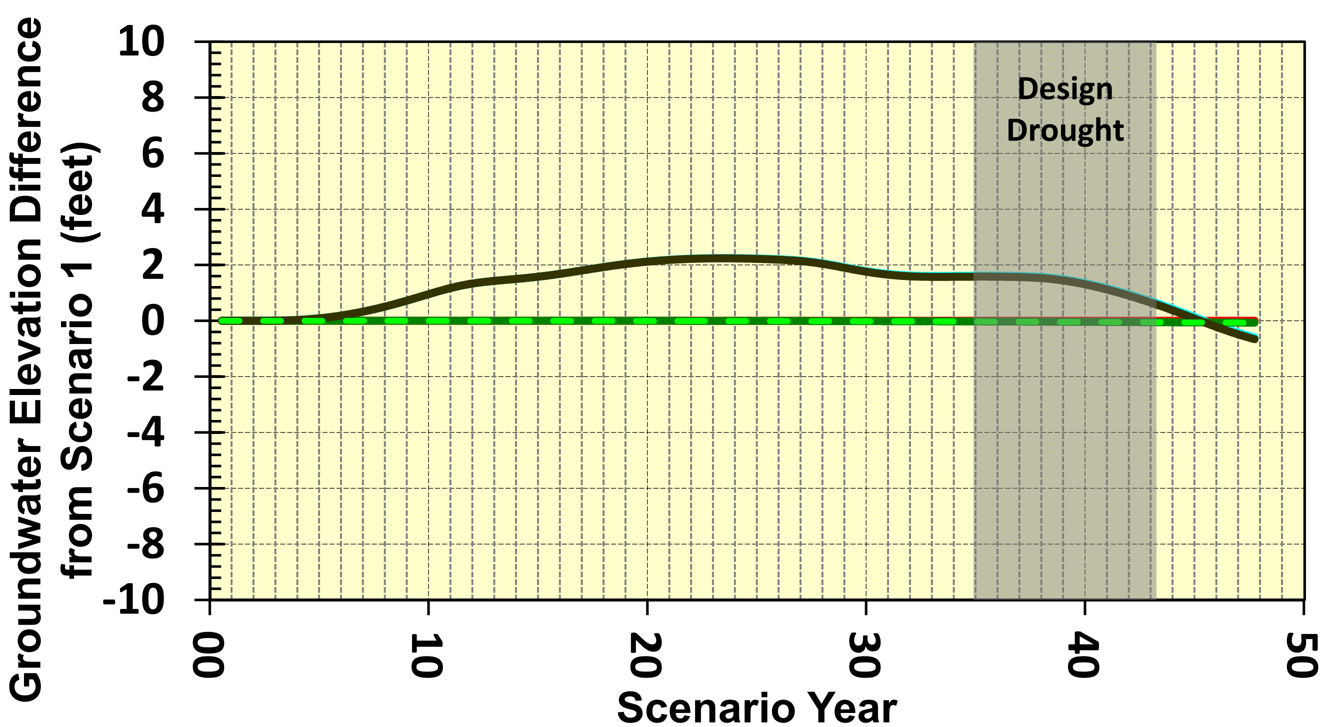
Model Layer 1 Hydrographs for Burlingame Cluster

K/J 0864001
April 2012
Figure 10.3-13a





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:
- Single-Aquifer

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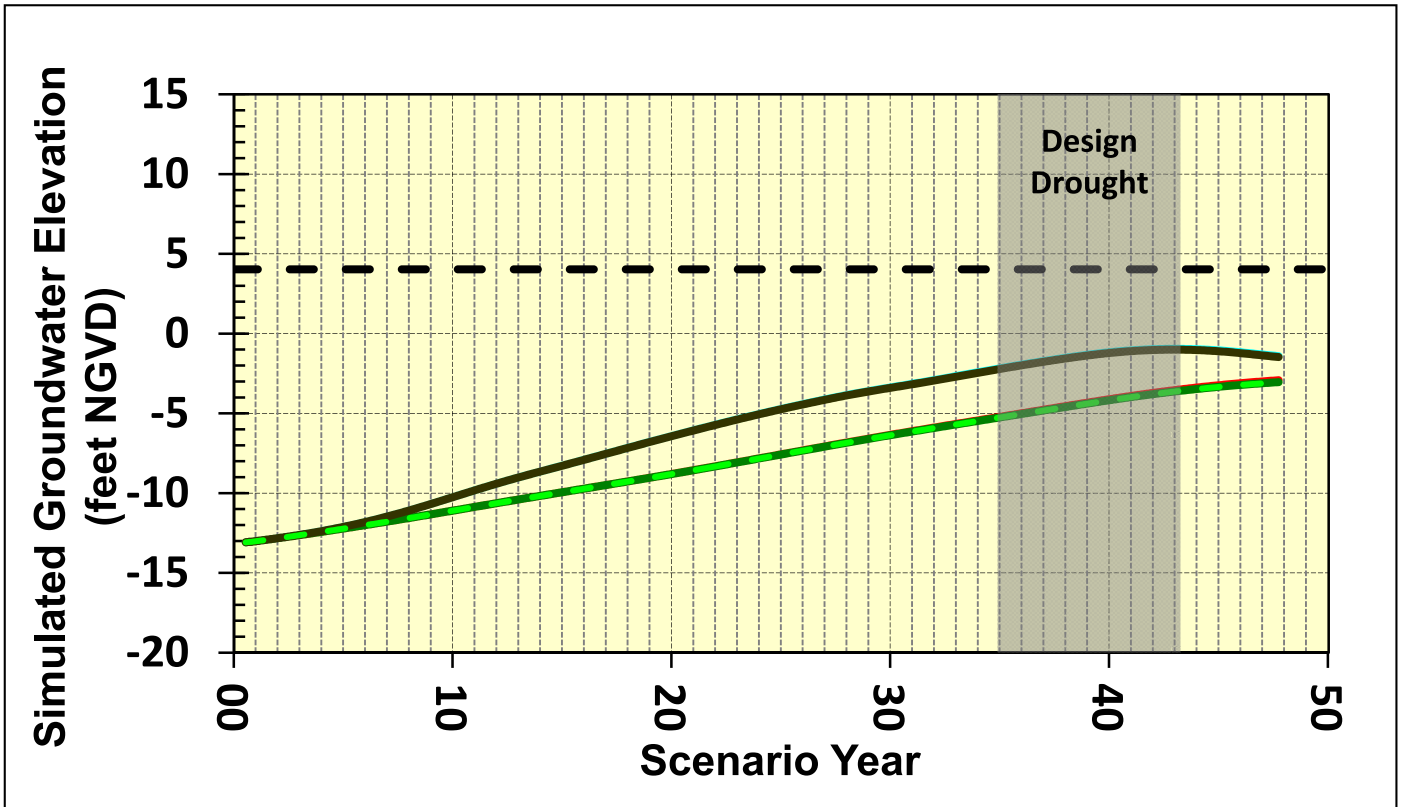
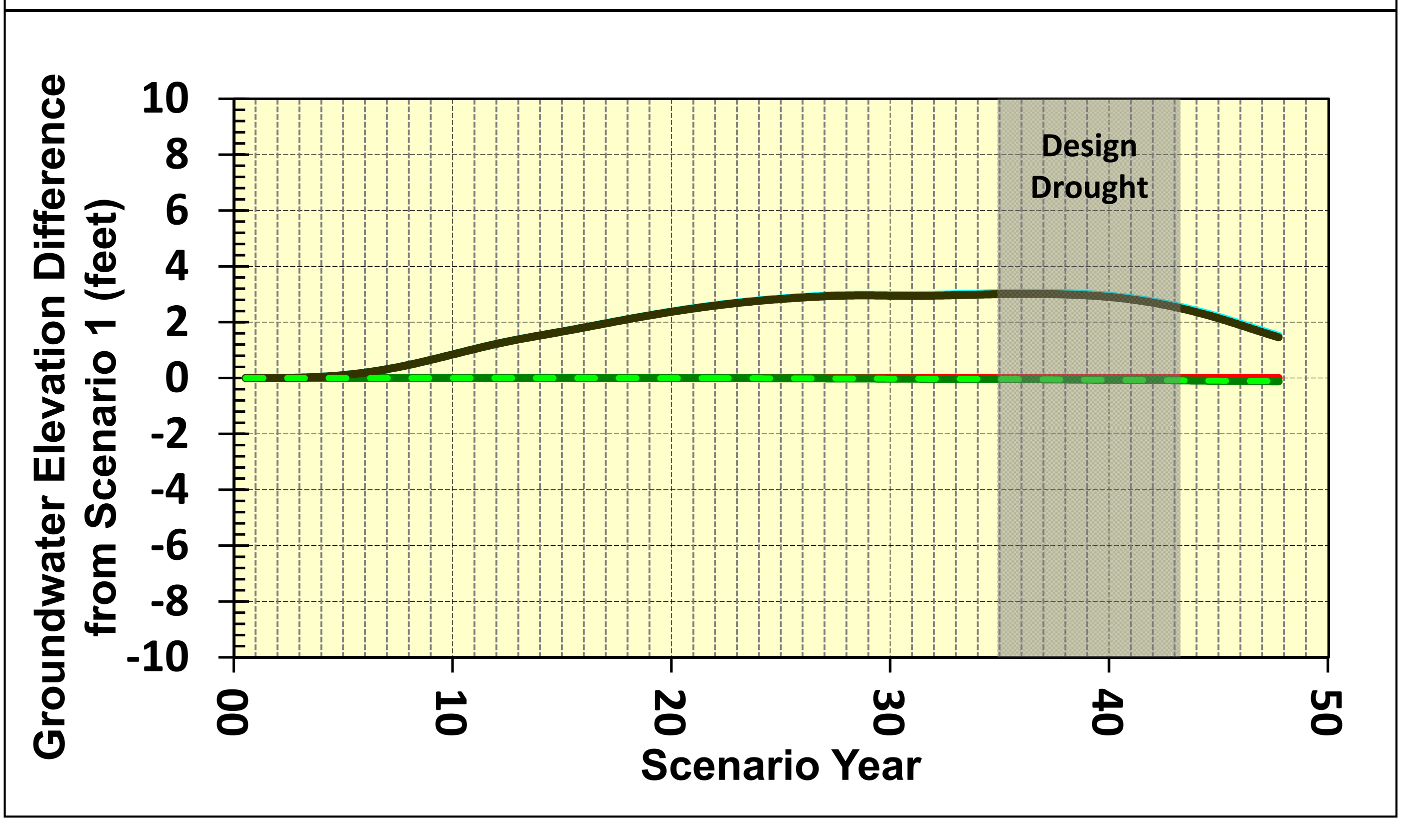
Model Layer 4 Hydrographs for Burlingame Cluster

K/J 0864001
April 2012
Figure 10.3-13b





Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:

- Single-Aquifer

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Regional Groundwater Storage and Recovery Project
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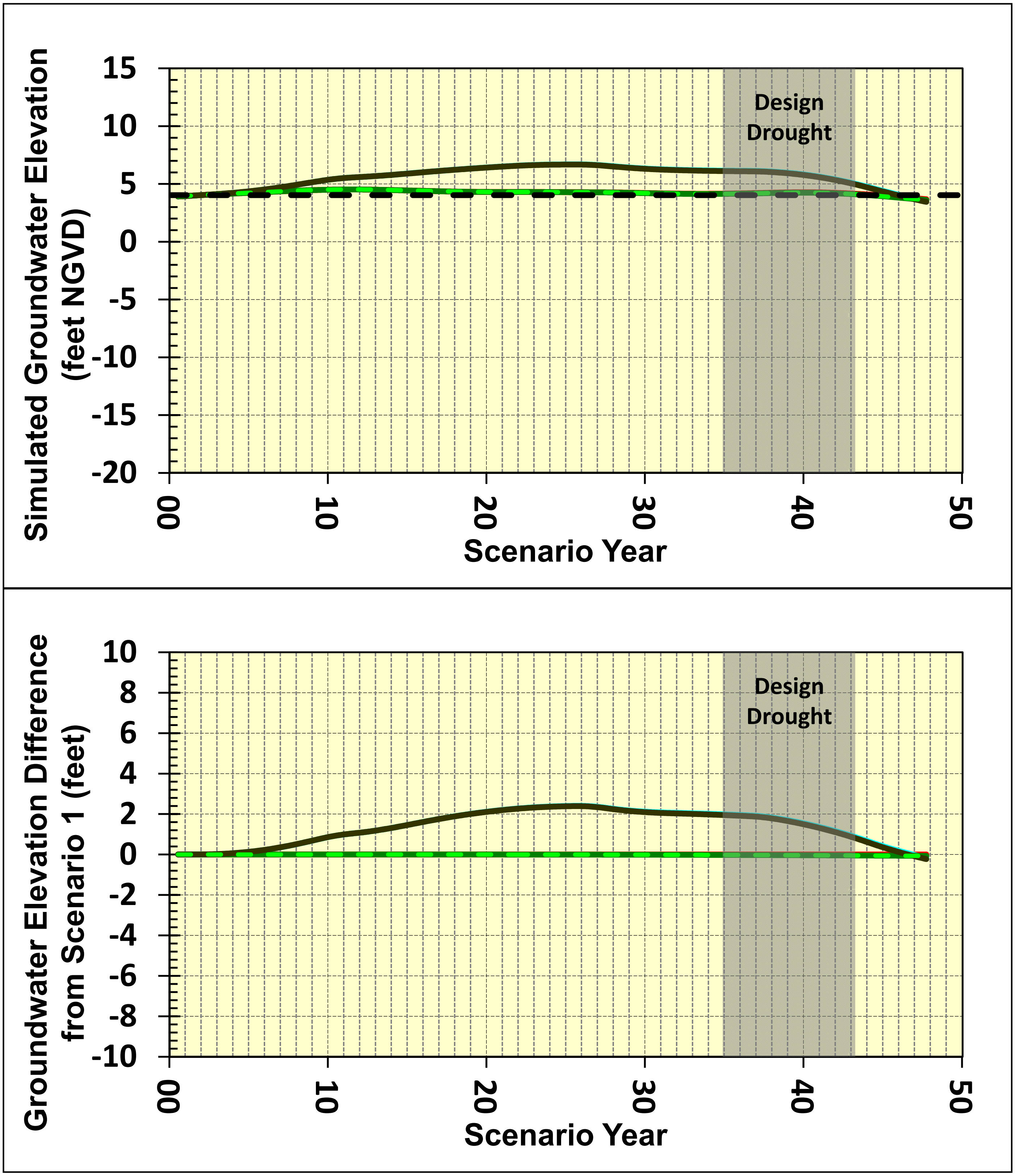
Model Layer 1 Hydrographs for SFO Cluster

K/J 0864001
April 2012

Figure 10.3-14



Note: Zero elevation is equivalent to mean sea level NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

Exclusion Heads:
- Single-Aquifer

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Regional Groundwater Storage and Recovery Project
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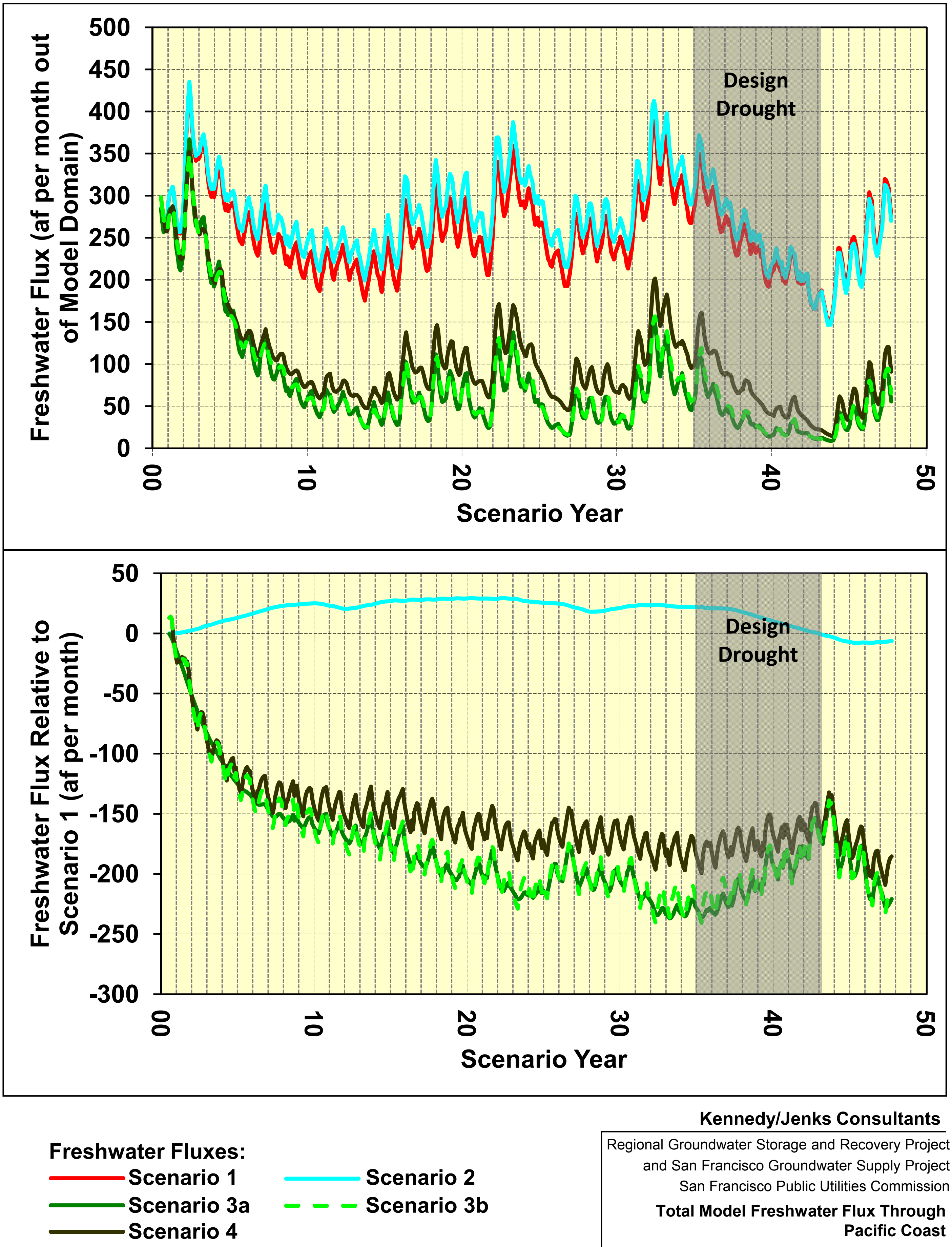
San Francisco Public Utilities Commission

Model Layer 1 Hydrographs for UAL Cluster

K/J 0864001
April 2012
Figure 10.3-15



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Regional Groundwater Storage and Recovery Project
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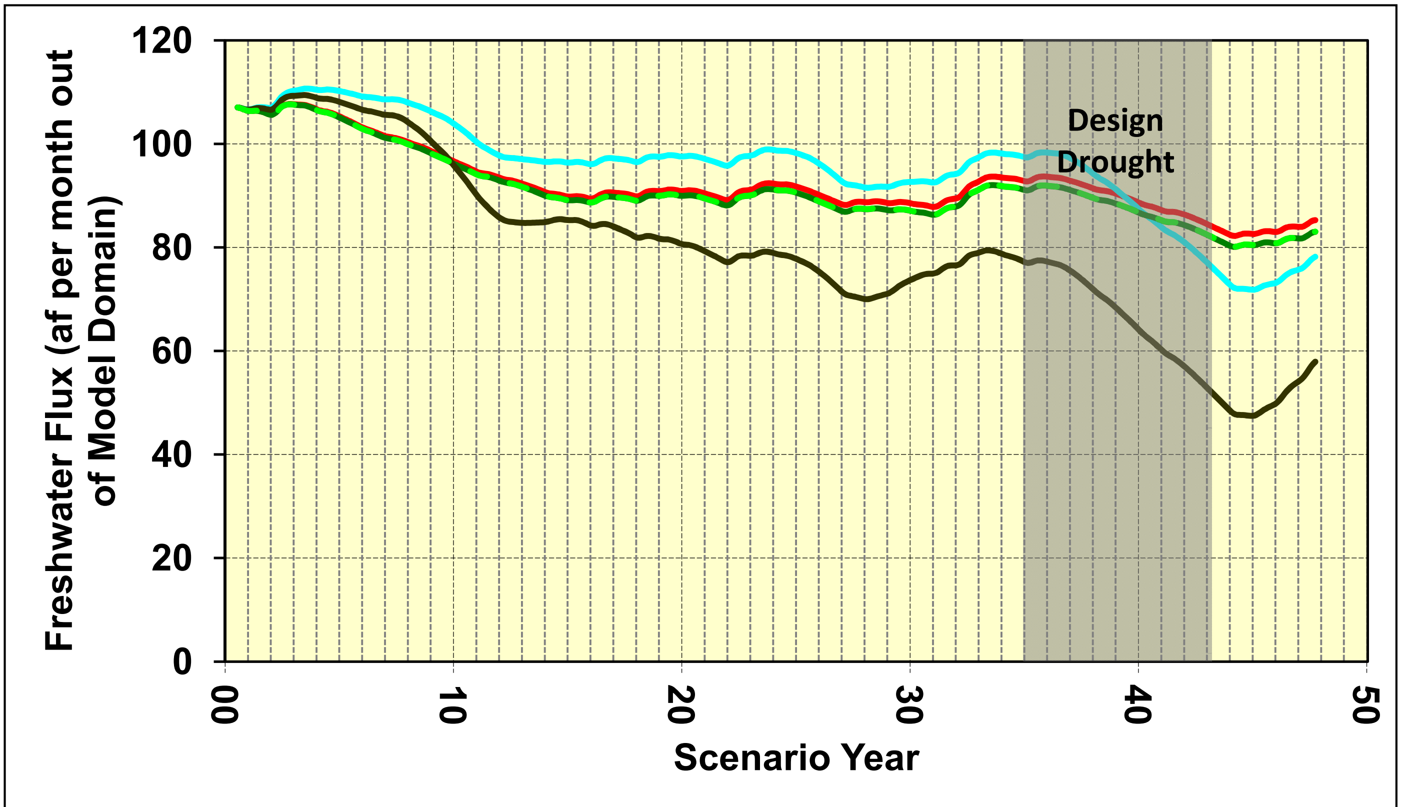
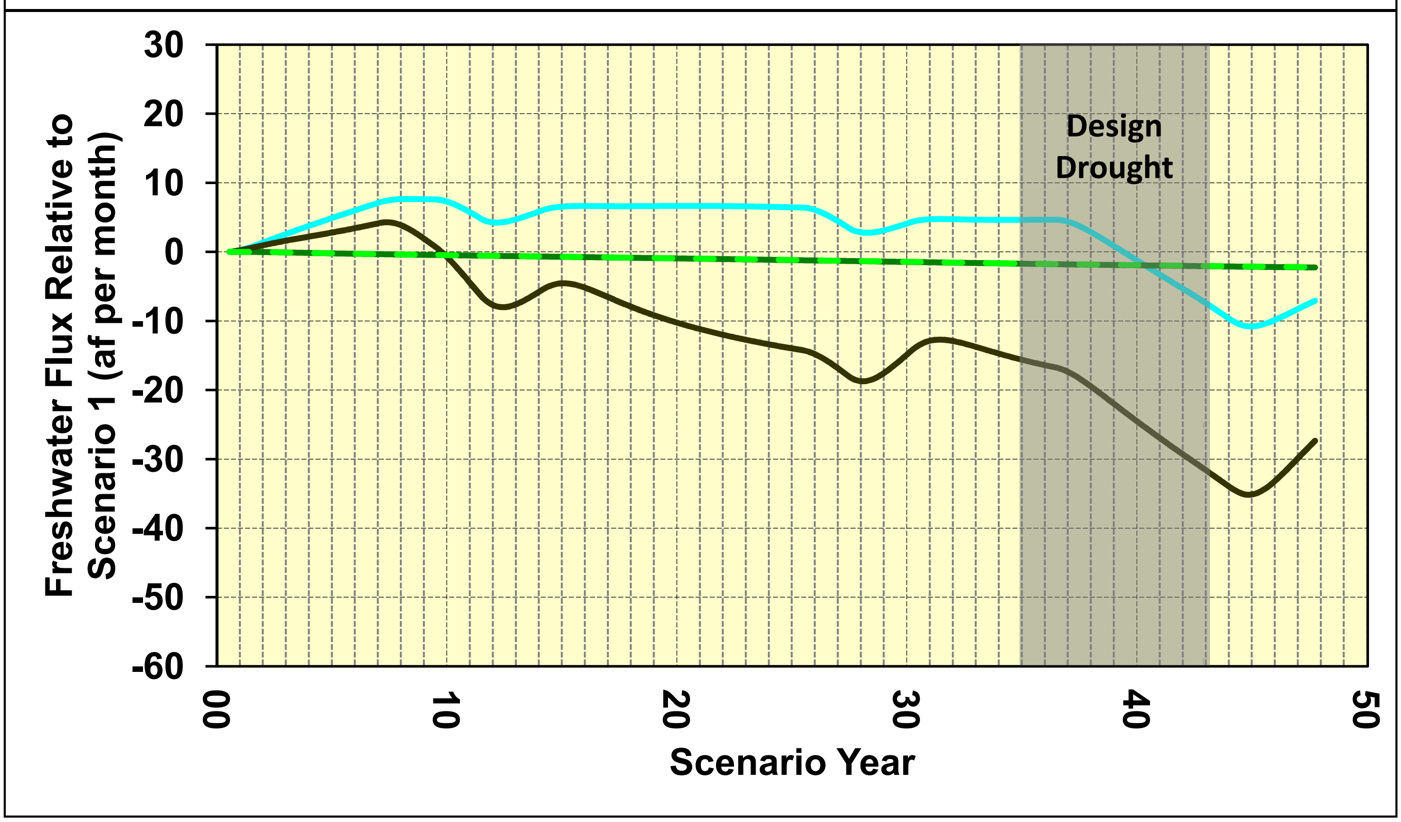
San Francisco Public Utilities Commission

Total Model Freshwater Flux Through Pacific Coast

K/J 0864001
April 2012

Figure 10.3-16





Freshwater Fluxes:

Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

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Total Model Freshwater Flux Through Bay Coast

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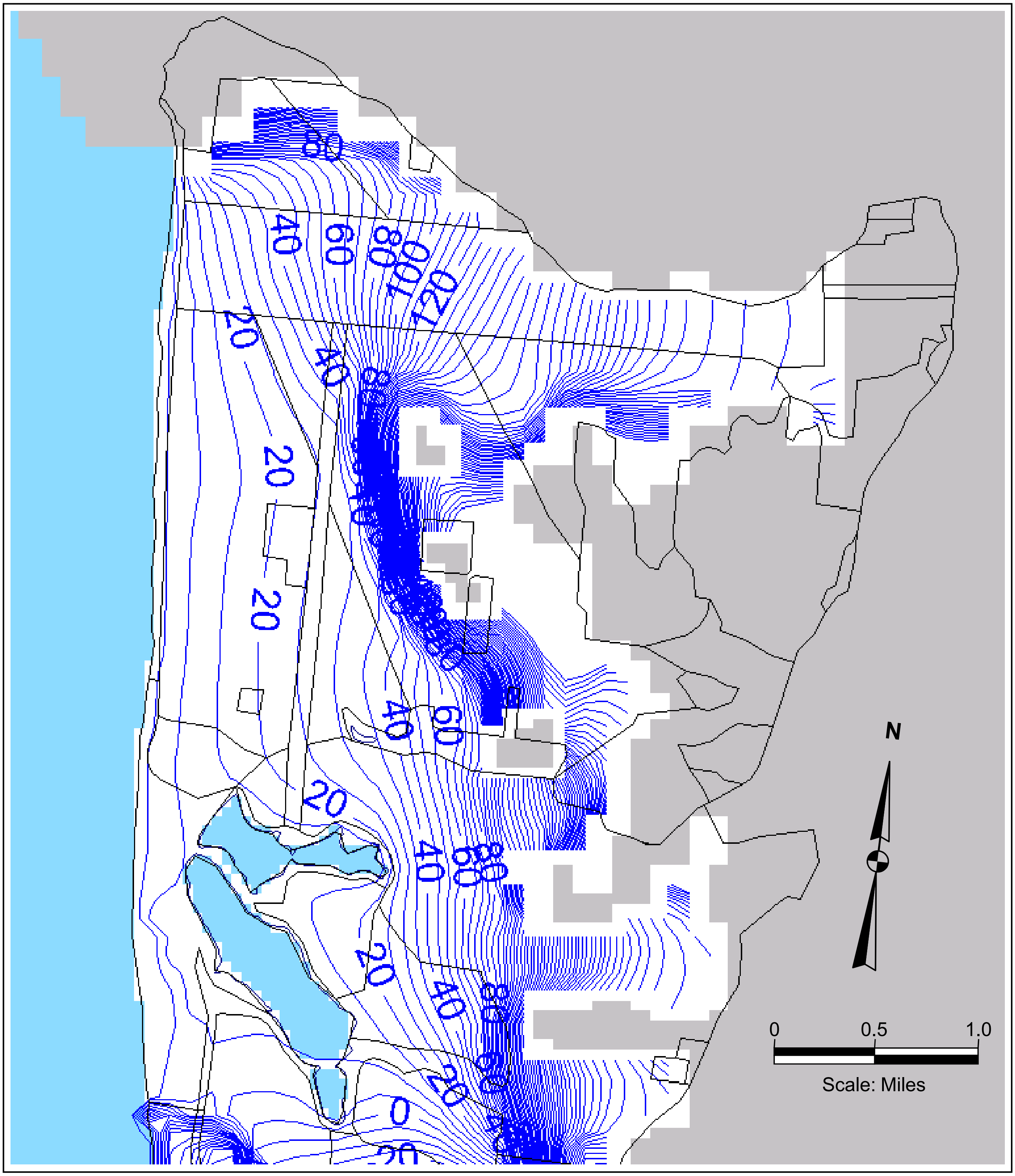
April 2012

Figure 10.3-17



Note: Elevations are in feet NGVD 29. Contour interval is 5 feet.

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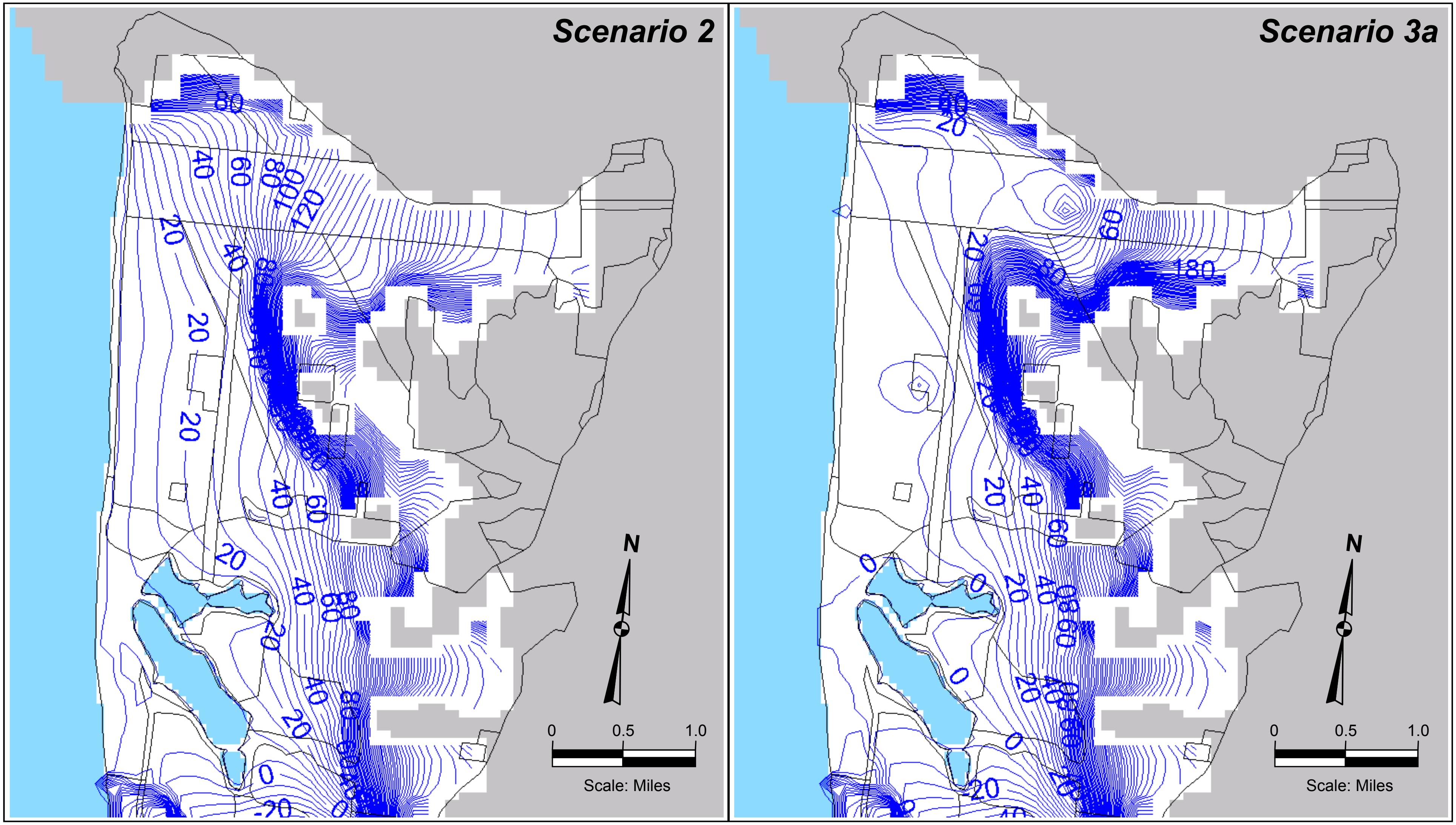
Water Table Elevation at End of Scenario 1 (Model Layer 1)

K/J 0864001
April 2012

Figure 10.3-18



Note: Elevations are in feet NGVD 29. Contour interval is 5 feet.

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Water Table Elevation at End of Scenarios 2 and 3a (Model Layer 1)

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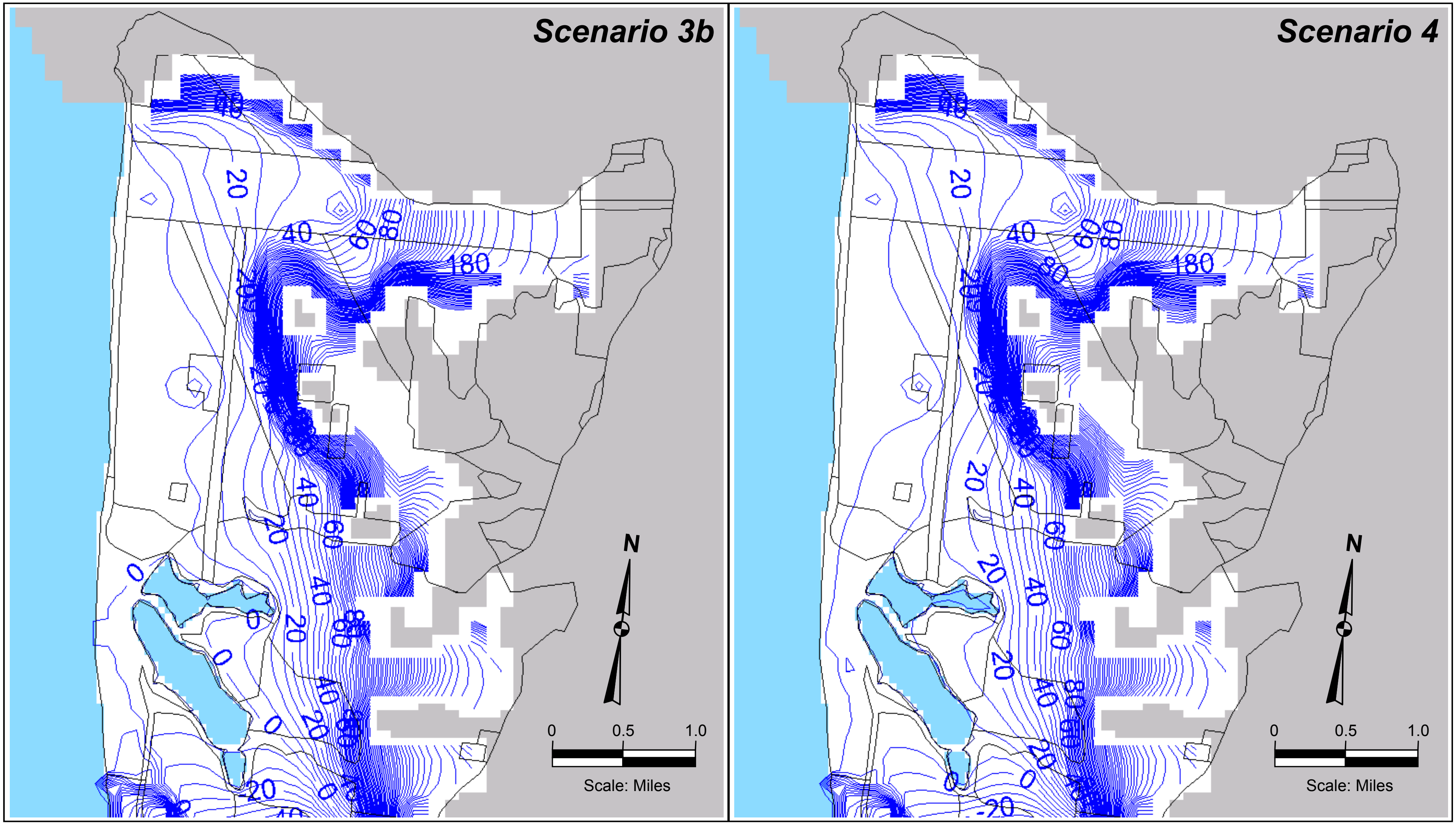
April 2012

Figure 10.3-19



Note: Elevations are in feet NGVD 29. Contour interval is 5 feet.

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Water Table Elevation at End of Scenarios 3b and 4 (Model Layer 1)

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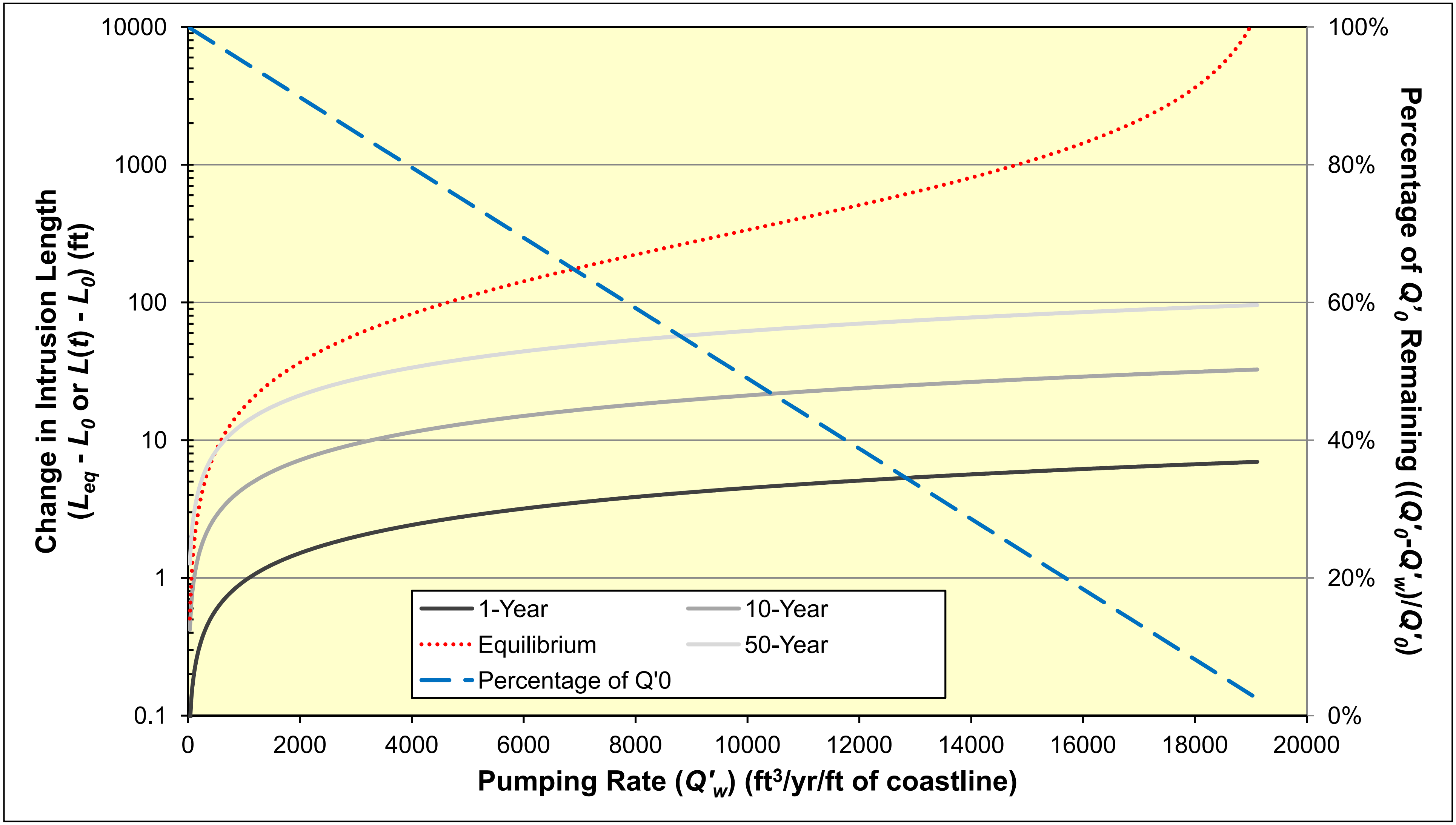
April 2012
Figure 10.3-20



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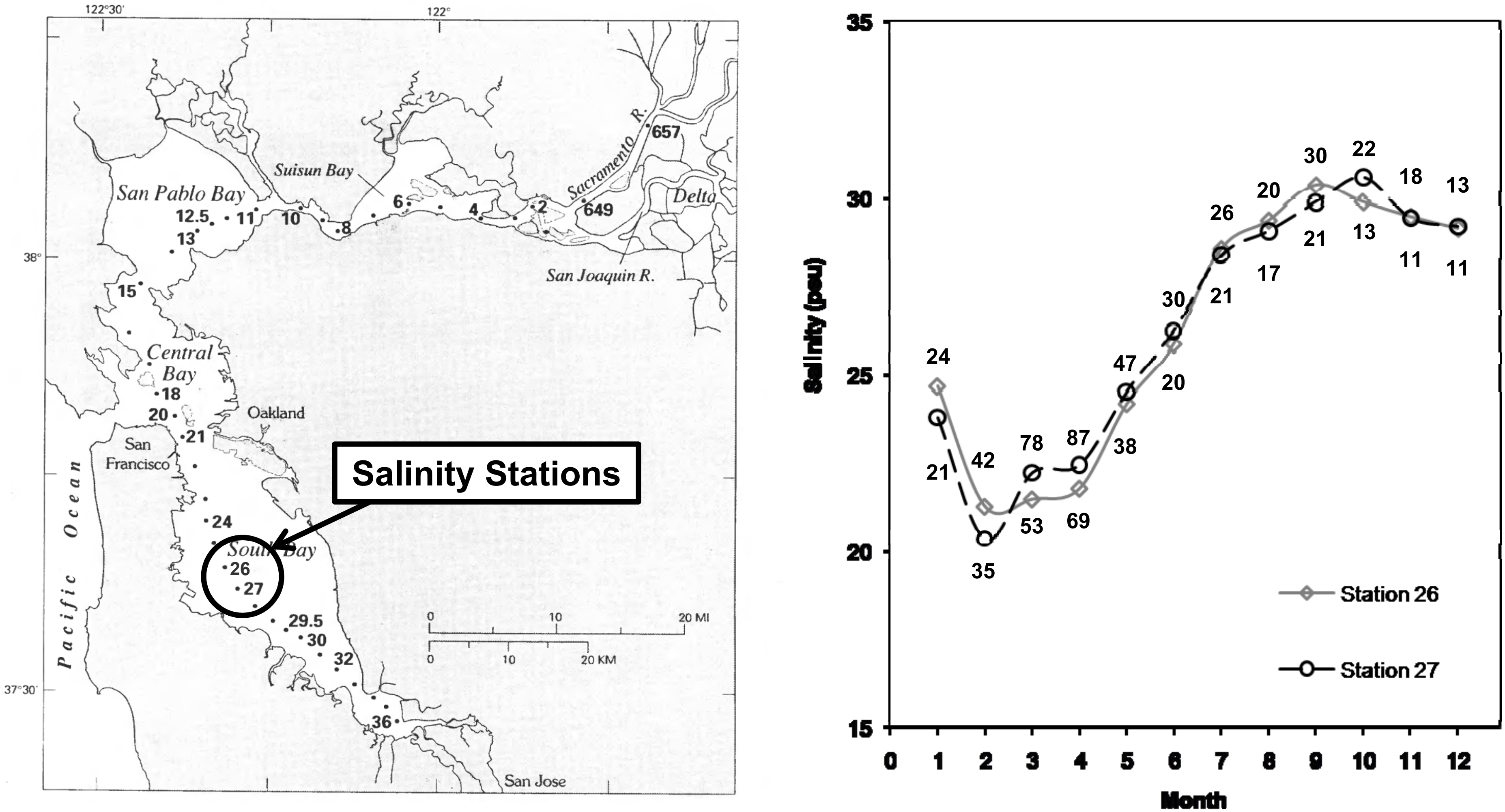
Analytical Model of Rate of Change of Intrusion Length versus Pumping

K/J 0864001
April 2012

Figure 10.3-21



Note: Data from the U.S. Geological Survey; see for example Baylosis et al. (1998). Period of record is 1969 to 1998. Readings are from 1 meter depth. Numbers above the data are the number of records for Station 26, while numbers below the data are the number of records for Station 27. Map is modified from Baylosis et al. (1998).

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Monthly Salinity in the South San Francisco Bay

K/J 0864001
April 2012
Figure 10.3-22

Tables

Table 10.3-1: Summary of Model Scenario Pumping Assumptions

Model Scenarios		Scenario 1 Existing Conditions	Scenario 2 GSR	Scenario 3a SFGW	Scenario 3b SFGW	Scenario 4 Cumulative
Establish Initial Conditions		Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence
	June 2009 Condition	√	√	√	√	√
Model Scenario Simulation Period						
	47.25 years (including Design Drought) Hydrologic Sequence: July 1996 to September 2003 -> October 1958 to November 1992 -> December 1975 to June 1978 -> July 2003 - September 2006		√	√	√	√
Pumping Assumptions for Municipal Use						
PA Municipal Wells (mgd)						
	"Take" Periods	6.84	6.90	6.84	6.84	6.90
	"Put" Periods	6.84	1.38	6.84	6.84	1.38
	"Hold" Periods	6.84	6.90	6.84	6.84	6.90
GSR Project Proposed Municipal Wells (mgd)						
	"Take" Periods	0.0	7.23	0.0	0.0	7.23
	"Put" Periods	0.0	0.04	0.0	0.0	0.04
	"Hold" Periods	0.0	0.04	0.0	0.0	0.04
SFGW Project Proposed Municipal Wells (mgd)						
	Year-Round Pumping	0.0	0.0	3.0	4.0	4.0
Total Municipal Pumping (PA + GSR + SFGW)						
	"Take" Periods	***6.84***	***14.13***	***9.84***	***10.84***	***18.13***
	"Put" Periods	***6.84***	***1.42***	***9.84***	***10.84***	***5.42***
	"Hold" Periods	***6.84***	***6.94***	***9.84***	***10.84***	***10.94***
Irrigation and Other Non-Potable Pumping Assumptions (mgd)(1)						
Golden Gate Park	Elk Glen (GGP)	0.081	0.081	0.081	0.000	0.000
	South Windmill (GGP)	0.498	0.498	0.498	0.000	0.000
	North Lake (GGP)	0.563	0.563	0.563	0.000	0.000
	Sub-Total	***1.142***	***1.142***	***1.142***	***0.000***	***0.000***
Golf Courses	Burlingame Golf Club	0.150	0.150	0.150	0.150	0.150
	California Golf No. 02	0.192	0.192	0.192	0.192	0.192
	Green Hills No. 05	0.099	0.099	0.099	0.099	0.099
	Lake Merced Golf No. 01	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 02	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 03	0.010	0.010	0.010	0.010	0.010
	Olympic Club No. 09(2)	0.002	0.002	0.002	0.002	0.002
	SF Golf West	0.035	0.035	0.035	0.035	0.035
	Sub-Total	***0.495***	***0.495***	***0.495***	***0.495***	***0.495***
Cemeteries	Cypress Lawn No. 02	0.020	0.020	0.020	0.020	0.020
	Cypress Lawn No. 03	0.144	0.144	0.144	0.144	0.144
	Eternal Home	0.013	0.013	0.013	0.013	0.013
	Hills of Eternity No. 02	0.020	0.020	0.020	0.020	0.020
	Holy Cross No. 03(3)	0.190	0.190	0.190	0.190	0.230
	Home of Peace No. 02	0.039	0.039	0.039	0.039	0.039
	Italian Cemetery	0.033	0.033	0.033	0.033	0.033
	Olivet	0.098	0.098	0.098	0.098	0.098
	Woodlawn No. 02	0.085	0.085	0.085	0.085	0.085
	Sub-Total	***0.641***	***0.641***	***0.641***	***0.641***	***0.681***
Other	Hillsborough Residents No. 1-12	0.291	0.291	0.291	0.291	0.291
	Edgewood Development Ctr.	0.009	0.009	0.009	0.009	0.009
	Zoo No.05	0.321	0.321	0.321	0.321	0.321
	Stern Grove	0.004	0.004	0.012	0.013	0.013
	Sub-Total	***0.626***	***0.626***	***0.634***	***0.635***	***0.635***
	Total Irrigation and Other Non-Potable Pumping	***2.90***	***2.90***	***2.91***	***1.77***	***1.81***

Key:
afy - acre-feet per year
mgd - million gallons per day
PA - Partner Agencies
GGP - Golden Gate Park
GSR - Regional Groundwater Storage and Recovery
SFGW - San Francisco Groundwater Supply
SFPUC - San Francisco Public Utilities Commission

Notes:
(1) Pumping wells that are listed identify the wells in the model scenarios whose pumping assumptions were modified compared to the 2008 No-Project Scenario by HydroFocus (May, 2011, ver. 3.1), as a result of revised Soil Moisture Budget (SMB). Pumping rates for the three wells in GGP and the California Golf No. 02, Edgewood Development Center, Zoo No. 05, and Stern Grove wells were further modified compared to the results of revised SMB.
(2) Olympic Club No. 09 values include pumping for both Olympic Golf Club wells.
(3) Holy Cross No. 3 well irrigation pumping for Scenarios 1, 2, 3a, and 3b is based on the results of revised SMB. Based on the projected future build-out at the Holy Cross cemetery, an additional pumping of 0.04 mgd (45 afy) was estimated to occur under Scenario 4 (Cumulative).

Table 10.3-2a: Statistics for Relative Differences Between Model Scenario Groundwater Head and Scenario 1 Head in Model Layer 1

	Scenario	2				3a				3b				4			
	Location	Maximum Difference[a]	Minimum Difference[b]	Avgerage Difference[c]	Average Offset[d]	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset
Pacific Coast	North Windmill	0.1	0.0	0.0	0.0	0.0	-12.4	-10.2	-12.2	0.0	-13.2	-10.5	-12.1	0.0	-13.1	-10.4	-12.0
Pacific Coast	South Windmill	0.1	-0.1	0.1	0.0	0.0	-9.7	-7.9	-9.5	0.3	-11.5	-8.9	-10.1	0.3	-11.4	-8.7	-9.9
Pacific Coast	Kirkham	0.2	-0.1	0.1	0.0	0.0	-6.8	-5.6	-6.6	0.2	-6.9	-5.5	-6.4	0.2	-6.7	-5.3	-6.1
Pacific Coast	Ortega	0.5	-0.2	0.3	0.0	0.0	-6.4	-5.5	-6.3	0.0	-6.1	-5.3	-6.0	0.0	-5.6	-4.7	-5.4
Pacific Coast	West Sunset Playground	1.3	-0.2	0.8	0.5	-4.0	-23.8	-20.9	-23.0	-3.7	-22.4	-19.8	-21.6	-3.7	-20.3	-18.0	-19.4
Pacific Coast	Taraval	0.6	-0.1	0.4	0.2	0.0	-5.2	-4.4	-5.1	0.0	-4.9	-4.2	-4.8	0.0	-4.1	-3.4	-3.8
Pacific Coast	Zoo	2.7	-0.4	1.6	0.9	0.0	-7.2	-5.3	-7.1	0.0	-6.9	-5.1	-6.8	0.0	-3.0	-1.4	-2.3
Pacific Coast	Fort Funston	0.1	-0.1	0.0	0.0	0.0	-0.1	-0.1	-0.1	0.0	-0.1	-0.1	-0.1	0.1	-0.2	0.0	-0.1
Pacific Coast	Thornton Beach	0.5	0.0	0.3	0.3	0.0	-0.3	-0.1	-0.3	0.0	-0.3	-0.1	-0.3	0.2	-1.0	-0.1	-0.6
Bay Coast	Burlingame	1.3	0.0	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.7	0.8
Bay Coast	SFO	3.1	0.0	2.0	2.5	0.0	-0.1	0.0	-0.1	0.0	-0.1	0.0	-0.1	3.0	0.0	2.0	2.5
Bay Coast	UAL	2.4	-0.2	1.4	1.0	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	0.0	2.4	-0.2	1.4	1.0

Notes: (a) Maximum positive difference from Scenario 1. If this value is negative, the head was lower than Scenario 1 at all times.
(b) Maximum negative difference from Scenario 1. If this value is positive, the head was higher than Scenario 1 at all times.
(c) Average difference from Scenario 1.
(d) Average difference from Scenario 1 over Scenario Years 37 to 47.

Table 10.3-2b: Statistics for Relative Differences Between Model Scenario Groundwater Head and Scenario 1 Head in Model Layer 4

	Scenario	2				3a				3b				4			
	Location	Maximum Difference[a]	Minimum Difference[b]	Avgerage Difference[c]	Average Offset[d]	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset
Pacific Coast	North Windmill	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pacific Coast	South Windmill	0.1	-0.1	0.1	0.0	0.0	-7.3	-6.0	-7.1	2.3	-7.7	-5.1	-6.0	2.3	-7.6	-4.9	-5.8
Pacific Coast	Kirkham	0.3	-0.2	0.2	0.0	0.0	-5.5	-4.6	-5.4	0.5	-5.5	-4.3	-5.0	0.5	-5.3	-4.0	-4.7
Pacific Coast	Ortega	0.9	-0.7	0.5	-0.2	0.0	-6.3	-5.3	-6.2	0.0	-6.0	-5.1	-5.9	0.0	-5.8	-4.2	-5.3
Pacific Coast	West Sunset Playground	2.5	-1.6	1.3	-0.2	-0.1	-12.2	-10.2	-11.9	-0.1	-11.7	-9.8	-11.5	-0.1	-10.6	-7.2	-9.3
Pacific Coast	Taraval	3.0	-2.0	1.6	-0.2	-0.1	-12.1	-10.1	-11.9	-0.1	-11.7	-9.7	-11.4	-0.1	-10.4	-6.5	-8.8
Pacific Coast	Zoo	6.1	-4.3	3.3	-0.4	-0.1	-18.9	-15.4	-18.5	-0.1	-18.3	-14.9	-17.9	-0.1	-16.0	-8.5	-12.6
Pacific Coast	Fort Funston	0.6	-0.7	0.2	-0.3	0.0	-0.4	-0.3	-0.4	0.0	-0.4	-0.3	-0.4	0.4	-1.2	-0.2	-0.8
Pacific Coast	Thornton Beach	1.2	-1.4	0.3	-0.7	0.0	-0.3	-0.2	-0.3	0.0	-0.3	-0.2	-0.3	1.0	-2.6	-0.5	-1.8
Bay Coast	Burlingame	2.3	-0.6	1.3	0.7	0.0	-0.1	0.0	0.0	0.0	-0.1	0.0	-0.1	2.2	-0.7	1.2	0.7
Bay Coast	SFO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bay Coast	UAL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes: (a) Maximum positive difference from Scenario 1. If this value is negative, the head was lower than Scenario 1 at all times.
(b) Maximum negative difference from Scenario 1. If this value is positive, the head was higher than Scenario 1 at all times.
(c) Average difference from Scenario 1.
(d) Average difference from Scenario 1 over Scenario Years 37 to 47.

Table 10.3-2c: Statistics for Relative Differences Between Model Scenario Groundwater Head and Scenario 1 Head in Model Layer 5

	Scenario	2				3a				3b				4			
	Location	Maximum Difference[a]	Minimum Difference[b]	Avgerage Difference[c]	Average Offset[d]	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset	Maximum Difference	Minimum Difference	Avgerage Difference	Average Offset
Pacific Coast	North Windmill	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	South Windmill	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Kirkham	0.3	-0.2	0.2	-0.1	0.0	-5.0	-4.2	-5.0	0.5	-5.1	-3.9	-4.5	0.5	-4.8	-3.6	-4.3
	Ortega	1.1	-1.0	0.5	-0.4	0.0	-5.9	-4.9	-5.8	0.0	-5.6	-4.7	-5.5	0.0	-5.6	-3.8	-5.0
	West Sunset Playground	3.4	-3.6	0.8	-1.7	-0.1	-7.0	-5.9	-6.9	0.0	-6.7	-5.6	-6.6	0.0	-8.5	-3.9	-6.8
	Taraval	4.6	-5.2	0.8	-2.6	0.0	-5.6	-4.7	-5.5	0.0	-5.4	-4.5	-5.3	1.1	-8.7	-2.6	-6.2
	Zoo	12.2	-14.4	1.5	-7.5	0.0	-6.4	-5.2	-6.3	0.0	-6.2	-5.0	-6.1	8.5	-16.9	-1.3	-10.3
	Fort Funston	1.8	-2.2	0.2	-1.2	0.0	-0.4	-0.3	-0.4	0.0	-0.4	-0.3	-0.4	1.6	-2.5	0.0	-1.5
	Thornton Beach	1.5	-2.0	0.3	-1.0	0.0	-0.3	-0.2	-0.3	0.0	-0.3	-0.2	-0.3	1.4	-3.1	-0.5	-2.1
Bay Coast	Burlingame	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	SFO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	UAL	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes: (a) Maximum positive difference from Scenario 1. If this value is negative, the head was lower than Scenario 1 at all times.
(b) Maximum negative difference from Scenario 1. If this value is positive, the head was higher than Scenario 1 at all times.
(c) Average difference from Scenario 1.
(d) Average difference from Scenario 1 over Scenario Years 37 to 47.

Table 10.3-3: Aquifer Thicknesses and Exclusion Head Values at Westside Basin Coastal Monitoring Points

	Well or Cluster	Single Aquifer		Multi-Aquifer					
				Shallow		Primary Production		Deep	
		b [a]	E_h [b]	*b*	E_h	*b+d* [c]	E_h	*b+d*	E_h
Pacific Coast	North Windmill	270	7.0	100	2.6	270	7.0	--	--
	South Windmill	360	9.4	120	3.1	360	9.4	--	--
	Kirkham	450	11.7	110	2.9	310	8.1	450	11.7
	Ortega	490	12.7	100	2.6	340	8.8	490	12.7
	West Sunset Playground	400	10.4	70	1.8	340	8.8	400	10.4
	Taraval	550	14.3	130	3.4	390	10.1	550	14.3
	Zoo	630	16.4	80	2.1	400	10.4	630	16.4
	Fort Funston	1200	31.2	--	--	--	--	--	--
	Thornton Beach	3000	78.0	--	--	--	--	--	--
Bay Coast	Burlingame	308	8.0	--	--	--	--	--	--
	SFO	155	4.0	--	--	--	--	--	--
	UAL	155	4.0	--	--	--	--	--	--

Notes:

(a) *b* = Depth (below sea level) of aquifer bottom (for Single-Aquifer and Shallow Aquifer cases), or aquifer thickness (for Primary Production and Deep Aquifer cases) (see Figure 10.3-3).

(b) *Eh* = Exclusion head, defined in Section 3.5.1.

(c) *d* = Depth (below sea level) of bottom of the confining unit (see Figure 10.3-3).

Table 10.3-4: Seasonal Fluctuation in Head for Model Layers 1, 4, and 5 at the Pacific Ocean and San Francisco Bay Monitoring Network Wells

Scenario	1			2			3a			3b			4		
Model Layer / Location	1	4	5	1	4	5	1	4	5	1	4	5	1	4	5
North Windmill	1.7	--	--	1.7	--	--	1.6	--	--	0.8	--	--	0.8	--	--
South Windmill	0.7	-0.7	--	0.7	-0.7	--	0.6	-0.8	--	0.7	0.3	--	0.7	0.3	--
Kirkham	0.9	0.3	0.3	0.9	0.3	0.3	0.9	0.3	0.2	0.6	0.3	0.2	0.6	0.3	0.2
Ortega	0.6	0.3	0.3	0.6	0.3	0.3	0.6	0.3	0.2	0.6	0.2	0.2	0.6	0.2	0.2
West Sunset Playground	0.7	0.3	0.1	0.7	0.3	0.1	0.5	0.3	0.1	0.5	0.2	0.0	0.5	0.3	0.1
Taraval	0.5	0.4	-0.1	0.5	0.3	-0.1	0.5	0.3	-0.1	0.5	0.3	-0.2	0.5	0.3	-0.2
Zoo	1.3	0.3	-0.5	1.3	0.2	-0.5	1.2	0.1	-0.6	1.2	0.1	-0.6	1.3	0.2	-0.5
Fort Funston	1.3	0.0	0.0	1.3	0.0	0.0	1.3	0.0	0.0	1.3	0.0	0.0	1.3	0.0	0.0
Thornton Beach	0.6	0.0	0.0	0.6	0.0	0.0	0.6	0.0	0.0	0.6	0.0	0.0	0.6	0.0	0.0
Burlingame	0.0	-0.1	--	0.0	-0.1	--	0.0	-0.1	--	0.0	-0.1	--	0.0	-0.1	--
SFO	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--	0.1	--	--
UAL	0.0	--	--	0.0	--	--	0.0	--	--	0.0	--	--	0.0	--	--

Note:
Table cells containing "--" indicate that this Model Layer is not present in this location. Seasonal fluctuation is defined as the average difference between May head (generally representing the highest head annually) and November head (generally representing the lowest head annually).

Table 10.3-5: Model-Predicted Flux Through the Pacific Ocean and San Francisco Bay Coasts, Both Absolute and Relative to Scenario 1 (in acre-feet per month)

	Location	Scenario	1	2	3a	3b	4
Absolute	Pacific	AMax[a]	432	435	367	351	352
		AMin[b]	149	146	9	9	15
		AAvg[c]	255	273	75	77	103
	Bay	AMax	108	111	108	108	109
		AMin	82	72	80	80	47
		AAvg	93	96	91	91	80
Relative	Pacific	RMax[d]	--	29	-1	14	14
		RMin[e]	--	-8	-237	-241	-209
		RAvg[f]	--	17	-181	-179	-153
	Bay	RMax	--	8	0	0	4
		RMin	--	-11	-2	-2	-35
		RAvg	--	3	-1	-1	-13

Notes:

(a) Maximum absolute freshwater flux.

(b) Minimum absolute freshwater flux.

(c) Average absolute freshwater flux.

(d) Maximum flux difference from Scenario 1; if this value is negative, flux is always lower than in Scenario 1.

(e) Minimum flux difference from Scenario 1; if this value is positive, flux is always higher than in Scenario 1.

(f) Average flux difference from Scenario 1.

Table 10.3-6a: Percentage of Simulation Duration Below the Freshwater Exclusion Head (Model Layer 1)

Single-Aquifer Case

	Location	Scenario 1	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4
Pacific Coast	North Windmill	0%	0%	**57%**	**60%**	**59%**
	South Windmill	**33%**	**31%**	**95%**	**98%**	**98%**
	Kirkham	100%	100%	100%	100%	100%
	Ortega	100%	100%	100%	100%	100%
	West Sunset Playground	0%	0%	**99%**	**99%**	**99%**
	Taraval	100%	100%	100%	100%	100%
	Zoo	100%	100%	100%	100%	100%
	Fort Funston	100%	100%	100%	100%	100%
	Thornton Beach	**63%**	**61%**	**64%**	**64%**	**64%**
Bay Coast	Burlingame	100%	100%	100%	100%	100%
	SFO	100%	100%	100%	100%	100%
	UAL	**10%**	**7%**	**11%**	**11%**	**7%**

Shallow Aquifer

	Location	Scenario 1	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4
Pacific Coast	North Windmill	0%	0%	**5%**	**4%**	**4%**
	South Windmill	0%	0%	**73%**	**85%**	**83%**
	Kirkham	0%	0%	**77%**	**75%**	**66%**
	Ortega	0%	0%	**89%**	**89%**	**83%**
	West Sunset Playground	0%	0%	**90%**	**90%**	**85%**
	Taraval	0%	0%	**91%**	**91%**	**86%**
	Zoo	0%	0%	**35%**	**30%**	**0%**
	Fort Funston	--	--	--	--	--
	Thornton Beach	--	--	--	--	--
Bay Coast	Burlingame	--	--	--	--	--
	SFO	--	--	--	--	--
	UAL	--	--	--	--	--

Notes:
(1) Percentage represents the percentage of timesteps (i.e. months) with head below the exclusion head (see Section 3.5.1).
(2) -- = Model Layer is not present at this location.

Table 10.3-6b: Percentage of Simulation Duration Below the Freshwater Exclusion Head (Model Layer 4)

Single-Aquifer Case						
	Location	Scenario 1	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4
Pacific Coast	North Windmill	--	--	--	--	--
	South Windmill	**99%**	**99%**	100%	100%	100%
	Kirkham	100%	100%	100%	100%	100%
	Ortega	100%	100%	100%	100%	100%
	West Sunset Playground	100%	100%	100%	100%	100%
	Taraval	100%	100%	100%	100%	100%
	Zoo	100%	100%	100%	100%	100%
	Fort Funston	100%	100%	100%	100%	100%
	Thornton Beach	100%	100%	100%	100%	100%
Bay Coast	Burlingame	100%	100%	100%	100%	100%
	SFO	--	--	--	--	--
	UAL	--	--	--	--	--

Primary Production Aquifer						
	Location	Scenario 1	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4
Pacific Coast	North Windmill	--	--	--	--	--
	South Windmill	**99%**	**99%**	100%	100%	100%
	Kirkham	100%	100%	100%	100%	100%
	Ortega	100%	100%	100%	100%	100%
	West Sunset Playground	100%	100%	100%	100%	100%
	Taraval	100%	100%	100%	100%	100%
	Zoo	100%	100%	100%	100%	100%
	Fort Funston	--	--	--	--	--
	Thornton Beach	--	--	--	--	--
Bay Coast	Burlingame	--	--	--	--	--
	SFO	--	--	--	--	--
	UAL	--	--	--	--	--

Notes:

(1) Percentage represents the percentage of timesteps (i.e. months) with head below the exclusion head (see Section 3.5.1).

(2) -- = Model Layer is not present at this location.

Table 10.3-6c: Percentage of Simulation Duration Below the Freshwater Exclusion Head (Model Layer 5)

Single-Aquifer Case

	Location	Scenario 1	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4
Pacific Coast	North Windmill	--	--	--	--	--
	South Windmill	--	--	--	--	--
	Kirkham	100%	100%	100%	100%	100%
	Ortega	100%	100%	100%	100%	100%
	West Sunset Playground	100%	100%	100%	100%	100%
	Taraval	100%	100%	100%	100%	100%
	Zoo	100%	100%	100%	100%	100%
	Fort Funston	100%	100%	100%	100%	100%
	Thornton Beach	100%	100%	100%	100%	100%
Bay Coast	Burlingame	--	--	--	--	--
	SFO	--	--	--	--	--
	UAL	--	--	--	--	--

Deep Aquifer

	Location	Scenario 1	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4
Pacific Coast	North Windmill	--	--	--	--	--
	South Windmill	--	--	--	--	--
	Kirkham	100%	100%	100%	100%	100%
	Ortega	100%	100%	100%	100%	100%
	West Sunset Playground	100%	100%	100%	100%	100%
	Taraval	100%	100%	100%	100%	100%
	Zoo	100%	100%	100%	100%	100%
	Fort Funston	--	--	--	--	--
	Thornton Beach	--	--	--	--	--
Bay Coast	Burlingame	--	--	--	--	--
	SFO	--	--	--	--	--
	UAL	--	--	--	--	--

Notes:

(1) Percentage represents the percentage of timesteps (i.e. months) with head below the exclusion head (see Section 3.5.1).

(2) -- = Model Layer is not present at this location.

Table 10.3-7: Descriptions, Values, and Sources for Parameters Used in Analytical Rate Estimation Model (see Section 7.1)

Parameter	Type	Description	Value	Units	Source
b_u	parameter	Thickness of the unconfined aquifer below sea level	360	feet	LSCE, 2010
b_c	parameter	Thickness of the confined aquifer	240	feet	LSCE, 2010
d	parameter	Depth to the top of the confined aquifer below sea level	120	feet	LSCE, 2010
n_e	parameter	Effective (or available) porosity	0.2	--	CH2MHILL, 1995
x	variable	Horizontal location within the aquifer	--	feet	--
h_f	calculated	Freshwater head above sea level at location x	--	feet	--
K_h	parameter	Horizontal hydraulic conductivity of the aquifer	3652.5	ft/yr	CH2MHILL, 1995
ρ_f	constant	Density of fresh water	1	g/cm^3	Standard
ρ_s	constant	Density of salt water	1.026	g/cm^3	Standard
α	constant	Elasticity of the aquifer materials	1.00E-08	Pa^{-1}	Freeze and Cherry, 1979
β	constant	Compressibility of water	4.40E-10	Pa^{-1}	Freeze and Cherry, 1979
S_s	parameter	Specific storage of the confined aquifer	0.00002	ft^{-1}	Yates et al., 1990
Q'_0	parameter	Freshwater flux to the ocean per foot of shoreline prior to pumping	19600	ft^3/yr/ft of coastline	Yates et al., 1990
Q'_w	input	Rate of pumping per foot of shoreline	--	ft^3/yr/ft of coastline	--
Δt	input	Time period over which pumping is applied	--	years	--
z	calculated	Depth to saltwater interface below sea level	--	feet	--
L	calculated	Length from the discharge point to the toe of the wedge	--	feet	--

Table 10.3-8: Average Water Quality for Westside Basin Monitoring Wells

	Calcium	n	Magnesium	n	Sodium	n	Potassium	n	Total Alkalinity	n	Chloride	n	Sulfate	n	Specific Conductance	n	Total Dissolved Solids	n	Hardness as $CaCO_3$	n	pH	n
North Westside Basin																						
Kirkham MW-130	28.5	3	25.8	3	26.3	3	1.5	3	123	3	33.3	13	33.5	3	447	14	258	14	172	4	8.0	4
Kirkham MW-255	28.1	3	30.3	3	22.4	3	1.4	3	133	3	36.3	13	30.0	3	460	14	274	14	196	4	7.9	4
Kirkham MW-385	56.1	3	7.4	3	25.8	3	4.9	3	119	3	34.6	13	64.2	3	455	14	285	14	166	4	8.1	4
Kirkham MW-435	46.9	3	4.0	3	35.2	3	7.4	3	113	3	31.2	13	60.3	3	445	14	277	14	132	4	8.2	4
Ortega MW-125	26.8	3	22.1	3	26.3	3	1.3	3	106	3	30.8	14	36.3	2	436	14	257	13	147	4	7.9	4
Ortega MW-265	14.4	3	12.4	3	20.9	3	1.0	3	81	2	26.1	14	12.2	2	353	13	210	12	86	3	8.1	3
Ortega MW-400	16.2	3	12.7	3	22.7	3	1.4	3	90	2	23.0	14	10.7	3	274	14	178	14	92	3	8.2	3
Ortega MW-475	13.3	3	1.9	3	43.2	3	3.1	3	78	3	28.9	14	14.1	3	285	14	173	14	42	4	8.3	4
Taraval MW-145	29.4	3	25.8	3	29.6	3	1.8	3	132	2	36.6	13	24.4	3	483	14	296	14	171	3	7.9	3
Taraval MW-240	21.8	3	20.1	3	23.1	3	1.7	3	104	2	34.2	14	18.9	3	376	14	228	14	137	3	7.8	3
Taraval MW-400	18.4	3	15.4	3	21.9	3	1.6	3	90	2	27.2	14	26.3	2	308	14	189	12	116	3	8.2	3
Taraval MW-530	11.7	2	5.4	2	51.1	2	2.4	2	120	2	24.6	14	8.8	2	326	14	199	14	56	3	8.4	3
Zoo MW-275	20.4	5	18.7	4	37.3	4	4.4	5	115	4	67.0	12	7.3	4	466	14	264	13	116	5	8.6	5
Zoo MW-450	22.5	5	25.4	5	41.7	5	2.6	5	134	4	43.8	12	18.8	5	483	14	287	14	142	5	8.4	5
Zoo MW-565	27.6	4	10.2	4	67.5	4	3.4	4	167	3	53.2	13	7.3	3	503	13	293	13	103	4	8.3	4
SWM MW-57	--	0	--	0	--	0	--	0	--	0	160.1	8	53.0	1	1191	8	667	7	--	0	--	0
SWM MW-140	--	0	--	0	--	0	--	0	--	0	60.8	8	39.0	1	675	8	381	7	--	0	--	0
Edgewood School	24.7	2	25.3	2	25.2	3	1.4	2	116	4	30.5	4	35.9	4	448	4	258	3	170	4	7.4	4
Elk Glen 2	34.6	5	37.1	5	27.1	5	1.0	4	142	5	40.2	6	52.4	6	575	6	367	6	227	6	7.7	6
LMMW1S	60.4	4	90.4	4	102.1	4	2.8	4	317	4	252.5	4	108.3	4	1545	4	853	4	568	4	6.8	4
LMMW1D	30.0	2	45.0	2	47.5	2	3.2	2	161	2	105.0	2	27.5	2	781	2	435	2	265	2	7.9	2
LMMW-2S	40.0	4	32.7	4	59.5	4	2.9	4	214	4	95.0	4	30.5	4	777	4	417	4	260	4	7.5	4
LMMW-2D	41.1	4	33.6	4	58.9	4	3.2	4	222	4	95.3	4	30.4	4	790	4	432	4	258	4	7.5	4
LMMW3S	45.5	11	50.6	10	46.1	11	1.8	10	310	10	51.9	10	28.5	10	786	10	453	10	287	9	7.2	10
LMMW3D	29.8	11	32.1	11	42.0	11	1.9	10	180	10	76.5	11	13.3	11	600	11	339	11	204	10	7.6	11
LMMW4SS	37.1	2	41.5	2	33.0	2	1.7	2	194	1	55.5	1	44.5	1	624	1	464	1	244	1	7.3	1
LMMW6D	27.8	11	28.4	10	36.9	11	1.4	10	127	10	52.7	11	32.5	11	556	11	334	11	186	10	8.0	11
LMMW7SS	43.2	3	44.4	3	55.6	3	1.4	3	240	2	44.4	2	46.4	2	753	2	476	2	271	2	7.6	2
(NE) Windmill	28.6	1	36.2	1	30.6	1	1.7	1	174	2	48.0	2	36.0	2	575	2	269	2	221	2	7.5	2
New GG Park (N) Lake	26.0	4	31.6	4	27.8	4	1.1	4	143	4	42.7	4	27.5	4	505	4	304	4	193	4	7.6	4
New GG Park (S) Windmil	29.5	4	35.8	4	28.0	4	1.5	4	149	5	42.8	4	43.7	3	562	4	340	4	234	4	7.9	4
(NW) Windmill	20.0	1	24.3	1	24.6	1	1.3	1	140	3	42.7	3	20.0	3	467	3	173	2	174	3	7.8	3
Olympic Club #8	38.5	1	39.7	1	46.0	1	2.0	1	189	1	84.0	1	30.5	1	685	1	--	0	--	0	8.1	1
Pine Lake Prod Well	32.7	1	33.4	1	36.4	1	1.1	1	144	1	35.3	1	37.0	1	565	1	336	1	244	1	7.2	1
(S) Windmill	26.5	3	29.1	3	26.1	3	1.4	3	133	4	40.3	5	26.7	5	476	5	262	4	185	5	7.7	5
West Sunset Playground	17.5	9	18.1	9	23.0	9	1.0	9	88	8	28.1	9	28.7	9	353	9	222	9	124	9	8.5	9
(S) Sunset Playground	30.2	3	32.6	3	36.8	3	1.3	3	159	2	41.7	3	33.0	3	573	3	366	3	205	3	7.4	3
CPS MW-190	44.2	3	44.7	3	44.4	3	1.5	3	267	3	42.3	3	44.0	3	725	3	413	3	295	3	7.6	3
CPS MW-270	29.9	3	23.0	3	46.0	3	1.5	3	171	3	70.3	3	9.7	3	552	3	297	3	168	3	7.9	3
LMPS MW-155	26.7	4	25.0	4	36.5	3	2.2	4	106	4	38.6	3	45.7	3	492	2	317	4	175	3	7.7	4
LMPS MW-270	24.2	4	17.6	4	55.9	4	1.5	4	127	4	43.7	3	34.7	3	522	3	323	4	134	4	7.8	3
LMPS MW-440	19.3	4	21.2	4	30.8	4	1.3	4	109	4	50.3	3	8.0	3	412	3	247	4	135	4	8.2	4
South Westside Basin																						
Burlingame-S	49.5	9	33.3	9	423	9	5.0	9	240	9	342	9	448	9	2,401	8	1,393	9	--	0	7.3	8
Burlingame-M	31.4	9	19.0	9	69.7	9	3.1	9	181	9	82.3	9	61.9	9	656	8	464	9	--	0	7.2	8
Burlingame-D	35.6	9	20.9	9	83.2	9	4.6	9	206	9	64.1	9	43.3	9	596	8	402	9	--	0	7.3	8
SFO-D	55.0	9	34.3	9	179	8	9.2	9	234	9	609	9	76.4	9	2,036	9	1,202	9	--	0	7.5	8
SFO-S	423.7	9	519.7	9	4,689	9	66.9	9	610	9	9,910	9	802	9	30,757	7	16,300	8	--	0	7.3	9

Notes:

(1) Data from SFPUC 2010 Annual Groundwater Monitoring Report (SFPUC, 2011). Data marked "anomalous or questionable result" were removed from these averages.

(2) n is the number of samples included in the average.

(3) All analytes except Specific Conductance and pH are reported in units of milligrams per liter; Specific Conductance is reported in micromhos per centimeter, while pH is reported in pH units.

Attachment A

Analytical Approach

Attachment A: Analytical Approach

A. Analytical Approach

Because the numerical groundwater model is not perfectly suited to simulating the occurrence of seawater intrusion, an analytical approach to the problem of seawater intrusion is also applied in this section. This method combines a physical treatment of the relation between freshwater head and the depth to the seawater interface with a Darcy's Law approach to relating freshwater flux to the location of the interface. This approach does not explicitly deal with the problem of the transition zone (i.e., it assumes a sharp interface). It should be noted that the analytical solutions presented here deal with simplified aquifer constructions, and are not meant to exactly model reality, but rather provide another useful estimate of the future occurrence of seawater intrusion under a variety of conditions.

A.1. Ghyben-Herzberg Relation

The analytical solution to seawater intrusion was first developed in the late nineteenth (Badon-Ghyben, 1888) and early twentieth (Herzberg, 1901) centuries. Independently of each other, these two investigators found that the seawater-freshwater interface in coastal aquifers occurs at a depth below sea level about 38 times the freshwater head at a given location (Cheng and Ouazar, 1999). This is due to the difference in densities between seawater and freshwater.

Assuming that the seawater and freshwater zones are in approximate hydrostatic equilibrium, the pressure in each zone is defined based on the head in the aquifer:

$$p_s = zg\rho_s$$

$$p_f = g\rho_f\left(z + h_f\right)$$

where p_s is the pressure on the seawater side of the interface, z is the depth (below msl) to the interface, g is the acceleration due to gravity, ρ_s is the density of seawater, p_f is the pressure on the freshwater side of the interface, ρ_f is the density of freshwater, and h_f is the water table elevation (height above msl). Because the pressure must be the same on both sides of this interface, these two equations can be related:

$$zg\rho_s = g\rho_f\left(z + h_f\right)$$

$$z = \frac{\rho_f}{\rho_s - \rho_f} h_f$$

With standard values of density for freshwater (1.0 g/cm^3) and seawater (1.026 g/cm^3), this equates to:

$$z = 38h_f$$

With this proportionality in mind, a schematic of a simplified aquifer can be constructed (Figure 10.3-3). The shape of the head profile in this schematic is dictated by the flux through the aquifer and the hydraulic conductivity (see Section A.3.4); the seawater-freshwater interface and the freshwater head gradient both steepen approaching the discharge point because the freshwater flux (which is assumed to be equal at all horizontal locations up to the discharge point) must pass through a progressively smaller thickness of freshwater aquifer. According to Darcy's law (see Section A.3.4), the flux is proportional to the product of the aquifer thickness and the head gradient, so as the freshwater aquifer thickness declines the head gradient must increase to compensate.

For this simplified treatment of a coastal aquifer, a number of assumptions are made:

- Flow is steady, i.e., flow does not change over time.
- The interface between the seawater and freshwater sections of the aquifer is sharp, i.e., there is no transition zone.
- The seawater portion of the aquifer is under hydrostatic conditions, i.e., there is no flow within this section of the aquifer.
- Flow in the freshwater aquifer is essentially horizontal, which amounts to the Dupuit-Forchheimer assumption in an unconfined aquifer.
- The aquifer top (where applicable) and base (whether a fine-grained layer or the bedrock surface) are horizontal.

The first assumption listed, that of steady flow, runs counter to the purpose of this TM, i.e., determining how changes in the flow regime will affect seawater intrusion. However, considering the timescales involved in seawater intrusion, the assumption of steady flow is safe for a screening-level analysis.

A.2. Upconing of the Seawater-Freshwater Interface

While the Ghyben-Herzberg relationship can predict the depth to the interface between freshwater and salt water in the aquifer away from active wells, in the vicinity of these wells the relationship does not hold. If a well is screened over only a portion of the aquifer, the reduced pressure around the screen leads to upward movement of groundwater below the well. The Ghyben-Herzberg relationship assumes horizontal flow, while, with a well that is not screened across the entire aquifer thickness, a significant component of vertical flow exists in the vicinity of the well. If a seawater-freshwater interface exists below the well, the upward movement of groundwater deflects this interface upward, a process called "upconing."

Bouwer (1978) developed a solution to the location of the interface below a well when upconing is occurring. This method starts with the results of the Ghyben-Herzberg solution (i.e., the depth to the interface at the well location), and modifies them slightly to determine the extent of upconing:

$$Z = \frac{\rho_f}{\rho_s - \rho_f} \frac{Q}{2\pi K z_i}$$

where Z is the height of the cone beneath the center of the well (measured from the location of the interface determined by the Ghyben-Herzberg relationship), Q is the discharge in the well, K is the horizontal hydraulic conductivity, and z_i is the depth of the Ghyben-Herzberg interface below the bottom of the well.

Attachment A: Analytical Approach

A.3. Key Data Sets

The specifics of the analytical method are described in Section A.4 below. For the solutions provided below, the pertinent data are the freshwater head, the flux of freshwater into the ocean, the horizontal hydraulic conductivity of the aquifer, the thickness of the aquifer, and the location of the discharge of freshwater into the ocean. Most of these numbers can be derived directly from the numerical groundwater model, but the purpose of this section is to provide an analysis of the issue of seawater intrusion that is as independent of the numerical model as possible. Therefore, values for these variables and parameters will be based on independent estimates from previously published reports or actual field observations. The numerical model will be used to provide values of freshwater head under the various model scenarios, as the effects of the changes in the pumping regime have not been independently quantified.

A.3.1. Freshwater Head

The freshwater head in the aquifer is determined based on field measurements of depth to groundwater in the various monitoring wells present throughout the Basin. These measurements are not a perfect method for determining the head in the aquifer for several reasons. For this analysis, horizontal flow is assumed, meaning that there is no vertical head gradient within the aquifer. In any column of an actual aquifer, the head is not the same everywhere, and the wells in the monitoring network sample across a fairly tightly constrained thickness of the aquifer. Head can also vary significantly between layers in a stacked aquifer structure such as that present in the Westside Basin, although the monitoring well network was constructed carefully to not sample multiple layers. The monitor well network also does not sample all horizontal locations in the aquifer. The monitor well is a discrete point within a continuous and extensive aquifer, and the data measured within a network of monitor wells must not be considered to capture all variability within the aquifer.

With these caveats in mind, head must be defined for this analysis based on actual measurements from the existing monitoring well network, the details of which are summarized in Section 2.2.2 above. Head has been measured in the North Westside Basin since 2002 for the Zoo cluster, 2003 for the Thornton Beach cluster, 2004 for the Kirkham, Ortega, and Taraval clusters, and 2006 for the South Windmill cluster. Hydrographs for these wells are presented in the annual groundwater monitoring reports for the Westside Basin (i.e., SFPUC, 2011). These hydrographs, along with head values measured at some wells further inland (e.g., the West Sunset Playground well), are used to assess current conditions according to the analytical method.

In addition to the current conditions, future conditions will be assessed. To do so, head levels predicted by the numerical model will be considered in relation to the freshwater head needed at each monitoring location to prevent seawater intrusion to occur at that point.

A.3.2. Horizontal Hydraulic Conductivity

Horizontal hydraulic conductivity (K_h) is an empirical proportionality constant that dictates the degree to which an aquifer allows water to pass through it. This parameter is not easily predicted based solely on the physical properties of the aquifer, although numerous hydrologic textbooks provide ranges of values for typical rocks and unconsolidated deposits (i.e., Freeze and Cherry, 1979, p.29). Instead, K_h is usually determined at individual wells using aquifer tests, calculated based on established time-drawdown relationships. These tests have been performed at a number of locations in the Basin in the past, and this section summarizes those published values.

In the North Westside Basin, K_h values were collected from various references by Phillips et al. (1993). These values, measured mostly in Golden Gate Park or along the Pacific coast between Golden Gate Park and Lake Merced, varied from 5 to 31 ft/d, with an average value of 17.3 ft/d, an arithmetic mean of 16.5 ft/d, and a geometric mean of 15.4 ft/d.

CH2M HILL (1995) performed a seawater intrusion model analysis on the North Westside Basin. K_h was determined for three model layers, roughly corresponding (from lowest to highest) with the Merced Formation, the Colma Formation, and the surficial dune sands (plus unconfined portions of the Colma Formation). While initial estimates were based on the values presented in Phillips et al. (1993), calibration of the model resulted in values of K_h of 10 ft/d for the upper two layers and 8 ft/d for the lowest layer. While these calibrated values are useful for giving additional insight into the likeliness of values within the existing range, they cannot be considered to be exact, due to the non-uniqueness inherent in a numerical solution within a complex model domain.

LSCE (2005) presented the results of an aquifer test performed at the South Sunset Playground well. The constant-rate test was run for 4.6 days at an average discharge rate of 409 gallons per minute. Using the Cooper-Jacob method, the aquifer transmissivity was determined to be about 27,100 gallons per day per foot (gpd/ft). No aquifer thickness is reported, so K_h cannot be calculated (transmissivity, T, is equal to the product of K_h and the aquifer thickness, B).

Rather than choose a single value of K_h for the Pacific Coast, a range of values (5 to 31 ft/d) will be used. The part of the analytical method that uses values of K_h (see Section A.6) was not performed for the Bay Coast due to the lack of an independent estimate for freshwater flux (see Section A.3.4).

A.3.3. Aquifer Thickness

The aquifer thickness is likely the most likely parameter to determine accurately. The aquifer materials are well-defined at the individual well locations and can be interpolated in between. The movement of a seawater-freshwater interface through a real aquifer happens in a very complex manner, due to the heterogeneity of the aquifer.

Seawater tends to intrude along the base of an aquifer, atop a relatively impermeable layer (Figure 10.3-3). In a complex aquifer, with multiple low-permeability lenses, the seawater may intrude at multiple levels, depending on the continuity of these lenses; for a seawater intrusion front to intrude along a low-permeability lens surrounded on both top and bottom by higher-permeability aquifer layers, that lens must stretch continuously into the saline portion of the aquifer (i.e., Figure 5.2 in Bear, 1999). Until the intrusion front comes on-land, the area where it resides (i.e., offshore) is very poorly understood because no sediment profiles have been constructed beneath the Ocean or the Bay. Low-permeability layers that are very extensive onshore may be assumed to be continuous to the ocean floor, but this is unsure.

Attachment A: Analytical Approach

According to the cross-sections presented in LSCE (2010), all of the clay layers are discontinuous in the North Westside Basin (i.e., Figure 8 in Appendix A of LSCE, 2010). In the northernmost two cross-sections perpendicular to the coast (J-J' and Z-Z'), clay layers are either specifically discontinuous (i.e., J-J') or thin enough that they are unlikely to be continuous from the Great Highway a significant distance offshore. The southernmost cross-section north of Lake Merced (Y-Y') does have a thick, seemingly continuous clay layer present between the Shallow and Primary Production Aquifers, as well as a series of clay layers between the Primary Production and Deep Aquifers, so the analysis may have to consider the aquifer in three sections in this southern area. For completeness, both a sectioned aquifer and a non-sectioned aquifer will be considered. At the coast, the aquifer thickness varies from 450 ft at Golden Gate Park to 510 ft at the Ortega cluster to 630 ft at the Zoo cluster. If the area of the Zoo cluster is partitioned into three aquifers, their thicknesses are approximately 60, 290, and 120 ft (Shallow, Primary Production, and Deep Aquifers, respectively).

The same cross-sections do not extend all the way into the Bay (LSCE, 2010). However, the two southernmost cross-sections perpendicular to the Bay (N-N' and O-O') indicate that most or all of the subsurface sediments are made up of fine-grained sediments from at least the Bay Plain into the San Francisco Bay. Again, as with the North Westside Basin, there are no sediment profiles beneath the Bay itself, but it is safe to assume that the deposits in this area are continuous. Because the cross-sections do not stretch offshore, the aquifer thicknesses given here are measured at South Airport Boulevard. At cross-section N-N', the aquifer thickness is about 170 ft, while the thickness at cross-section O-O' is about 130 ft.

A.3.4. Freshwater Flux

The flux of freshwater toward the Ocean (or Bay) is important for keeping the seawater-freshwater interface offshore. Unlike the groundwater head elevation, this flux is not monitored directly anywhere in the Basin. Few estimates have been made of the flux. Yates et al. (1990) used a water budget calculation for 1988 to determine that a total of 0.45 acre-feet (af) (19,600 cubic feet) of outflow occurred per foot of coastline in the Golden Gate Park area, while about 640 af of freshwater flowed into the Ocean in the Lake Merced area. Outflows have not previously been estimated for the coastline between these two areas. Outflows have also not been independently estimated for the Bay Coast.

Flux can also be calculated based on Darcy's Law, which is an empirical relationship between the head gradient in an aquifer and the flux through it:

$$Q' = -KBi$$

where Q' is the flux through the aquifer [L^3/T], K is the hydraulic conductivity [L/T], B is the aquifer thickness [L], and i is the head gradient [L/L]. The values of K and B are discussed in Sections A.3.2 and A.3.3 above. Values of i can be determined based on values of head (see Section A.3.1).

A.4. Seawater Wedge Toe Location Methodology

An analytical solution can be created for the location of the toe of the seawater intrusion wedge under both unconfined and confined conditions using a combination of the Ghyben-Herzberg solution and Darcy's Law. This analytical solution has previously been developed in various sources, for example Bear (1972) and Strack (1976).

A.4.1. Unconfined Solution

A schematic of seawater intrusion into an unconfined aquifer is shown in Figure 10.3-3a. At any location within the freshwater aquifer, Darcy's Law can be used to relate the head gradient to the flux through the aquifer. To do this, the basic version of Darcy's Law presented in Section A.3.4 is modified by replacing the aquifer thickness (*B* in the above equation) with the thickness of freshwater above the seawater wedge in the interface area and expressing the head gradient in terms of the change in freshwater head over distance:

$$Q' = -K\left(z + h_f\right)\frac{dh_f}{dx}$$

where *Q'* is the freshwater flux through the aquifer and *x* is measured as the distance seaward from the toe of the seawater wedge (*x* = 0). The Ghyben-Herzberg solution relates *z* to h_f using the relationship between ρ_s and ρ_f, and can be used to remove *z* from this equation:

$$Q' = -Kh_f\left(\frac{\rho_s}{\rho_s - \rho_f}\right)\frac{dh_f}{dx}$$

which can be rearranged to:

$$Q' = -\frac{K}{2}\left(\frac{\rho_s}{\rho_s - \rho_f}\right)\frac{dh_f^2}{dx}$$

This equation can be solved by integrating over *x* (and rearranged):

$$\frac{\rho_s - \rho_f}{\rho_s}\frac{2Q'x}{K} = -h_f^2 + const$$

The constant in this equation is the freshwater head at *x* = 0, the location of the toe of the wedge:

$$\frac{\rho_s - \rho_f}{\rho_s}\frac{2Q'x}{K} = h_f^2\Big|_{x=0} - h_f^2$$

Evaluated at *x* = *L*, the assumed location of freshwater discharge (and the point where the freshwater head (h_f) and aquifer thickness diminish to zero), the equation becomes:

$$h_f^2\Big|_{x=0} = \frac{\rho_s - \rho_f}{\rho_s}\frac{2Q'L}{K}$$

The Ghyben-Herzberg solution also contains a relationship for the value of h_f at *x* = 0 (because at this point the value of *z* is by definition to the aquifer thickness, as thickness of the seawater wedge in the freshwater aquifer is equal to zero), which can then replace the left-hand side of the equation:

$$h_f^2\Big|_{x=0} = \left(\frac{\rho_s - \rho_f}{\rho_f}\right)^2 b^2$$

$$\left(\frac{\rho_s - \rho_f}{\rho_f}\right)^2 b^2 = \frac{\rho_s - \rho_f}{\rho_s}\frac{2Q'L}{K}$$

where *b* is the thickness of the aquifer lying below sea level (note the difference from the entire aquifer thickness, *B*, introduced above; $b = B - h_f$). Finally, this equation can be rearranged to solve for *L* as a function of *Q'*:

$$L = \frac{\rho_s}{\rho_f}\frac{\rho_s - \rho_f}{\rho_f} b^2 \frac{K}{2Q'}$$

It should be noted that this solution does not depend on the freshwater head, except as its gradient affects the value of *Q'*. The values of ρ_s and ρ_f are constant, so applying this simplified solution requires knowledge of *K* (Section A.3.2), *b* (Section A.3.3), and *Q'* (Section A.3.4).

A.4.2. Confined Solution

A schematic for seawater intrusion in a confined aquifer is given in Figure 10.3-3b. In terms of the parameters involved in the analytical solution, the difference between the two aquifer constructions is that the thickness of the confined aquifer changes only due to the shape of the seawater wedge at the base of the aquifer, whereas the thickness of the unconfined aquifer also changes due to the changing water table surface. Because the entire thickness of the aquifer is, by definition, at or below the elevation of the assumed discharge point of the aquifer, *b* in the following equation is equal to *B* in Section A.3.3.

The Darcy's Law application for a confined aquifer is given by the equation:

$$Q' = -K(z - d)\frac{dh_f}{dx}$$

where d is the depth from msl to the top of the aquifer. The Ghyben-Herzberg solution can then be used to replace the value of *z*:

$$Q' = -K\left(\frac{\rho_f}{\rho_s - \rho_f} h_f - d\right)\frac{dh_f}{dx}$$

This equation can then be integrated over *x*:

$$Q'x = -K\left(\frac{\rho_f}{\rho_s - \rho_f}\frac{h_f^2}{2} - h_f d\right) + const$$

Attachment A: Analytical Approach

Again, this constant is defined by solving for the value of h_f at $x = 0$:

$$Q'x = K\frac{\rho_f}{\rho_s - \rho_f}\frac{h_f^2\big|_{x=0} - h_f^2}{2} - Kd\left(h_f\big|_{x=0} - h_f\right)$$

Solving at $x = L$:

$$Q'L = K\frac{\rho_f}{\rho_s - \rho_f}\frac{h_f^2\big|_{x=0} - h_f^2\big|_{x=L}}{2} - Kd\left(h_f\big|_{x=0} - h_f\big|_{x=L}\right)$$

The Ghyben-Herzberg solution equates the freshwater head with the various vertical aquifer parameters. This changes depending on location. At $x = 0$, the location of the toe of the wedge, the depth to the interface is equal to about 38 times the freshwater head above msl; this depth is equal to the aquifer thickness (b) plus the depth to the top of the aquifer (d):

$$h_f\big|_{x=0} = \frac{\rho_s - \rho_f}{\rho_f}\left(b + d\right)$$

At the coast, the depth to the interface is equal to the depth of the aquifer, as the freshwater thickness diminishes to zero:

$$h_f\big|_{x=L} = \frac{\rho_s - \rho_f}{\rho_f}d$$

These values can be substituted into the equation above:

$$Q'L = \frac{K}{u}\frac{\left[u\left(b + d\right)\right]^2 - \left[ud\right]^2}{2} - Kd\left[u\left(b + d\right) - ud\right]$$

where:

$$u = \frac{\rho_s - \rho_f}{\rho_f}$$

Rearranging the above equation and simplifying yields:

$$Q'L = Ku\frac{\left(b + d\right)^2 - d^2}{2} - Kubd$$

$$Q'L = Ku\left(\frac{b^2 + 2bd + d^2 - d^2}{2} - bd\right)$$

$$Q'L = Ku\left(\frac{b^2}{2} + bd - bd\right)$$

Attachment A: Analytical Approach

Rearranging this equation can be used to express the intrusion length (*L*) in terms of the freshwater flux (*Q'*):

$$L = \frac{\rho_s - \rho_f}{\rho_f} b^2 \frac{K}{2Q'}$$

It should be noted that the depth to the top of the aquifer (*d*) does not appear in the solution for intrusion length for a confined aquifer. As with the unconfined solution, the values of *K*, *Q'*, and *b* must be known to use this solution.

A.5. Exclusion Head Methodology

As implied by the analytical solutions presented in Section A.4, there is a simple relationship between freshwater head (h_f) and aquifer thickness (*b*) at the location of the most extensive intrusion of the seawater wedge into an unconfined freshwater aquifer, termed the toe of the wedge:

$$h_{f,toe} = \frac{\rho_s - \rho_f}{\rho_f} b$$

It should be remembered that the value of *b* used in this formulation is the thickness of the aquifer below sea level only. For a confined aquifer, the freshwater head is:

$$h_{f,toe} = \frac{\rho_s - \rho_f}{\rho_f} (b + d)$$

where b is the aquifer thickness and d is the depth below sea level of the top of the aquifer.

This simple relationship for freshwater head at the toe can be used as a management tool; to prevent intrusion from reaching any given location in the freshwater aquifer, the toe of the seawater wedge must be kept seaward of the location. To do so, the freshwater head at that location must be kept above the level at which it would be were the toe of the wedge to reach that location. This head is here termed the “exclusion head,” and is equivalent to the “potential constraint” used in a management study by Mantoglou (2003), which showed this approach to be a conservative management tool.

To apply the exclusion head methodology, the parameter *b* (and *d* where conditions are confined) must be defined. The exclusion head is then calculated using assumed values of the densities of seawater and freshwater (see Section A.1).

A.6. Rate of Seawater Intrusion at Golden Gate Park

In an effort to quantify the rate of seawater intrusion into the freshwater aquifer under various pumping conditions, a simplified mathematical model was created to estimate the change in the position of the toe of the seawater wedge over time. This mathematical model is based on the analytical model presented in Section A.4. The model was developed by assuming that the movement of the wedge could be described by assuming that the interface moves in the short

Attachment A: Analytical Approach

term due to changes in the amount of freshwater present in the aquifer. This section describes the development of the model and its application to an idealized case designed to resemble conditions at the South Windmill Cluster in Golden Gate Park. A similar analysis was not performed for the Bay Coast because of the lack of an independent estimate of freshwater flux (see Section A.3.4).

The theory behind this method is that the movement of the seawater-freshwater interface can be described by assuming that the well pumping over a given time period can be converted to a volume of water removed. This approach makes a number of assumptions, most of which are similar to the analytical method for estimating the intrusion length (see Section A.4). Additional assumptions include:

- The pumping rate is a small percentage of the freshwater flux.
- The aquifer thickness landward of the intrusion wedge toe is approximately constant.
- The discharge point does not move from the coast.
- The system is unconfined and functions as a single aquifer.

The second assumption greatly simplifies the mathematical solution. Implicit in this assumption is that the head gradient landward of the wedge toe is approximately flat; this does not introduce substantial error into the analysis because head gradients in permeable alluvial sediments are typically very flat compared to the total aquifer thickness; Yates et al. (1990) reported a maximum gradient in the North Westside Basin of 0.035 ft/ft in the Lake Merced area, with typical gradients on the order of 0.010 ft/ft, including in the Golden Gate Park area). It should be noted that the analytical solution presented below does not depend on the head or head gradient directly, so the assumption of a constant aquifer thickness (and therefore flat gradient) does not preclude freshwater flux toward the ocean and is an appropriate approximation.

The last assumption is required because the confined solution is much more complicated than is the unconfined solution, due to the effects of aquifer elasticity and water compressibility (together contributing to the specific storage of the confined aquifer). This assumption is applicable at the western end of Golden Gate Park because the -100 foot clay is absent, leaving the Shallow and Primary Production Aquifers in direct communication; this implies that they can be considered a single aquifer. Elsewhere in the North Westside Basin, where the clay layers are present, this assumption would not apply.

As shown in Section A.4, the intrusion length into the aquifer (i.e., the distance from the discharge point to the toe of the wedge) is equal to:

$$L = \frac{K}{2Q'_0}\frac{\rho_s}{\rho_f}\frac{\rho_s - \rho_f}{\rho_f}b^2$$

where Q'_0 is the initial freshwater flux per foot of coastline before modification by pumping (all other terms are defined in Section A.4). The volume of water within any slice of the aquifer of infinitesimal width dx is equal to:

$$dV' = h_f n_e \frac{\rho_s}{\rho_s - \rho_f} dx$$

Attachment A: Analytical Approach

where n_e is the effective porosity of the aquifer[6]. Integrating from the coast to the toe of the wedge, the total initial volume of freshwater per foot of coastline above the wedge is equal to:

$$V_0' = -\left(\frac{\rho_s}{\rho_s - \rho_f}\right)^2 \frac{n_e K}{3Q_0'}\left[\left[\left(\frac{\rho_s - \rho_f}{\rho_f}\right)^2 b^2 - \frac{\rho_s - \rho_f}{\rho_f}\frac{2Q_0' L_0}{K}\right]^{3/2} - \left[\left(\frac{\rho_s - \rho_f}{\rho_f}\right)^2 b^2\right]^{3/2}\right]$$

which, when substituting the above equation for computing L, simplifies to:

$$V_0' = \frac{n_e K}{3Q_0'}\left(\frac{\rho_s}{\rho_f}\right)^2 \frac{\rho_s - \rho_f}{\rho_f} b^3$$

Pumping removes a volume of water from the aquifer (V'_w) that is equal to the product of the pumping rate and the time over which it is applied:

$$V_w'(t) = Q_w'(t - t_0)$$

where *Q'*$_w$ is the pumping rate, *t* is the time, and t_0 is the time when pumping was initiated. In this case, the pumping rate must be converted to an equivalent flux per foot of shoreline, which implies that the pumping in the basin results in a uniform decrease in the freshwater flux rate. This pumping from the aquifer induces some movement of the intrusive wedge inland (as extra recharge would move the wedge closer to the ocean). The volume of water removed from the aquifer from the new location of the toe of the wedge to the coast is equal to the volume of water removed from the aquifer. The volume of freshwater contained in the aquifer from the location of the new toe to the coast prior to pumping is equal to the volume of freshwater above the seawater-freshwater interface plus the volume of water in the stretch of aquifer that becomes intruded by the wedge during its movement. Assuming that the freshwater head is approximately flat landward of the toe of the wedge, the freshwater head is equal everywhere to its value at the toe of the wedge, which is equal to:

$$h_{f,toe} = \frac{\rho_s - \rho_f}{\rho_f} b$$

The volume of freshwater in the aquifer that becomes intruded by the wedge is equal to:

$$V_i' = n_e b \frac{\rho_s}{\rho_f}\left(L(t) - L_0\right)$$

where *L*(*t*) is the distance from the coast to the toe of the wedge at time *t*. The total volume of freshwater in the aquifer from the coast to the new location of the wedge of the toe prior to pumping is:

[6] Note that this assumes that the intruding seawater does not interact with the non-effective porosity of the aquifer, i.e. $n - n_e$. In reality, this non-effective porosity will lead to (very slightly) lower salinity behind an intruding wedge, and the leaving of salts behind by a retreating wedge.

Attachment A: Analytical Approach

$$V'_{0,Total} = V'_0 + V'_i = \frac{n_e K}{3Q'_0}\left(\frac{\rho_s}{\rho_f}\right)^2 \frac{\rho_s - \rho_f}{\rho_f} b^3 + n_e\left(L(t) - L_0\right)\frac{\rho_s}{\rho_f} b$$

The wedge at time *t* has a volume equal to:

$$V'_t = V'_{0,Total} - V'_w(t)$$

Combining this with earlier equations produces an equation for the total volume of freshwater above the transient wedge at time *t*:

$$V'_t = \frac{n_e K}{3Q'_0}\left(\frac{\rho_s}{\rho_f}\right)^2 \frac{\rho_s - \rho_f}{\rho_f} b^3 + n_e\left(L(t) - L_0\right)\frac{\rho_s}{\rho_f} b - Q'_w\left(t - t_0\right)$$

Assuming the value of Q'_0 is not significantly changed by the pumping, this volume can also be computed by:

$$V'_t = -\left(\frac{\rho_s}{\rho_s - \rho_f}\right)^2 \frac{n_e K}{3Q'_0}\left[\left[\left(\frac{\rho_s - \rho_f}{\rho_f}\right)^2 b^2 - \frac{\rho_s - \rho_f}{\rho_f}\frac{2Q'_0 L(t)}{K}\right]^{3/2} - \left[\left(\frac{\rho_s - \rho_f}{\rho_f}\right)^2 b^2\right]^{3/2}\right]$$

The assumption that Q'_0 is not changed significantly is only applicable if the value of Q'_w is small compared to Q'_0, i.e., most of the initial freshwater flux is not captured by the wells. Results based on values of Q'_w that represent a significant fraction of Q'_0 should be used with caution. The value of Q'_0 reported by Yates et al. (1990) was 19,600 ft^3/yr per foot of coastline; the pumping entailed by the SFGW Project is about 8,810 ft^3/yr per foot of coastline above the pumping reported by Yates et al. (1990) for Scenario 3a, and about 9,220 ft^3/yr per foot of coastline above for Scenario 3b; the large magnitude of these changes relative to the initial freshwater flux indicates that this assumption is not completely valid in this case, and the results should be considered approximate.

These two values for the total volume of freshwater can be equated to each other. The equation for the value of L_0 can be substituted into this equation to simplify it to:

$$Q'_w\left(t - t_0\right) - n_e b\frac{\rho_s}{\rho_f} L_0 = \left(\frac{\rho_s}{\rho_f}\right)^2 \frac{2n_e b^2}{3L_0^{1/2}}\left[L_0 - L(t)\right]^{3/2} - n_e b\frac{\rho_s}{\rho_f} L(t)$$

or

$$\frac{Q'_w\left(t - t_0\right)}{n_e b}\frac{\rho_f}{\rho_s} = \frac{\rho_s}{\rho_f}\frac{2b}{3L_0^{1/2}}\left(L_0 - L(t)\right)^{3/2} + \left(L_0 - L(t)\right)$$

This equation cannot be solved for *L*(*t*) using separation of variables. Instead, this model must be solved iteratively. This iterative solution can be performed in any spreadsheet software (e.g., Microsoft Excel) by minimizing the difference between the specified pumping rate and the pumping rate calculated using the equation above by optimizing values of $L(t)$.

A.7. Effect of a Sloping Aquifer Base

The above analytical methods assume a horizontal aquifer. As shown in LSCE (2010), the actual aquifer bases in the North Westside Basin have been shown to be sloped toward the Ocean. A similar analytical method assuming a sloping aquifer base could not be constructed because the solution is inseparable. Abarca et al. (2007) performed numerical simulations that investigated the effect of a sloping aquifer boundary, both parallel and perpendicular to the coastal boundary. Their results indicated that a slope toward the Ocean slightly decreases the intrusion length into an aquifer, but not substantially. The presence of a slope parallel to the coast, on the other hand, can greatly increase the length of seawater intrusion into the lowest parts of the aquifer base. Mulligan et al. (2007) demonstrate that freshwater flux tends to be concentrated in paleochannels, which would represent the low points in the aquifer base demonstrated by Abarca et al. (2007) to be locations of greater intrusion; the concentration of freshwater flux into these same areas may keep this intrusion at bay.

24 April 2012

Task 10.4 Technical Memorandum

San Francisco Public Utilities Commission

Changes in Groundwater Levels and Storage for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Prepared For: Greg Bartow and Jeff Gilman, SFPUC

Prepared by: Michael Maley, Dennis Orlowski, Sevim Onsoy, and Matt Baillie, Kennedy/Jenks Consultants

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1. Introduction

This Technical Memorandum (TM) was prepared to document work performed by Kennedy/Jenks Consultants (Kennedy/Jenks) for the San Francisco Public Utilities Commission (SFPUC) pursuant to the amended Task Order (TO) authorizations CUW30103-TO-1.12 of the Proposed Regional Groundwater Storage and Recovery (GSR) Project and CUW30102-TO-2.7 of the Proposed San Francisco Groundwater Supply (SFGW) Project. These projects are funded by the SFPUC's Water System Improvement Program (WSIP).

1.1. GSR and SFGW Project Description

The GSR Project is a conjunctive use project that would allow for increased groundwater supplies in the southern portion of the Westside Basin (South Westside Basin) during periods of drought when SFPUC surface water supplies become limited (MWH, 2008). The project would be designed to provide up to 60,500 acre-feet (af) of stored water to meet SFPUC system demands during the last 7.5 years of SFPUC's Design Drought. The SFPUC plans to install 16 new production wells for the GSR Project to recover the stored groundwater. Under the Draft GSR Operating Agreement, the SFPUC would "store" water in the South Westside Groundwater Basin through the mechanism of in-lieu recharge by providing surface water as a substitute for groundwater pumping by the Partner Agencies (PAs). As a result of the in-lieu deliveries, up to 60,500 af of groundwater storage or "put" credits could accrue to the SFPUC Storage Account. During shortages of SFPUC system water due to drought, emergencies, or scheduled maintenance, the PAs would return to pumping from their existing wells, and SFPUC would extract groundwater from their new wells as long as a positive balance exists in the SFPUC Storage Account.

The SFGW Project would provide a reliable, local source of high-quality groundwater in the northern portion of the Westside Basin (North Westside Basin) to supplement the San Francisco municipal water system. The SFGW Project would construct up to six wells and associated facilities in the western part of San Francisco and extract an annual average of up to 4.0 million gallons per day (mgd) of water from the North Westside Basin (SFPUC, 2009b). The extracted groundwater, which would be used both for regular and emergency water supply purposes, would be blended in small quantities with imported surface water before entering the municipal drinking water system for distribution. The SFGW Project includes two phases, In phase one, SFPUC would build four new groundwater wells at the Lake Merced Pump Station, West Sunset Playground, South Sunset Playground, and the Golden Gate Park Central Pump Station. In phase two, SFPUC would modify two existing irrigation wells (South Windmill Replacement and North Lake) in Golden Gate Park, converting them into municipal water supply wells.

The locations of existing and proposed GSR and SFGW wells, existing PA wells, and monitoring wells are shown on Figure 10.4-1. Additional detailed discussion of the GSR and SFGW Projects is provided in the Task 10.1 Technical Memorandum - Groundwater Modeling Analysis for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project (TM-10.1).

1.2. Objective

Implementation of the proposed GSR and SFGW Projects would influence groundwater levels and storage in the Westside Groundwater Basin (Westside Basin or Basin). Depending on the magnitude of these changes to Basin groundwater conditions, various existing and planned beneficial uses of Basin groundwater could be affected. Evaluation of the potential groundwater effects is a key management issue for the long-term sustainability of the groundwater resources and overall Basin management.

The purpose of this TM is to evaluate potential changes in future groundwater levels and regional changes in groundwater storage resulting from the proposed operation of the GSR and SFGW Projects, primarily with respect to long-term water supply and groundwater management of the Westside Basin. This TM presents information on the past, current, and projected future conditions in the subsurface related to the issue of groundwater storage. The scope of work includes a discussion of Basin hydrogeology and the physical processes that could cause long-term declines in groundwater storage that may affect the existing and planned water uses in the Basin.

2. Approach and Conceptual Understanding

Presented within this section is a basic framework for understanding the natural hydrogeologic processes and anthropogenic factors that can affect groundwater levels and storage in the Westside Basin.

2.1. General Approach

The general approach used to evaluate potential changes in groundwater storage resulting from implementation of the GSR and SFGW Projects is based on an analysis of measured groundwater data and evaluation of groundwater modeling results. This combined approach is considered to be a screening-level analysis to be used for regional groundwater management, with a focus on evaluating whether or not the GSR and SFGW projects would be expected to affect the long-term capability of groundwater users to maintain groundwater pumping for existing or planned land uses.

The groundwater model allows evaluation of the complex interactions produced by the GSR and SFGW projects by simulating potential future conditions. The Westside Basin Groundwater-Flow Model, a regional, basin-wide groundwater model developed by HydroFocus (2007, 2009, and 2011) for the City of Daly City (Daly City), was reviewed with assistance from California Water Service Company (Cal Water), the City of San Bruno (San Bruno), and SFPUC, and the model was accepted for use in selected applications by all parties as capable of supporting water resources planning and management in the Westside Basin. For this evaluation, five model scenarios were constructed and simulated to evaluate potential groundwater and related hydrological effects from the GSR and SFGW Projects and from the Cumulative Scenario that involves the GSR and SFGW Projects and other reasonable foreseeable future projects. The development of the model scenarios is documented in TM-10.1.

For this evaluation, existing data and reports were reviewed and summarized to provide a discussion of how the Basin has responded to historical pumping and other hydrogeologic conditions. Evaluating historical conditions (based on an analysis of measured data) provides a context against which to assess the groundwater modeling results.

2.2. Westside Groundwater Basin

This section provides a brief overview of the physical setting and hydrogeology of the Westside Basin More detailed descriptions of the evaluations of the hydrogeology of the Westside Basin are presented LSCE (2010) and TM10.1. Figure 10.4-2 provides a representative cross section from north to south across the Westside Basin. There are three aquifer systems that are commonly referred to in the Westside Basin. These include:

- Shallow Aquifer: this aquifer is present in the northern part of the Basin, in the vicinity of Lake Merced and the southern portion of the Sunset district of San Francisco. The base of the Shallow Aquifer is defined as the top of the “-100 foot clay.”

- Primary Production Aquifer: this aquifer is present throughout the Basin, overlying the “W-clay” where present. Where the W-clay is not present in locations to the south (in the South San Francisco area), the Primary Production Aquifer is divided into shallow and deep units separated by a clay unit at an elevation of approximately -300 feet mean sea level (msl).
- Deep Aquifer: this aquifer underlies the W-clay, and thus its extent is limited to the generally-known extent of that clay unit (LSCE, 2010).

The three aquifer systems are separated by thick, extensive clay units (e.g., the -100 ft clay and W-clay). Because of the discontinuous nature of these clay layers, the basin is considered to be a semi-confined aquifer system where limited flow occurs between the different aquifer systems where local geologic conditions permit (LSCE, 2010).

2.3. Existing Groundwater Monitoring and Reporting Activities

Over the last decades, there has been a substantial increase in data collection efforts and cooperative management of groundwater resources in the Westside Basin among the SFPUC, the City of San Bruno, the City of Daly City, and California Water Service Company (Cal Water, municipal water purveyor to South San Francisco). Annual monitoring reports have been published by the SFPUC since 2006 (LSCE, 2006 and SFPUC, 2007, 2008 and 2009) and summarized in (LSCE (2010) and TM10.1.

2.4. Conceptual Understanding of Groundwater Levels and Storage

Groundwater levels and storage within a basin are affected by changes in the water balance for that basin. A water balance is an accounting of the amount of groundwater entering (inflow) and leaving (outflow) the groundwater basin. Simply stated, based on the law of conservation of mass, a water balance for a groundwater system is expressed as:

Change in Groundwater Storage = Total Groundwater Inflow – Total Groundwater Outflow

Typical inflow components to a groundwater basin include precipitation, groundwater (subsurface) inflow, and return flow from irrigation. Common outflow components include groundwater (subsurface) outflow and pumping. Interactions between the aquifer and lakes, bays and oceans (groundwater-surface water interactions) can either be groundwater inflow or outflows depending upon the relative difference in head between the groundwater and the surface water body. As indicated by the above expression, the difference between total groundwater inflow and total groundwater outflow results in a change to the volume of groundwater stored in the basin, referred to as “groundwater storage” (Fetter, 1988). Changes in groundwater storage are manifested as changes in groundwater levels measured in wells; net positive changes in groundwater storage result in increased water levels, and net negative changes result in lowered water levels.

3. Groundwater Model Analysis

To evaluate groundwater conditions that may result from the operation of the GSR and SFGW Projects, a series of model scenarios was developed using the Westside Basin Groundwater-Flow Model (HydroFocus 2007, 2009, and 2011). The development of the model assumptions and scenarios is documented in TM-10.1. This section provides an evaluation of model-predicted changes in groundwater levels and storage related to implementation of the GSR and SFGW Projects based on the model scenarios.

3.1. Modeling Scenarios

Five model scenarios were constructed and simulated to evaluate potential groundwater and related hydrological effects from the GSR and SFGW Projects and from the Cumulative Scenario that involves the GSR and SFGW Projects and other reasonably foreseeable future projects. The following is a summary of the five scenarios used for the groundwater model analysis:

1. Scenario 1, Existing Conditions: Scenario 1 Existing Conditions, does not include the SFPUC Projects (either the GSR or SFGW Project). Groundwater pumping by the PAs and irrigation pumping are representative of the existing pumping conditions (as of June 2009). As described in TM10.1, the PA pumping was established based on the historical pumping rates, using the median of the 1959-2009 pumping data for individual agencies.
2. Scenario 2, GSR Project Only: Scenario 2 represents implementation of the GSR Project operations including: “Put” periods represent when groundwater pumping by SFPUC and the PAs does not occur and groundwater is placed into the SFPUC Storage Account through in-lieu recharge; “Hold” periods represent when the PAs are pumping and no in-lieu recharge is occurring because the SFPUC Storage Account is full; and “Take” periods represent when both SFPUC and the PAs are pumping from the South Westside Basin.
3. Scenario 3a, SFGW Project Only (3 mgd): For Scenario 3a, the four new wells constructed for the SFGW Project would pump at an annual average rate of 3.0 mgd; however, the two existing irrigation wells in Golden Gate Park would remain irrigation wells, and their irrigation pumping rates would be the same as in Scenario 1.
4. Scenario 3b, SFGW Project Only (4 mgd): For Scenario 3b, the four new wells constructed for the SFGW Project and the two modified irrigation wells in Golden Gate Park would pump at an annual average rate of 4.0 mgd. Irrigation in Golden Gate Park is assumed to be replaced by the Westside Recycled Water Project. Total combined pumping for Scenario 3b is slightly less than under Scenario 3a, because the total SFGW Project pumping in Scenario 3b would increase by 1.0 mgd; however, the irrigation pumping that was replaced would be slightly more than 1.0 mgd.
5. Scenario 4, Cumulative Scenario: Scenario 4 represents implementation of both the GSR and SFGW Projects (Scenarios 2 and 3b) along with other reasonably foreseeable

future projects. The other foreseeable projects are discussed in more detail in TM10-1 but primarily include the Daly City Vista Grande Drainage Area Improvements Project, which increases stormwater diversions into Lake Merced, the Daly City A-Street Replacement Well which shifts some of the Daly City pumping outside the South Westside Basin, and a minor increase in irrigation pumping based on the planned build-out of the Holy Cross cemetery.

As discussed in TM-10.1, the strongest predictive ability of the existing model is in relative changes over time, rather than the simulated groundwater levels. Therefore, it is more appropriate to analyze the results of the groundwater model using differences in water levels relative to a base case rather than simulated groundwater elevations. Scenario 1, the Existing Conditions scenario, forms the base case against which the results of the GSR-only, SFGW-only, and Cumulative Scenarios are compared.

To allow for the model scenarios to be directly comparable, all five model scenarios are set up using similar initial conditions and background hydrology. All of the modeled scenarios have the same projected simulation period of 47.25 years and use initial groundwater conditions that represent June 2009 conditions. All five model scenarios use the same hydrologic sequence, which includes an 8.5-year Design Drought period used in the Program Environmental Impact Report (PEIR; SFPUC, 2007; SFPUC, 2009a). The Design Drought repeats the December 1975 to March 1978 drought period following the dry conditions of July 1987 to November 1992. To incorporate the Design Drought, the historical hydrological sequence was rearranged. A more detailed discussion of the development of the background hydrology is presented in TM-10.1.

The GSR-Only Scenario and the Cumulative Scenario (Scenarios 2 and 4) involve the SFPUC Storage Account. The SFPUC Storage Account is a bookkeeping method that tracks the volume of groundwater stored in the Basin from in-lieu recharge during put periods minus the amount of groundwater pumped from the SFPUC Storage Account during take periods. As part of the initial conditions, the accrued volume in the SFPUC Storage Account at the start of the model scenarios is approximately 20,000 acre-feet (af) based on records of in-lieu exchange with the Partner Agencies prior to July 2009. During the Design Drought, the SFPUC Storage Account is taken from a full condition of 60,500 af to an empty condition of no in-lieu storage available at the end of the Design Drought. During a recovery period following the Design Drought, the scenarios include a 3-year put period that adds 20,000 af to the SFPUC Storage Account. Using this condition, the SFPUC Storage Account begins and ends with 20,000 af for both Scenarios 2 and 4. This allows for a more direct comparison in evaluating the long-term changes in groundwater levels and storage without having to factor in differences in the amount of in-lieu storage.

Table 10.4-1 presents a summary of the estimated Basin-wide average pumping rates corresponding to each of the model scenarios. Note that in addition to the anticipated GSR and SFGW Project wells, average pumping rates are also provided for the PA wells and for irrigation wells in Golden Gate Park.

3.2. Evaluation of Model-Predicted Changes in Groundwater Levels

The groundwater model simulates monthly changes in groundwater levels throughout the Westside Basin for each model scenario. The following discussion summarizes the model results for changes in groundwater elevations.

3.2.1. Methodology

The evaluation of groundwater levels proceeds with groups of wells or other analyzed locations from north to south through the Westside Basin. The analyzed locations begin in the North Westside Basin with well locations in the Golden Gate Park and Lake Merced subarea, and end in the South Westside Basin with locations in the San Bruno subarea (Figure 10.4-1). Progressing with the analysis in this manner helps to emphasize the relative geographic extent that each of the evaluated Project Scenarios (SFGW-Only, GSR-Only, and Cumulative) is expected to have on Basin groundwater conditions.

To facilitate this analysis, model-predicted groundwater levels corresponding to Model Layers 1 and 4 were evaluated. Model Layer 1 results provide information related to expected changes in the Shallow Aquifer, whereas Model Layer 4 results give an indication of groundwater level changes anticipated in the heavily-pumped Primary Production Aquifer. For each location analyzed within the Westside Basin, hydrographs are presented on Figures 10.4-3 through 10.4-13. Figure numbers that end in “a” (e.g., Figure 10.4-4a) pertain to Model Layer 1 results, whereas figure numbers that end in “b” (e.g., Figure 10.4-3b) show Model Layer 4 output. The following locations were selected to evaluate model-predicted changes in groundwater levels corresponding to each scenario:

- SWM-GS (Figure 10.4-3)
- Ortega MW (Figure 10.4-4)
- Santiago-S MW (Figure 10.4-5)
- LMMW-4S (Figure 10.4-6)
- Harding Park MW (Figure 10.4-7)
- Olympic MW (Figure 10.4-8)
- DC-3 (Figure 10.4-9)
- DC-A-St (Figure 10.4-10)
- Cypress Lawn 2 (Figure 10.4-11)
- SSF-02 (Figure 10.4-12)
- SB-12 (Figure 10.4-13)

On each figure, the upper hydrograph shows model-simulated groundwater elevation in feet (NGVD 1929), while the lower pane shows the relative difference between the groundwater levels of each Project Scenario and those of Scenario 1. Positive differences indicate that the Project Scenario has a higher groundwater elevation relative to Scenario 1, while negative results indicate that the Project Scenario has a lower groundwater elevation relative to Scenario 1. The groundwater elevation differences are normalized for fluctuations in the Existing Conditions Scenario, and so provide an evaluation of the direct effect on groundwater levels due to the GSR, SFGW and Cumulative scenarios.

3.2.2. North Westside Basin Area (Golden Gate Park to South Lake Merced)

The North Westside Basin extends from Golden Gate Park to Lake Merced (Figure 10.4-1). The locations evaluated in the North Westside Basin include SWM-GS, Ortega MW, Santiago-S MW, LMMW-4S, Harding Park MW, and Olympic-MW. Hydrographs corresponding to these well locations are presented as Figures 10.4-3 through 10.4-8.

Scenario 1 represents groundwater elevation results without either the GSR or SFGW Projects, and defines the background conditions including wet, normal and dry precipitation years. In the North Westside Basin, these climatic variations are clearly shown on the hydrograph, but the variations are more pronounced in Model Layer 1 than in Model Layer 4. After a sharp increase in groundwater levels representing a period of above average precipitation during Scenario Years 1 to 4, the groundwater levels fluctuate within a narrow range in response to climatic conditions. As discussed in TM-10.1, the hydrologic sequence used for all scenarios includes a Design Drought with below normal precipitation from Scenario Years 36 to 44.

In the northern locations (SWM-GS, Ortega MW, and Santiago-S MW; Figures 10.4-3 through 10.4-5) groundwater levels at the end of the 47.25-year Scenario return to approximately the same levels as at the beginning of the Scenario. Groundwater levels show seasonal variations due to irrigation pumping that are more pronounced in Model Layer 1 than in Model Layer 4. The locations near Lake Merced (LMMW-4S, Harding Park MW and Olympic-MW; Figures 10.4-6 through 10.4-8) show fairly distinct responses in Model Layer 1 versus Model Layer 4; in Model Layer 1, the groundwater level trends are similar to those at the more northern locations, showing strong responses to climatic conditions, whereas variations in groundwater levels in Model Layer 4 are more subdued. This is due to the presence of the -100 foot clay in the Lake Merced vicinity, greater depth to Model Layer 4, and the influence of groundwater conditions in the South Westside Basin on these locations. The difference in groundwater elevations between Model Layers 1 and 4 is smallest in the north (near Golden Gate Park) and greatest in the south (near Lake Merced).

Scenario 2 represents the operation of the GSR Project, which is located in the South Westside Basin. The model results show that all the North Westside Basin locations have at least some response to GSR Project operation. From the beginning of the Scenario to the start of the Design Drought, groundwater levels are higher than under Scenario 1. During the Design Drought, groundwater levels drop below Scenario 1 for the more southerly locations, showing the effects of increased pumping during this period. The recovery period following the Design Drought shows that groundwater levels recover to near-Scenario 1 levels after 3 years of in-lieu recharge.

Results for Scenario 2 for the northern locations in Golden Gate Park and north of Lake Merced (SWM-GS, Ortega MW, and Santiago-S MW; Figures 10.4-3 through 10.4-5) show little change relative to Scenario 1. For example, at the Ortega MW location (Figure 10.4-4), groundwater levels are generally about 0.5 to 1.0 foot higher relative to Scenario 1, but drop to less than 0.5 foot below Scenario 1 at the end of the Design Drought. The subdued response of groundwater conditions in these more northerly locations is expected because of the distance to the GSR and PA wells in the South Westside Basin.

The locations near Lake Merced (LMMW-4S, Harding Park MW and Olympic-MW; Figures 10.4-6 through 10.4-8) show more pronounced effects from the GSR Project. Overall, groundwater levels are generally higher relative to Scenario 1 throughout the Scenario in both Model Layers 1 and 4. This is due to the general decrease in pumping in the South Westside Basin and the effects of in-lieu recharge. Groundwater levels near Lake Merced are generally 5 to 10 feet higher relative to Scenario 1; however, groundwater levels in Model Layer 4 at the Olympic-MW location are about 10 to 30 feet higher relative to Scenario 1 until the start of the Design Drought.

The effects of pumping during the take periods are more pronounced in the southern part of the North Westside Basin than the northern part, and are also more pronounced in Model Layer 4 than in Model Layer 1. At the Olympic-MW location, the three take periods have more of an effect on water levels than further north. In general, groundwater levels in both Model Layers 1 and 4 remain higher than under Scenario 1 until the Design Drought, when both the SFPUC and PA wells are pumping. The lowest groundwater levels occur at the conclusion of the Design Drought.

The 3 years from the end of the Design Drought to the end of the scenario are put years. At the end of this period, groundwater levels have recovered to within 1 to 5 feet of those of Scenario 1 in all of the North Westside Basin locations for both Model Layers 1 and 4.

Scenarios 3a and 3b simulate the operation of the SFGW Project, which is located in the North Westside Basin. Scenario 3a assumes 1.142 mgd of irrigation pumping in Golden Gate Park and 3.0 mgd of project pumping for water supply throughout the North Westside Basin, whereas Scenario 3b assumes 4.0 mgd of project pumping for water supply, and that pumping of groundwater for irrigation in Golden Gate Park is replaced by recycled water. In total, Scenario 3b assumes 0.142 mgd less total pumping than Scenario 3a. Pumping is redistributed among the SFGW Project wells so that there is a 0.072 mgd decrease in pumping in the Golden Gate Park area. Because this overall change in pumping is minor, the regional response of groundwater levels to these scenarios is comparable; therefore, the results for Scenarios 3a and 3b will be discussed together.

In general, all locations evaluated in the North Westside Basin area show a similar declining trend relative to Scenario 1 for groundwater levels due to the SFGW Project operations. There is an initial decrease in groundwater levels relative to Scenario 1 in the first 5 to 10 years of the scenario, followed by a leveling out over the rest of the simulation period. In the northern locations, the rate of change relative to Scenario 1 after about Scenario Year 20 is near zero, whereas the locations near Lake Merced show a steady decline in groundwater levels relative to Scenario 1, but at a rate much less than the initial decline.

In the northern locations (SWM-GS, Ortega MW, and Santiago-S MW; Figures 10.4-3 through 10.4-5), groundwater levels decline by about 5 to 10 feet within the first 10 years of Scenarios 3a and 3b. After this initial decline, groundwater level declines relative to Scenario 1 are greatly reduced to near stable for the remainder of the Scenarios, including the period of the Design Drought. In these northern locations, the change in groundwater levels relative to Scenario 1 is similar for both Model Layers 1 and 4.

The locations near Lake Merced (LMMW-4S, Harding Park MW and Olympic-MW; Figures 10.4-6 through 10.4-8) show a slower rate of decline in the first 10 to 15 years than observed further north, but the decline relative to Scenario 1 continues at a reduced rate throughout the scenario instead of leveling off. The largest groundwater level declines occur in Model Layer 4 at the Harding Park MW and Olympic-MW locations, with a maximum decline of approximately 30 feet relative to the Scenario 1 by the end of the simulation period (Figures 10.4-7 and 10.4-8).

Scenario 4 represents the combined effects of the GSR (Scenario 2) and SFGW (Scenario 3b) Projects. As such, the resulting groundwater level responses in the North Westside Basin tend to be intermediate between the responses seen for Scenarios 2 and 3b. Groundwater levels are more similar to Scenario 3b in Golden Gate Park and north of Lake Merced, and more similar to Scenario 2 near and south of Lake Merced. Scenario 4 also includes additional water being diverted into Lake Merced; however, the response in groundwater levels to these changes to Lake Merced is not clearly recognizable, being overshadowed by the pumping changes in Scenario 2.

In the northern locations (SWM-GS, Ortega MW, and Santiago-S MW; Figures 10.4-3 through 10.4-5), groundwater levels follow a similar trend to those of Scenario 3b. This is expected because Scenario 2 has little effect on groundwater levels in this area. Groundwater levels for Scenario 4 are generally 0 to 5 feet higher than those for Scenario 3b, but still 5 to 10 feet below those of Scenario 1. The responses are similar in Model Layers 1 and 4.

The locations near Lake Merced (LMMW-4S, Harding Park MW and Olympic-MW; Figures 10.4-6 through 10.4-8) show trends similar to Scenario 2, but with groundwater levels about 10 to 20 feet lower than under Scenario 2, and 10 to 20 feet higher than under Scenario 3b. Relative to Scenario 1, groundwater levels are similar in Model Layer 1, but about 10 to 20 feet lower in Model Layer 4. As with the Scenario 3b results, the greatest projected water level declines were observed in Model Layer 4 at the Olympic MW location (Figure 10.4-8b). Figures 10.4-6 and 10.4-7 also show that the LMMW-4S and Harding Park locations appear to be equally affected by the operation of the proposed GSR and SFGW Projects. The effects of the additional water being diverted into Lake Merced should be most apparent in these wells in Model Layer 1; however, no clearly recognizable response is seen. It may be that the scale of the effects from the changes to Lake Merced is small and results in only minor variations. Alternatively, it is possible that the interaction of the GSR project (which generally raises water levels in the Lake Merced area) and the SFGW project (which generally lowers water levels) in Scenario 4 partially obscures the effect of the Lake Merced diversions upon groundwater levels.

3.2.3. South Westside Basin Area (Daly City to San Bruno)

The South Westside Basin area extends from Daly City in the north to San Bruno in the south. Locations evaluated in this area include DC-3, DC-A-St, Cypress Lawn No. 02, SSF-02, and SB-12. Hydrographs corresponding to these locations are presented in Figures 10.4-9 through 10.4-13. As discussed previously, historic groundwater pumping in the South Westside Basin has resulted in sustained declines in groundwater levels in the area.

Scenario 1 represents the change in groundwater elevations without either the GSR or SFGW Project and defines the background conditions, including wet, normal and dry precipitation years. In considering these results it should be recalled that the initial conditions include 20,000 af of storage in the SFPUC Storage Account and that the first seven years of the simulation correspond to a very wet period. These factors may contribute to high groundwater levels early in the simulation, with lower levels occurring later under the corresponding average and dry precipitation years.

- For the Daly City locations (DC-3 and DC-A-St; Figures 10.4-9 and 10.4-10), groundwater levels in both Model Layers 1 and 4 show a similar trend of steady decline from the initial conditions of about 40 feet over the 47-year Scenario. Groundwater elevations in Model Layer 1 and 4 are within 10 to 20 feet of each other.
- For the Colma and South San Francisco locations (Cypress Lawn No. 02 and SSF-02; Figures 10.4-11 and 10.4-12), groundwater levels in Model Layers 1 and 4 decline from the initial conditions steadily over the 47-year scenario, by about 10 to 30 feet in Model Layer 1 and 40 to 50 feet in Model Layer 4. Groundwater levels in Model Layer 1 are about 80 to 170 feet higher than those in Model Layer 4.
- In the San Bruno area (SB-12; Figure 10.4-13), groundwater levels in Model Layer 1 show an increasing trend from the initial conditions with a total rise of about 20 feet over the 47-year simulation period, whereas groundwater levels in Model Layer 4 show a decreasing trend from the initial conditions with a total decline of about 50 feet. The difference in groundwater levels between Model Layers 1 and 4 is about 200 to 250 feet.

Climatic variations are subdued on the hydrographs for Model Layer 4, Scenario 1. This is because groundwater levels are relatively deep in the South Westside Basin and tend to be less responsive to annual variations in recharge.

Scenario 2 represents the operation of the GSR Project, which is located in the South Westside Basin. Overall, all South Westside Basin locations show a distinct groundwater level response to the GSR Project. Groundwater levels increase during put periods and decrease during take periods. The greatest increase in groundwater level occurs after the first extended put period from Scenario Years 1 to 7, then groundwater levels slowly decline. Two take periods (from Scenarios Year 9 to 12 and Scenarios Year 25 to 28) show distinct declines in groundwater levels; however, levels recover to near their pre-take-period levels after the subsequent put periods. All locations evaluated in the South Westside Basin area have their lowest groundwater levels just after the Design Drought. During the Design Drought, pumping occurs from both the PA and SFPUC wells; the greatest declines in groundwater levels during the Design Drought correspond to well locations in the Daly City and Colma areas, because most of the GSR Project extraction wells would be located in this area.

After the end of the 8.5-year Design Drought, the South Westside Basin locations show a rise in groundwater levels because the three years from the end of the Design Drought to the end of the Scenario are put years. In Model Layer 4 representing the Primary Production Aquifer, groundwater levels recover 70 to 100 feet from the end of the Design Drought. At this time, the SFPUC Storage Account is at about 20,000 af which is about one-third of the SFPUC Full Storage Account at 60,500 af. Groundwater levels are generally about 20 to 40 feet below the levels for Scenario 1 at the end of the Scenario 2.

For the Daly City locations (DC-3 and DC-A-St; Figures 10.4-9 and 10.4-10), groundwater levels remain above Scenario 1 levels throughout Scenario 2, including two take periods, until the Design Drought. During the Design Drought, groundwater levels drop below Scenario 1 levels by about 40 feet in Model Layer 1 and from 70 to 100 feet in Model Layer 4. After the Design Drought, groundwater levels recover to about 20 to 50 feet in Model Layer 1 and are 2 to 20 feet below Scenario 1 levels at the end of the simulation. For Model Layer 4, groundwater levels recover about 70 to 80 feet and range from 10 feet above to 20 feet below Scenario 1 levels at the end of the simulation period.

For the Colma and South San Francisco locations (Cypress Lawn No. 02 and SSF-02; Figures 10.4-11 and 10.4-12), groundwater levels show a similar pattern to those of the Daly City area. In Model Layer 1, the responses to put and take periods are more subdued, and groundwater levels are about 10 to 15 feet higher than under Scenario 1. During the Design Drought, groundwater levels are from 0 to 20 feet below those of Scenario 1. Groundwater levels in Model Layer 4 respond more strongly to the put/take/hold pattern, but groundwater levels are lower than observed in Daly City. Groundwater levels drop below Scenario 1 during the first two take periods. At the start of the Design Drought, groundwater levels are near those of Scenario 1 and decline by 120 to 140 feet by the end of the Design Drought. During the three year put period at the end of the scenario, groundwater levels recover to 25 to 50 feet below Scenario 1 levels.

In the San Bruno area (SB-12; Figure 10.4-13), groundwater levels in Model Layer 1 show an increasing trend that does not reflect the pattern of put and take periods, with groundwater levels about 5 to 10 feet higher than under Scenario 1. Rising groundwater levels for Model Layer 1 at this location were also experienced in the HydroFocus 2008 No-Project Scenario and are discussed by HydroFocus (2011). Model Layer 4 shows a similar pattern to the Colma and South San Francisco locations, with similar magnitudes.

<u>Scenarios 3a and 3b</u> represent the operation of the SFGW Project, which is located in the North Westside Basin. Therefore, groundwater level changes in the South Westside Basin show little

to no change relative to Scenario 1 in either Model Layer 1 or 4. The effects of the SFGW Project are greatest in the Daly City area and diminish southward. The maximum groundwater level decline relative to Scenario 1 for Scenarios 3a and 3b is approximately 20 feet in Model Layer 4 at the Daly City locations (Figures 10.4-9b and 10.4-10b), whereas in Model Layer 4 at SB-12, in the San Bruno area, there is a barely discernible decline in predicted groundwater levels (Figure 10.4-13b).

Scenario 4 represents the combined effects of pumping in the SFGW and GSR Project wells, and also other reasonably foreseeable future projects. Groundwater levels for Scenario 4 in the South Westside Basin generally match the results for Scenario 2. Although Scenario 4 includes simulated pumping stresses for both the SFGW and GSR Project production wells, the general patterns of groundwater level responses more closely approximate the levels for Scenario 2 due to the proximity of GSR Project wells.

In the Daly City area (Figures 10.4-9 and 10.4-10), groundwater levels in Model Layer 1 closely follow the same trends as observed in Model Layer 4, but are generally about 20 to 40 feet higher. In both Model Layers 1 and 4, groundwater levels for Scenario 4 are generally 1 to 15 feet higher compared to Scenario 2 levels. Since both Scenario 2 and Scenario 4 use the same GSR Project pumping assumptions, the differences are attributed to the other reasonably foreseeable future projects applied in the Cumulative Scenario. Since locations nearer to Lake Merced, such as the Olympic MW location (Figure 10.4-10) on the south side of Lake Merced show Scenario 2 groundwater levels higher relative to Scenario 4, the observed condition in Daly City cannot be attributed to water additions at Lake Merced. Instead, the higher Scenario 4 groundwater levels demonstrate the local effects of the Daly City A-Street Replacement Well. For Scenario 4, the pumping from the Daly City A-Street Well is shifted to the proposed Daly City A-Street Replacement Well, which is located on the west side of the Serra Fault (Figure 10.4-1). This change in location has a substantial effect because about 17 percent of the Daly City groundwater production would be shifted from the main basin to a location east of the Serra Fault. The conceptual understanding is that the Serra Fault is a barrier to groundwater flow; therefore, the change in the pumping location has the net effect of reducing pumping in the main basin east of the Serra Fault by about 475 afy. The result is that Scenario 4 groundwater levels in the Daly City area are higher than Scenario 2 groundwater levels because there is a decrease in pumping in the Daly City area relative to Scenario 2.

South of Daly City, groundwater levels for Scenario 4 are nearly identical to groundwater levels for Scenario 2. In the Colma, South San Francisco and San Bruno areas, the effect of SFGW Project pumping is generally diminished, as is the effects of the proposed Daly City A-Street Replacement Well described above. As with Scenario 2, the effects from the GSR Project pumping are seen primarily in Model Layer 4 with limited effects from GSR Project pumping on groundwater levels in Model Layer 1.

For Scenario 4, the lowest simulated groundwater levels correspond to take periods, with substantial recovery of levels during put periods. For Scenario 4, the greatest predicted declines in groundwater levels occur during the Design Drought at locations in the Daly City and Colma areas, with groundwater levels in Model Layer 4 ranging from approximately 60 to 135 feet below those of Scenario 1 (Figures 10.4-9b through 10.4-13b). During the three-year put period following the Design Drought, groundwater levels in Model Layer 4 recover 60 to 100 feet. At the end of the simulation, groundwater levels in Model Layer 4 range from about 10 feet higher to 50 feet lower relative to Scenario 1 levels in the South Westside Basin.

3.3. Evaluation of Model-Simulated Changes in Groundwater Storage

The groundwater model provides a mechanism to evaluate the changes in groundwater storage predicted for each scenario. The net difference between inflows (e.g. recharge) and outflows (e.g. pumping) in a groundwater system (water balance) results in a change in groundwater storage, which in turn results in a corresponding change in groundwater levels (Section 2.4).

3.3.1. Methodology

For the Basin-wide storage evaluation, the groundwater model was used to determine the changes in groundwater storage for both the whole Basin and for specific subareas for each model scenario, and these results were compared to the storage changes computed for Scenario 1. Based on the model scenario results, volumetric water budget graphs and tables were prepared for the entire simulation period. The water budget includes the major components of inflows to and outflows from the Westside Basin. This water budget analysis was conducted at three different regional scales listed below, with results for each scale for each scenario :

- Westside Basin (Figures 10.4-14 and 10.4-15, and Tables 10.4-2 through 10.4-6).
- Comparison of the SFPUC Storage Account to Scenario 2 aquifer storage (Figure 10.4-16).
- North and South Westside Basins (Figures 10.4-17 through 10.4-20).
- Five subareas that are collectively referred to by HydroFocus (2009 and 2011) as “Developed Subbasin” (Figures 10.4-21 through 10.4-24 and Table 10.4-7).

Separate water balances were established for each of the five model scenarios, and are presented in Attachment C for TM-10.1. Table 10.4-2 presents the annual water balance for the entire Westside Basin for Scenario 1. Tables 10.4-3 through 10.4-6 present the annual water balance for the entire Westside Groundwater Basin for Scenarios 2, 3a, 3b, and 4 relative to Scenario 1. Figure 10.4-14 plots model-simulated total changes in groundwater storage for the entire Westside Basin for all evaluated scenarios, and Figure 10.4-15 shows the simulated storage change for each scenario relative to Scenario 1.

Figure 10.4-16 provides a graphical comparison of the volume of water in the SFPUC Storage Account to the aquifer storage calculated by MODFLOW model for the GSR Project Scenario (Scenario 2) relative to Scenario 1.

Figures 10.4-17 through 10.4-20 present a graphical comparison of water balance components for Scenarios 2, 3a, 3b, and 4 relative to Scenario 1 to demonstrate where the water for the

GSR and SFGW Project pumping is sourced. Graphs are based on the data presented in Attachment 10.1-D in TM-10.1. Since the GSR Project is located in the South Westside Basin and the SFGW Project is located in the North Westside Basin, these graphs are provided to illustrate the relative effects on the North and South Westside Basins from the Project conditions applied for each scenario.

Similar to the approach taken by HydroFocus (2009 and 2011), a water budget was developed for five water budget zones that are collectively referred to as the Developed Subbasin: Lake Merced/Golden Gate Park, Daly City, Colma, Cal Water, and San Bruno. The water balance components were calculated using the U.S. Geological Survey post-processor ZONEBUDGET (Harbaugh, 1990). Table 10.4-7 contains summary tables of the water budgets developed for each of the five model subareas. Results for the five model subareas (both simulated and relative to Scenario 1) are also presented on Figures 10.4-21 through 10.4-24 for the Project Scenarios (Scenarios 2, 3a, 3b, and 4).

The evaluation of Basin-wide changes in groundwater storage provides an overall analysis of the effects related to the various scenarios.

3.3.2. Scenario 1 - Existing Conditions

Scenario 1 represents the change in groundwater elevations without either the GSR or SFGW Projects and defines the background conditions, including wet, normal and dry precipitation years. Groundwater storage for Scenario 1 shows an initial increase in Scenario Years 1 and 2, but that is followed by a general decline over the scenario period except for periods of increase during Scenario Years 21 to 23 and Years 30 to 35. There is a substantial decline during the Design Drought period, followed by an increase in Scenario Years 44 to 47. By the end of Scenario 1, groundwater storage has declined approximately 28,000 af for the entire Westside Basin (Figure 10.4-14).

The 28,000-af decline in groundwater storage in Scenario 1 is due to the assumptions used for the background hydrology as necessitated by the inclusion of the Design Drought for consistency with the PEIR. The Design Drought repeats the 1976-77 drought. The result of repeating the drought is that there is an overall rainfall deficit over the 47-year scenario of nearly 20 inches compared to the 1958-2005 year sequence used in the HydroFocus 2008 No-Project Scenario (HydroFocus, 2011). Over the duration of the HydroFocus 2008 No-Project Scenario there is little to no change in groundwater storage. Recharge from precipitation and irrigation return flow (also dependent on rainfall) is calculated by the Soil Moisture Budget procedure discussed in TM-10.1 and documented in HydroFocus (2007, 2009, and 2011). Comparing the recharge calculated by the Soil Moisture Budget for the SFPUC scenarios with the HydroFocus 2008 No-Project Scenario shows that the 28,000-af decline in groundwater storage in Scenario 1 can be accounted for by the difference in rainfall between the different sets of background hydrology assumptions used. Therefore, the background hydrologic assumptions used in Scenario 1 provide a conservative analysis of the potential changes in groundwater storage. In evaluating groundwater storage, the results will primarily be discussed in terms of relative differences from Scenario 1 (Figure 10.4-15).

3.3.3. Scenario 2 - GSR Project

Scenario 2 represents the operation of the GSR Project, which is located in the South Westside Basin. The key components of the GSR Project are: in-lieu recharge during the put periods when groundwater pumping by SFPUC and the PAs does not occur and groundwater is placed into the SFPUC Storage Account using in-lieu recharge; hold periods when the PAs are pumping and no in-lieu recharge is occurring because the SFPUC Storage Account is full; and take periods which represent periods when both SFPUC and the PAs are pumping from the South Westside Basin. Scenario 2 starts with June 2009 initial groundwater levels that includes 20,000 af already in the SFPUC Storage Account from activities between 2002 and 2009 (LSCE, 2005). .

Scenario 2 begins with a 6.5-year put period that is reflected by an increased groundwater storage of 36,000 af across the whole Basin (not the SFPUC Storage Account) relative to Scenario 1 (Figure 10.4-15). From Scenario Years 7 through 36, there is a general decline in groundwater storage that is interrupted by sharp decreases during the two take periods followed by an equally sharp increase during the put period that returns the groundwater storage to the general declining trend relative to Scenario 1 (Figure 10.4-15). The Design Drought is an extended take period when the entire SPPUC Storage Account of 60,500 af is depleted. Over the duration of the Design Drought, there is an approximately 60,000-af decline in groundwater storage relative to Scenario 1. Following the Design Drought, about 20,000 af of in-lieu recharge is added to the Basin during the subsequent put period, and that is reflected by the 20,000-af increase in groundwater storage in the Basin.

Figure 10.4-15 shows that by the end of the simulation period the model-predicted aggregate reduction in groundwater storage is approximately 20,000 af. This means that at the conclusion of Scenario 2 there is predicted to be approximately 20,000 af less groundwater in storage in the entire Westside Basin than if the GSR Project were not implemented. However, as shown on Figure 10.4-15, Scenario 2 has a surplus of Basin groundwater storage relative to Existing Conditions is anticipated to exist for most of the entire simulation duration. Groundwater storage in the Basin is projected to decline, but still remains above Existing Condition storage levels, in response to the simulated take period around Scenario Year 11 and 27. This is due to increased pumping by GSR production wells during those drought periods, when available surface water supplies would be curtailed. However, it is not until sometime after the start of the Design Drought that Basin-wide groundwater storage is predicted to fall below that under the Existing Conditions Scenario. A relatively rapid recovery in groundwater storage volume is projected after the conclusion of the Design Drought period.

Scenario 2 assumes that there is an initial condition of 20,000 af of groundwater storage in the SFPUC Storage Account at the beginning of the scenario and that the SFPUC Storage Account is returned to a value of 20,000 af as a result of the put periods following the Design Drought. Figure 10.4-16 shows the SFPUC Storage Account and MODFLOW simulated aquifer storage on separate axes to illustrate that the SFPUC Storage Account is tracked separately. The total change in storage over the whole Basin does not represent any surpluses or deficits in the SFPUC Storage Account. Therefore, the groundwater storage deficit of 20,000 af relative to

Scenario 1 at the end of Scenario 2 indicates that the storage efficiency of the whole Basin is less than 100 percent. Averaged over the 47-year simulation period, the average annual loss is 425 afy.

Decline in groundwater storage primarily takes place when the groundwater storage is higher relative to Scenario 1. For example, during the 6.5-year put period at the beginning of the scenario, approximately 40,500 af of in-lieu recharge is added to the Basin; however, the increase in storage in the entire Basin relative to Scenario 1 is only 36,000 af (Figure 10.4-16). This indicates that about 4,500 af of storage is lost during the extended put period. During the following 30-year period, the SFPUC Storage Account is typically at 60,500 af with two short put-take cycles during this time. At the beginning of the Design Drought period, 40,500 af of the net additions of groundwater have been added to the basin through the GSR Project as represented by the SFPUC Storage Account (Figure 10.4-16). However, the MODFLOW model results show a steady decline in aquifer storage such that aquifer storage at the beginning of the Design Drought is only 20,000 af higher relative to Scenario 1.

Conversely, during the Design Drought and the following recovery period, the changes in groundwater storage more closely match the additions and subtractions under the operations of the GSR Project (Figure 10.4-16). Therefore, higher aquifer storage losses occur during periods when groundwater storage is higher relative to Scenario 1 and less aquifer storage losses occur when groundwater storage is lower relative to Scenario 1.

Therefore, a one to one ratio of supplemental surface water deliveries to the PAs does not result in an equal amount of simulated aquifer storage accrual via in-lieu recharge during put periods. During hold periods, when aquifer storage is above recent historic levels, some amount of aquifer storage loss occurs which is not accounted for in the SFPUC Storage Account.

The “efficiency” of the GSR Project is defined as the relative difference between the SFPUC Storage Account and the change in aquifer storage for Scenario 2 relative to Scenario 1. Based on this analysis, the efficiency of the GSR Project with respect to overall groundwater storage varies depending upon Basin conditions. During the initial filling process over the first seven years of put periods, the GSR Project is about 88 percent efficient. During the long period of primarily hold periods after this initial filling to the beginning of the Design Drought, the GSR Project has an efficiency of about 67 percent. During the Design Drought and recovery after the Design Drought, the GSR Project has nearly 100 percent efficiency. The overall average efficiency of the GSR Project over the 47.25 year simulation period is approximately 78 percent. This average efficiency is conservative because Scenario 2 includes a relatively long (30 year) period when the basin is largely full which magnifies the losses. Verification of actual losses can be conducted in the future by comparing modeled and actual groundwater elevations.

For comparison, a 2008 survey (MWH, 2009) found that loss factors used in seven conjunctive use programs in California in “ranged from 0 percent to 15 percent. These loss factors were intended to attain or maintain positive storage balances, account for evaporation/transpiration, account for operational/non-recoverable basin losses, and to minimize political concerns.” These losses factors imply an efficiency of 85 percent to 100 percent in the surveyed programs.

The GSR Project thus has a lower efficiency range of 67 percent to 100 percent (average 78 percent).

In comparing the water balance summary for Scenarios 1 and 2 for the North and South Westside Basins subareas (Figure 10.4-17 and TM10.1 Attachment 10.1-D), the changes in pumping from the GSR Project primarily result in a change in aquifer storage in the South Westside Basin and a shift in groundwater flow between the North and South Westside Basins. Other water balance components show only minor variations as result of GSR Project operations. During put periods, most of the reduced pumping (in-lieu recharge) results in an increase in aquifer storage with a minor amount resulting in a change in groundwater flow from the South to the North Westside Basin. Conversely, during take periods, most of the increased pumping is derived from a decline in aquifer storage with a minor amount resulting in a change in groundwater flow from the North to the South Westside Basin. During hold periods, there are only minor declines in aquifer storage. Overall, the changes in the North Westside Basin are minor relative to those observed in the South Westside Basin. With increasing groundwater levels, the hydraulic gradient in the North Westside Basin shifts to a more westward direction, resulting in slight increases in outflows to Lake Merced and to the Pacific Ocean.

For Scenario 2, the conservation of basin groundwater storage expected for the GSR Project is shown by positive relative storage changes for all five Developed Subbasin model subareas, but is particularly evident in the central South Westside Basin where GSR wells are concentrated (Table 10.4-7 and Figure 10.4-21). For the Daly City and San Bruno subareas, the proposed pumpage rates are smaller than under the Existing Conditions Scenario, which reflects the cessation or reduction of pumping during put periods. The largest relative storage increases, 140 and 141 afy, are shown for the Colma and Cal Water (South San Francisco) subareas, respectively, both located in the central South Westside Basin. In essence, the relative groundwater storage increases in the Colma and Cal Water subareas are provided by groundwater flow from adjacent subareas (Daly City and San Bruno, respectively). The Lake Merced/GGP subarea is shown to be relatively unaffected during GSR Project operation, except for somewhat less groundwater flow to the Daly City subarea to the south.

3.3.4. Scenario 3a and 3b - SFGW Project

Scenarios 3a and 3b represent the operation of the SFGW Project, which includes additional groundwater pumping in the North Westside Basin. The changes in groundwater storage are similar for Scenarios 3a and 3b (Figures 10.4-14 and 10.4-15). Basin-wide groundwater storage shows a steady decline over the duration of the scenario, but the rate of decline decreases over the simulation period. At the end of the simulation period, groundwater storage declines by approximately 32,000 and 30,000 af for Scenarios 3a and 3b, respectively. The slight differences in storage changes between the two scenarios are attributable primarily to the somewhat greater total Basin pumping rate in Scenario 3a (12.75 mgd) compared to Scenario 3b (12.61 mgd; Table 10.4-1).

Figures 10.4-18 and 10.4-19 show the water balance components for Scenario 3a and 3b, respectively, relative to Scenario 1 in the North Westside Basin. The results for Scenario 3a and

3b are similar so they are discussed together. Figures 10.4-18 and 10.4-19 indicate that the majority of the increased pumping would initially come from groundwater storage (i.e. loss of groundwater storage). Loss of groundwater storage is highest in the first five years of the simulation. Over the first 10 to 15 years of the simulation, annual storage loss resulting from SFGW Project pumping would continue to decline, while the interception of groundwater flow to the Pacific Ocean would continue to increase. This represents that after the initial decline in groundwater levels, groundwater pumping by the SFGW Project is primarily sustained by the interception of groundwater flow that would otherwise have discharged to the Pacific Ocean. There are little to no changes in the South Westside Basin due to the increased pumping from the SFGW Project.

For Scenarios 3a and 3b, pumping associated with SFGW Project wells located in the North Westside Basin is shown on Table 10.4-7 and Figures 10.4-22 and 10.4-23 as substantial increases in pumping rates for the Lake Merced/Golden Gate Park subarea relative to Scenario 1. Based on this subarea zone budget analysis, 76 percent of the increased groundwater pumping from the SFGW Project wells in the North Westside Basin is offset the interception of groundwater flow to the Ocean, while the decrease in storage represents only 15 percent of the increased groundwater pumping. As expected, the effects of Scenarios 3a and 3b on the subareas in the South Westside Basin is small compared to the changes seen in the Lake Merced/Golden Gate Park subarea.

3.3.5. Scenario 4 – Cumulative Scenario

Scenario 4 represents the combined effects of operations of the GSR (Scenario 2) and SFGW (Scenario 3b) Projects. Scenario 4 also includes additional water being diverted into Lake Merced.

For Scenario 4, Figure 10.4-15 shows that groundwater storage increases to about 22,000 af above that of Scenario 1 after the initial 7-year put period. Groundwater storage steadily declines over following 30 years closely following the trend of Scenario 2 but about 15,000 to 20,000 af lower relative to Scenario 2 reflecting the influence of the SFGW Project. At the beginning of the Design Drought, the groundwater in storage is about 4,000 af lower than under Scenario 1. During the Design Drought, the combined pumping of the GSR and SFGW Projects lowers the groundwater storage to about 65,000 af lower than under Scenario 1. After the put period at the end of the simulation period, groundwater storage for the entire Westside Basin is approximately 45,000 af less than under Scenario 1. Because of the similar trends in groundwater storage between Scenario 2 and 4, the storage efficiency for Scenario 4 is considered to be similar to Scenario 2. Because Scenario 4 includes assumptions not included in Scenario 1, a direct comparison to estimate efficiency is not appropriate.

The overall trend in groundwater storage changes for Scenario 4 follows that of Scenario 2, but the volume of groundwater storage for Scenario 4 is lower, reflecting the increased pumping by the SFGW Project (Figure 10.4-15). However, the difference in storage between Scenarios 2 and 4 is less than the decrease of storage under Scenarios 3a and 3b. This discrepancy is the primarily the result of additional recharge under Scenario 4 due to the stormwater additions to Lake Merced under the Daly City Vista Grande Basin Improvements Project.

Figure 10.4-20 shows the net change in the water balance for the North and South Westside Basins. In general, the graphs look like a composite of Scenarios 2 and 3b, as would be expected. The influence of the other foreseeable projects under the Cumulative Scenario is relatively small with respect to groundwater storage. A portion of the increase in groundwater storage in Scenario 4 compared to Scenario 1 is a result of additional seepage from Lake Merced, amounting to about 4,000 af by the end of Scenario 4. This can be seen on Figure 10.4-20 and Table 10.4-6 (also see TM 10.1 Attachment 10.1-D) where Lake Merced has an overall net discharge to groundwater due to the stormwater additions from the Daly City Vista Grande Basin Improvements Project.

For the Developed Subbasin subareas, storage changes related to pumping of the SFGW Project in the North Westside Basin and pumping of the GSR Project in the South Westside Basin are shown on Table 10.4-7 and Figure 10.4-24. By combining the Design Drought pumping conditions of Scenario 2 with the year-round pumping of the SFGW Project wells in the North Westside Basin, Scenario 4 has the maximum Basin storage declines during the Design Drought among the Project Scenarios relative to the Existing Conditions.

4. Historical Data Evaluation and Qualitative Assessment

The results of significant groundwater modeling efforts, such as the Westside Basin Groundwater-Flow Model, are often substantiated by other independent means. While the model development process involves internal calibration and validation (using comparisons to observed groundwater levels), additional efforts are often undertaken to evaluate the "reasonableness" of model results as they relate to observable measurements or practical expectations. The process of comparing model results to observed data, or evaluating the results from the perspective of what might be reasonable based on scientific principles, is termed "empirical analysis." The purpose of conducting an empirical analysis of groundwater modeling results is to provide an additional, independent confirmation of the model results.

4.1. Groundwater Level Analysis

The empirical analysis conducted for this TM involved comparing groundwater level changes predicted by the model to historic groundwater levels measured within the Westside Basin. To facilitate the comparisons, the ranges of groundwater levels (low to high) simulated by the model for each scenario were compared to the ranges of recorded historic groundwater levels.

The historic groundwater levels were measured in wells that are included in the Westside Basin Groundwater Monitoring Network. Most of the continuous water level data available from these wells were collected from the early 2000s through 2009 (SFPUC, 2010). However, some of the well measurement data extend back to the mid-1990s, a period during which extreme drought conditions (and thus very low local groundwater levels) were experienced in the Westside Basin. Actual groundwater level measurements from that recent drought period are particularly useful for comparing to model results because both sets of measurements, actual and simulated, reflect groundwater levels under particularly stressed Basin conditions.

Table 10.4-8 provides a summary of the comparison between historic and model-predicted groundwater levels corresponding to each of the evaluated scenarios (refer to Figure 10.4-1 for the locations of wells listed on the table). The selected well locations provided in Table 10.4-8 encompass representative portions of the Basin, from Golden Gate Park in the north to Burlingame in the south. The monitoring wells are grouped according to whether they are completed in the Shallow Aquifer or the Primary Production Aquifer and the period when measured data are available for each location is shown.

This comparison of the range of observed groundwater levels to the range of simulated groundwater levels for each scenario provides context for evaluating the simulation results for the GSR and SFGW Projects to the range of groundwater levels that have been observed in the Basin. A direct comparison is limited because the historical conditions represent a different set of conditions than those included in the scenarios. Rather the intent is to compare whether the GSR and SFGW Project scenario results show groundwater levels that are substantially higher or lower than was has been experienced historically.

From Table 10.4-8, the results of the comparisons show the following:

- For Scenario 1, the simulated groundwater levels are generally within the range of historical groundwater levels measured in the Basin over the past 5 to 15 years.
- For Scenario 2, groundwater levels in the North Westside Basin and the Shallow Aquifer are generally within the historical range whereas groundwater levels in the South Westside Basin and the Primary Production Aquifer show a range wider than the historical range representing the effects of the put-take-hold conditions of the GSR Project operations.
- For Scenarios 3a and 3b, groundwater levels in the North Westside Basin are typically below the historical range showing the effects of the SFGW Project operations. In the South Westside Basin, groundwater levels are generally within the historical range.
- For Scenario 4, groundwater levels in the North Westside Basin are generally below the historical range, representing the effects of the SFGW Project. In the South Westside Basin and the Primary Production Aquifer show a range wider than the historical range representing the effects of the put-take-hold conditions of the GSR Project operations.

Overall, this empirical analysis demonstrates that the ranges of model-predicted changes in groundwater levels for each of the scenarios fall reasonably within the ranges measured in the Basin over the past 15 years or so.

4.2. In-Lieu Recharge Demonstration Study

From fall 2002 to spring 2005, SFPUC, in coordination with the PAs, conducted an In-Lieu Recharge Demonstration Study (Demonstration Study; also known as the Westside Basin Conjunctive Use Pilot Project) in the Westside Basin. The primary purpose of the Demonstration Study was to evaluate the response of Basin groundwater conditions to reduced pumping by the PAs (i.e. implementation of “in-lieu” recharge). The manner in which the Demonstration Study was conducted is closely representative of planned operations for the proposed GSR Project. Therefore, the response of Basin groundwater conditions observed during the Demonstration Study is an important indicator for forecasting the potential Basin response to future implementation of the GSR Project.

4.2.1. Project Overview

The In-Lieu Recharge Demonstration Study involved the cessation of municipal pumping in the South Westside Basin by Daly City, Cal Water, and San Bruno. Supplemental surface water provided by SFPUC to each of the PAs was used to replace the water supply normally obtained by pumping in the Basin.

The Demonstration Study occurred mostly from October 2002 through March 2005, when it was discontinued in the San Bruno area (LSCE, 2005b and 2010). Between January 2003 to March 2005, SFPUC delivered approximately 3,900 af of water to San Bruno, 6,200 af to Daly City, and 1,820 af to Cal Water. After the completion of the Demonstration Study in 2005, SFPUC continued to deliver supplemental surface water to Cal Water through January 2007 and to Daly City through April 2007, resulting in reduced groundwater pumping in these areas. With the continued surface water delivery of SFPUC to Cal Water and Daly City, the total surface water delivery to the PAs from October 2002 through April 2007 reached approximately 20,000 afy. No supplemental deliveries were conducted from May 2007 to May 2009.

After cessation of the Demonstration Study in March 2005, San Bruno pumping resumed at about 1,800 to 2,300 afy (LSCE, 2010). Groundwater pumping for municipal supply by Cal Water in the South San Francisco area resumed on a limited basis in March 2008 and totaled 206 af during 2008 (LSCE, 2010). Daly City pumping was about 3,600 af for 2008.

4.2.2. Results

Results from the Demonstration Study indicated that in-lieu recharge in the Westside Basin can be successfully accomplished by reducing pumping, resulting in increases in groundwater storage. During the Demonstration Study, groundwater levels were measured in select wells located throughout the Basin to document the recovery, or rise, in groundwater levels resulting from reduced pumping. From these data, the amount of groundwater storage increase associated with the rising water levels was estimated for the three areas of the Basin encompassed by each of the PAs. Groundwater levels rose by about 20 feet in the Daly City area, 13 feet in the South San Francisco area, and 12 feet in the San Bruno area during the period of the Demonstration Study (LSCE, 2005b). Details of the changes in groundwater levels are discussed in more detail in reports by LSCE (2005b, 2010).

For the entire area within the three PA service areas, the total increase in groundwater storage in the South Westside Basin during the Demonstration Study was estimated to be approximately 13,000 af (LSCE, 2005b). At the start of the Demonstration Study, Daly City reduced groundwater production by 2.9 mgd from October 2002 to March 2005. In other words, the aquifer in the Daly City area was being recharged, by in-lieu means, at the rate of approximately 2.9 mgd for approximately 2 years and 5 months. By the end of that period, it was estimated that approximately 6,300 af of in-lieu recharge had occurred in Daly City. Cal Water reduced groundwater pumping by 1.2 mgd for approximately 2 years and 4 months (from November 2002 to March 2005), which resulted in an estimated resultant groundwater storage increase of approximately 3,600 af. The storage increase for San Bruno was estimated to be 3,000 af (LSCE, 2005b).

For Scenarios 2 and 4, 13,000 af of groundwater recharge occurred during the major put periods of the simulation including the first three years of the simulation, the recovery after two take periods during the simulation, and after the Design Drought. In these cases, the simulated groundwater levels rose by about 50 feet in the Daly City area, 50 feet in the South San Francisco area, and 40 feet in the San Bruno area. The model results show some differences because the drawdown during the preceding take period included the operation of both the GSR Project and PA municipal wells which is different than the conditions of the Demonstration Study. Therefore, a portion of the rise in groundwater levels includes an aquifer recovery from the decreased pumping. Therefore, it is considered that the model results are comparable to the observed conditions from the Demonstration Study.

The results of the Demonstration Study show the responsiveness of the Westside Basin aquifers to in-lieu recharge, the increase in Basin groundwater storage related to cessation of large-scale municipal pumping. The Demonstration Study results are likely not directly applicable to full-scale implementation of the proposed GSR Project due to the variable subsurface conditions present throughout the entire Basin, and due to the Basin storage inefficiencies discussed previously. However, the approximate relationship of reduced large-scale pumping to increases in groundwater storage demonstrated by the Demonstration Study gives an indication of the magnitude of storage increases that could be reasonably expected in the Basin with GSR Project implementation.

4.3. Westside Groundwater Basin Water Budget

A groundwater budget for the entire Westside Basin was produced as part of the calibration of the Westside Basin Groundwater-Flow Model (HydroFocus, 2007, 2009, and 2011). Groundwater budgets have been developed for Golden Gate Park, the Golden Gate Park and Lake Merced area, and the Daly City area, and are presented in LSCE (2010).

Under existing conditions the predominant inflow component is percolating rain and irrigation water, which together are the primary recharge mechanisms in the Westside Basin system (HydroFocus, 2007). Inflow from Lake Merced and the GGP lakes is relatively minor, with modeled inflow from the Ocean and Bay even smaller and limited to the coastal fringe areas. The primary outflow component is large-scale pumping from municipal and irrigation wells in the Basin. Outflows to the Ocean and Bay are relatively modest (although substantially greater than simulated inflow rates from the same), and outflow seepage to Lake Merced is lower still (but greater on average than simulated inflows to the lake).

The average annual recharge for the Westside Basin from the period 1959 through 2009 was estimated by the groundwater model to be 14,740 afy (HydroFocus, 2011). Of that, 7,006 afy were apportioned to the North Westside Basin and 7,734 afy to the South Westside Basin. For the North Westside Basin, recharge was estimated by LSCE (2007) to be 6,800 afy, while Phillips et al. (1993) estimated 4,850 afy of recharge for 1988 and 1989, the first two years of an extended drought period. The estimate by Phillips et al. (1993) was developed for a drought period, and is not considered representative of long-term average conditions. No other estimates of total recharge for the South Westside Basin have been documented.

In discussing the water balance, the HydroFocus (2011) report focuses on the Developed Basin. The results of the 2008 No-Project Scenario (HydroFocus, 2011) are compared to the results of Scenario 1 (Table 10.4-7) for the Developed Basin. Key observations are that the recharge from precipitation and return flows are higher in the 2008 No-Project Scenario (11,532 afy compared to 10,310 afy annual average) as expected because Scenario 1 uses a more conservative hydrologic sequence that incorporates the Design Drought (TM 10.1). Pumpage rates are comparable with an annual average of 10,551 afy for the 2008 No-Project Scenario and

10,227 afy for Scenario 1. The differences are due to minor changes to the pumping assumptions as discussed in TM 10.1. Similarly, outflow to the Pacific Ocean is comparable with an annual average of 3,258 afy for the 2008 No-Project Scenario and 3,139 afy for Scenario 1. There is a difference in the net change in groundwater storage due primarily to the differences in recharge. The annual average change in aquifer storage is an increase of 3 afy for the 2008 No-Project Scenario and a decrease of 613 afy for Scenario 1.

This comparison of the 2008 No-Project Scenario to Scenario 1 shows that the overall model assumptions are similar. The use of the new hydrologic sequence makes Scenario 1 more conservative with respect to aquifer storage due to the overall decrease in groundwater recharge with the addition of the Design Drought to Scenario 1.

4.4. Total Groundwater Volume in Westside Basin

A volumetric calculation was made to evaluate a reasonable estimate for the total volume of groundwater currently present in the Westside Basin. The volumetric estimate is based the volume of the aquifer from the Westside Basin Groundwater Model and an estimate of the available pore space, or porosity, within the aquifer to store water. This is a static calculation of the total groundwater present in the Basin and does not consider recharge or the long-term effects of pumping. This volumetric estimate provides additional context for evaluating the scale of aquifer storage changes from the GSR and SFGW Project scenarios. This analysis compares the total groundwater storage changes from each model scenario and compares that to the total groundwater in the basin. The purpose of this comparison is only to provide a sense of the scale of the potential aquifer storage changes relative to the size of the groundwater basin. This analysis is not intended to provide an assessment of the sustainable yield or operational storage of the Westside Basin.

The method used to estimate the total groundwater in the Basin was based on results from the Westside Basin Groundwater-Flow Model (HydroFocus, 2011). Because the spatial distributions of the five Model Layers are different, the total groundwater volume was estimated separately for each layer. The upper surface of each Model Layer cell was defined as the lower of either the top aquifer elevation or, for Model Layer 1, the June 2009 groundwater elevation. The lower surface of each layer was the bottom aquifer elevation. The aquifer thickness is the difference between the upper and lower surface elevations. This process was repeated to determine the volume of each of the five Model Layers individually, and these volumes were then summed to determine the total aquifer volume.

To define the groundwater volume, the aquifer volume of each Model Layer was multiplied by the specific yield values used in the Westside Basin Groundwater-Flow Model (HydroFocus, 2011). The specific yield provides a representative estimate of the effective porosity of the aquifer. The specific yield used in the calibrated Westside Basin Groundwater-Flow Model (HydroFocus, 2011) was 0.14 for Model Layers 1 through 4 and 0.05 for Model Layer 5.

Using the above method results in a total saturated storage capacity, a reasonable maximum storage based on June 2009 groundwater levels calculated by the model. To facilitate this analysis, the Westside Basin is defined as three onshore subareas. The two offshore subareas included in the MODFLOW model underlying the Pacific Ocean and San Francisco Bay are not included in this analysis. The results of the volumetric calculations for the three onshore subareas are summarized below:

- The North Westside Basin subarea was defined as the portion of the Basin north of the San Mateo-San Francisco County Line and east of either Ocean Beach or the Serra Fault (where it is located onshore). The total estimated groundwater volume in this subarea is 223,000 af.
- The South Westside Basin subarea was defined as the portion of the Basin east of the Serra Fault, south of the San Mateo-San Francisco County Line, and west of the San Francisco International Airport. The total estimated groundwater volume in this subarea is 513,000 af.
- The Serra Block subarea was defined as the portion of the Basin east of the Pacific coast and west of the Serra Fault (where it is located onshore). The total estimated groundwater volume in this subarea is 340,000 af.

The total groundwater volume in the onshore Westside Basin estimated using this method was 1,078,000 af.

For the GSR-Only Scenario (2), the change in groundwater storage relative to the Existing Conditions Scenario (1) was a decrease of approximately 420 afy for a total change in storage over the 47-year simulation period of about -19,530 af. This volume represents about 1.8 percent of the total groundwater volume in the entire Westside Basin and 3.8 percent of the total groundwater volume of the South Westside Basin subarea.

For the SFGW-Only Scenario 3a, the change in groundwater storage relative to the Existing Conditions Scenario (1) was a decrease of approximately 680 afy for a total change in storage over the 47-year simulation period of about -32,170 af, representing about 3.0 percent of the total groundwater volume in the entire Westside Basin at the end of the simulation period and 14.4 percent of the total groundwater volume of the North Westside Basin subarea. For Scenario 3b, the change in groundwater storage relative to the Existing Conditions Scenario (1) was a decrease of about 640 afy, for a total change in storage over the 47-year simulation period of about -30,080 af, representing about 2.8 percent of the total groundwater volume in the entire Westside Basin and 13.5 percent of the total groundwater volume of the North Westside Basin subarea.

For the Cumulative Scenario (4), the change in groundwater storage relative to the Existing Conditions Scenario (1) was a decrease of approximately 970 afy for a total change in storage over the 47-year simulation period of about -45,480 af, representing about 4.2 percent of the total groundwater volume in the entire Westside Basin.

5. Summary

This section summarizes the results of the numerical modeling and analytical approaches with respect to changes in groundwater levels and storage in the Westside Basin.

5.1. Existing Conditions (Scenario 1)

Scenario 1 simulates Basin conditions without either the GSR or SFGW Projects and defines the background conditions against which the other model scenarios are compared, including wet, normal and dry precipitation years. By the end of Scenario 1, groundwater storage would decline approximately 28,000 af for the entire Westside Basin (Figure 10.4-14). The 28,000-af decline in groundwater storage in Scenario 1 is due to the assumptions used for the background hydrology, which include a Design Drought as necessitated by the need for consistency with the PEIR. The Design Drought repeats the historical 1976-77 drought, resulting in an overall rainfall deficit of nearly 20 inches over the 47-year simulation period. This rainfall deficit is nearly equivalent to losing a full year of precipitation and its associated recharge for the entire basin. Comparing the recharge calculated by the Soil Moisture Budget for the SFPUC scenarios with the HydroFocus 2008 No-Project Scenario shows that the decline in groundwater storage in Scenario 1 can be accounted for by the difference in rainfall between the different sets of background hydrology assumptions used. The background hydrology assumptions used for all of the scenarios therefore provide a conservative analysis with respect to the potential changes in groundwater levels and storage.

In the North Westside Basin, groundwater levels generally fluctuate within a narrow range in response to climatic conditions. Both groundwater levels and storage for Scenario 1 show an initial increase in Scenario Years 1 and 2, followed by a general decline over the scenario period except for periods of increase during Scenario Years 21 to 23 and Years 30 to 35. There is a substantial decline during the Design Drought period followed by an increase in Scenario Years 45 to 47.

In the South Westside Basin, groundwater levels in Model Layer 4 show a similar trend of steady decline over the 47-year simulation period. In Model Layer 1, groundwater levels show an increasing trend, with about a 20-foot rise over 47 years. The difference in groundwater elevations in the Shallow and Primary Production Aquifers (Model Layers 1 and 4) ranges from 10 to 20 feet in the Daly City area to 200 to 250 feet in the San Bruno area.

5.2. GSR Project Only (Scenario 2)

Scenario 2 represents the operation of the GSR Project, which is located in the South Westside Basin. Groundwater levels and storage show increases during put periods and decrease during take periods (see Section 3 for a definition of put/take/hold periods). Because of the Project location, the largest changes in groundwater levels and storage are primarily in the South Westside Basin. The general response to the GSR operations is greatest in the Primary

Production Aquifer (Model Layer 4) and more subdued to absent in the Shallow Aquifer (Model Layer 1), especially in the South San Francisco and San Bruno areas.

In general, groundwater levels and storage increase during put/hold periods and decrease during take periods. The greatest increase occurs during the first extended put period from Scenario Years 1 to 7, which is followed by a slow decline. Two take periods from Scenario Years 9 to 12 and Scenario Years 25 to 28 show up distinctly with declines in groundwater levels and storage. All locations have their lowest groundwater levels and storage at the end of the Design Drought when pumping from both the SFPUC and PA wells occurs. The greatest declines occur in the Daly City, South San Francisco and Colma areas because most of the GSR Project wells are located in this area. At the start of the Design Drought, groundwater levels and storage are well above Scenario 1 levels, but decline to well below Scenario 1 levels by the end of the Design Drought. During the 3-year put period from the end of the Design Drought to the end of the scenario, groundwater levels generally recover to near or above Scenario 1 levels.

In the North Westside Basin, the greatest effects of the GSR Project occur in locations near the southern end of Lake Merced primarily in the Primary Production Aquifer (Model Layer 4). Locations north of Lake Merced and in Golden Gate Park show little to no change in groundwater levels or storage due to the GSR Project.

Scenario 2 assumes that there is 20,000 af of groundwater in the SFPUC Storage Account at the beginning of the scenario (represented in the initial conditions) and 20,000 af in the SFPUC Storage Account at the end of the scenario due to the put period immediately following the Design Drought. Therefore, the reduction in groundwater storage of about 20,000 af relative to Scenario 1 is not due to any change in the SFPUC Storage Account, but rather to the fact that the storage efficiency of the Basin is less than 100 percent. Most of this decline occurs when groundwater levels are higher than under Scenario 1 during Scenario Years 7 through 36. Most of this loss in storage is attributed to declines in groundwater inflows from the North to the South Westside Basin. With the increased groundwater levels simulated under Scenario 2, the hydraulic gradient in the North Westside Basin shifts to a more westward direction, resulting in increased outflows to Lake Merced and to the Pacific Ocean. Based on this analysis, the overall average efficiency of the GSR Project of the 47.25 year simulation period is approximately 78 percent.

Based on this analysis, groundwater levels and storage during Scenario Years 1 through 36 are generally higher than Scenario 1. During the Design Drought, groundwater levels and storage decline below Scenario 1 levels, but show a strong recovery after the Design Drought. Therefore, from a groundwater Basin management perspective, the operation of the GSR Project is not expected to deplete or interfere with Basin groundwater supplies in a manner that would result in a substantial regional deficit in aquifer storage.

5.3. SFGW Project Only (Scenarios 3a and 3b)

The SFGW Project would construct up to six wells and associated facilities in the western part of San Francisco and pump either 3.0 mgd (Scenario 3a) or 4.0 mgd (Scenario 3b) of groundwater from the North Westside Basin (SFPUC, 2009). Scenario 3a assumes 3.0 mgd of pumping for water supply and 1.142 mgd irrigation pumping in Golden Gate Park, whereas Scenario 3b assumes 4.0 mgd of pumping for water supply, with pumping of groundwater for irrigation in Golden Gate Park replaced by recycled water. Because this overall change in pumping is minor, the regional response of groundwater levels to these scenarios is comparable, and the results for Scenarios 3a and 3b are discussed together.

In general, all well locations evaluated in the North Westside Basin area show a similar declining trend in groundwater levels relative to Scenario 1 due to the SFGW Project operations. There is an initial decrease in groundwater levels in the first 5 to 10 years of the scenarios. Following this, the rate of change in groundwater levels relative to Scenario 1 is much less. In the northern locations, the rate of change relative to Scenario 1 after about Scenario Year 20 is near zero, whereas the locations near Lake Merced show a steady decline in groundwater levels relative to Scenario 1, but at a rate much lower than during the initial decline.

In the South Westside Basin, modest groundwater level and storage declines occur in the Daly City area, but these effects diminish to the south and are barely discernible in the San Bruno area.

At the end of the scenarios, the reductions in Basin groundwater storage are approximately 30,000 af for both Scenarios 3a and 3b. For locations in the North Westside Basin, the results show that groundwater levels and storage tend to stabilize after an initial period of steeper declines. During the early simulation period, the majority of the increased pumping initially comes from groundwater storage. Over time, storage provides less of the SFGW Project pumping, and groundwater pumping is instead primarily sustained by the interception of groundwater flow to the Pacific Ocean. Therefore, from a long-term regional groundwater basin management perspective, the operation of the SFGW Project is not expected to deplete or interfere with Basin groundwater supplies in a manner that would result in a substantial regional deficit in aquifer storage or produce continuing long-term declines in groundwater levels.

5.4. Cumulative Project Scenario (Scenario 4)

Scenario 4 represents the combined effects of operations of the GSR (Scenario 2) and SFGW (Scenario 3b) Projects. The resulting groundwater level responses in the North Westside Basin tend to be intermediate between the responses seen for Scenarios 2 and 3b. Scenario 4 also includes additional stormwater being diverted into Lake Merced. The effect of these stormwater additions substantially improves lake levels in Lake Merced. Also, increases in groundwater levels resulting from the additional seepage due to these lake additions are primarily concentrated in the Shallow Aquifer in the vicinity of Lake Merced. Another change for Scenario 4 is the planned replacement of the Daly City A-Street Well with a production well located west of the Serra Fault, which is away from the main part of the Westside Basin. This change has the effect of reducing pumping in the Daly City area east of the Serra Fault due to the low groundwater flow across the fault.

In general, Scenario 4 responses in the North Westside Basin closely resemble those of Scenario 3b, whereas in the South Westside Basin the responses closely resemble those of Scenario 2. The Lake Merced and Daly City areas represent the transition zone, where a combined effect is seen. In these areas, the responses vary by aquifer; Shallow Aquifer (Model Layer 1) responses more closely resemble those of Scenario 3b, whereas Primary Production Aquifer (Model Layer 4) responses more closely resemble those of Scenario 2. The Daly City area also shows a slight increase in groundwater levels and storage relative to Scenario 1 due to the change in the location of the Daly City A-Street Well.

The overall trend in groundwater storage changes for Scenario 4 follows that of Scenario 2, but the volume of groundwater storage in Scenario 4 is lower, reflecting the increased pumping by the SFGW Project. However, the difference in storage between Scenarios 2 and 4 is less than the decrease in storage seen under Scenarios 3a and 3b. There is a slight increase in groundwater storage in Scenario 4 relative to Scenario 1 resulting from the additional seepage from Lake Merced, amounting to about 4,000 af by the end of Scenario 4. The storage efficiency is similar in Scenario 4 to Scenario 2 as the trends are very close to parallel.

With respect to regional groundwater management issues, the cumulative operation of the SFGW and GSR Projects, along with other reasonably foreseeable future projects, is not expected to deplete or interfere with Basin groundwater supplies in a manner that would result in a substantial regional deficit in aquifer storage.

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Figure List

Table List

Figures

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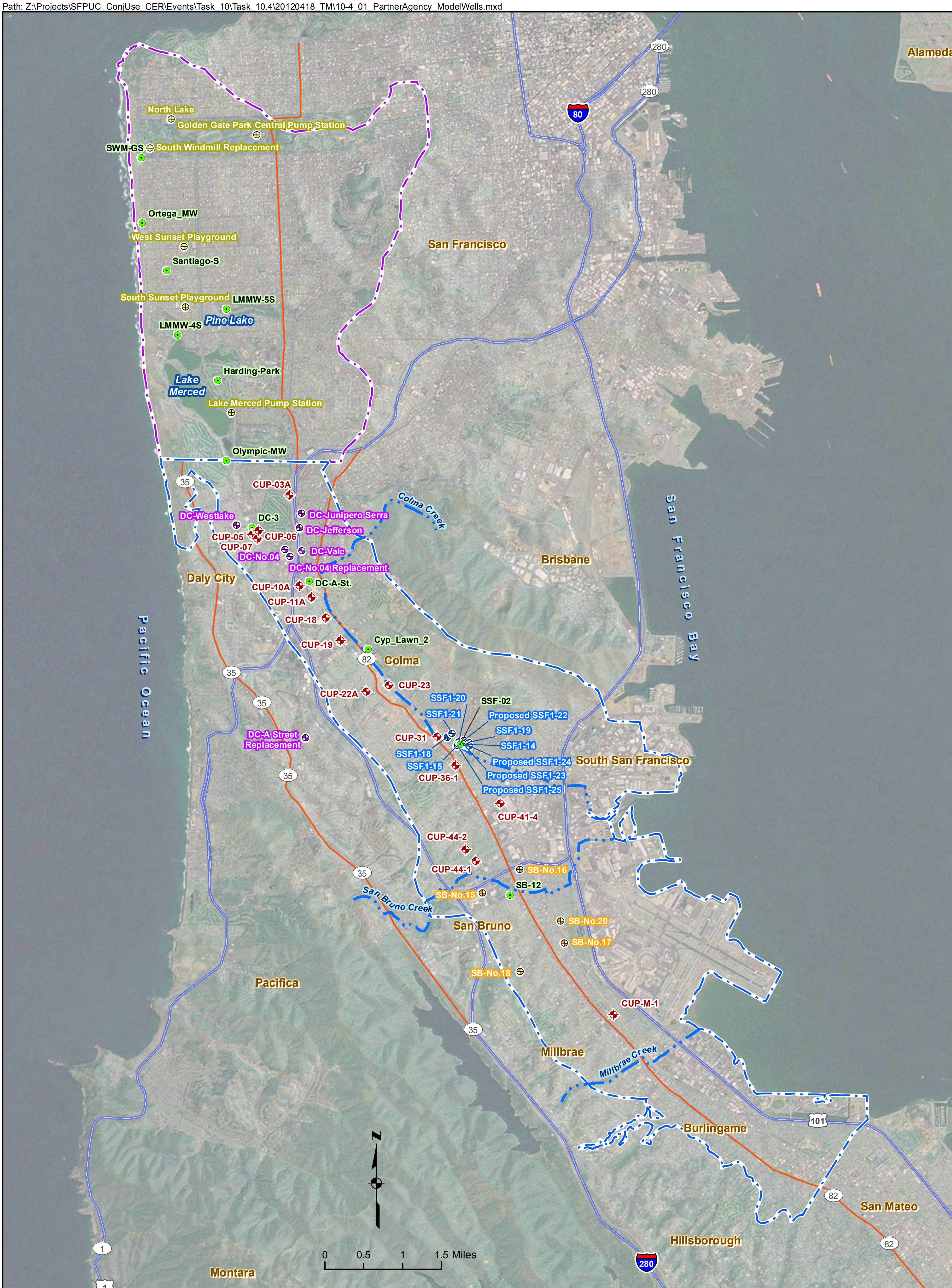


Aerial Photo Source: World Imagery from ESRI. Copyright:© 2009 ESRI, AND, TANA, UNEP-WCMC

Note:
The Santiago-S Location and the Harding Park Location are locations used by the Westside Basin Groundwater-Flow Model to track the model-simulated water levels. They represent historical well locations, but are not the current locations of active monitoring wells

Legend

- GSR Proposed Municipal Wells
- SFGW Proposed Municipal Wells
- Selected Representative Monitoring Wells
- Cal Water Municipal Wells
- Daly City Municipal Wells
- San Bruno Municipal Wells
- South Westside Groundwater Basin
- North Westside Groundwater Basin

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

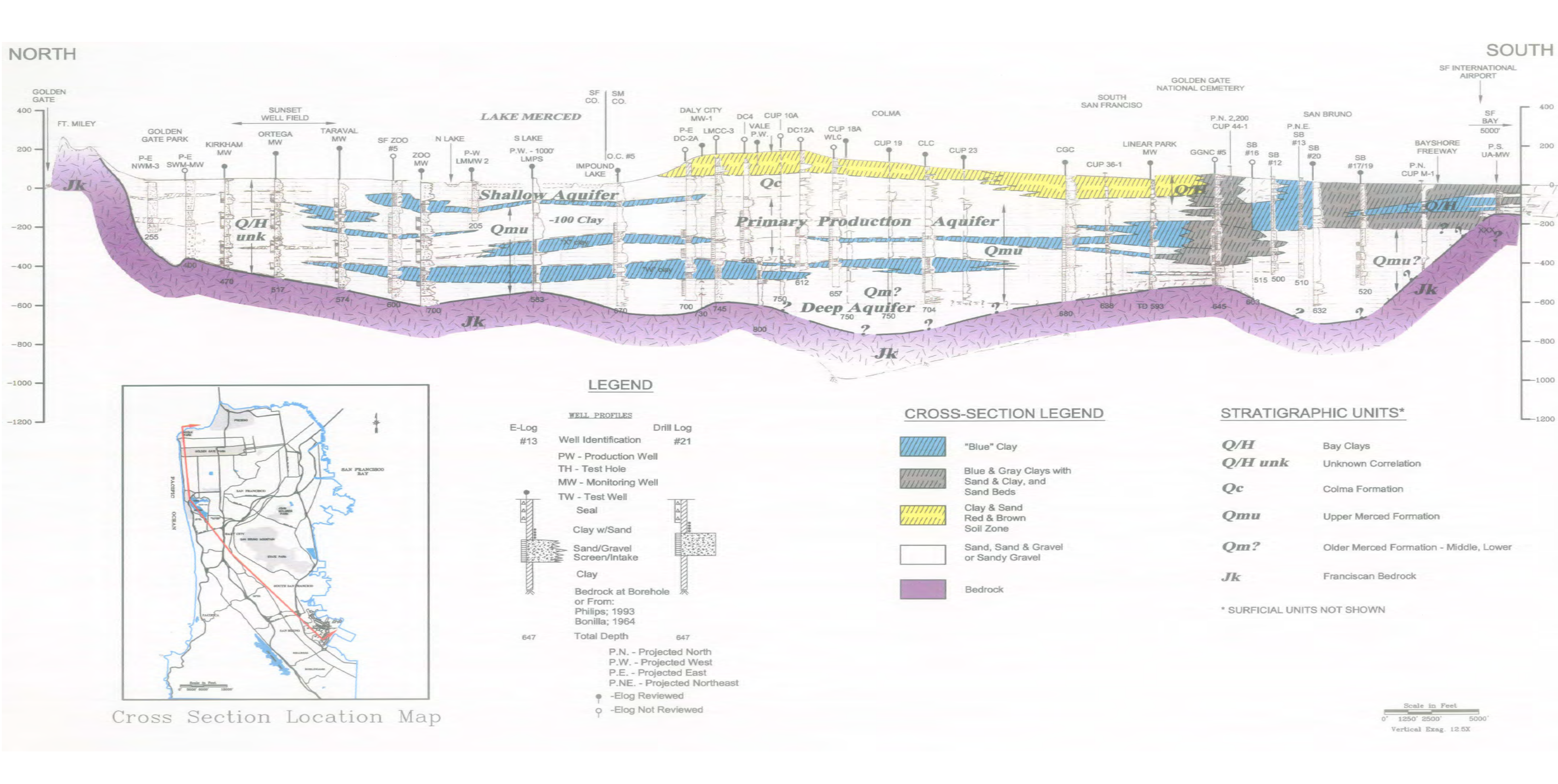
LOCATIONS OF PARTNER AGENCY WELLS, PROPOSED GSR AND SFGW PROJECT MUNICIPAL WELLS, AND SELECTED REPRESENTATIVE MONITORING WELLS WITH MODEL RESULTS

Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Figure
10.4-1

Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Date
April 2012



Source: Final Task 8B Technical Memorandum No.1, Hydrologic Setting of the Westside Basin, LSCE, May 2010.

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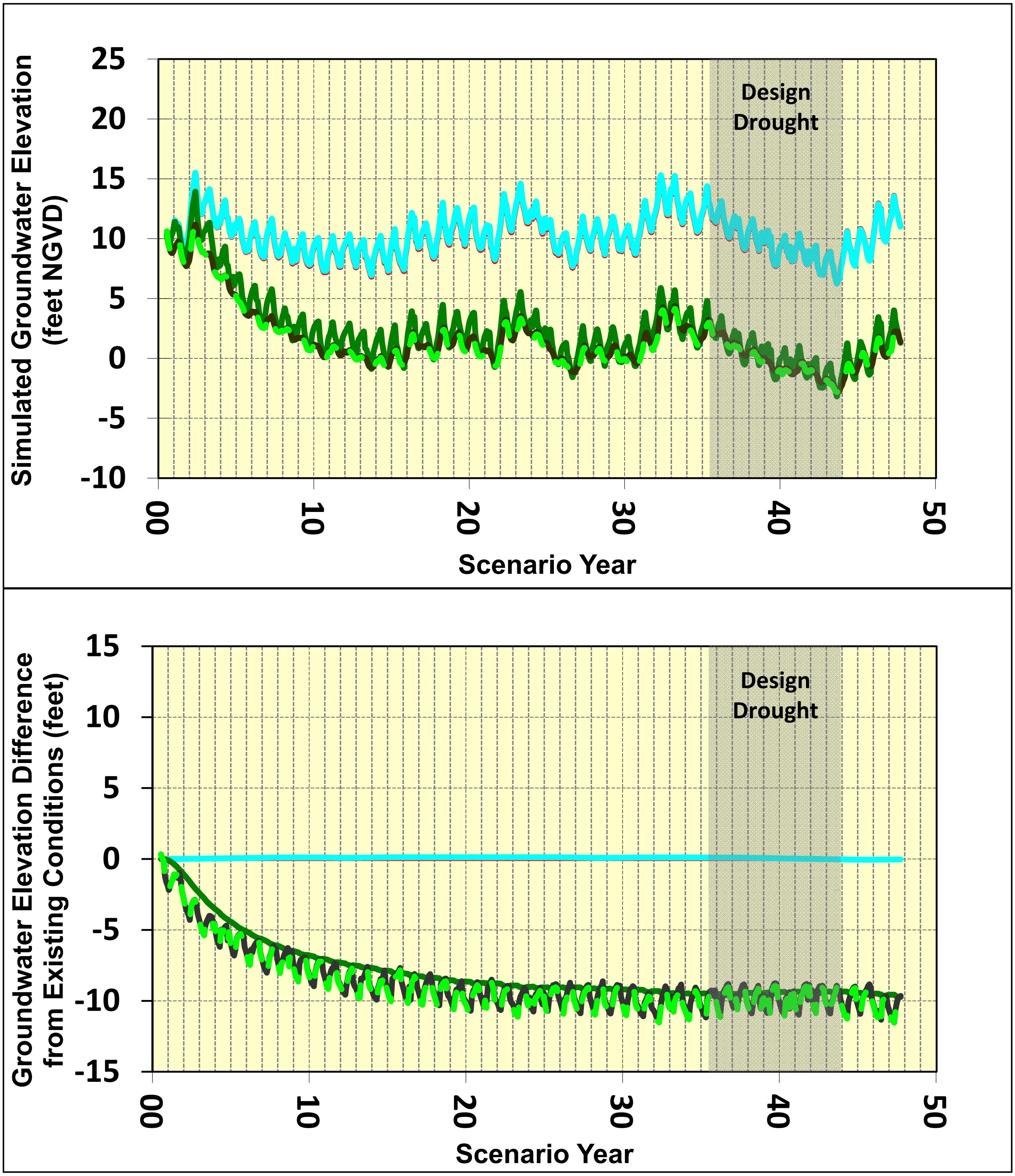
Regional Groundwater Storage and Recovery Project
And San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission
Westside Basin Regional Subsurface Hydrogeology
K/J 0864001
April 2012

Figure 10.4-2



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- **Scenario 1**
- **Scenario 2**
- **Scenario 3a**
- **Scenario 3b**
- **Scenario 4**

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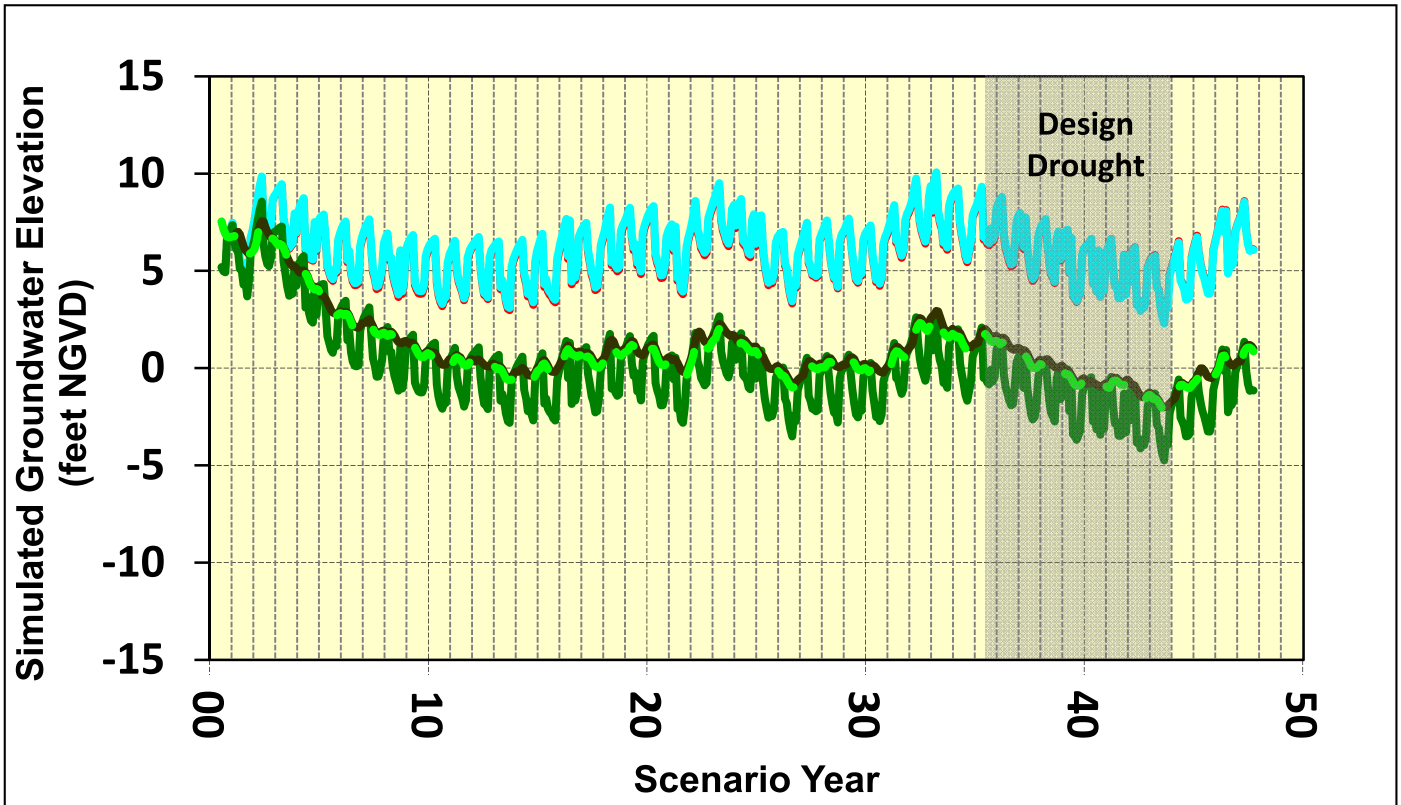
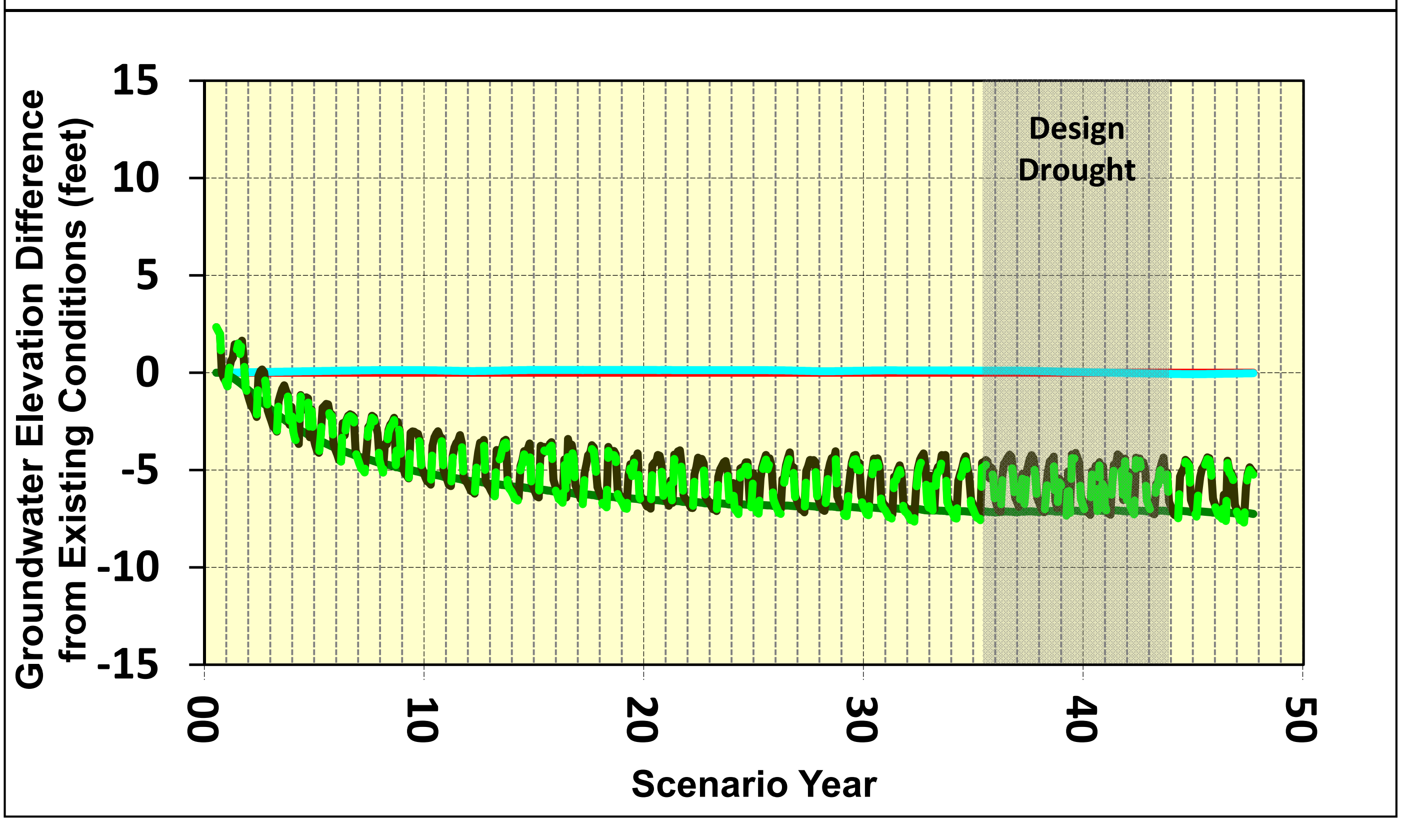
Regional Groundwater Storage and Recovery Project
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 1 Hydrographs for SWM-GS

K/J 0864001
April 2012

Figure 10.4-3a





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

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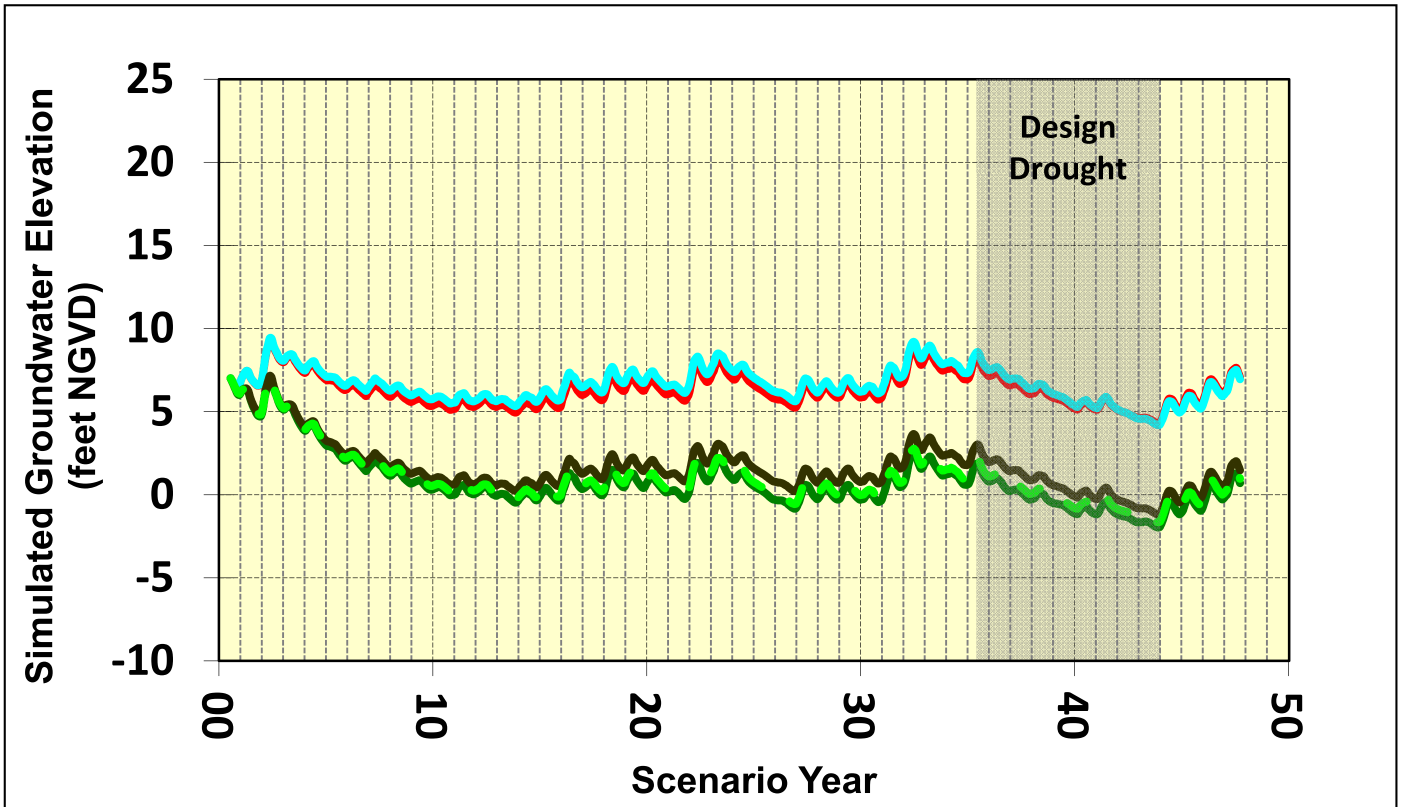
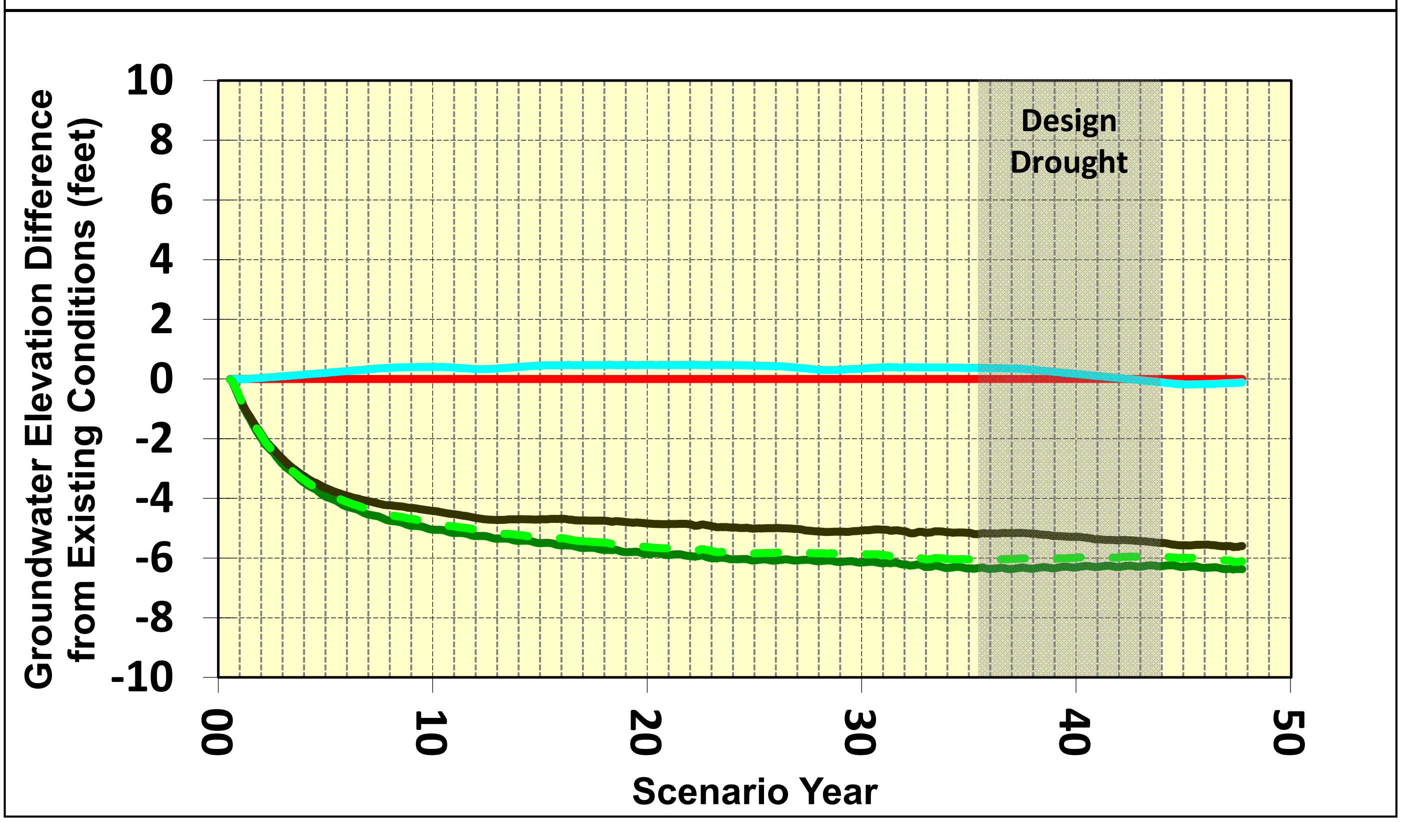
Regional Groundwater Storage and Recovery Project
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Model Layer 4 Hydrographs for SWM-GS

K/J 0864001
April 2012
Figure 10.4-3b





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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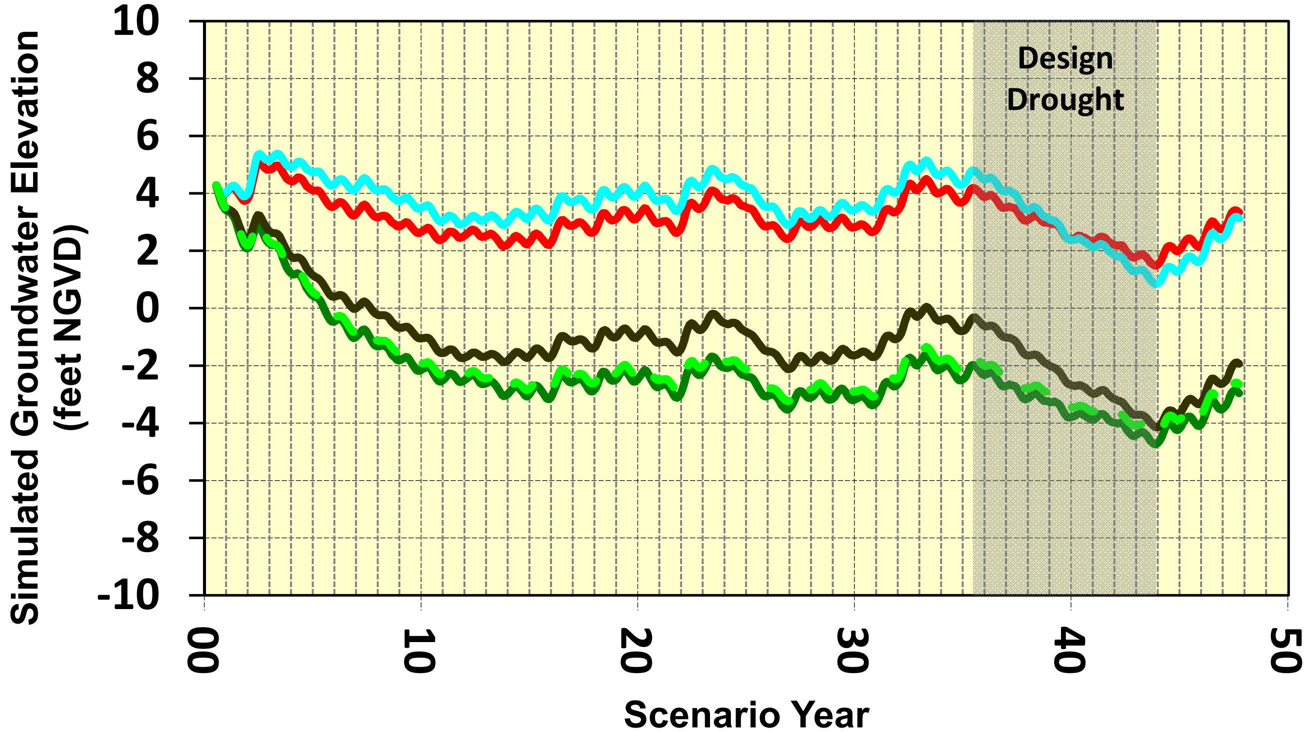
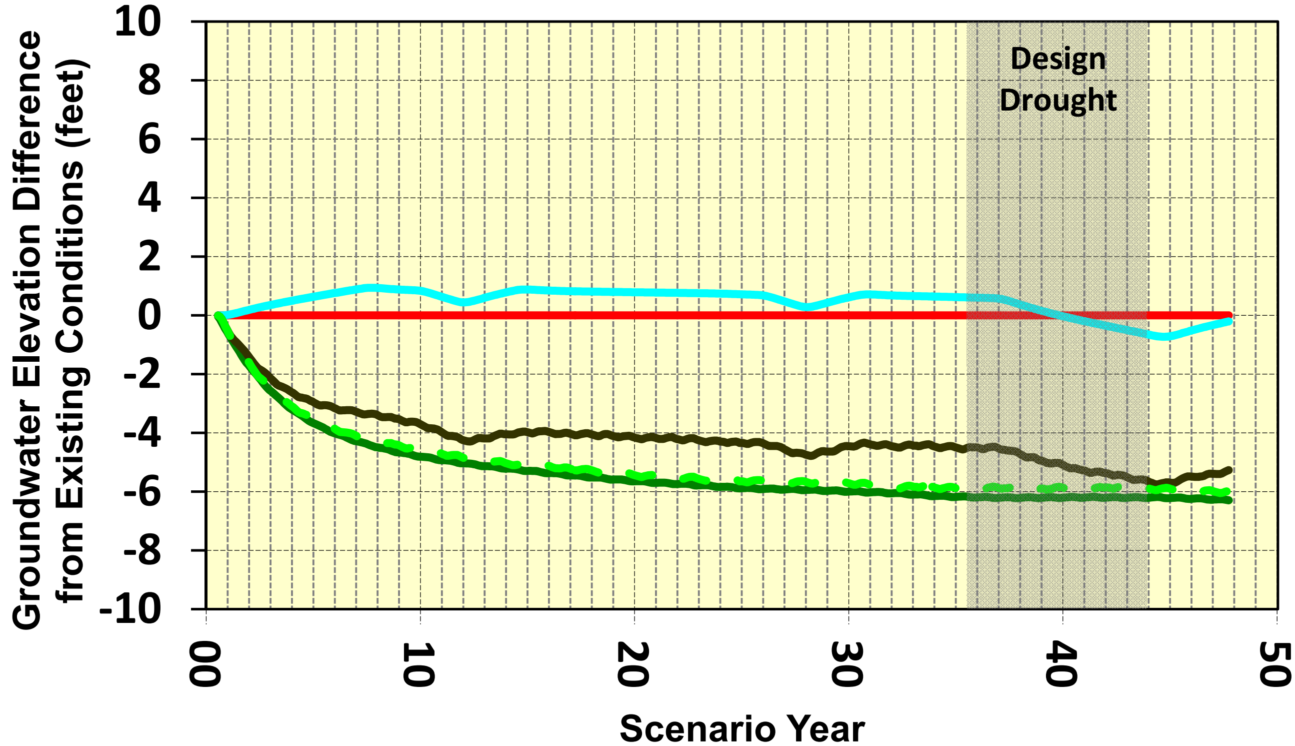
San Francisco Public Utilities Commission

Model Layer 1 Hydrographs for Ortega MW

K/J 0864001
April 2012

Figure 10.4-4a





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- **Scenario 1**
- **Scenario 2**
- **Scenario 3a**
- **Scenario 3b**
- **Scenario 4**

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Model Layer 4 Hydrographs for Ortega MW

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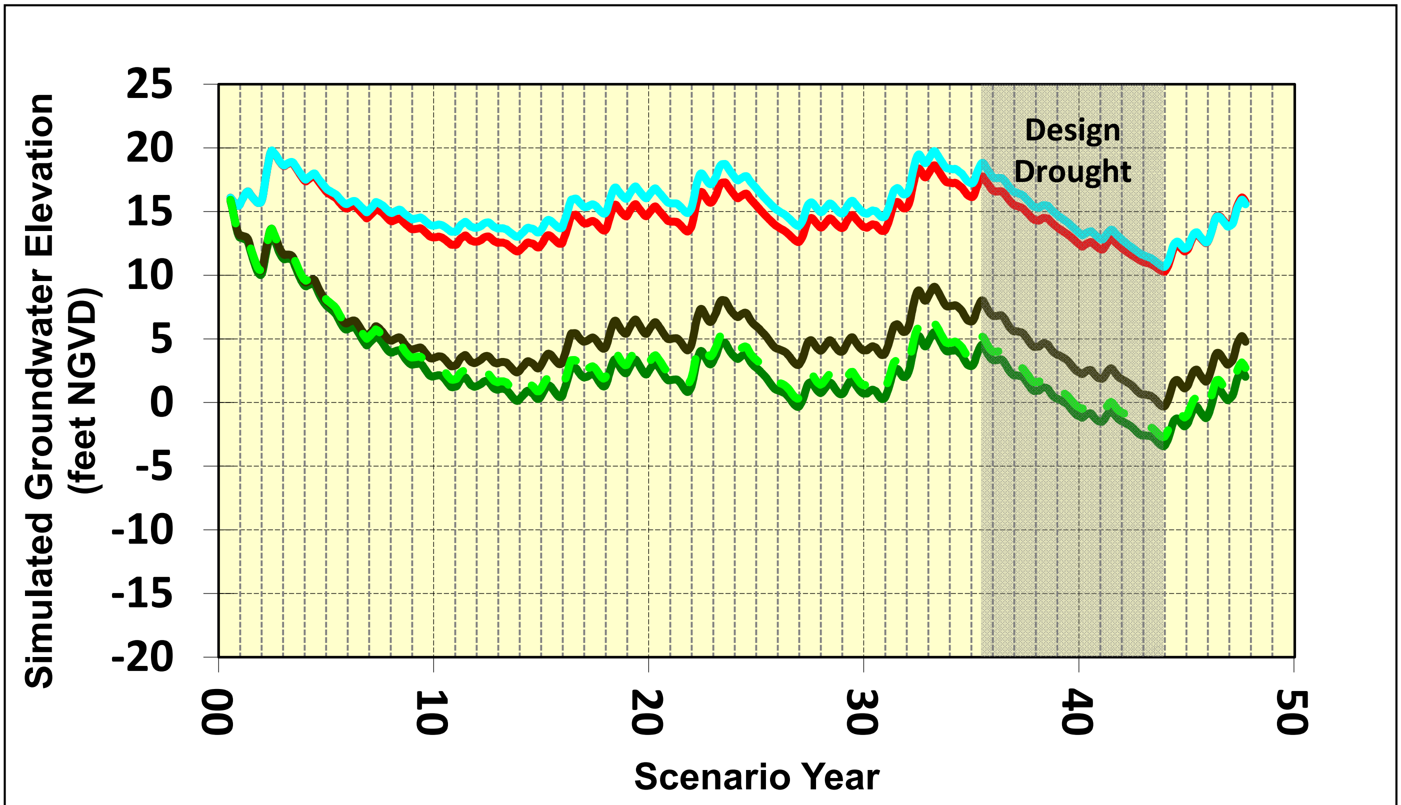
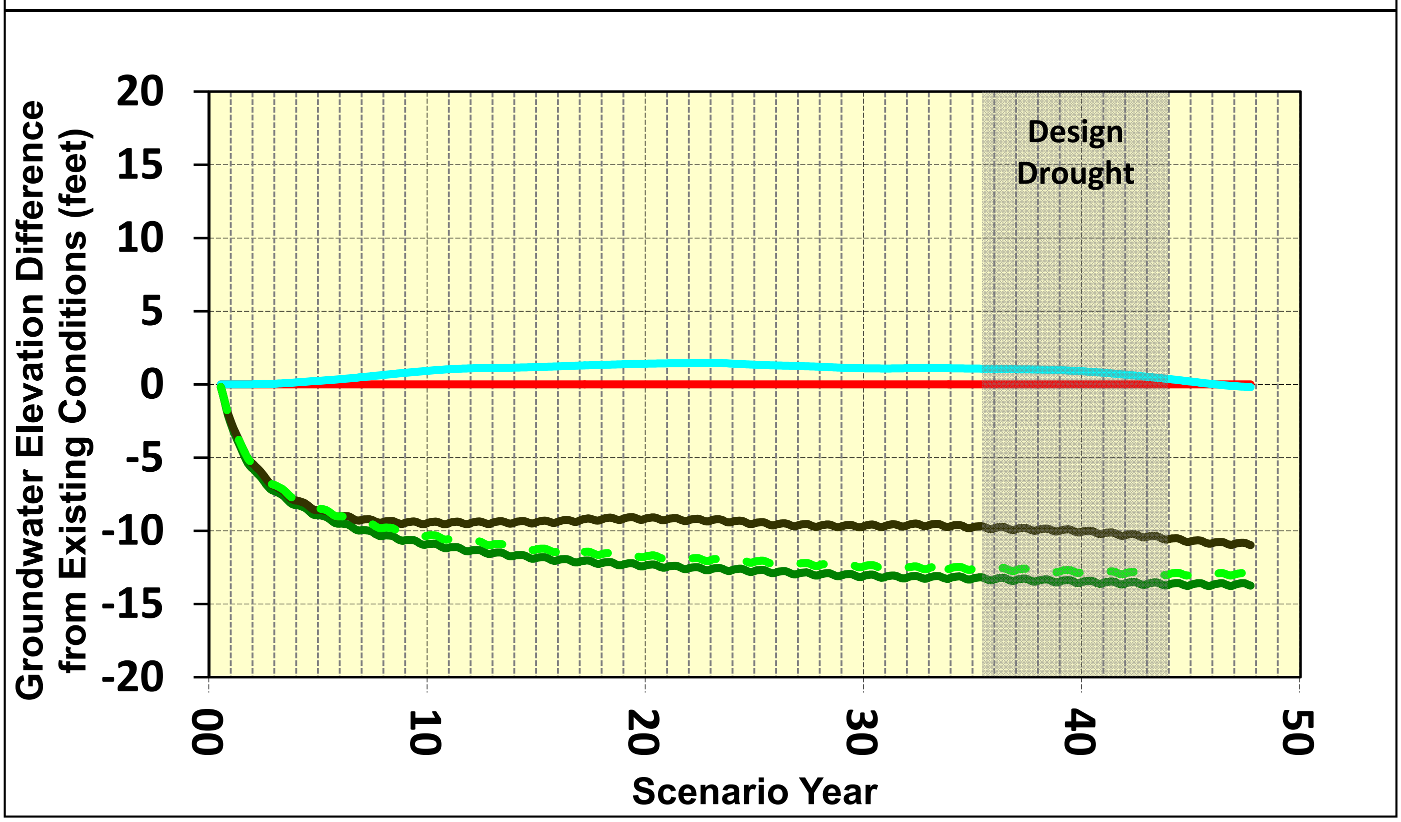
Figure 10.4-4b





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Model Layer 1 Hydrographs for Santiago-S MW

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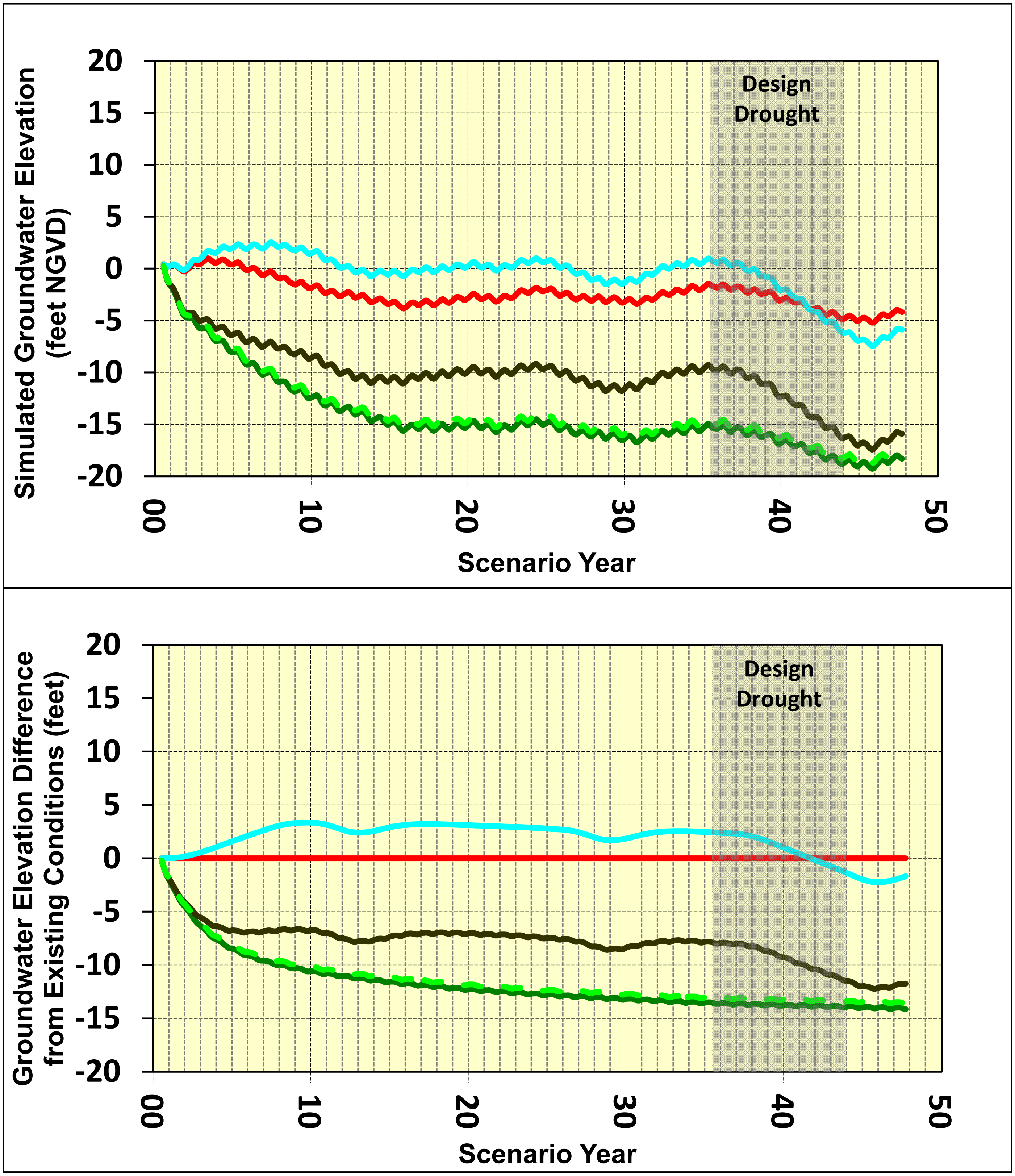
Figure 10.4-5a



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

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and San Francisco Groundwater Supply Project
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Model Layer 4 Hydrographs for Santiago-S MW

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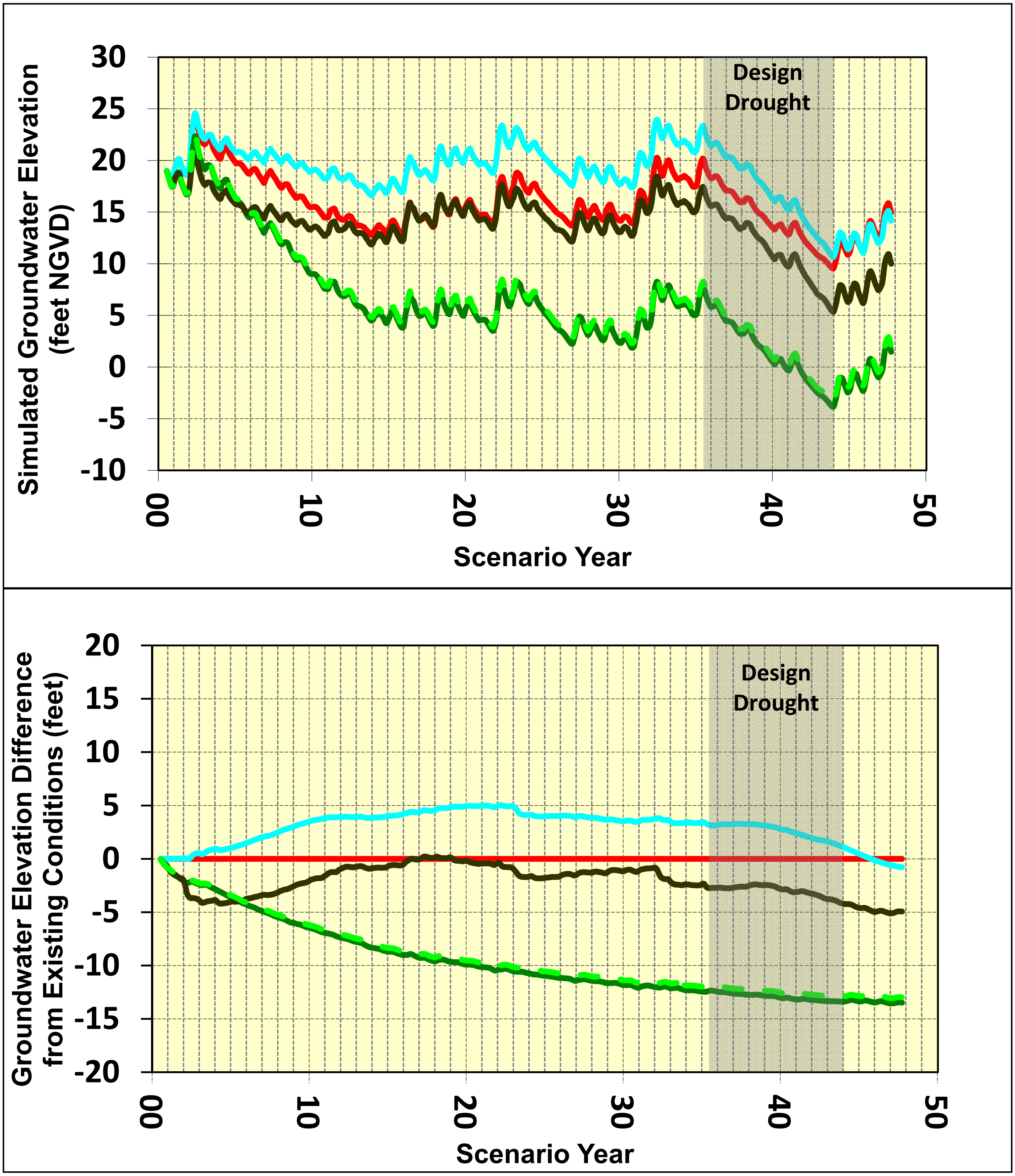
Figure 10.4-5b



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- **Scenario 1**
- **Scenario 2**
- **Scenario 3a**
- **Scenario 3b**
- **Scenario 4**

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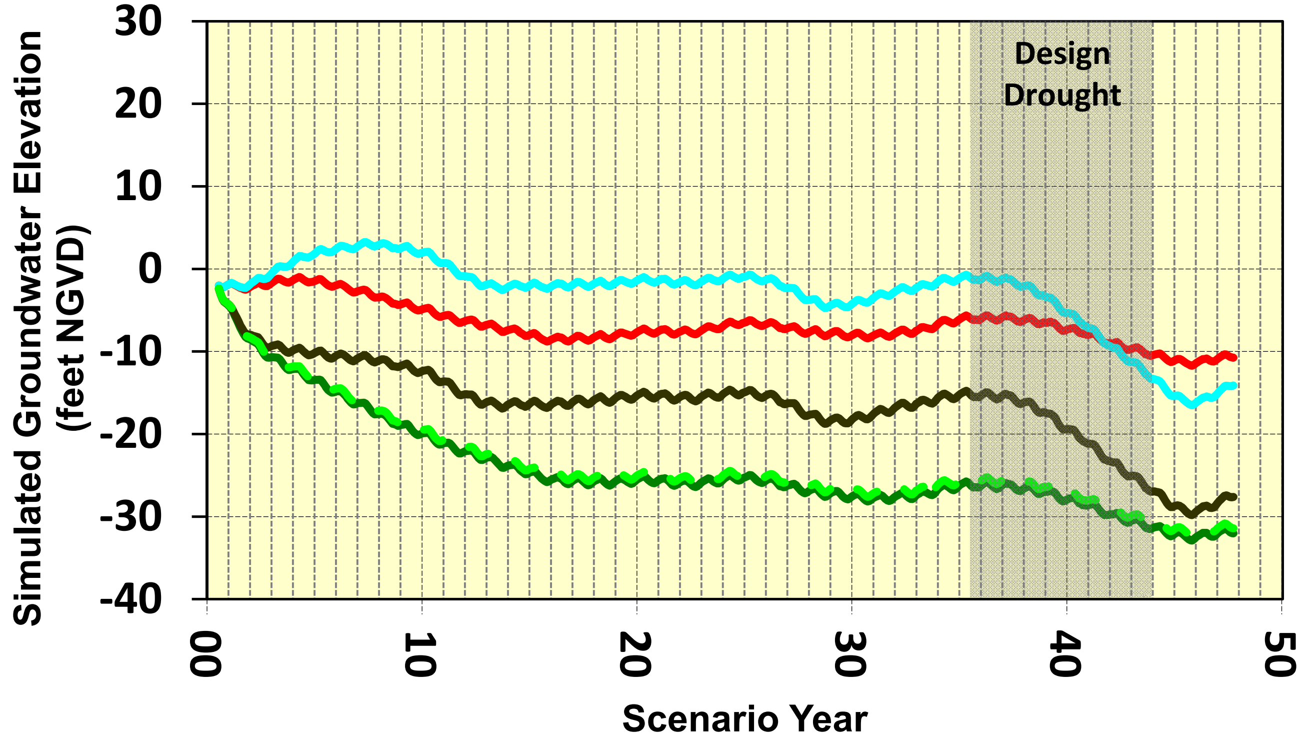
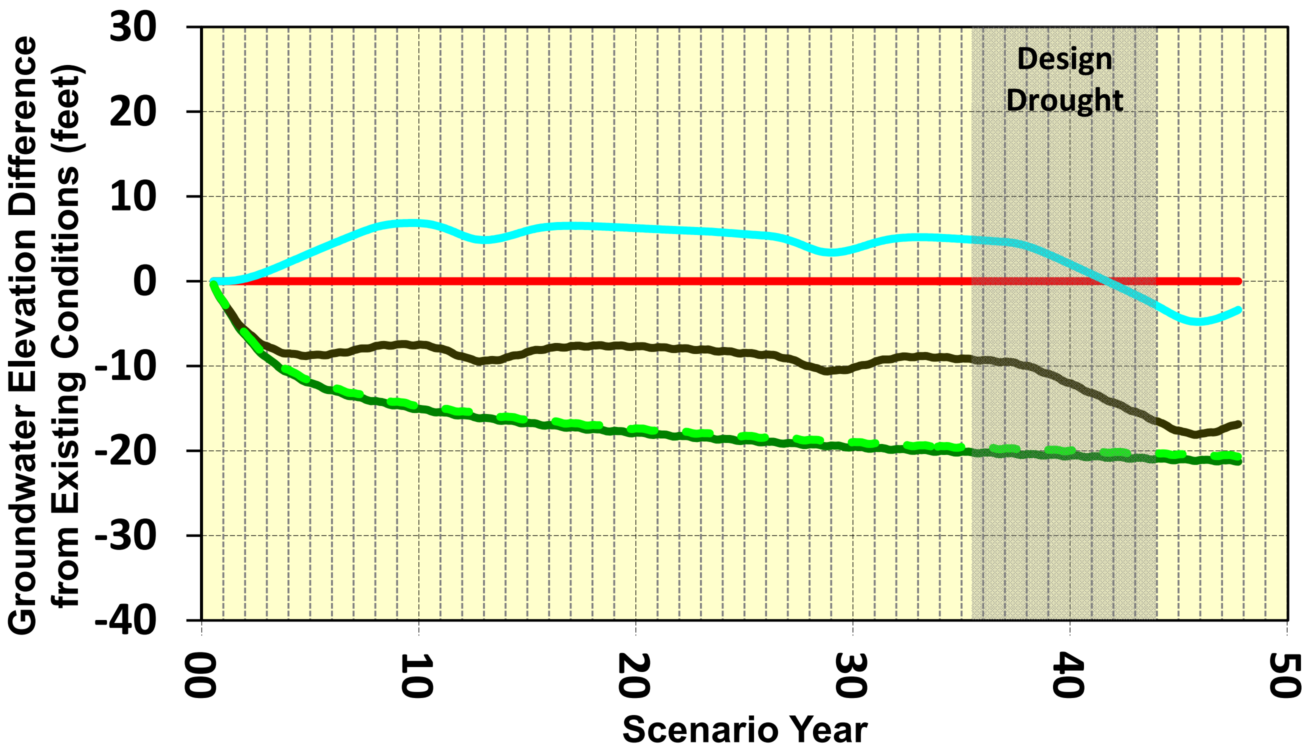
Model Layer 1 Hydrographs for LMMW-4S

K/J 0864001
April 2012

Figure 10.4-6a





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Regional Groundwater Storage and Recovery Project
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Model Layer 4 Hydrographs for LMMW-4S

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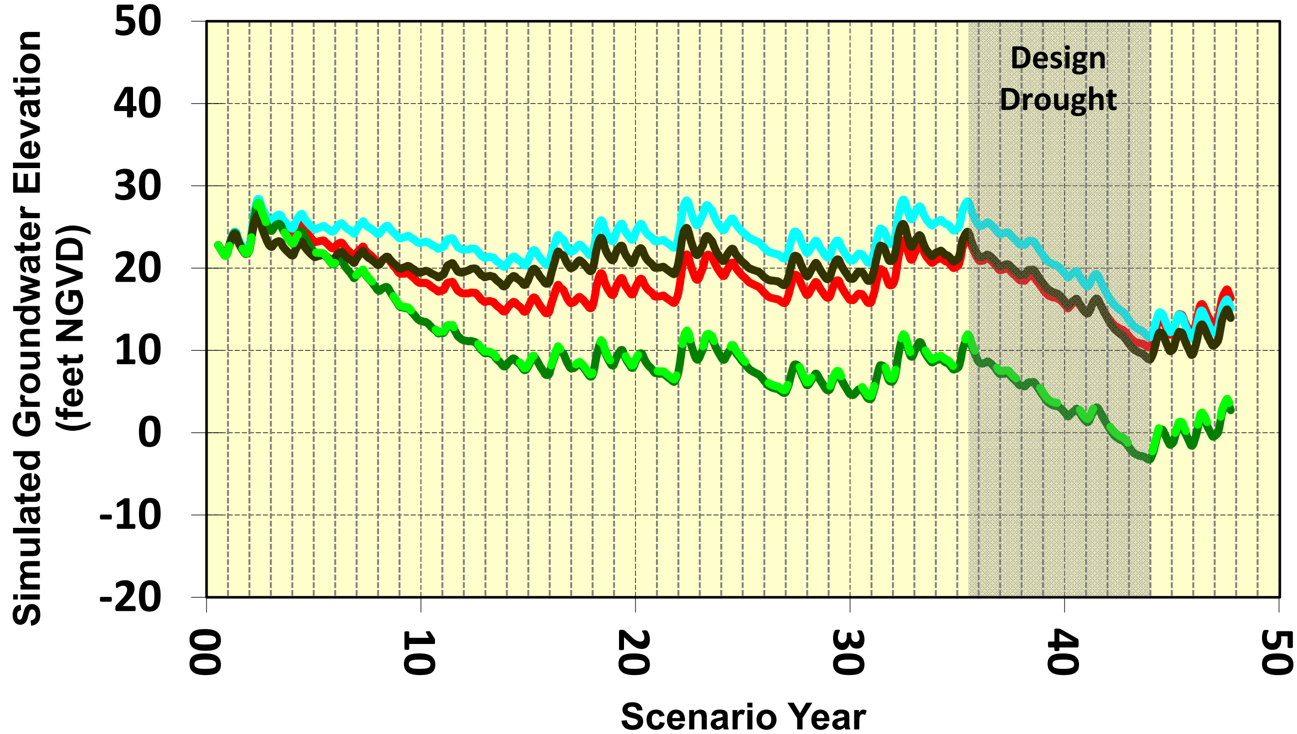
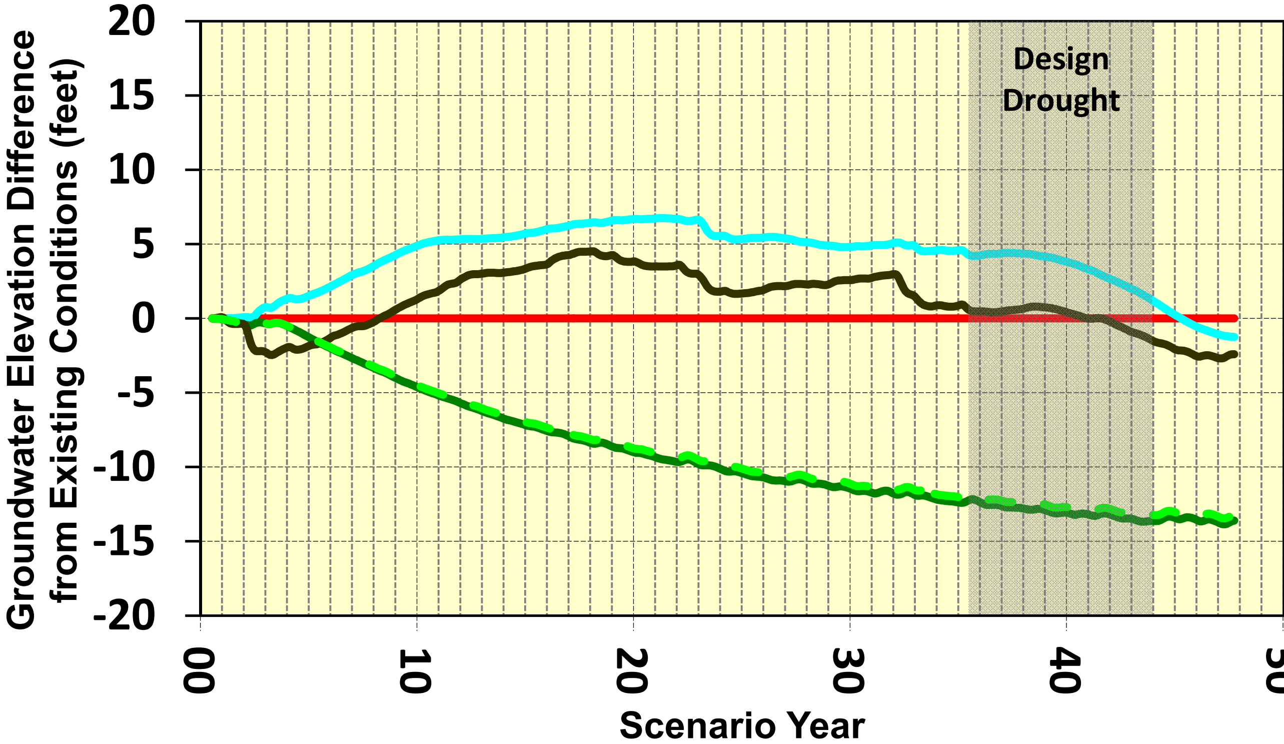
Figure 10.4-6b





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Regional Groundwater Storage and Recovery Project
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Model Layer 1 Hydrographs for Harding Park MW

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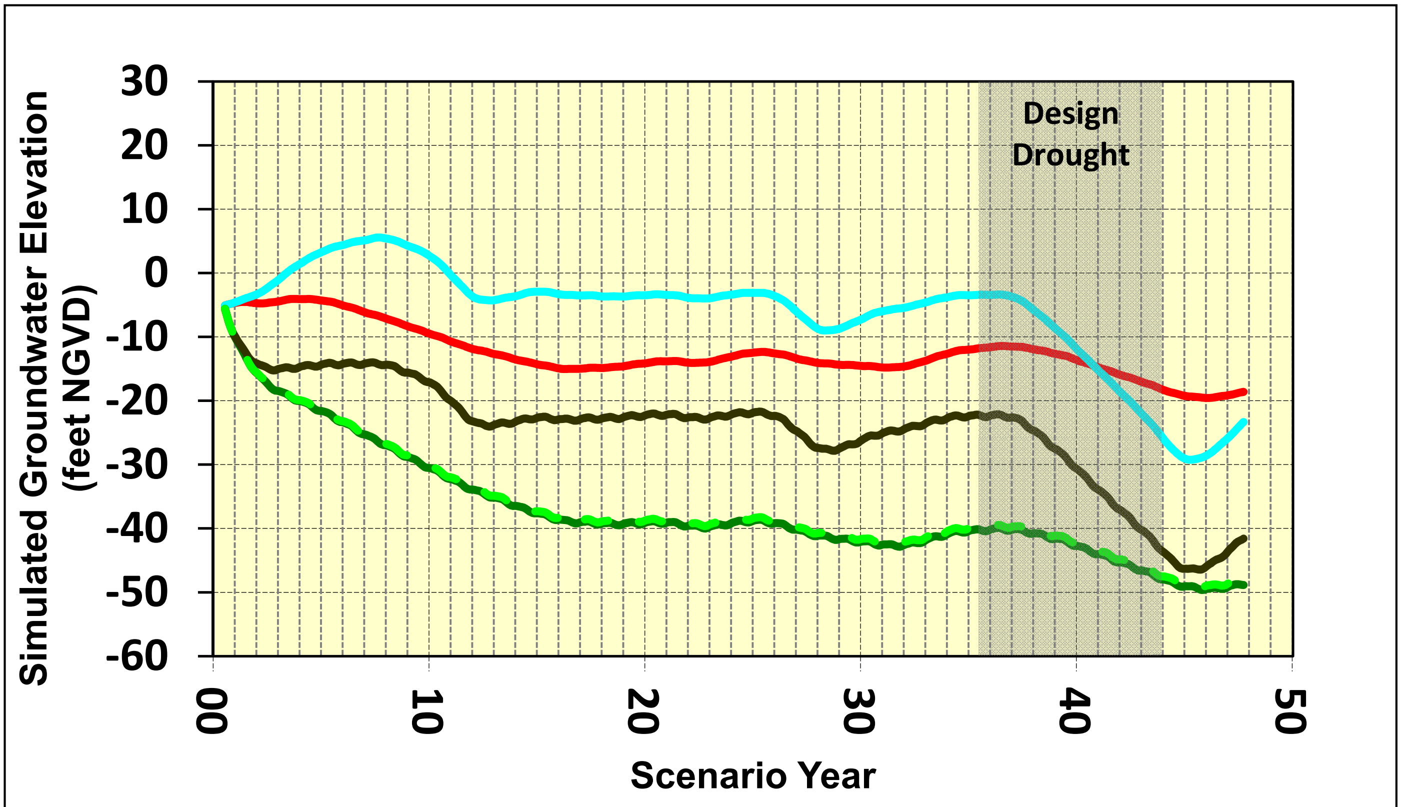
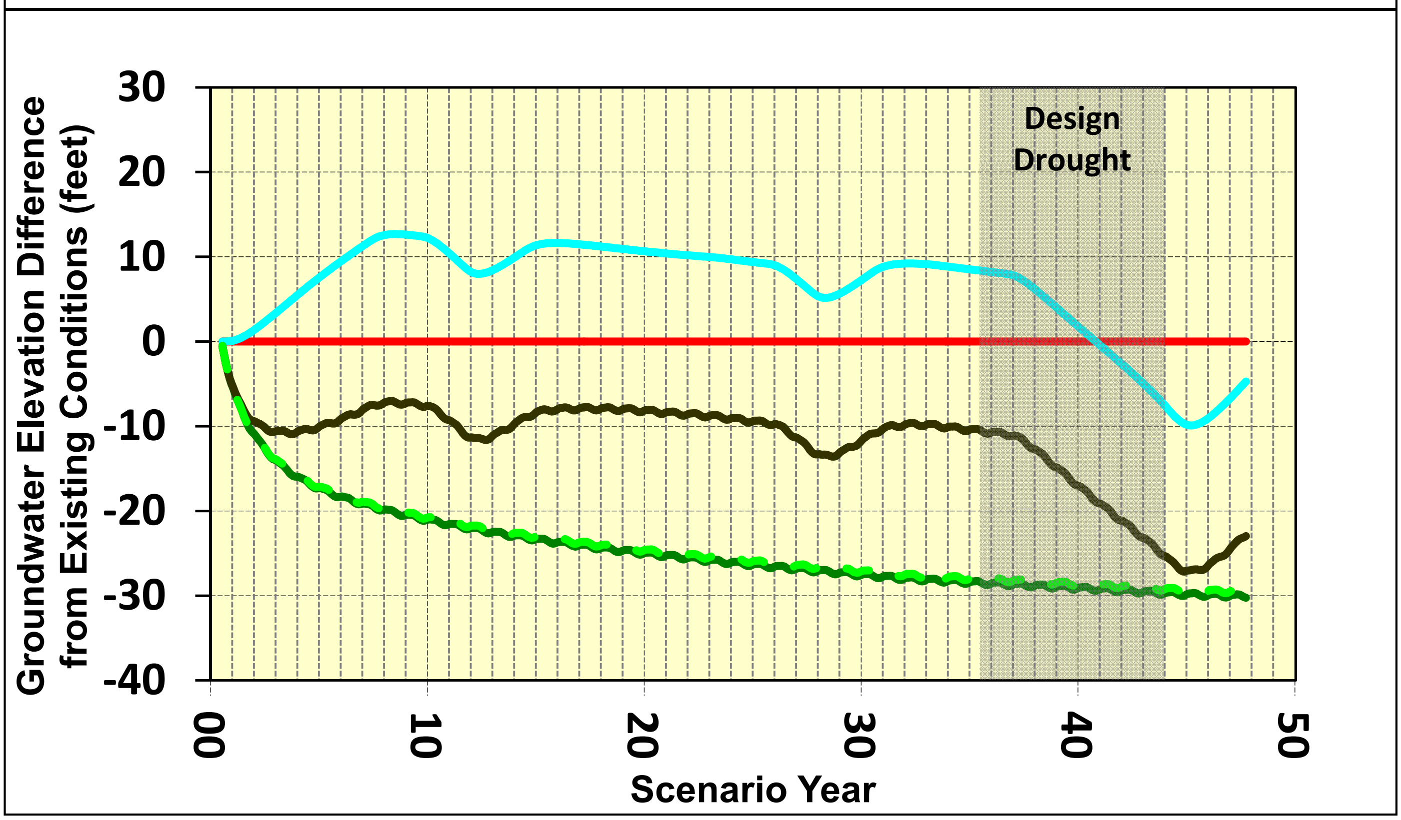
Figure 10.4-7a





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- **Scenario 1**
- **Scenario 2**
- **Scenario 3a**
- **Scenario 3b**
- **Scenario 4**

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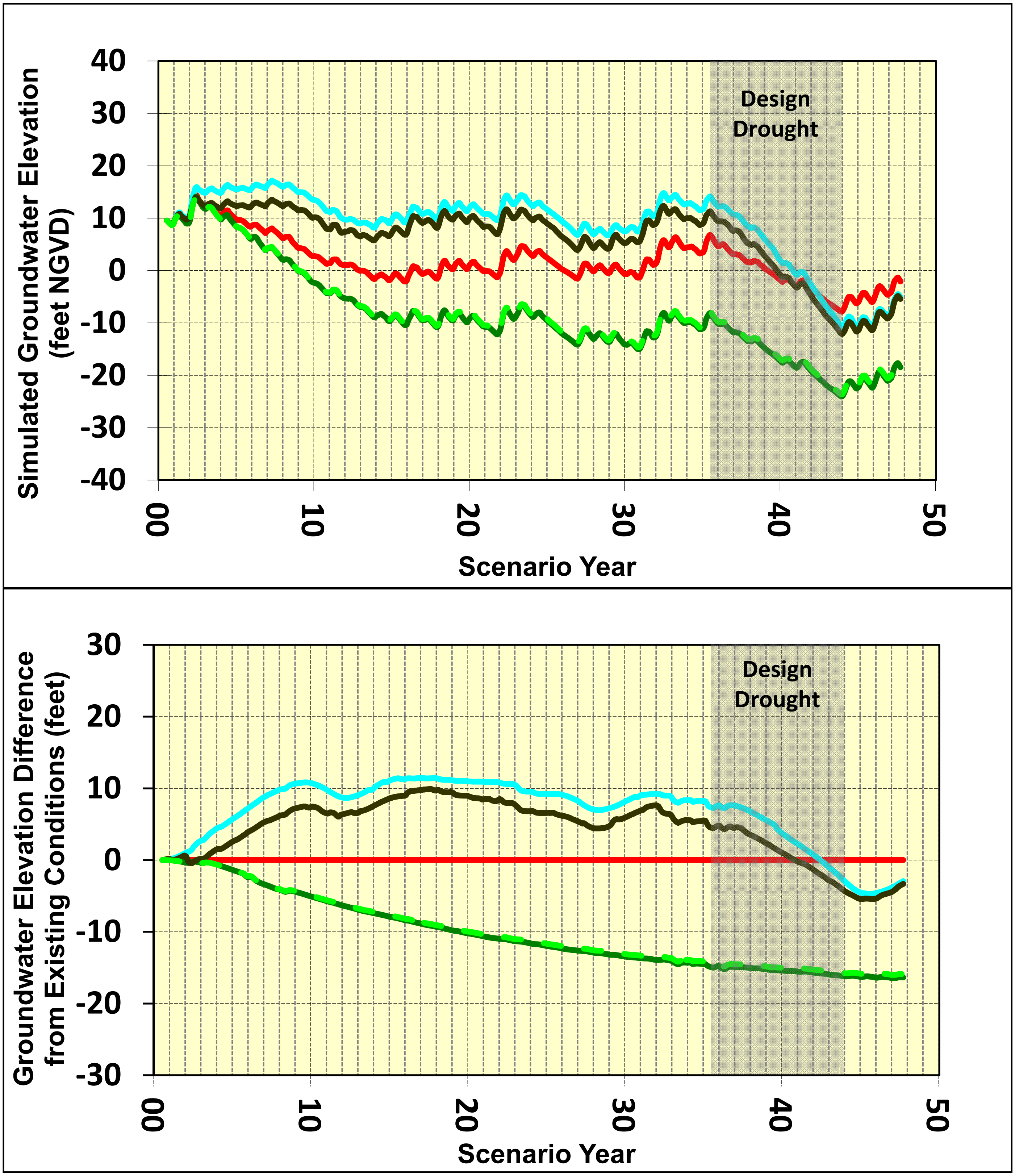
Model Layer 4 Hydrographs for Harding Park MW

K/J 0864001
April 2012

Figure 10.4-7b



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- **Scenario 1**
- **Scenario 2**
- **Scenario 3a**
- **Scenario 3b**
- **Scenario 4**

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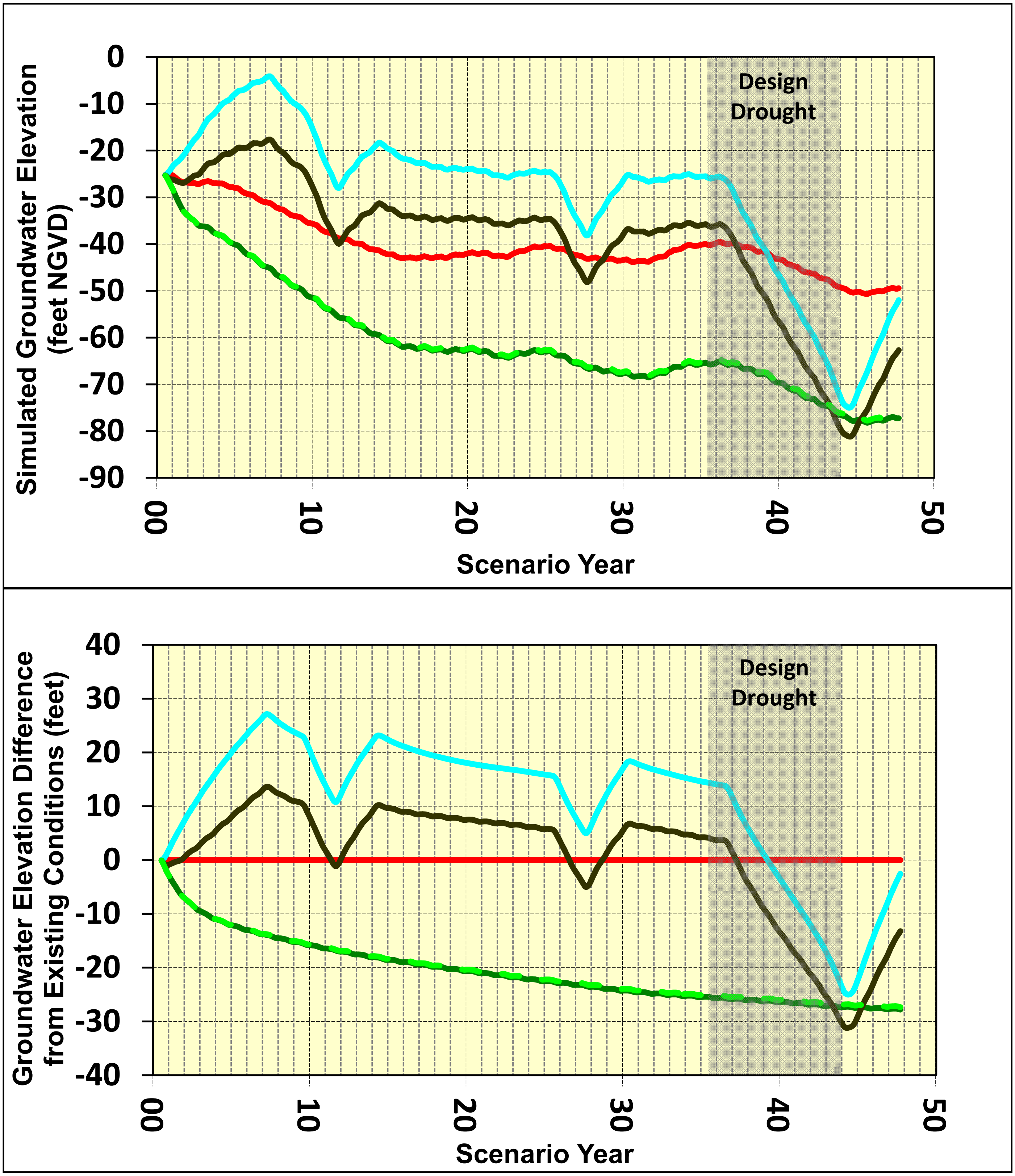
Model Layer 1 Hydrographs for Olympic MW

K/J 0864001
April 2012

Figure 10.4-8a



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Model Layer 4 Hydrographs for Olympic MW

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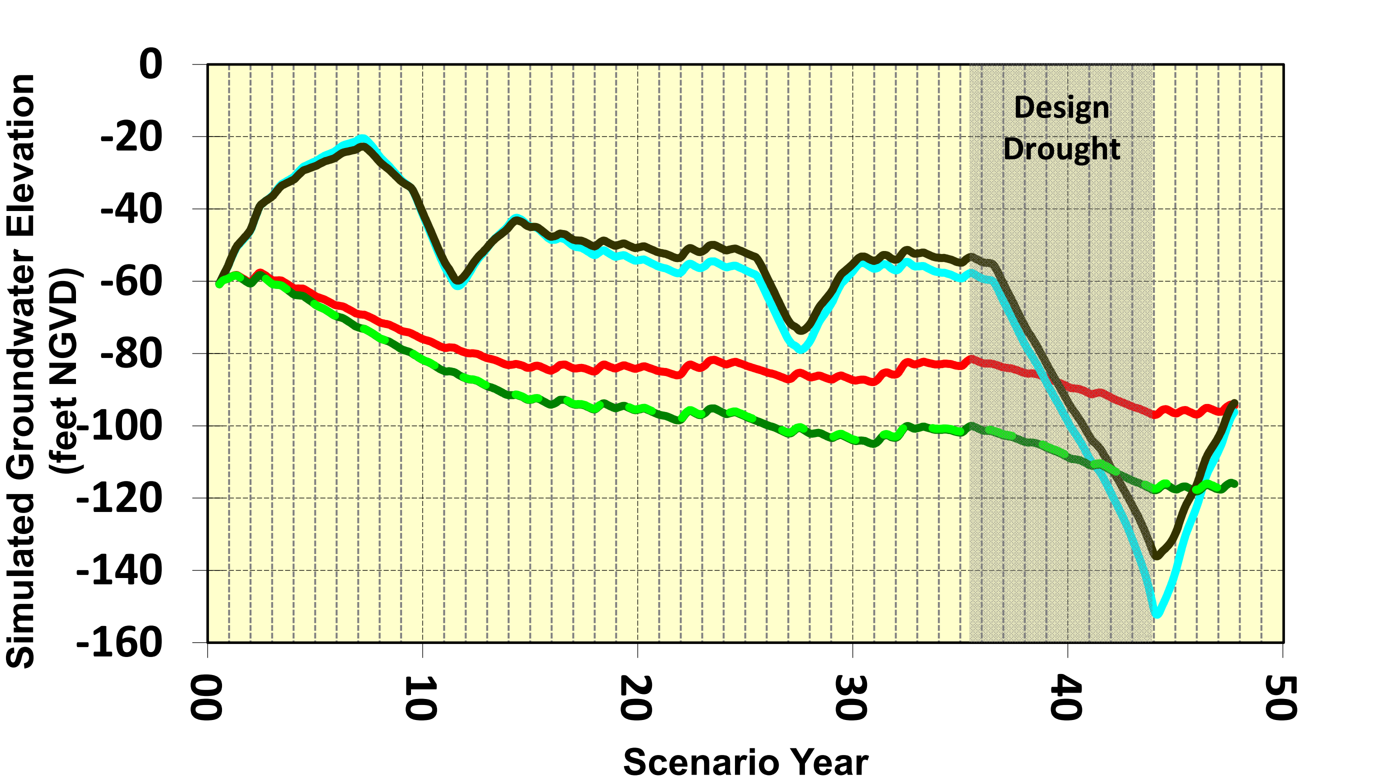
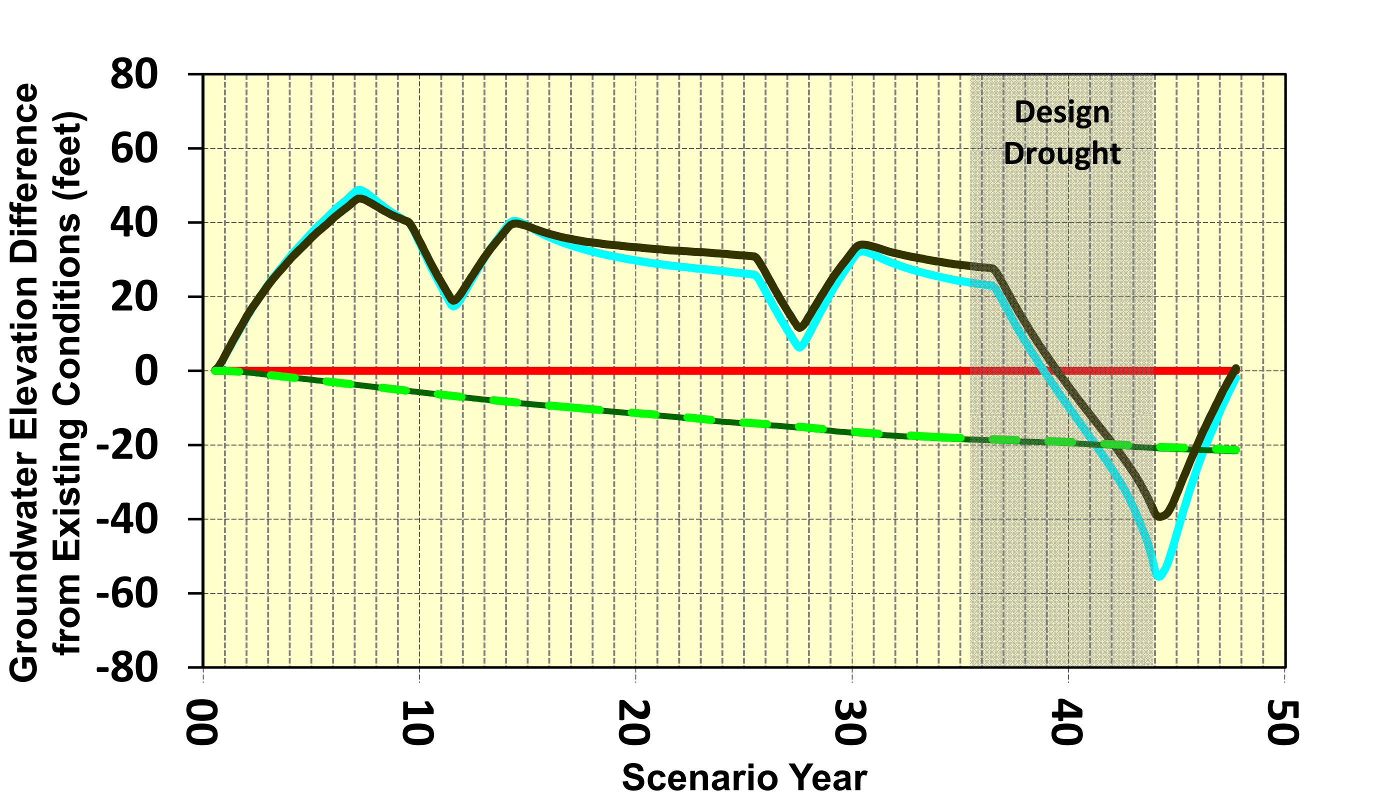
April 2012

Figure 10.4-8b





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Model Layer 1 Hydrographs for DC-3

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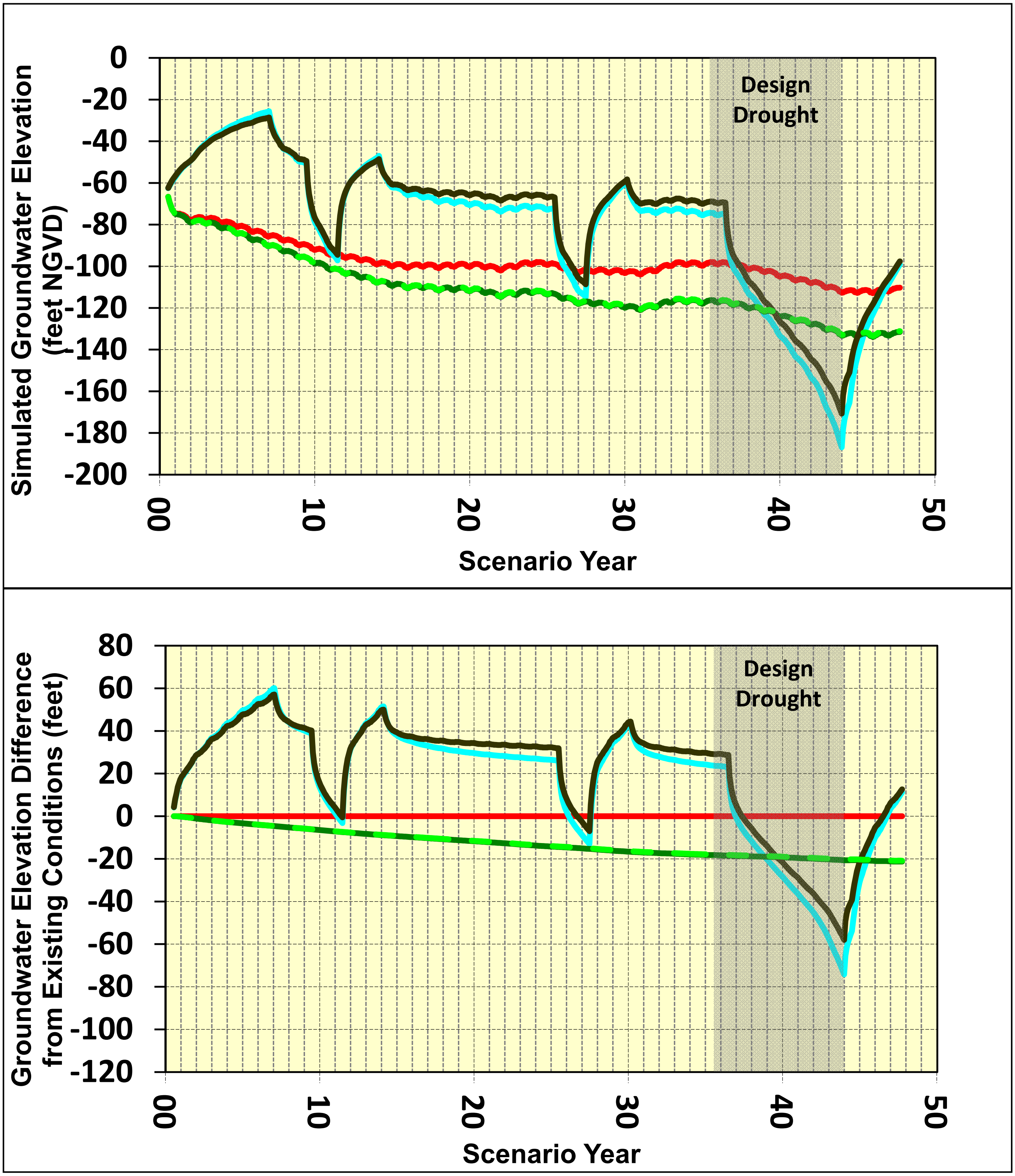
April 2012

Figure 10.4-9a



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Regional Groundwater Storage and Recovery Project
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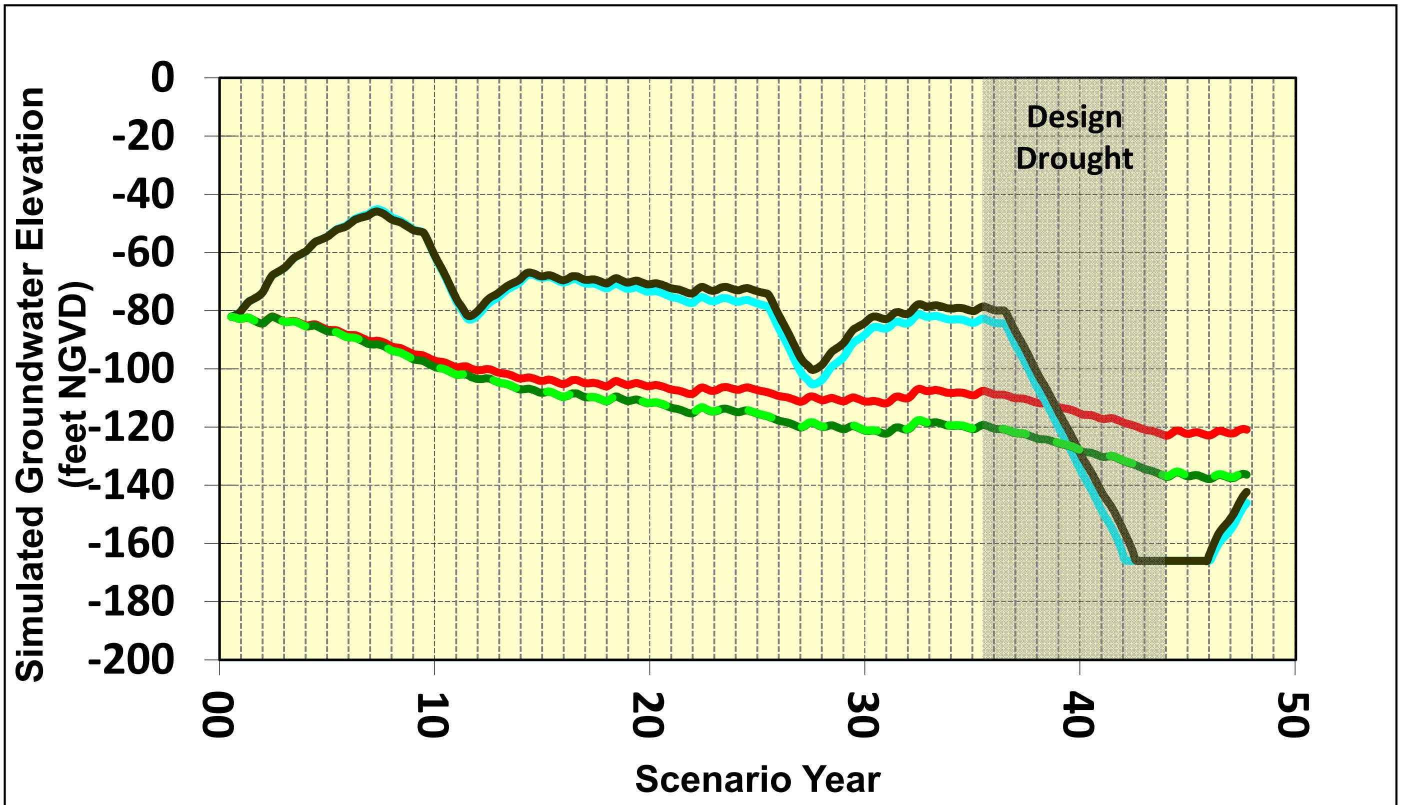
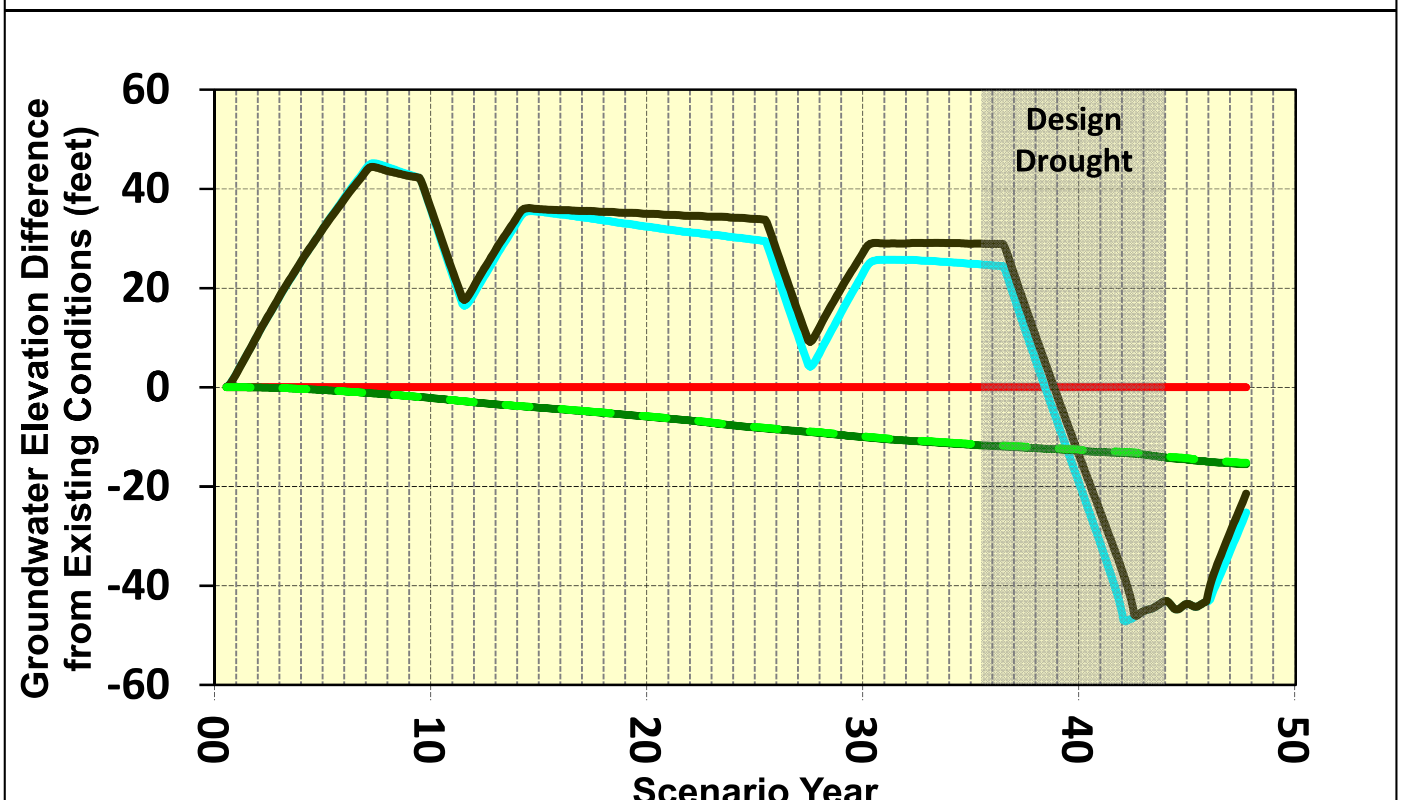
Model Layer 4 Hydrographs for DC-3

K/J 0864001
April 2012

Figure 10.4-9b





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:
- **Scenario 1**
- **Scenario 2**
- **Scenario 3a**
- **Scenario 3b**
- **Scenario 4**

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Model Layer 1 Hydrographs for DC-A-St

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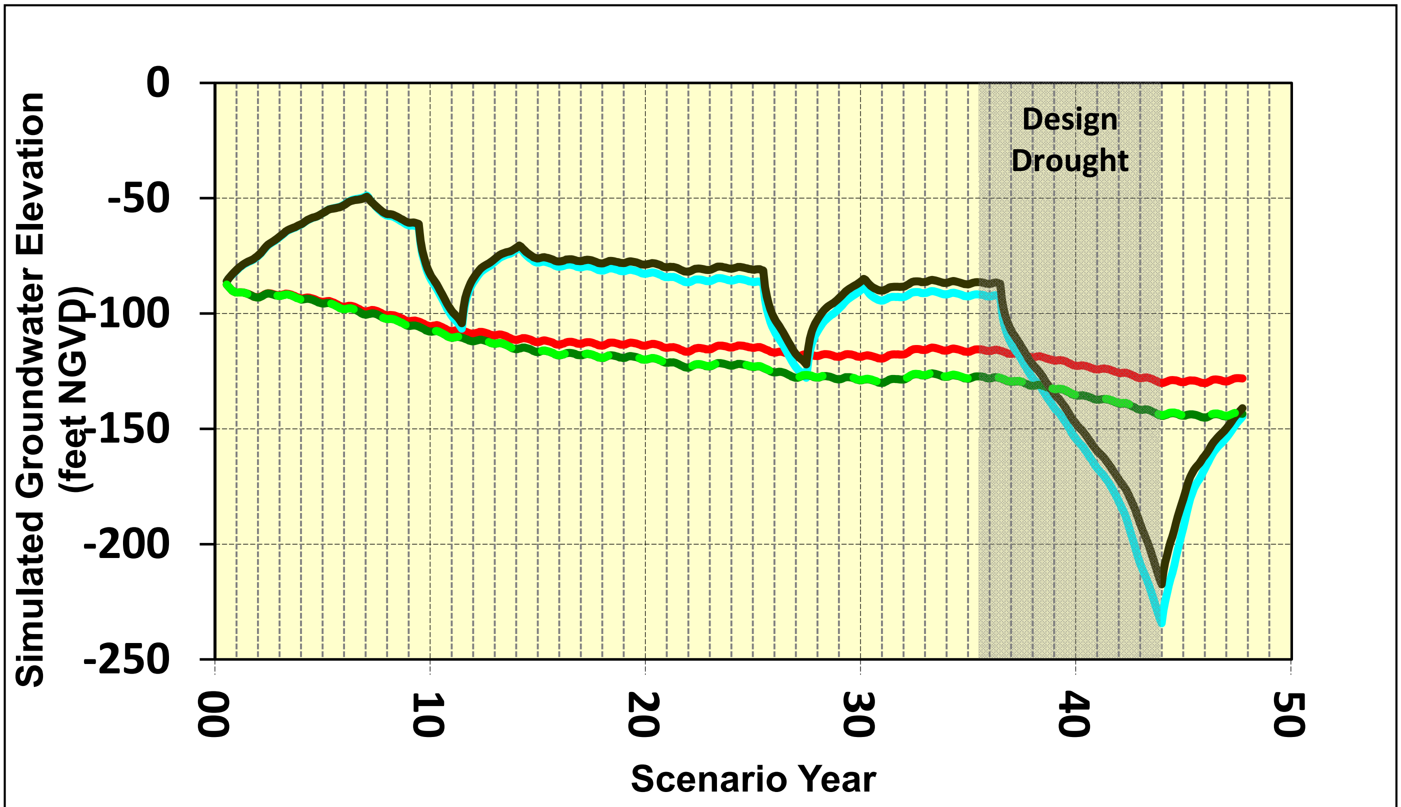
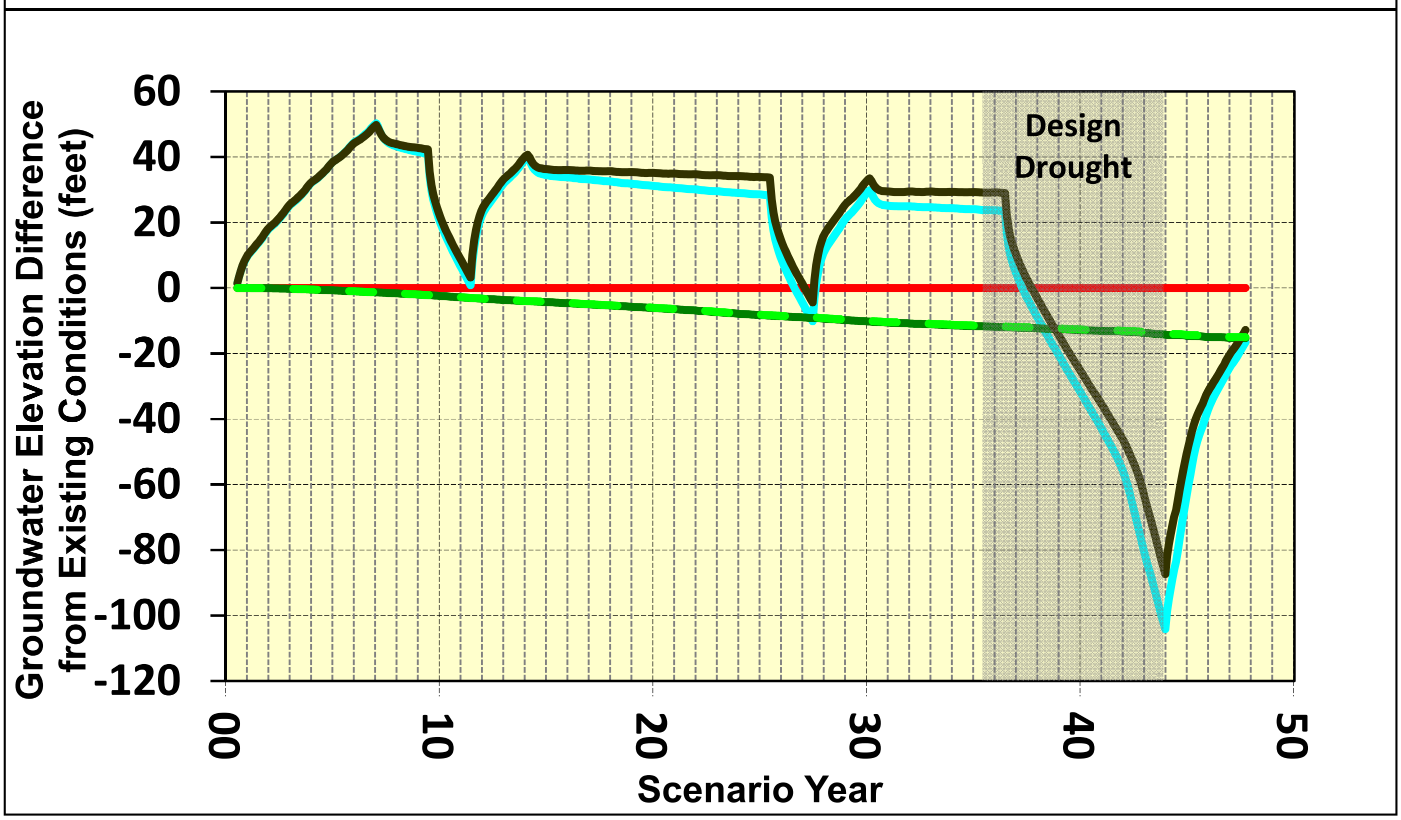
April 2012
Figure 10.4-10a





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

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Model Layer 4 Hydrographs for DC-A-St

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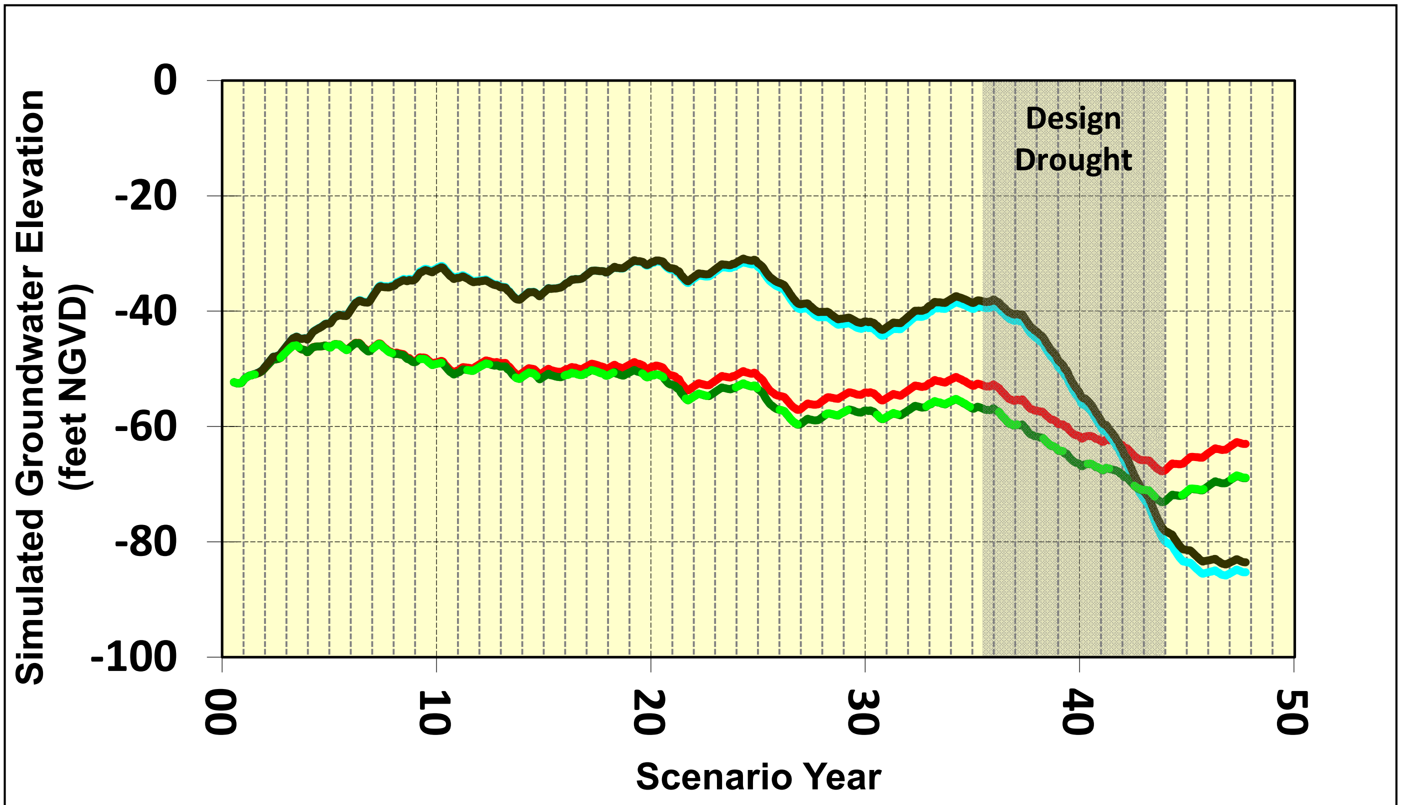
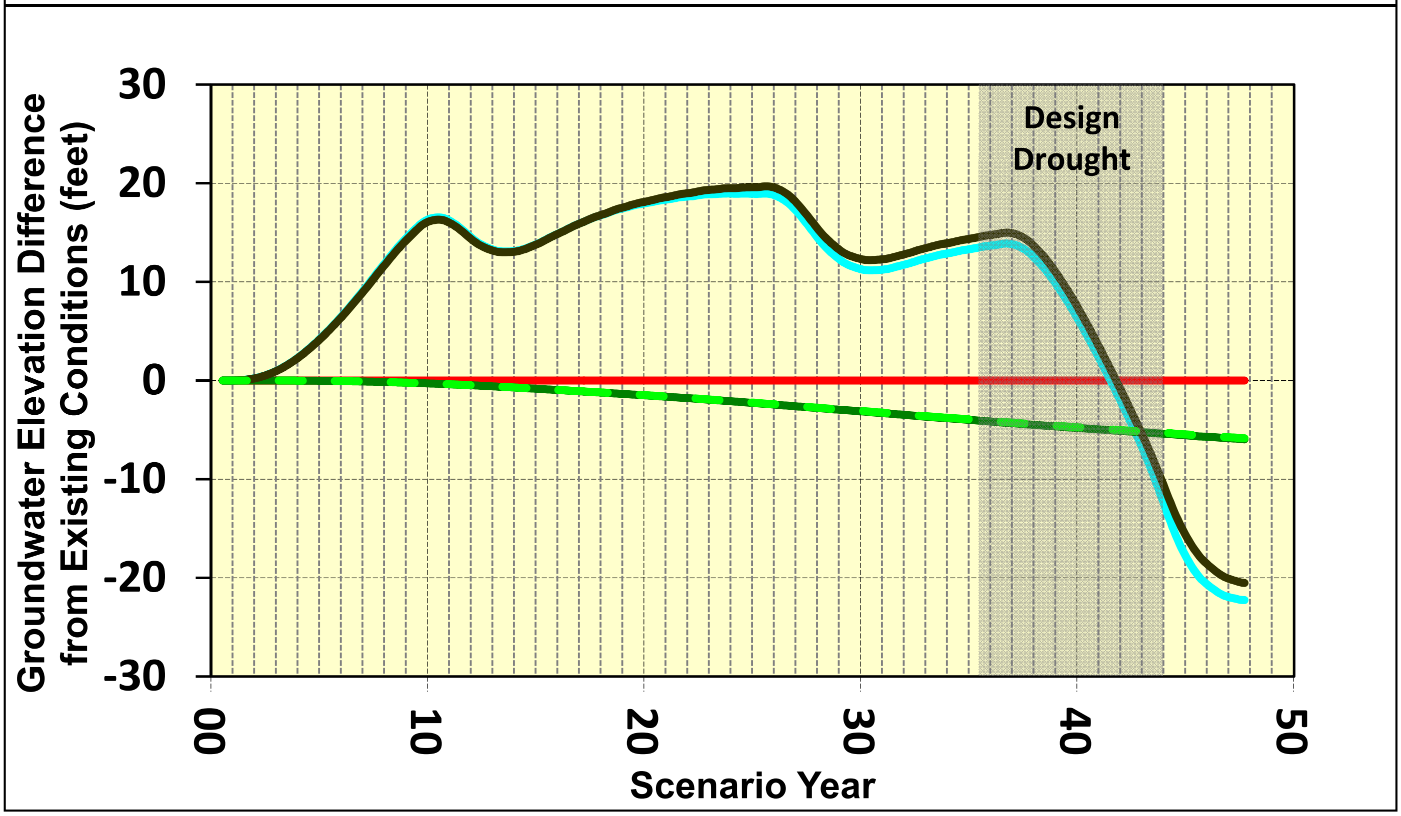
Figure 10.4-10b





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

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Model Layer 1 Hydrographs for Cypress Lawn 2

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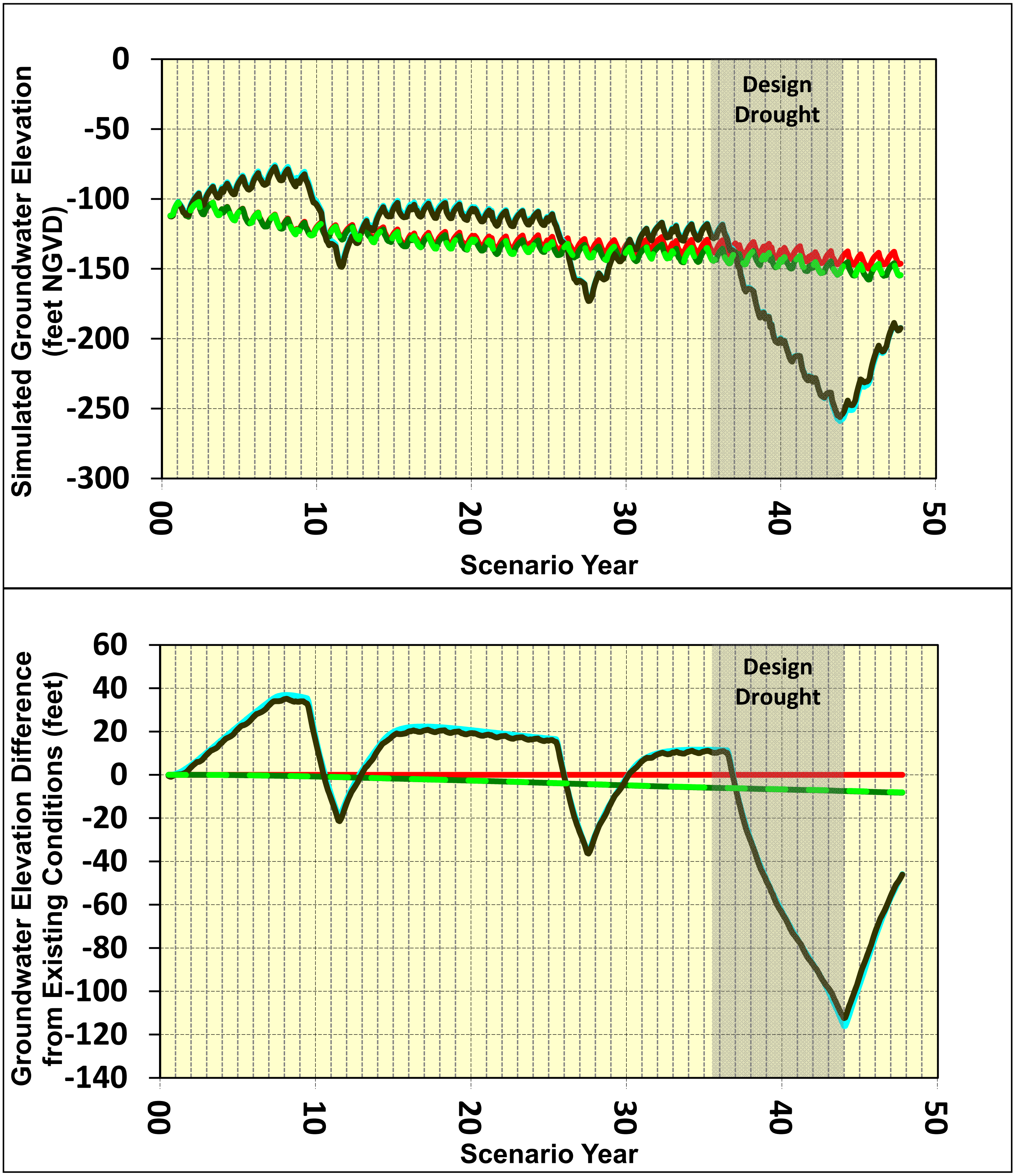
April 2012

Figure 10.4-11a



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

Scenario 1 | Scenario 2
Scenario 3a | Scenario 3b | Scenario 4

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and San Francisco Groundwater Supply Project
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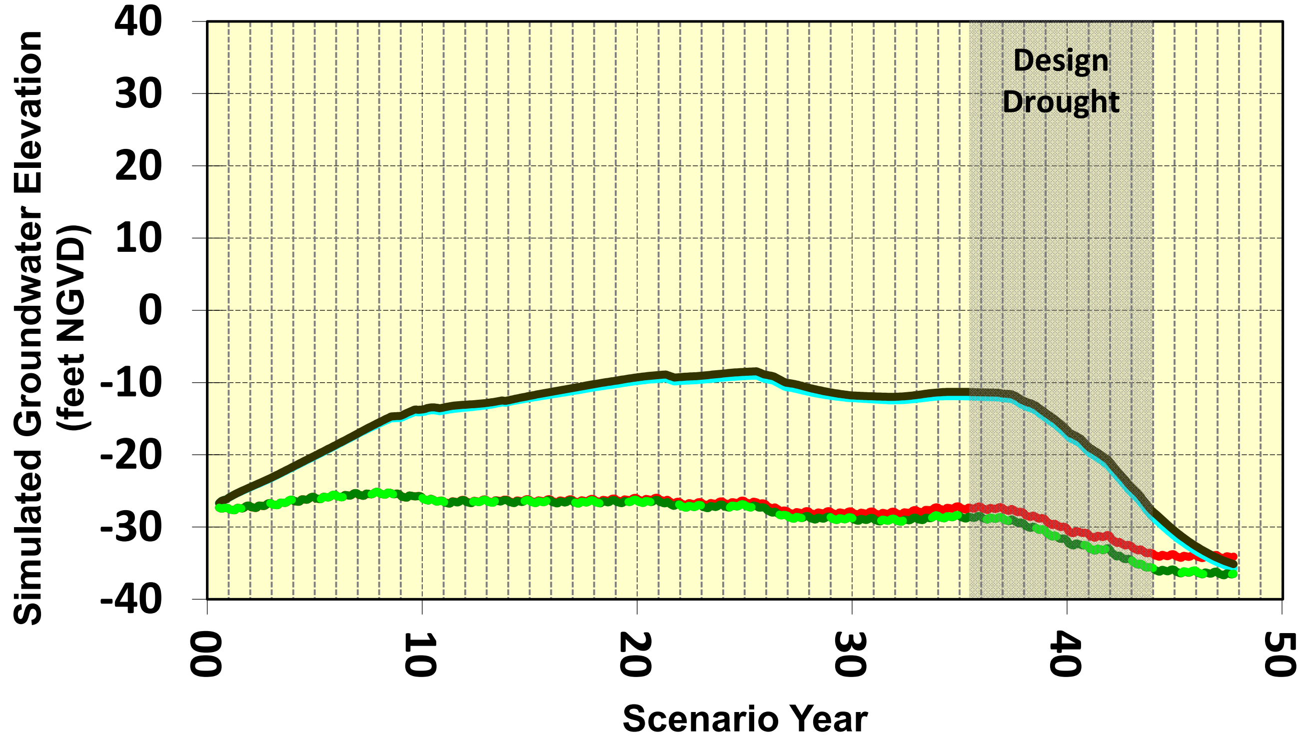
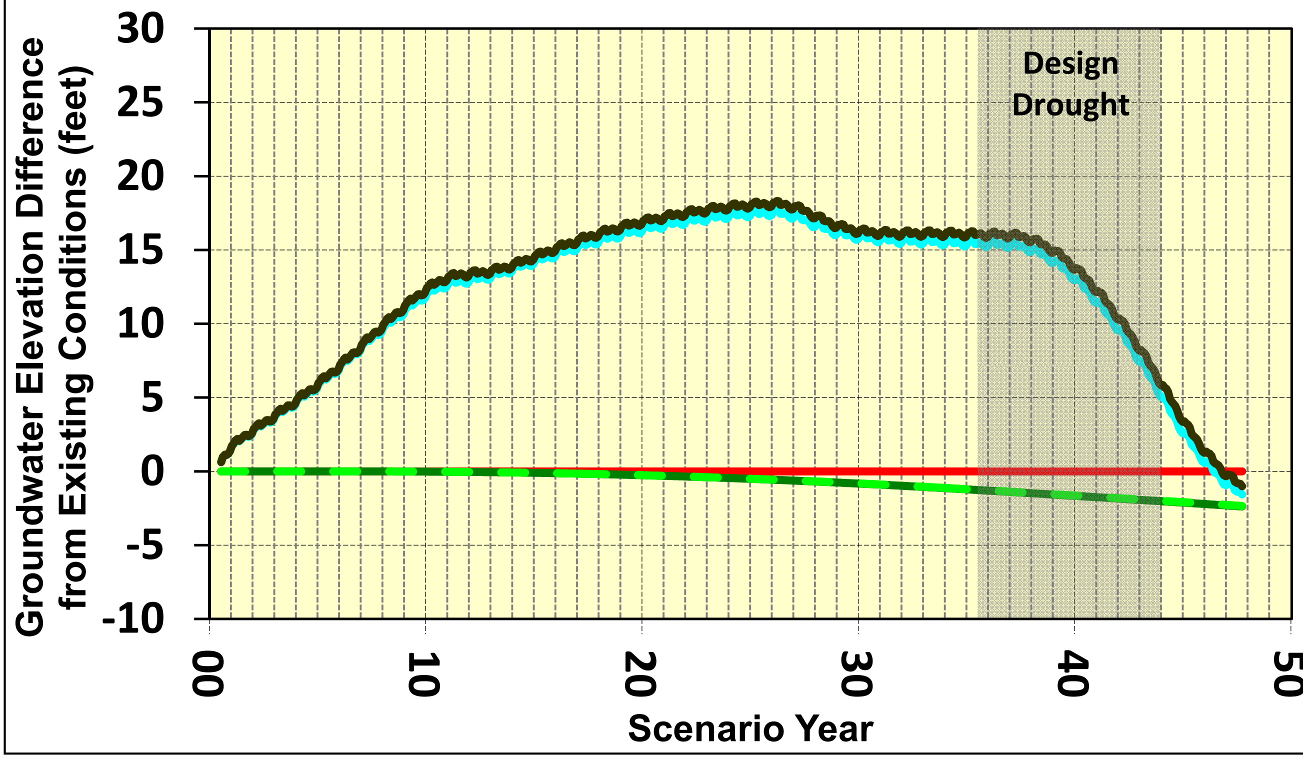
Model Layer 4 Hydrographs for Cypress Lawn 2

K/J 0864001
April 2012

Figure 10.4-11b





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- **Scenario 1**
- **Scenario 2**
- **Scenario 3a**
- **Scenario 3b**
- **Scenario 4**

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Model Layer 1 Hydrographs for SSF-02

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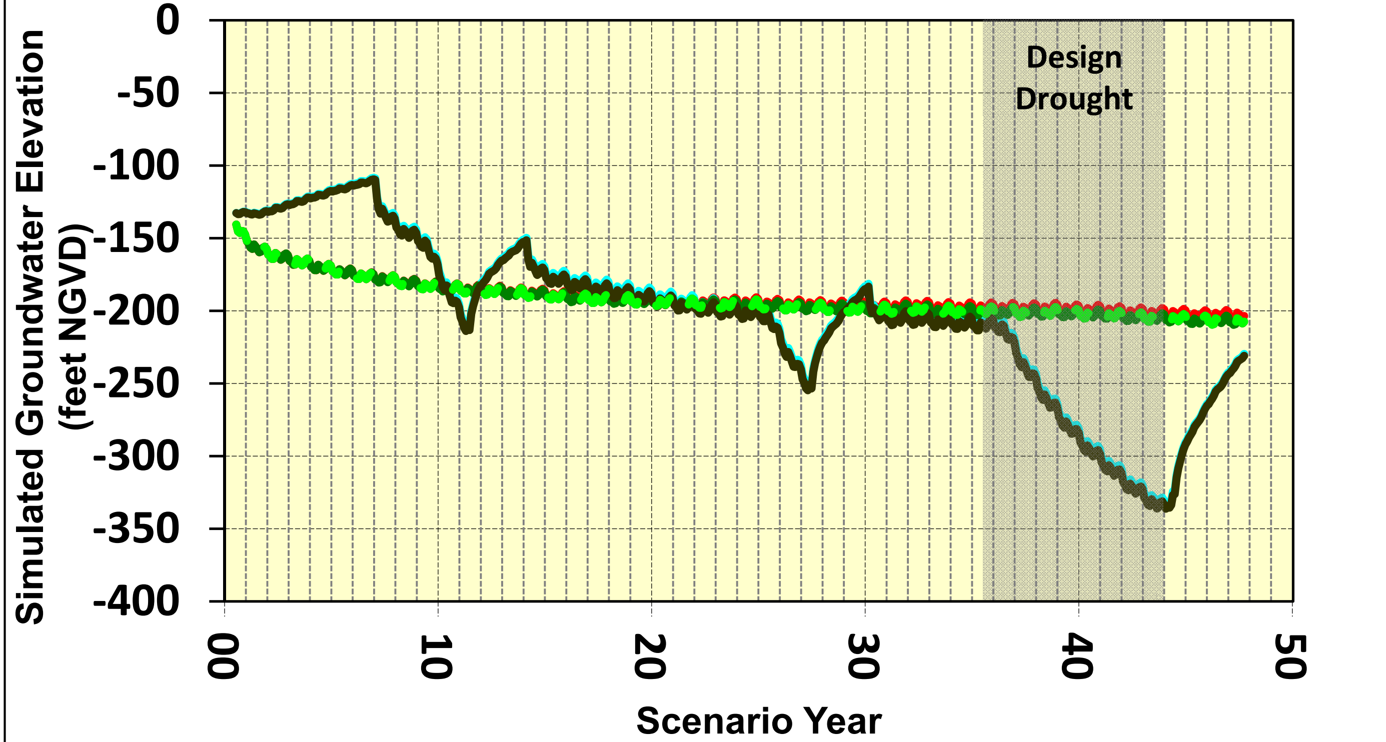
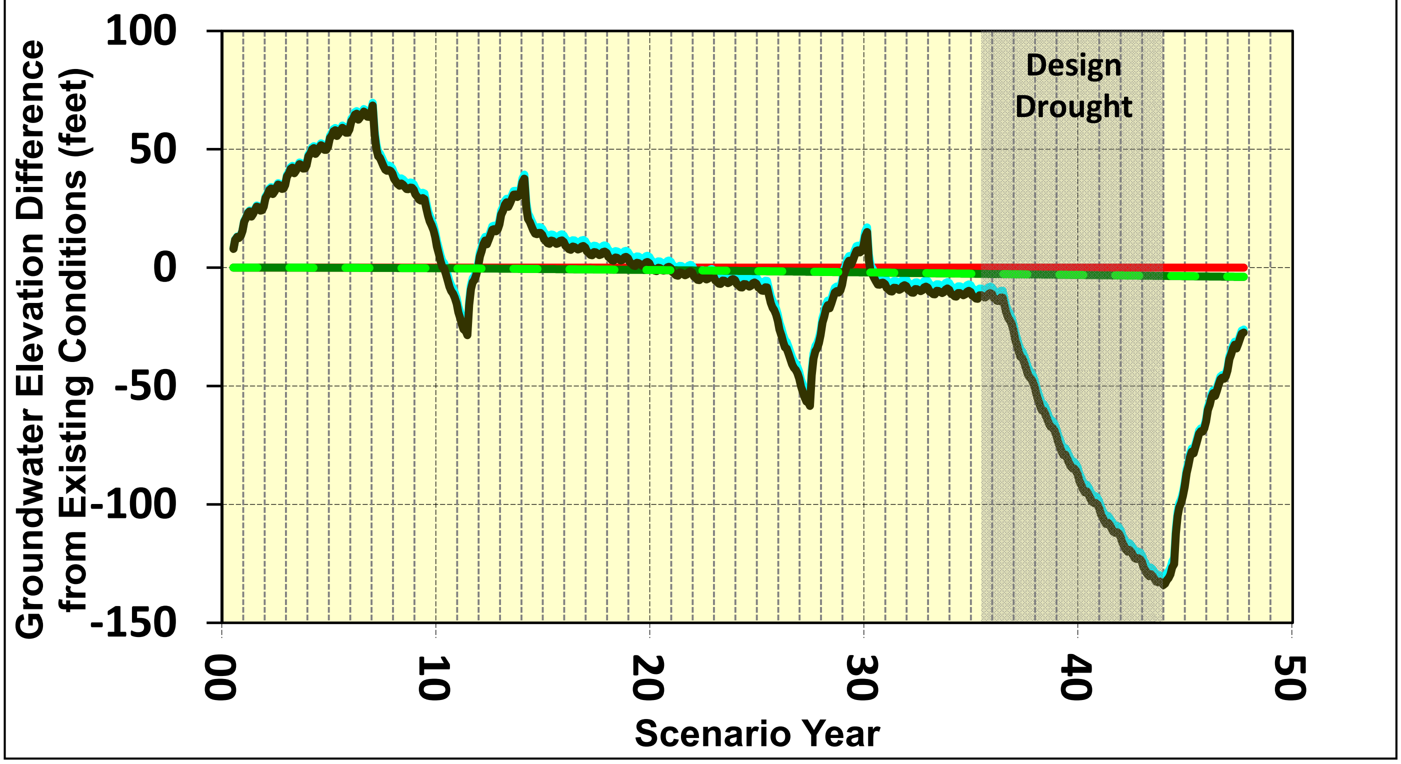
Figure 10.4-12a





Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:
- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Model Layer 4 Hydrographs for SSF-02

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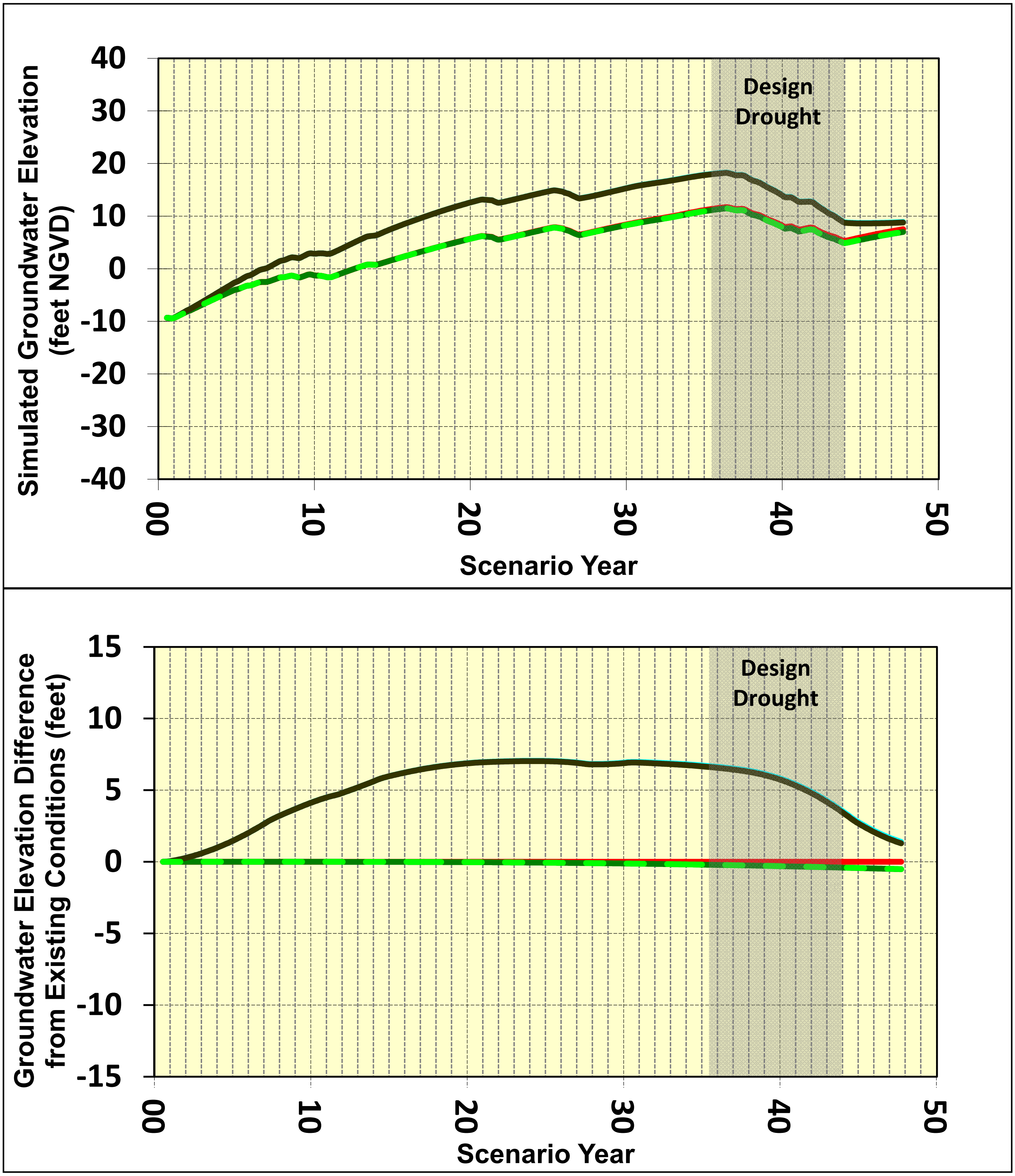
Figure 10.4-12b



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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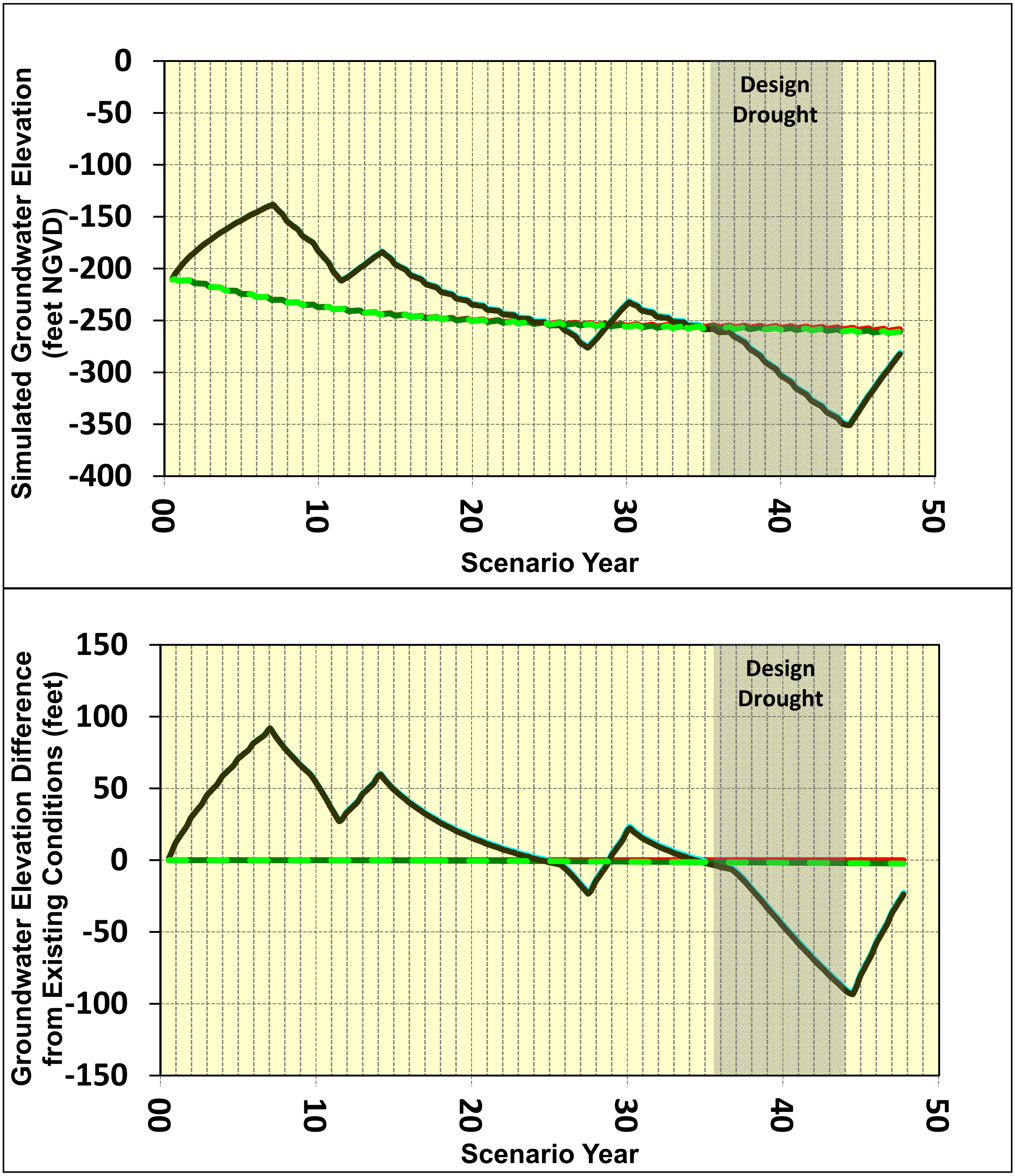
Model Layer 1 Hydrographs for SB-12

K/J 0864001
April 2012
Figure 10.4-13a



Note: Mean sea level is equivalent to zero feet NGVD.

Model Heads:

- Scenario 1
- Scenario 2
- Scenario 3a
- Scenario 3b
- Scenario 4

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Model Layer 4 Hydrographs for SB-12

K/J 0864001
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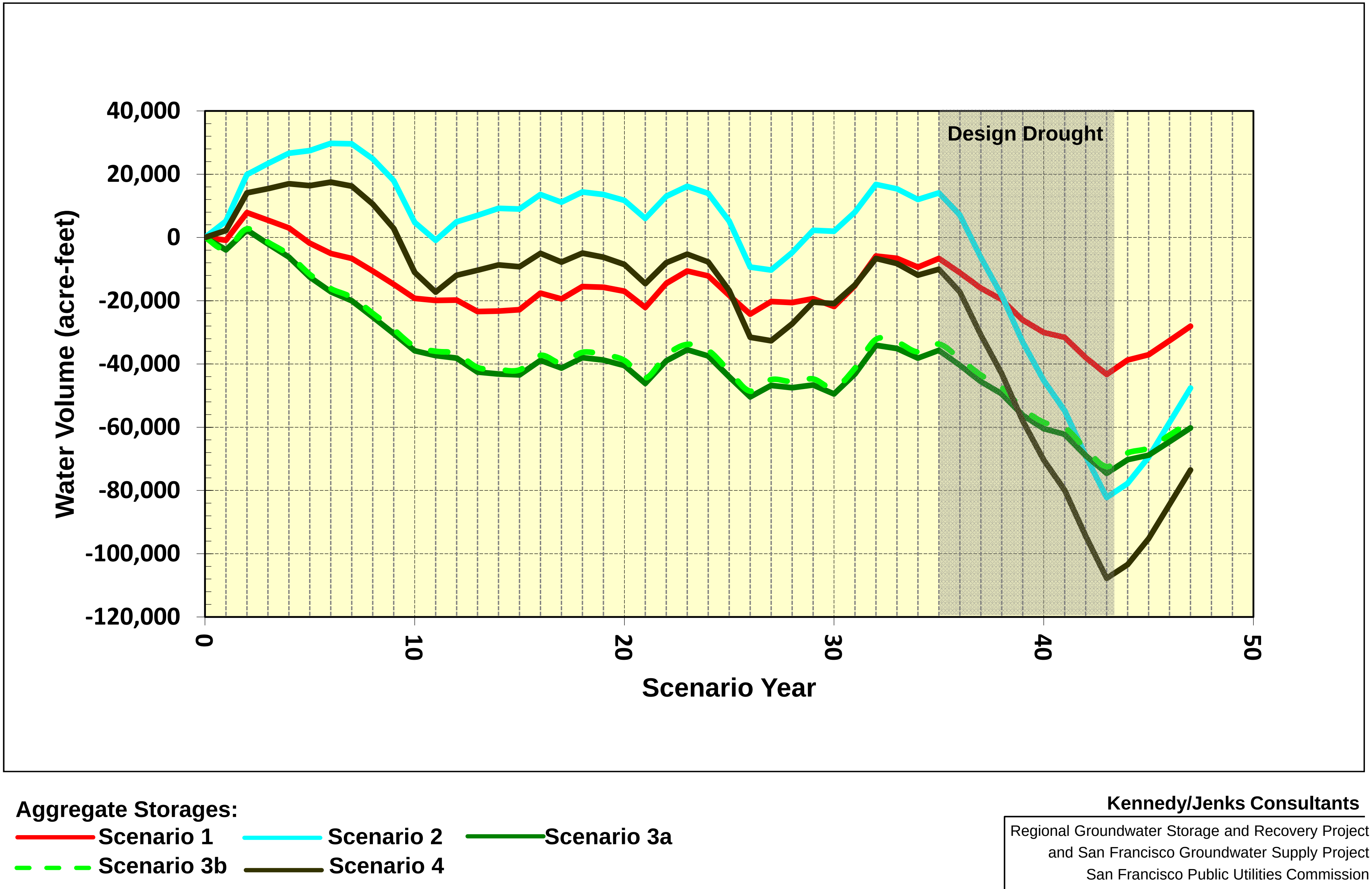
Figure 10.4-13b



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San Francisco Public Utilities Commission

Model-Simulated Aggregate Change in Groundwater Storage

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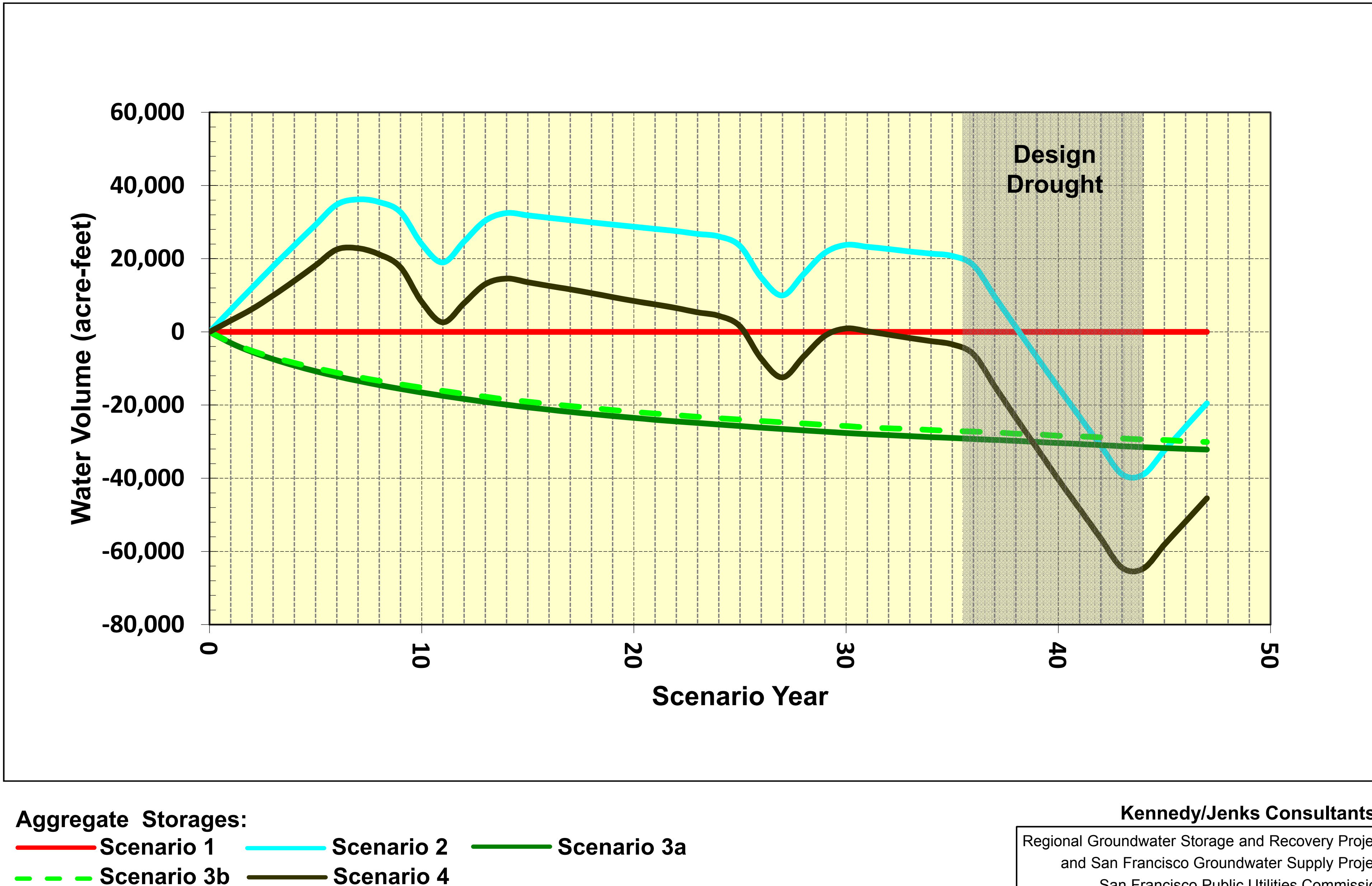
Figure 10.4-14



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Model-Simulated Cumulative Change in Groundwater Storage Relative to Existing Conditions

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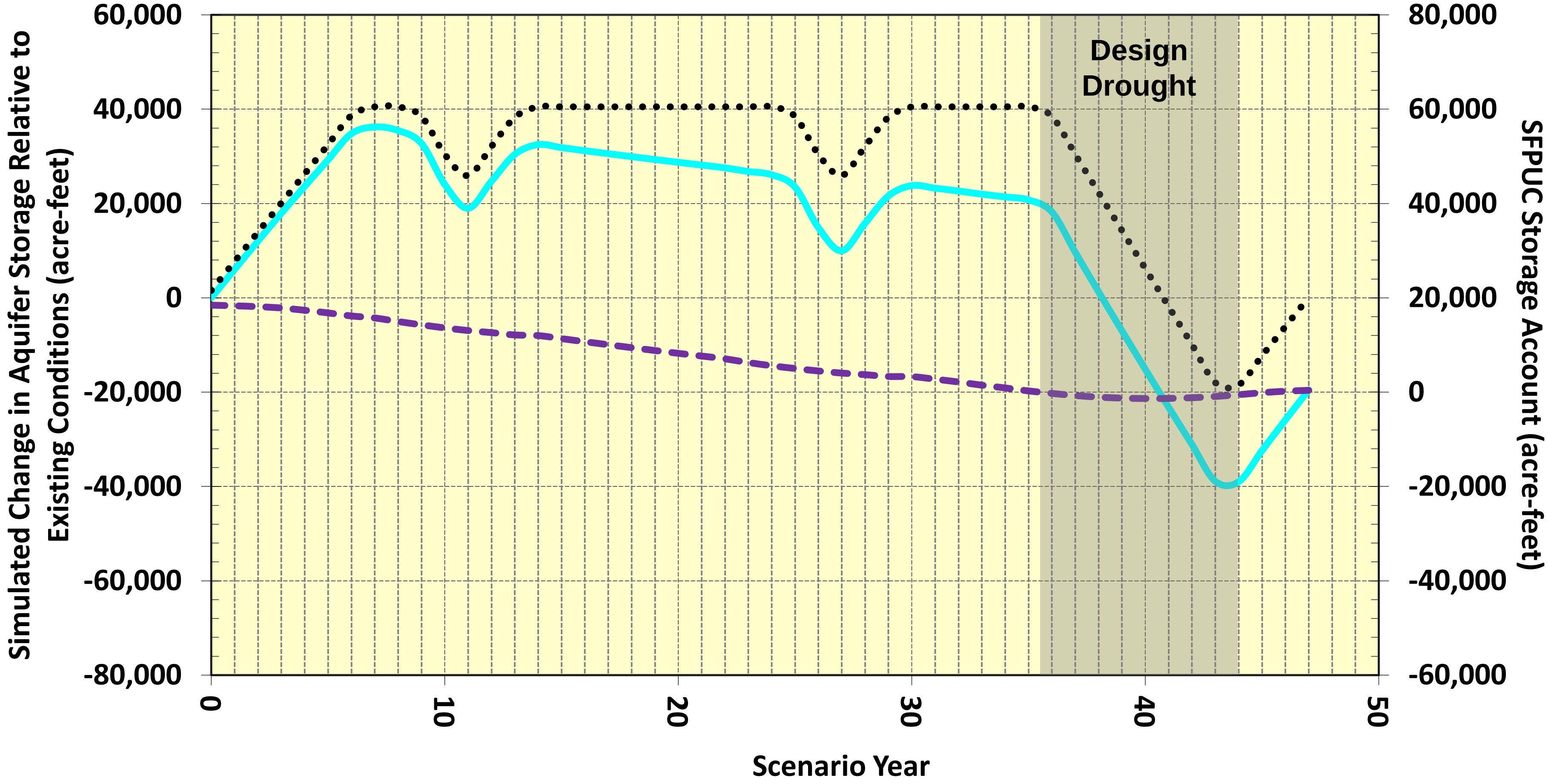
Figure 10.4-15



Note: SFPUC Storage Account axis is offset by 20,000 acre-feet relative to the Aquifer Storage axis to account for the 20,000 acre-feet in the SFPUC Storage Account at the start of the Scenario 2 simulation.

Legend:

- Water in SFPUC Storage Account (right-hand axis)
- Scenario 2 Simulated Aquifer Storage Relative to Scenario 1 (Existing Conditions)
- Difference between SFPUC Storage Account and Scenario 2 Aquifer Storage

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Comparison of SFPUC Storage Account to Groundwater Storage Relative to Existing Conditions

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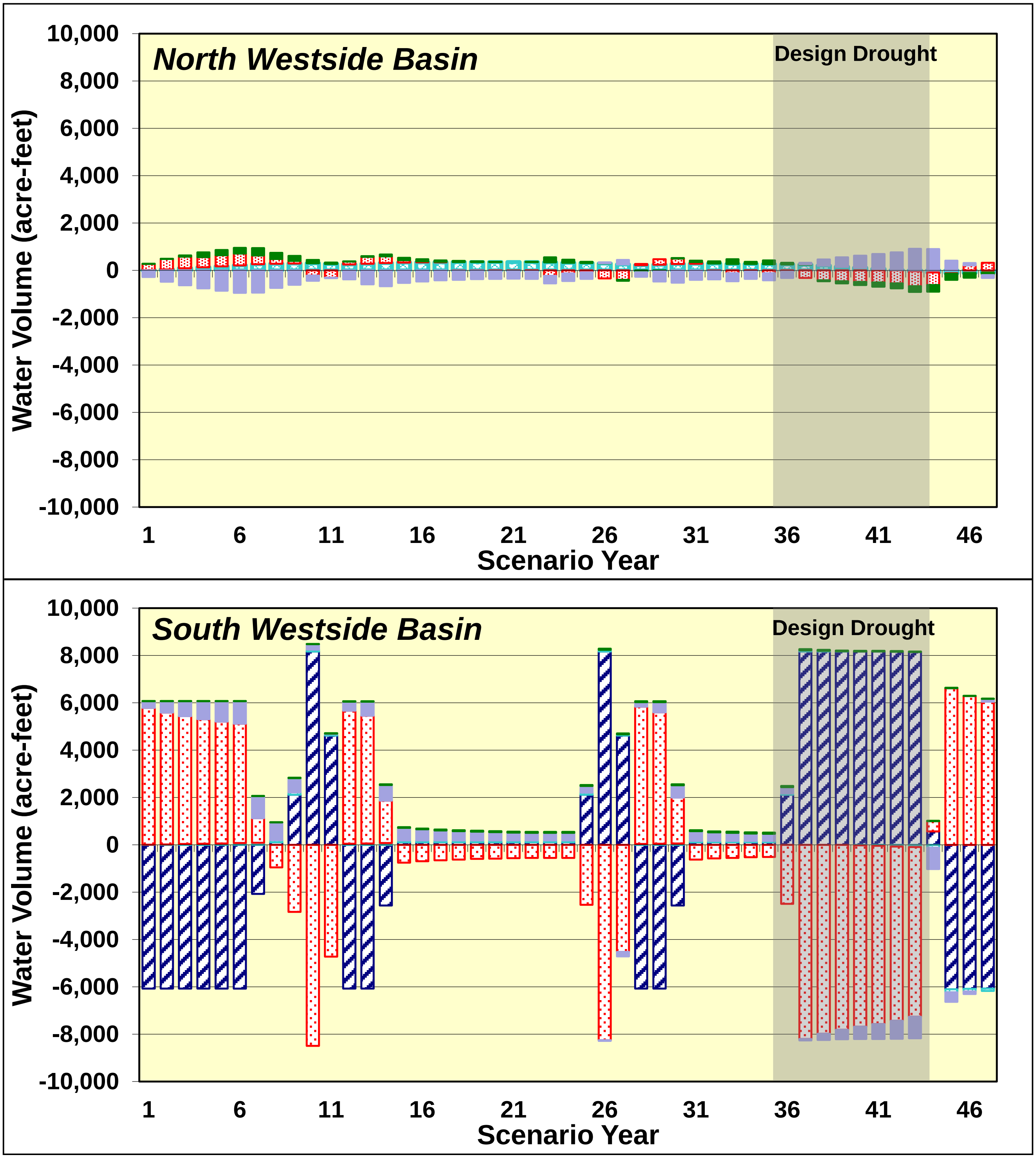
Figure 10.4-16



Note: For pumping, a positive value is an increase in pumping and a negative value is a decrease in pumping relative to Scenario 1.
For groundwater flow, a positive value is outflow from the basin, and a negative value is inflow into the basin.

Components of Analysis of Water Sources to Accommodate Pumping :

- Pumping – change in pumping relative to Scenario 1
- Ocean – change in outflow to the ocean relative to Scenario 1
- Surface Water – change in outflow to surface water relative to Scenario 1
- Aquifer Storage – change in aquifer storage relative to Scenario 1
- Groundwater flow – relative groundwater flow from adjoining basin

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San Francisco Public Utilities Commission

Scenario 2 – Analysis of Water Sources to Accommodate Changes in Pumping Relative to Scenario 1

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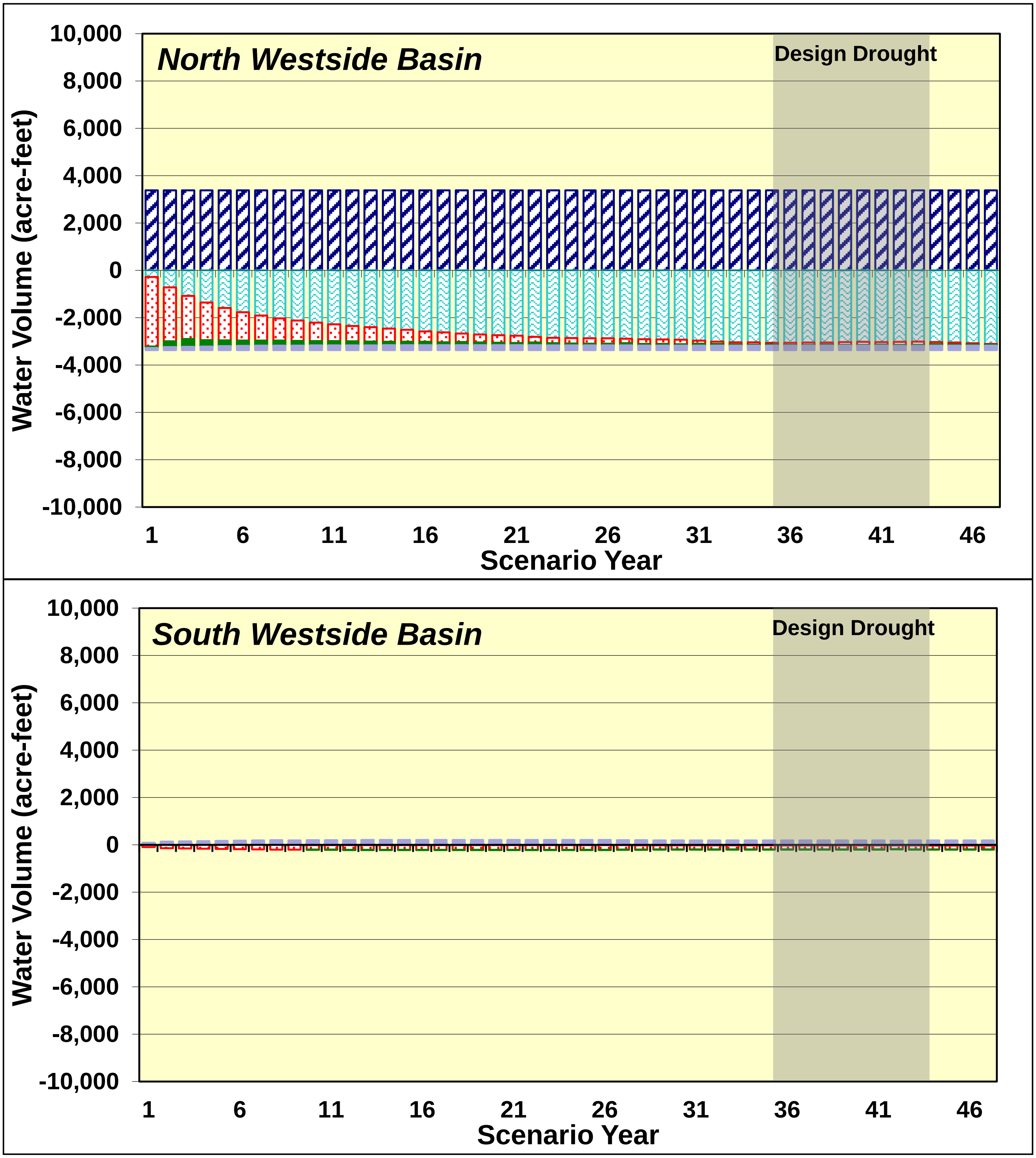
Figure 10.4-17



Note: For pumping, a positive value is an increase in pumping and a negative value is a decrease in pumping relative to Scenario 1.
For groundwater flow, a positive value is outflow from the basin, and a negative value is inflow into the basin.

Components of Analysis of Water Sources to Accommodate Pumping :

- **Pumping – change in pumping relative to Scenario 1**
- **Ocean – change in outflow to the ocean relative to Scenario 1**
- **Surface Water – change in outflow to surface water relative to Scenario 1**
- **Aquifer Storage – change in aquifer storage relative to Scenario 1**
- **Groundwater flow – relative groundwater flow from adjoining basin**

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San Francisco Public Utilities Commission

Scenario 3a – Analysis of Water Sources to Accommodate Changes in Pumping Relative to Scenario 1

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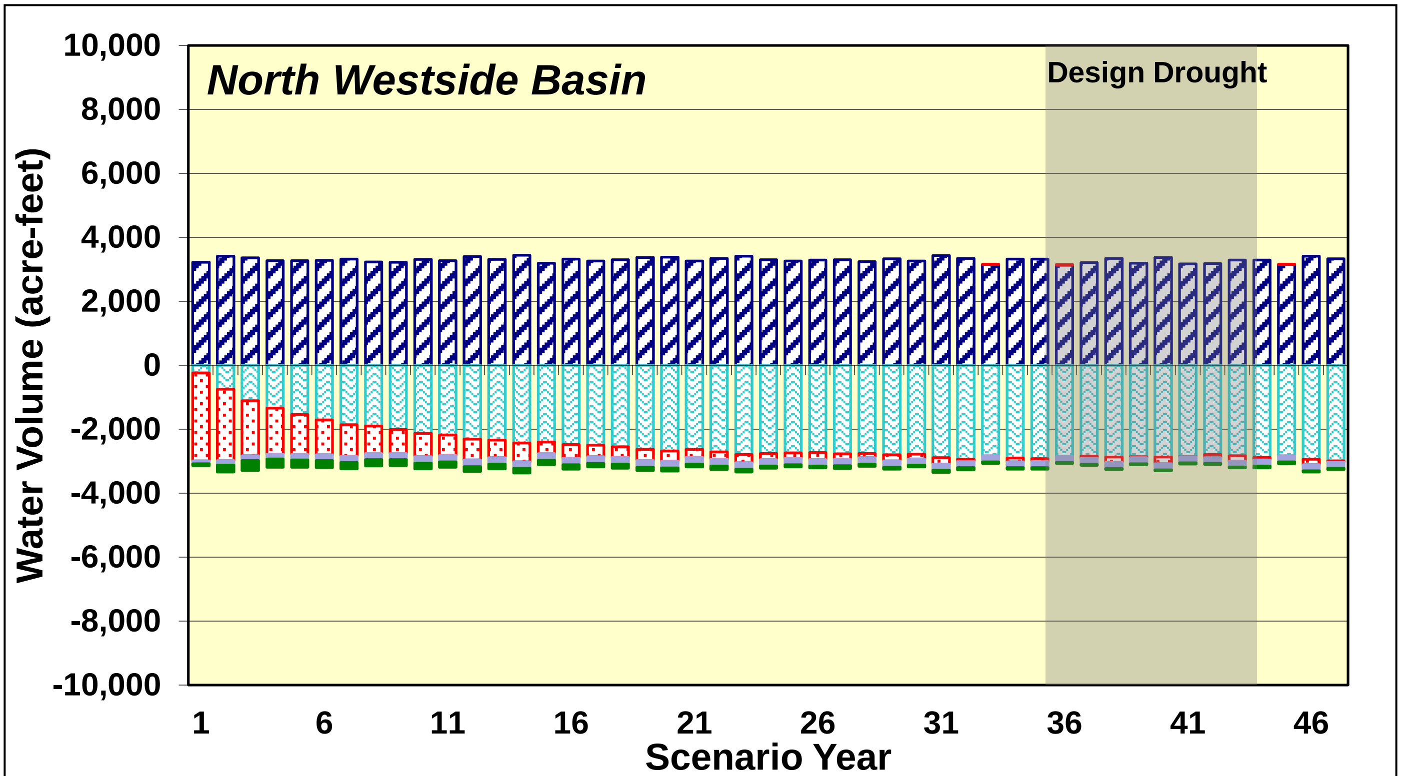
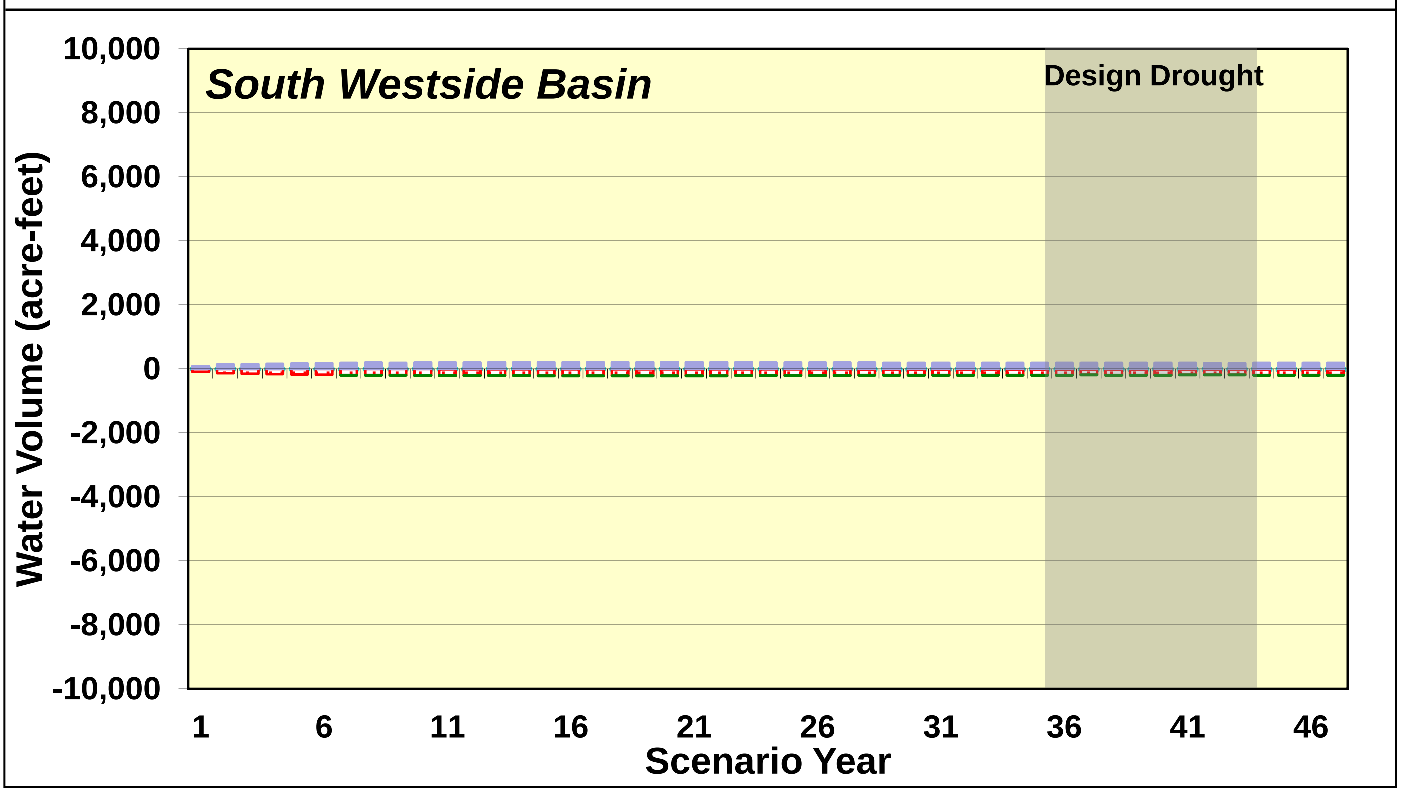
Figure 10.4-18





Note: For pumping, a positive value is an increase in pumping and a negative value is a decrease in pumping relative to Scenario 1. For groundwater flow, a positive value is outflow from the basin, and a negative value is inflow into the basin.

Components of Analysis of Water Sources to Accommodate Pumping :

- **Pumping – change in pumping relative to Scenario 1**
- **Ocean – change in outflow to the ocean relative to Scenario 1**
- **Surface Water – change in outflow to surface water relative to Scenario 1**
- **Aquifer Storage – change in aquifer storage relative to Scenario 1**
- **Groundwater flow – relative groundwater flow from adjoining basin**

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San Francisco Public Utilities Commission

Scenario 3b – Analysis of Water Sources to Accommodate Changes in Pumping Relative to Scenario 1

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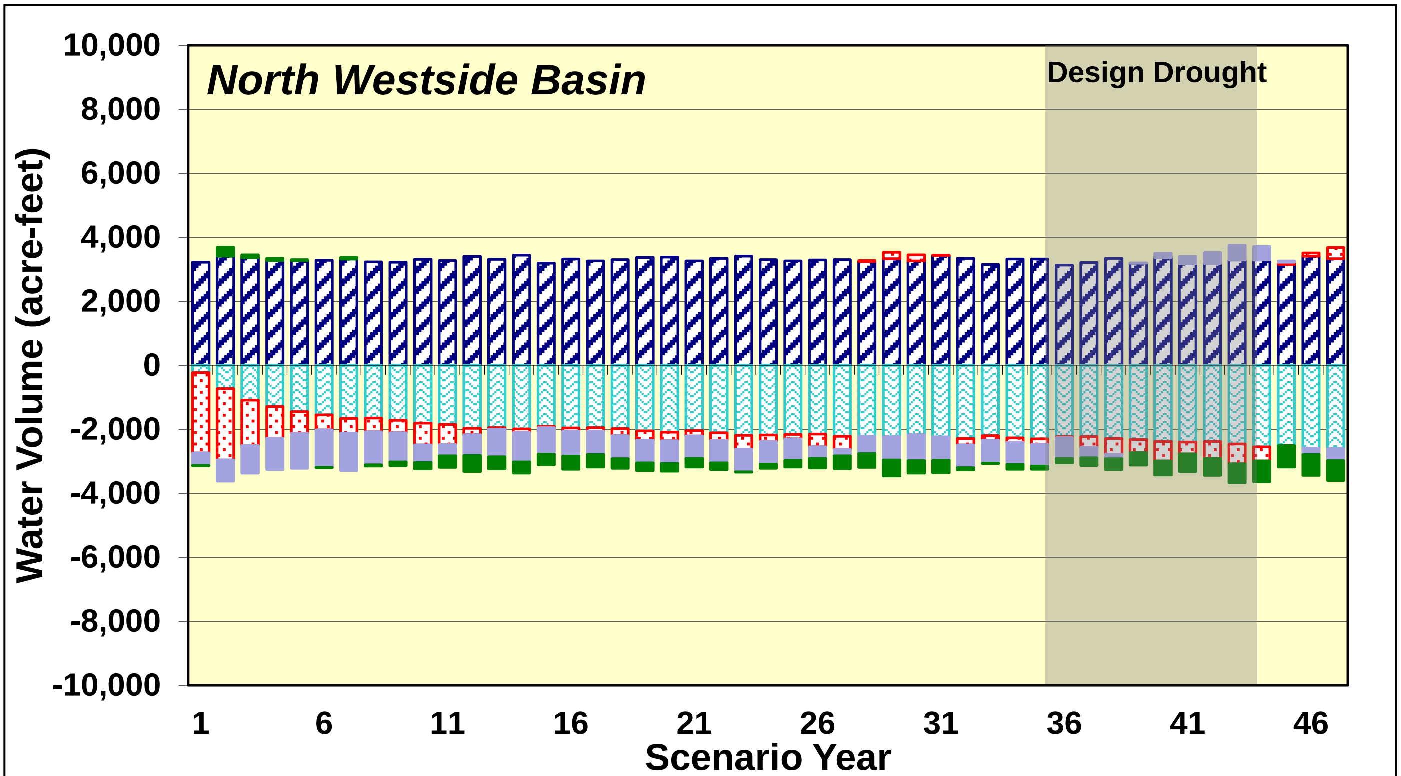
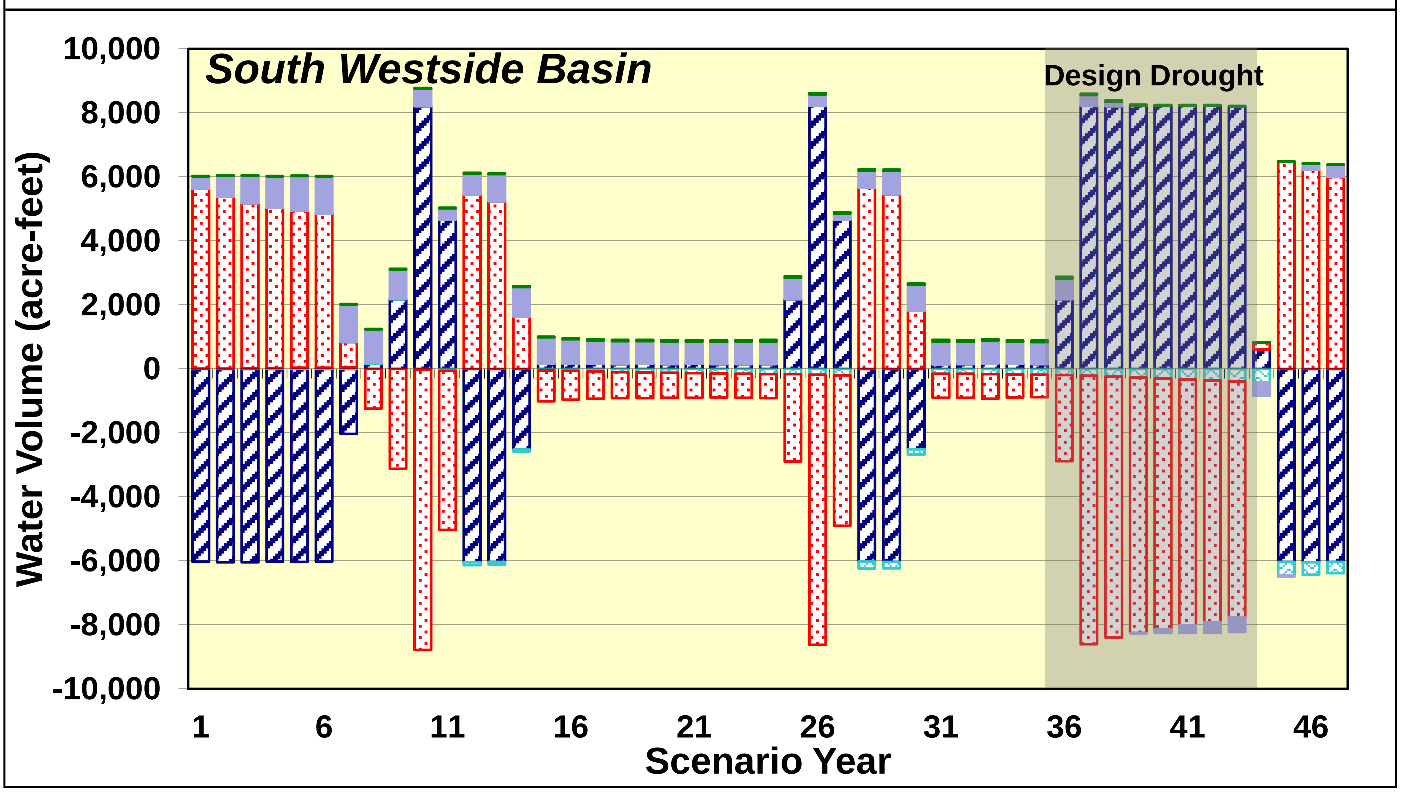
April 2012
Figure 10.4-19





Note: For pumping, a positive value is an increase in pumping and a negative value is a decrease in pumping relative to Scenario 1. For groundwater flow, a positive value is outflow from the basin, and a negative value is inflow into the basin.

Components of Analysis of Water Sources to Accommodate Pumping :

- **Pumping – change in pumping relative to Scenario 1**
- **Ocean – change in outflow to the ocean relative to Scenario 1**
- **Surface Water – change in outflow to surface water relative to Scenario 1**
- **Aquifer Storage – change in aquifer storage relative to Scenario 1**
- **Groundwater flow – relative groundwater flow from adjoining basin**

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Scenario 4 – Analysis of Water Sources to Accommodate Changes in Pumping Relative to Scenario 1

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April 2012
Figure 10.4-20

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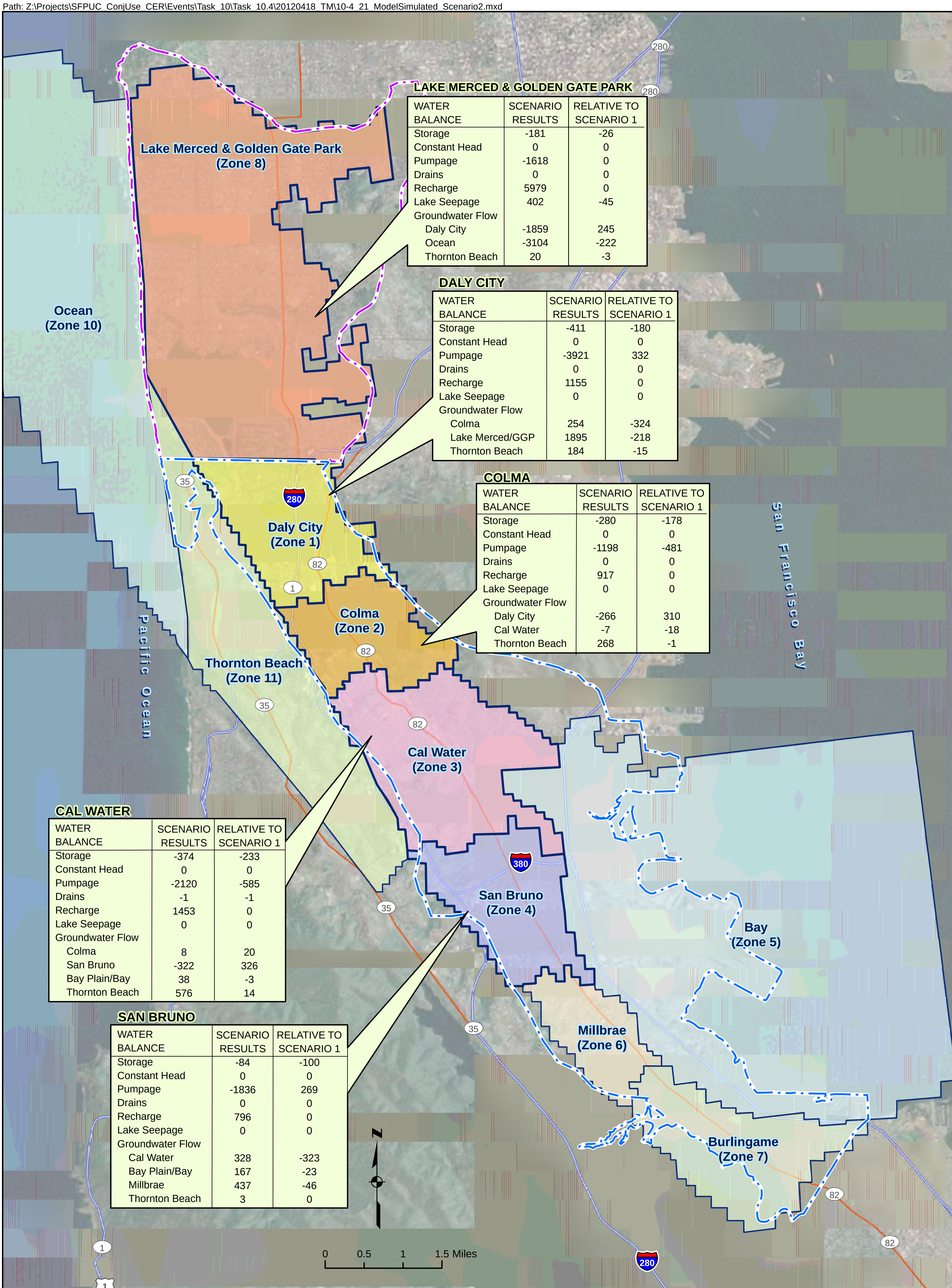

LAKE MERCED & GOLDEN GATE PARK

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-181	-26
Constant Head	0	0
Pumpage	-1618	0
Drains	0	0
Recharge	5979	0
Lake Seepage	402	-45
Groundwater Flow		
Daly City	-1859	245
Ocean	-3104	-222
Thornton Beach	20	-3

DALY CITY

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-411	-180
Constant Head	0	0
Pumpage	-3921	332
Drains	0	0
Recharge	1155	0
Lake Seepage	0	0
Groundwater Flow		
Colma	254	-324
Lake Merced/GGP	1895	-218
Thornton Beach	184	-15

COLMA

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-280	-178
Constant Head	0	0
Pumpage	-1198	-481
Drains	0	0
Recharge	917	0
Lake Seepage	0	0
Groundwater Flow		
Daly City	-266	310
Cal Water	-7	-18
Thornton Beach	268	-1

CAL WATER

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-374	-233
Constant Head	0	0
Pumpage	-2120	-585
Drains	-1	-1
Recharge	1453	0
Lake Seepage	0	0
Groundwater Flow		
Colma	8	20
San Bruno	-322	326
Bay Plain/Bay	38	-3
Thornton Beach	576	14

SAN BRUNO

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-84	-100
Constant Head	0	0
Pumpage	-1836	269
Drains	0	0
Recharge	796	0
Lake Seepage	0	0
Groundwater Flow		
Cal Water	328	-323
Bay Plain/Bay	167	-23
Millbrae	437	-46
Thornton Beach	3	0

Legend

South Westside Groundwater Basin
North Westside Groundwater Basin

Model Sub-areas

Lake Merced and Golden Gate Park
Daly City
Colma
Cal Water
San Bruno
Millbrae
Burlingame
Ocean
Thornton Beach
Bay

Note:
Values are in units of acre-feet per year based on the annual average values over the simulated period.

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MODEL SIMULATED AVERAGE ANNUAL WATER BALANCE FOR SPECIFIC WESTSIDE BASIN MODEL SUBAREAS SCENARIO 2

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Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Figure
10.4-21

Date
April 2012

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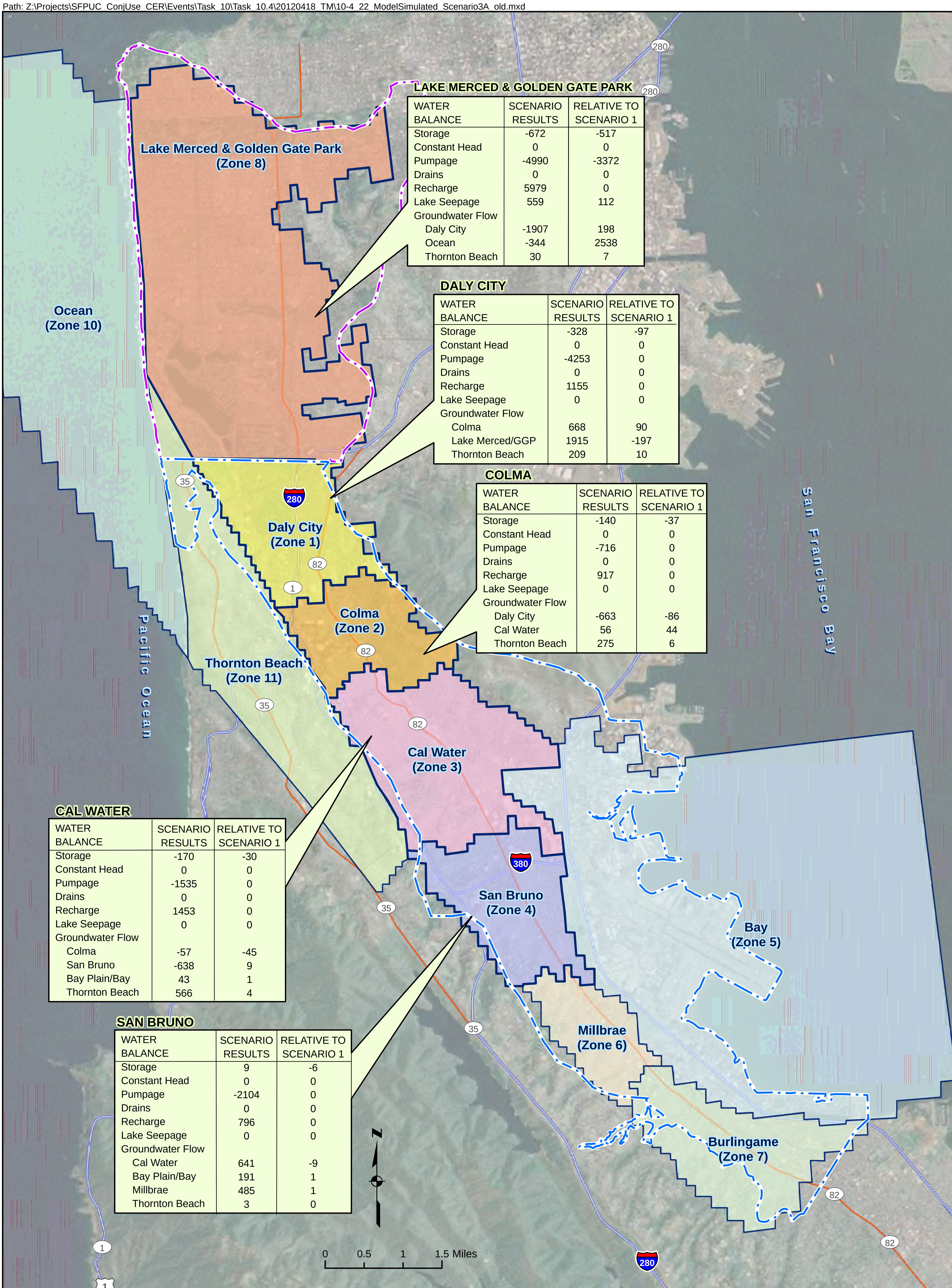

LAKE MERCED & GOLDEN GATE PARK

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-672	-517
Constant Head	0	0
Pumpage	-4990	-3372
Drains	0	0
Recharge	5979	0
Lake Seepage	559	112
Groundwater Flow		
Daly City	-1907	198
Ocean	-344	2538
Thornton Beach	30	7

DALY CITY

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-328	-97
Constant Head	0	0
Pumpage	-4253	0
Drains	0	0
Recharge	1155	0
Lake Seepage	0	0
Groundwater Flow		
Colma	668	90
Lake Merced/GGP	1915	-197
Thornton Beach	209	10

COLMA

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-140	-37
Constant Head	0	0
Pumpage	-716	0
Drains	0	0
Recharge	917	0
Lake Seepage	0	0
Groundwater Flow		
Daly City	-663	-86
Cal Water	56	44
Thornton Beach	275	6

CAL WATER

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-170	-30
Constant Head	0	0
Pumpage	-1535	0
Drains	0	0
Recharge	1453	0
Lake Seepage	0	0
Groundwater Flow		
Colma	-57	-45
San Bruno	-638	9
Bay Plain/Bay	43	1
Thornton Beach	566	4

SAN BRUNO

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	9	-6
Constant Head	0	0
Pumpage	-2104	0
Drains	0	0
Recharge	796	0
Lake Seepage	0	0
Groundwater Flow		
Cal Water	641	-9
Bay Plain/Bay	191	1
Millbrae	485	1
Thornton Beach	3	0

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Legend

South Westside Groundwater Basin
North Westside Groundwater Basin

Model Sub-areas

Lake Merced and Golden Gate Park
Daly City
Colma
Cal Water
San Bruno
Millbrae
Burlingame
Ocean
Thornton Beach
Bay

Note:
Values are in units of acre-feet per year based on the annual average values over the simulated period.

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MODEL SIMULATED AVERAGE ANNUAL WATER BALANCE FOR SPECIFIC WESTSIDE BASIN MODEL SUBAREAS SCENARIO 3A

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Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Figure
10.4-22

Date
April 2012

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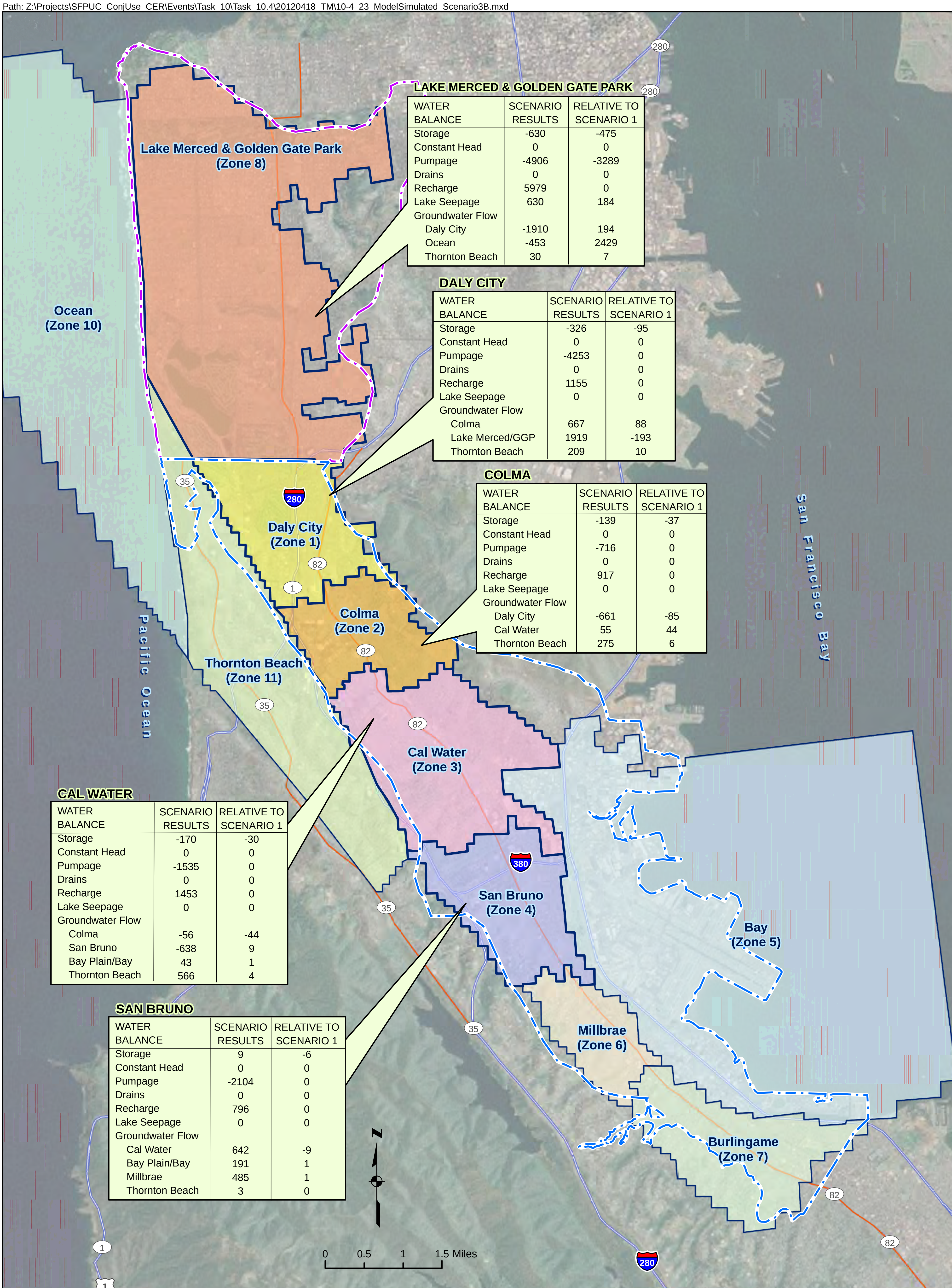

LAKE MERCED & GOLDEN GATE PARK

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-630	-475
Constant Head	0	0
Pumpage	-4906	-3289
Drains	0	0
Recharge	5979	0
Lake Seepage	630	184
Groundwater Flow		
Daly City	-1910	194
Ocean	-453	2429
Thornton Beach	30	7

DALY CITY

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-326	-95
Constant Head	0	0
Pumpage	-4253	0
Drains	0	0
Recharge	1155	0
Lake Seepage	0	0
Groundwater Flow		
Colma	667	88
Lake Merced/GGP	1919	-193
Thornton Beach	209	10

COLMA

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-139	-37
Constant Head	0	0
Pumpage	-716	0
Drains	0	0
Recharge	917	0
Lake Seepage	0	0
Groundwater Flow		
Daly City	-661	-85
Cal Water	55	44
Thornton Beach	275	6

CAL WATER

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-170	-30
Constant Head	0	0
Pumpage	-1535	0
Drains	0	0
Recharge	1453	0
Lake Seepage	0	0
Groundwater Flow		
Colma	-56	-44
San Bruno	-638	9
Bay Plain/Bay	43	1
Thornton Beach	566	4

SAN BRUNO

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	9	-6
Constant Head	0	0
Pumpage	-2104	0
Drains	0	0
Recharge	796	0
Lake Seepage	0	0
Groundwater Flow		
Cal Water	642	-9
Bay Plain/Bay	191	1
Millbrae	485	1
Thornton Beach	3	0

Legend

- South Westside Groundwater Basin
- North Westside Groundwater Basin

Model Sub-areas
- Lake Merced and Golden Gate Park
- Daly City
- Colma
- Cal Water
- San Bruno
- Millbrae
- Burlingame
- Ocean
- Thornton Beach
- Bay

Note:
Values are in units of acre-feet per year based on the annual average values over the simulated period.

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MODEL SIMULATED AVERAGE ANNUAL WATER BALANCE FOR SPECIFIC WESTSIDE BASIN MODEL SUBAREAS SCENARIO 3B

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Figure 10.4-23

Date April 2012

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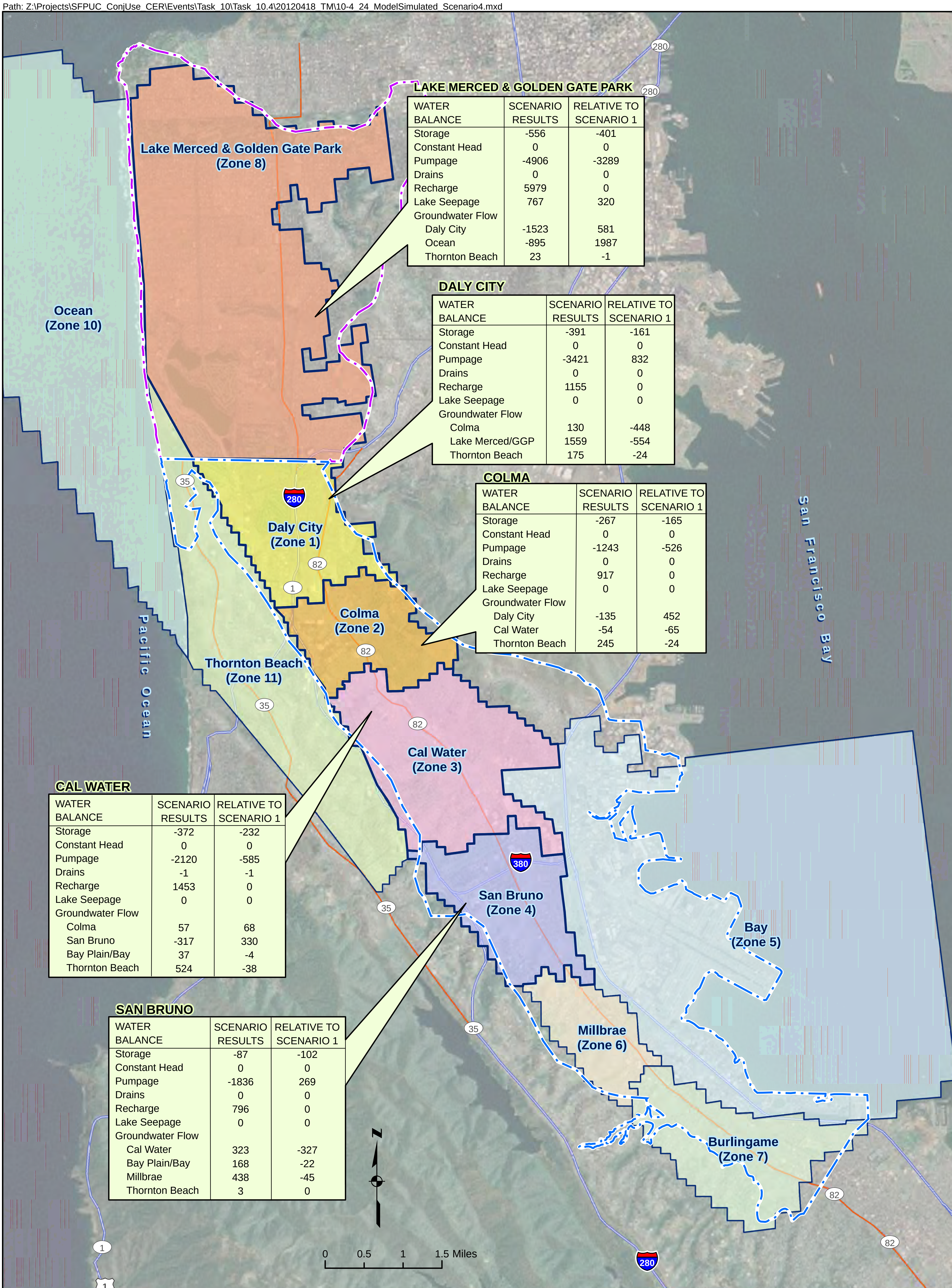

LAKE MERCED & GOLDEN GATE PARK

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-556	-401
Constant Head	0	0
Pumpage	-4906	-3289
Drains	0	0
Recharge	5979	0
Lake Seepage	767	320
Groundwater Flow		
Daly City	-1523	581
Ocean	-895	1987
Thornton Beach	23	-1

DALY CITY

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-391	-161
Constant Head	0	0
Pumpage	-3421	832
Drains	0	0
Recharge	1155	0
Lake Seepage	0	0
Groundwater Flow		
Colma	130	-448
Lake Merced/GGP	1559	-554
Thornton Beach	175	-24

COLMA

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-267	-165
Constant Head	0	0
Pumpage	-1243	-526
Drains	0	0
Recharge	917	0
Lake Seepage	0	0
Groundwater Flow		
Daly City	-135	452
Cal Water	-54	-65
Thornton Beach	245	-24

CAL WATER

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-372	-232
Constant Head	0	0
Pumpage	-2120	-585
Drains	-1	-1
Recharge	1453	0
Lake Seepage	0	0
Groundwater Flow		
Colma	57	68
San Bruno	-317	330
Bay Plain/Bay	37	-4
Thornton Beach	524	-38

SAN BRUNO

WATER BALANCE	SCENARIO RESULTS	RELATIVE TO SCENARIO 1
Storage	-87	-102
Constant Head	0	0
Pumpage	-1836	269
Drains	0	0
Recharge	796	0
Lake Seepage	0	0
Groundwater Flow		
Cal Water	323	-327
Bay Plain/Bay	168	-22
Millbrae	438	-45
Thornton Beach	3	0

Legend

South Westside Groundwater Basin
North Westside Groundwater Basin

Model Sub-areas

Lake Merced and Golden Gate Park
Daly City
Colma
Cal Water
San Bruno
Millbrae
Burlingame
Ocean
Thornton Beach
Bay

Note:
Values are in units of acre-feet per year based on the annual average values over the simulated period.

CITY AND COUNTY OF SAN FRANCISCO
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MODEL SIMULATED AVERAGE ANNUAL WATER BALANCE FOR SPECIFIC WESTSIDE BASIN MODEL SUBAREAS SCENARIO 4

Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Figure 10.4-24

Date April 2012

Tables

Tables

Table 10.4-1: Summary of Model Scenario Pumping Assumptions

Model Scenarios		Scenario 1 Existing Conditions	Scenario 2 GSR	Scenario 3a SFGW	Scenario 3b SFGW	Scenario 4 Cumulative
Establish Initial Conditions		Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence
	June 2009 Condition	√	√	√	√	√
Model Scenario Simulation Period						
	47.25 years (including Design Drought) Hydrologic Sequence: July 1996 to September 2003 -> October 1958 to November 1992 -> December 1975 to June 1978 -> July 2003 - September 2006		√	√	√	√
Pumping Assumptions for Municipal Use						
PA Municipal Wells (mgd)						
	"Take" Periods	6.84	6.90	6.84	6.84	6.90
	"Put" Periods	6.84	1.38	6.84	6.84	1.38
	"Hold" Periods	6.84	6.90	6.84	6.84	6.90
GSR Project Proposed Municipal Wells (mgd)						
	"Take" Periods	0.0	7.23	0.0	0.0	7.23
	"Put" Periods	0.0	0.04	0.0	0.0	0.04
	"Hold" Periods	0.0	0.04	0.0	0.0	0.04
SFGW Project Proposed Municipal Wells (mgd)						
	Year-Round Pumping	0.0	0.0	3.0	4.0	4.0
Total Municipal Pumping (PA + GSR + SFGW)						
	"Take" Periods	***6.84***	***14.13***	***9.84***	***10.84***	***18.13***
	"Put" Periods	***6.84***	***1.42***	***9.84***	***10.84***	***5.42***
	"Hold" Periods	***6.84***	***6.94***	***9.84***	***10.84***	***10.94***
Irrigation and Other Non-Potable Pumping Assumptions (mgd)[(1)]						
Golden Gate Park	Elk Glen (GGP)	0.081	0.081	0.081	0.000	0.000
	South Windmill (GGP)	0.498	0.498	0.498	0.000	0.000
	North Lake (GGP)	0.563	0.563	0.563	0.000	0.000
	Sub-Total	***1.142***	***1.142***	***1.142***	***0.000***	***0.000***
Golf Courses	Burlingame Golf Club	0.150	0.150	0.150	0.150	0.150
	California Golf No. 02	0.192	0.192	0.192	0.192	0.192
	Green Hills No. 05	0.099	0.099	0.099	0.099	0.099
	Lake Merced Golf No. 01	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 02	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 03	0.010	0.010	0.010	0.010	0.010
	Olympic Club No. 09[(2)]	0.002	0.002	0.002	0.002	0.002
	SF Golf West	0.035	0.035	0.035	0.035	0.035
	Sub-Total	***0.495***	***0.495***	***0.495***	***0.495***	***0.495***
Cemeteries	Cypress Lawn No. 02	0.020	0.020	0.020	0.020	0.020
	Cypress Lawn No. 03	0.144	0.144	0.144	0.144	0.144
	Eternal Home	0.013	0.013	0.013	0.013	0.013
	Hills of Eternity No. 02	0.020	0.020	0.020	0.020	0.020
	Holy Cross No. 03[(3)]	0.190	0.190	0.190	0.190	0.230
	Home of Peace No. 02	0.039	0.039	0.039	0.039	0.039
	Italian Cemetery	0.033	0.033	0.033	0.033	0.033
	Olivet	0.098	0.098	0.098	0.098	0.098
	Woodlawn No. 02	0.085	0.085	0.085	0.085	0.085
	Sub-Total	***0.641***	***0.641***	***0.641***	***0.641***	***0.681***
Other	Hillsborough Residents No. 1-12	0.291	0.291	0.291	0.291	0.291
	Edgewood Development Ctr.	0.009	0.009	0.009	0.009	0.009
	Zoo No.05	0.321	0.321	0.321	0.321	0.321
	Stern Grove	0.004	0.004	0.012	0.013	0.013
	Sub-Total	***0.626***	***0.626***	***0.634***	***0.635***	***0.635***
Total Irrigation and Other Non-Potable Pumping		***2.90***	***2.90***	***2.91***	***1.77***	***1.81***

Key:
afy - acre-feet per year
mgd - million gallons per day
PA - Partner Agencies
GGP - Golden Gate Park
GSR - Regional Groundwater Storage and Recovery
SFGW - San Francisco Groundwater Supply
SFPUC - San Francisco Public Utilities Commission

Notes:
(1) Pumping wells that are listed identify the wells in the model scenarios whose pumping assumptions were modified compared to the 2008 No-Project Scenario by HydroFocus (May, 2011, ver. 3.1), as a result of revised Soil Moisture Budget (SMB). Pumping rates for the three wells in the GGP, California Golf No. 02, Edgewood Development Center, Zoo No. 05, and Stern Grove wells were further modified compared to the results of revised SMB.
(2) Olympic Club No. 09 values include pumping for both Olympic Golf Club wells.
(3) Holy Cross No. 3 well irrigation pumping for Scenarios 1, 2, 3a, and 3b is based on the results of revised SMB. Based on the projected future build-out at the Holy Cross cemetery, an additional pumping of 0.04 mgd (45 afy) was estimated to occur under Scenario 4 (Cumulative).

Table 10.4-2: Scenario 1 (Existing Conditions) Westside Groundwater Basin Water Balance Summary

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	5	546	14,845	464	-4,684	-11,229	-753	-71	-877
2	5	558	24,505	456	-5,439	-10,299	-974	-72	8,739
3	5	552	13,329	475	-5,406	-10,445	-858	-73	-2,420
4	5	549	13,169	547	-4,988	-10,889	-758	-74	-2,440
5	5	549	10,129	623	-4,561	-10,804	-679	-74	-4,814
6	5	551	11,546	624	-4,317	-10,917	-653	-73	-3,234
7	5	552	12,988	614	-4,317	-10,717	-634	-72	-1,580
8	5	545	10,691	671	-4,064	-11,064	-680	-72	-3,968
9	6	549	10,235	853	-3,868	-11,113	-788	-70	-4,198
10	6	554	9,386	875	-3,717	-10,720	-767	-68	-4,451
11	7	549	13,455	807	-3,710	-10,879	-807	-68	-647
12	8	556	13,751	820	-3,780	-10,420	-772	-74	89
13	9	553	10,162	915	-3,568	-10,761	-841	-76	-3,609
14	10	558	13,533	1,086	-3,585	-10,315	-1,067	-75	145
15	11	549	14,876	1,040	-3,666	-11,154	-1,139	-81	437
16	12	556	19,804	925	-4,070	-10,766	-1,142	-84	5,234
17	10	549	12,678	995	-3,989	-10,883	-1,095	-88	-1,823
18	10	554	18,568	828	-4,225	-10,663	-1,102	-92	3,879
19	9	553	14,531	755	-4,322	-10,710	-932	-96	-212
20	9	556	13,363	791	-4,272	-10,673	-920	-100	-1,245
21	9	548	9,310	896	-3,869	-11,010	-912	-93	-5,120
22	10	554	22,751	765	-4,542	-10,729	-1,125	-94	7,591
23	9	556	19,036	745	-4,914	-10,402	-1,014	-101	3,915
24	9	549	13,397	837	-4,599	-10,670	-949	-105	-1,530
25	9	549	8,479	893	-4,123	-10,963	-904	-107	-6,167
26	11	550	8,071	921	-3,694	-10,827	-871	-96	-5,935
27	12	552	18,354	870	-3,946	-10,732	-1,017	-96	3,997
28	12	549	14,398	788	-4,057	-11,007	-911	-104	-331
29	12	553	15,609	801	-4,065	-10,650	-921	-109	1,231
30	13	550	11,960	905	-3,871	-10,961	-964	-112	-2,479
31	13	556	20,974	840	-4,352	-10,230	-1,076	-115	6,611
32	12	556	24,922	717	-5,079	-10,564	-1,106	-118	9,340
33	12	545	15,668	661	-5,124	-11,398	-951	-121	-709
34	11	554	12,389	855	-4,732	-10,800	-955	-124	-2,802
35	11	553	18,045	708	-4,839	-10,663	-951	-128	2,737
36	11	545	11,034	780	-4,601	-11,255	-871	-129	-4,486
37	11	545	9,932	915	-4,215	-11,035	-919	-121	-4,886
38	11	554	10,605	904	-4,058	-10,620	-900	-114	-3,618
39	12	549	7,905	926	-3,789	-11,119	-846	-106	-6,468
40	15	556	9,935	1,119	-3,588	-10,839	-1,052	-100	-3,953
41	17	549	12,714	1,156	-3,608	-11,081	-1,163	-100	-1,516
42	22	550	7,618	1,146	-3,322	-11,202	-1,120	-96	-6,403
43	28	549	7,975	1,171	-3,057	-10,827	-1,087	-87	-5,335
44	31	552	18,357	1,090	-3,379	-10,805	-1,216	-87	4,544
45	29	545	16,490	1,030	-3,669	-11,371	-1,263	-95	1,697
46	27	556	18,714	1,050	-4,069	-10,412	-1,305	-98	4,464
47	23	545	19,422	1,095	-4,385	-10,681	-1,383	-101	4,535
Average (afy)	**12**	**551**	**14,034**	**846**	**-4,172**	**-10,814**	**-960**	**-94**	**-597**
Maximum (afy)	**31**	**558**	**24,922**	**1,171**	**-3,057**	**-10,230**	**-634**	**-68**	**9,340**
Minimum (afy)	**5**	**545**	**7,618**	**456**	**-5,439**	**-11,398**	**-1,383**	**-129**	**-6,468**

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.

Table 10.4-3: Scenario 2 Westside Groundwater Basin Water Balance Summary, Relative to Existing Conditions

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	0	0	0	-13	-13	6,072	-1	0	6,045
2	0	0	0	-51	-59	6,072	44	0	6,005
3	0	0	0	-74	-121	6,072	23	-1	5,900
4	0	0	0	-152	-178	6,072	-40	-1	5,701
5	0	0	0	-204	-228	6,072	-18	-3	5,619
6	-1	0	0	-230	-284	6,072	-14	-4	5,540
7	-1	0	0	-262	-340	2,070	-46	-6	1,414
8	-1	0	0	-306	-371	-108	40	-10	-755
9	-2	0	0	-427	-384	-2,123	219	-14	-2,731
10	-2	0	0	-383	-380	-8,169	238	-17	-8,713
11	-3	0	0	-295	-334	-4,619	233	-19	-5,036
12	-2	0	0	-244	-301	6,072	239	-20	5,743
13	-4	0	0	-348	-332	6,072	319	-22	5,686
14	-7	0	0	-560	-378	2,557	485	-23	2,073
15	-8	0	0	-592	-404	-108	491	-28	-650
16	-8	0	0	-506	-411	-108	414	-33	-652
17	-6	0	0	-534	-417	-108	471	-36	-630
18	-6	0	0	-402	-422	-108	350	-38	-626
19	-5	0	0	-269	-427	-108	242	-40	-606
20	-5	0	0	-261	-429	-108	249	-42	-596
21	-5	0	0	-301	-427	-108	301	-41	-581
22	-6	0	0	-294	-428	-108	285	-41	-592
23	-5	0	0	-303	-418	-108	94	-43	-783
24	-5	0	0	-320	-394	-108	187	-43	-684
25	-5	0	0	-299	-382	-2,123	241	-44	-2,611
26	-6	0	0	-278	-359	-8,169	266	-43	-8,589
27	-6	0	0	-272	-298	-4,618	312	-41	-4,924
28	-5	0	0	-171	-253	6,072	248	-41	5,851
29	-6	0	0	-212	-275	6,072	254	-40	5,792
30	-8	0	0	-337	-313	2,557	322	-41	2,181
31	-8	0	0	-351	-336	-108	299	-42	-546
32	-6	0	0	-293	-339	-108	198	-43	-592
33	-6	0	0	-231	-329	-108	40	-45	-680
34	-6	0	0	-297	-321	-108	198	-47	-580
35	-5	0	0	-208	-316	-108	48	-48	-637
36	-5	0	0	-207	-306	-2,123	134	-47	-2,554
37	-5	0	0	-267	-288	-8,169	248	-42	-8,523
38	-4	0	0	-215	-231	-8,169	256	-39	-8,402
39	-3	0	0	-136	-160	-8,169	233	-35	-8,270
40	0	0	0	-81	-90	-8,169	210	-31	-8,160
41	6	0	0	-108	-23	-8,169	280	-28	-8,041
42	14	0	0	24	44	-8,162	187	-25	-7,918
43	25	0	0	327	109	-8,150	-85	-20	-7,794
44	34	0	0	390	178	-567	-114	-16	-96
45	31	0	0	392	217	6,100	-121	-13	6,606
46	20	0	0	306	205	6,076	-103	-9	6,496
47	11	0	0	186	177	6,073	-70	-6	6,371
Average (afy)	**0**	**0**	**0**	**-206**	**-246**	**-112**	**176**	**-28**	**-416**
Maximum (afy)	**34**	**0**	**0**	**392**	**217**	**6,100**	**491**	**0**	**6,606**
Minimum (afy)	**-8**	**0**	**0**	**-592**	**-429**	**-8,169**	**-121**	**-48**	**-8,713**

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.

Table 10.4-4 Scenario 3a Westside Groundwater Basin Water Balance Summary, Relative to Existing Conditions

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	0	0	0	21	270	-3,375	42	0	-3,042
2	2	0	0	61	708	-3,375	168	0	-2,436
3	6	0	0	126	1,067	-3,375	197	0	-1,979
4	21	0	0	113	1,338	-3,375	154	0	-1,748
5	48	0	0	96	1,538	-3,375	145	0	-1,548
6	87	0	0	194	1,678	-3,375	25	0	-1,390
7	122	0	0	267	1,791	-3,375	-58	0	-1,252
8	177	0	0	203	1,852	-3,375	2	0	-1,141
9	238	0	0	182	1,890	-3,375	16	0	-1,049
10	295	0	0	230	1,915	-3,375	-47	0	-981
11	342	0	0	224	1,945	-3,375	-47	0	-911
12	328	0	0	210	2,028	-3,375	-46	0	-855
13	400	0	0	120	2,010	-3,375	32	0	-812
14	420	0	0	-84	2,046	-3,375	232	0	-761
15	451	0	0	-99	2,072	-3,375	243	0	-709
16	385	0	0	-2	2,198	-3,375	144	0	-650
17	360	0	0	-44	2,269	-3,375	165	0	-624
18	351	0	0	99	2,328	-3,375	30	0	-566
19	305	0	0	189	2,417	-3,375	-79	0	-543
20	318	0	0	188	2,437	-3,375	-87	0	-518
21	423	0	0	136	2,348	-3,375	-46	0	-513
22	336	0	0	180	2,485	-3,375	-68	0	-441
23	244	0	0	200	2,615	-3,375	-111	0	-426
24	264	0	0	174	2,614	-3,375	-98	0	-421
25	370	0	0	164	2,514	-3,375	-96	0	-422
26	534	0	0	150	2,351	-3,375	-84	0	-425
27	510	0	0	127	2,396	-3,375	-43	0	-383
28	457	0	0	173	2,468	-3,375	-103	0	-379
29	451	0	0	163	2,491	-3,375	-92	0	-362
30	516	0	0	75	2,436	-3,374	-15	1	-361
31	412	0	0	119	2,574	-3,375	-41	1	-310
32	279	0	0	215	2,752	-3,374	-140	1	-269
33	246	0	0	277	2,810	-3,374	-232	1	-273
34	282	0	0	184	2,784	-3,374	-142	1	-267
35	291	0	0	306	2,792	-3,375	-257	1	-241
36	326	0	0	256	2,756	-3,374	-224	1	-259
37	415	0	0	152	2,658	-3,375	-116	1	-265
38	484	0	0	154	2,585	-3,374	-116	1	-267
39	601	0	0	131	2,456	-3,375	-102	1	-287
40	714	0	0	-82	2,333	-3,374	116	1	-292
41	740	0	0	-155	2,311	-3,375	200	1	-277
42	927	0	0	-173	2,118	-3,375	205	1	-296
43	1,095	0	0	-183	1,941	-3,374	215	1	-305
44	925	0	0	-147	2,128	-3,375	210	1	-257
45	777	0	0	-139	2,301	-3,375	194	2	-241
46	609	0	0	-146	2,497	-3,375	192	2	-221
47	485	0	0	-157	2,651	-3,374	199	2	-194
Average (afy)	**391**	**0**	**0**	**95**	**2,191**	**-3,375**	**13**	**1**	**-684**
Maximum (afy)	**1,095**	**0**	**0**	**306**	**2,810**	**-3,374**	**243**	**2**	**-194**
Minimum (afy)	**0**	**0**	**0**	**-183**	**270**	**-3,375**	**-257**	**0**	**-3,042**

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.

Table 10.4-5: Scenario 3b Westside Groundwater Basin Water Balance Summary, Relative to Existing Conditions

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	0	80	0	20	230	-3,223	40	0	-2,852
2	1	70	0	76	736	-3,412	213	0	-2,316
3	4	74	0	189	1,090	-3,364	248	0	-1,759
4	17	77	0	158	1,301	-3,271	167	0	-1,551
5	39	77	0	124	1,479	-3,270	149	0	-1,402
6	69	77	0	133	1,615	-3,274	113	0	-1,268
7	96	73	0	282	1,748	-3,317	-60	0	-1,178
8	127	81	0	219	1,752	-3,233	-4	0	-1,057
9	170	77	0	98	1,828	-3,219	107	0	-938
10	215	74	0	241	1,900	-3,312	-51	0	-934
11	248	77	0	238	1,919	-3,270	-56	0	-844
12	259	70	0	223	2,043	-3,395	-55	0	-855
13	305	73	0	134	2,028	-3,312	22	0	-750
14	346	70	0	-72	2,077	-3,436	222	0	-794
15	330	77	0	-87	2,065	-3,186	233	0	-568
16	297	70	0	9	2,177	-3,321	134	0	-634
17	268	77	0	-31	2,234	-3,261	155	0	-558
18	268	73	0	110	2,285	-3,294	20	0	-538
19	245	73	0	200	2,385	-3,368	-89	0	-554
20	252	70	0	201	2,433	-3,375	-97	0	-518
21	306	77	0	148	2,330	-3,255	-57	0	-450
22	274	73	0	190	2,442	-3,334	-78	0	-433
23	207	70	0	210	2,585	-3,411	-120	0	-459
24	210	77	0	186	2,554	-3,302	-109	0	-384
25	267	77	0	176	2,484	-3,255	-107	0	-357
26	394	77	0	162	2,344	-3,293	-96	0	-410
27	397	74	0	138	2,387	-3,301	-53	0	-359
28	330	77	0	183	2,442	-3,234	-113	0	-315
29	337	73	0	173	2,476	-3,328	-103	0	-372
30	371	77	0	86	2,418	-3,254	-26	0	-327
31	337	70	0	129	2,561	-3,425	-52	1	-380
32	240	70	0	225	2,717	-3,340	-151	1	-238
33	188	81	0	288	2,662	-3,146	-242	1	-168
34	213	73	0	196	2,697	-3,320	-154	1	-293
35	227	73	0	317	2,707	-3,321	-268	1	-264
36	230	81	0	268	2,638	-3,133	-235	1	-150
37	282	80	0	164	2,574	-3,214	-128	1	-241
38	336	74	0	166	2,544	-3,335	-128	1	-342
39	434	77	0	143	2,448	-3,188	-114	1	-198
40	558	70	0	-71	2,335	-3,373	105	1	-375
41	566	77	0	-145	2,310	-3,170	188	1	-172
42	701	77	0	-162	2,115	-3,181	194	1	-254
43	909	77	0	-171	1,943	-3,292	203	1	-330
44	771	74	0	-137	2,132	-3,286	198	1	-247
45	581	81	0	-129	2,279	-3,154	182	2	-158
46	480	70	0	-136	2,482	-3,413	180	2	-334
47	393	74	0	-146	2,620	-3,331	187	2	-202
Average (afy)	**300**	**75**	**0**	**105**	**2,161**	**-3,292**	**11**	**0**	**-640**
Maximum (afy)	**909**	**81**	**0**	**317**	**2,717**	**-3,133**	**248**	**2**	**-150**
Minimum (afy)	**0**	**70**	**0**	**-171**	**230**	**-3,436**	**-268**	**0**	**-2,852**

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.

Table 10.4-6 Scenario 4 Westside Groundwater Basin Water Balance Summary, Relative to Existing Conditions

Scenario Year	Inflow from Bay & Ocean (afy)	Seepage from GGP Lakes (afy)	Rain + Irrigation (afy)	Seepage from Lake Merced (afy)	Outflow to Bay & Ocean (afy)	Wells - Pumping (afy)	Seepage to Lake Merced (afy)	Drains (afy)	Change in Groundwater Storage (afy)
1	0	80	0	-4	218	2,793	16	0	3,104
2	0	70	0	-93	704	2,629	-181	0	3,128
3	0	74	0	-139	1,066	2,674	54	-1	3,729
4	4	77	0	-153	1,255	2,754	83	-1	4,019
5	12	77	0	-163	1,395	2,759	136	-3	4,213
6	26	77	0	-153	1,484	2,750	159	-4	4,338
7	36	73	0	-192	1,568	-1,290	142	-6	331
8	52	81	0	-205	1,551	-3,394	241	-10	-1,685
9	79	77	0	-295	1,625	-5,396	414	-14	-3,509
10	116	74	0	-188	1,708	-11,525	383	-17	-9,450
11	163	77	0	-10	1,753	-7,936	374	-19	-5,598
12	183	70	0	50	1,881	2,642	447	-21	5,252
13	196	73	0	6	1,840	2,716	379	-22	5,188
14	203	70	0	-240	1,845	-914	582	-24	1,521
15	178	77	0	-288	1,788	-3,349	622	-29	-1,002
16	154	70	0	-260	1,867	-3,476	674	-34	-1,004
17	129	77	0	-329	1,904	-3,416	720	-37	-951
18	128	73	0	-244	1,947	-3,444	543	-39	-1,037
19	108	73	0	-187	2,047	-3,523	433	-41	-1,090
20	110	70	0	-198	2,106	-3,529	432	-42	-1,052
21	142	77	0	-165	2,033	-3,416	435	-42	-936
22	126	73	0	-219	2,125	-3,488	431	-42	-993
23	82	70	0	-301	2,261	-3,556	311	-44	-1,177
24	81	77	0	-282	2,254	-3,453	412	-44	-956
25	115	77	0	-208	2,215	-5,429	413	-45	-2,862
26	202	77	0	14	2,131	-11,510	286	-44	-8,843
27	235	74	0	30	2,189	-7,962	370	-42	-5,107
28	204	77	0	167	2,238	2,789	265	-42	5,698
29	188	73	0	112	2,242	2,702	378	-41	5,655
30	182	77	0	15	2,151	-747	375	-41	2,013
31	157	70	0	-120	2,235	-3,564	509	-43	-756
32	99	70	0	-243	2,343	-3,488	323	-44	-940
33	68	81	0	-233	2,298	-3,315	239	-46	-908
34	78	73	0	-264	2,367	-3,475	408	-47	-860
35	88	73	0	-171	2,391	-3,472	266	-48	-873
36	89	81	0	-192	2,343	-5,311	335	-47	-2,702
37	126	80	0	-142	2,317	-11,435	378	-43	-8,717
38	186	74	0	84	2,339	-11,546	260	-39	-8,643
39	265	77	0	156	2,332	-11,411	232	-35	-8,385
40	372	70	0	0	2,307	-11,594	430	-31	-8,446
41	398	77	0	61	2,330	-11,389	494	-28	-8,057
42	489	77	0	174	2,247	-11,405	359	-25	-8,083
43	653	77	0	219	2,190	-11,495	369	-20	-8,007
44	598	74	0	243	2,360	-3,898	402	-16	-237
45	450	81	0	246	2,482	2,877	419	-13	6,542
46	357	70	0	178	2,624	2,623	474	-9	6,316
47	277	74	0	95	2,679	2,699	526	-6	6,343
Average (afy)	**174**	**75**	**0**	**-86**	**1,991**	**-3,450**	**356**	**-28**	**-968**
Maximum (afy)	**653**	**81**	**0**	**246**	**2,679**	**2,877**	**720**	**0**	**6,542**
Minimum (afy)	**0**	**70**	**0**	**-329**	**218**	**-11,594**	**-181**	**-48**	**-9,450**

Note: Water balance components represent annual average values on a water year basis. The sign convention is positive for groundwater flowing into the groundwater basin (inflows). The sign convention is negative for groundwater flowing out of the groundwater basin (outflows). This is consistent with the sign convention used by MODFLOW. For example, positive values for "Seepage from Lake Merced" represent flows from Lake Merced to the groundwater basin (aquifer). Negative values for "Seepage to Lake Merced" represent groundwater flow from the aquifer into Lake Merced.

Table 10.4-7: Annual Average Water Balances for Selected Subareas, Absolute and Relative to Existing Conditions, All Scenarios

Subarea	Component	Scenario 1 Simulated (afy)	Scenario 2 Simulated (afy)	Scenario 2 Relative (afy)	Scenario 3a Simulated (afy)	Scenario 3a Relative (afy)	Scenario 3b Simulated (afy)	Scenario 3b Relative (afy)	Scenario 4 Simulated (afy)	Scenario 4 Relative (afy)
Daly City	Storage	-230	-411	-180	-328	-97	-326	-95	-391	-161
	Constant Head	0	0	0	0	0	0	0	0	0
	Pumpage	-4,253	-3,921	332	-4,253	0	-4,253	0	-3,421	832
	Drains	0	0	0	0	0	0	0	0	0
	Recharge	1,155	1,155	0	1,155	0	1,155	0	1,155	0
	Lake Seepage	0	0	0	0	0	0	0	0	0
	Groundwater Flow									
	Colma	578	254	-324	668	90	667	88	130	-448
	Lake Merced/GGF	2,112	1,895	-218	1,915	-197	1,919	-193	1,559	-554
	Thornton Beach	199	184	-15	209	10	209	10	175	-24
Colma	Storage	-103	-280	-178	-140	-37	-139	-37	-267	-165
	Constant Head	0	0	0	0	0	0	0	0	0
	Pumpage	-716	-1,198	-481	-716	0	-716	0	-1,243	-526
	Drains	0	0	0	0	0	0	0	0	0
	Recharge	917	917	0	917	0	917	0	917	0
	Lake Seepage	0	0	0	0	0	0	0	0	0
	Groundwater Flow									
	Daly City	-577	-266	310	-663	-86	-661	-85	-135	442
	Cal Water	11	-7	-18	56	44	55	44	-54	-65
	Thornton Beach	269	268	-1	275	6	275	6	245	-24
Cal Water	Storage	-140	-374	-233	-170	-30	-170	-30	-372	-232
	Constant Head	0	0	0	0	0	0	0	0	0
	Pumpage	-1,535	-2,120	-585	-1,535	0	-1,535	0	-2,120	-585
	Drains	0	-1	-1	0	0	0	0	-1	-1
	Recharge	1,453	1,453	0	1,453	0	1,453	0	1,453	0
	Lake Seepage	0	0	0	0	0	0	0	0	0
	Groundwater Flow									
	Colma	-12	8	20	-57	-45	-56	-44	57	68
	San Bruno	-647	-322	326	-638	9	-638	9	-317	330
	Bay Plain/Bay	41	38	-3	43	1	43	1	37	-4
	Thornton Beach	562	576	14	566	4	566	4	524	-38
San Bruno	Storage	15	-84	-100	9	-6	9	-6	-87	-102
	Constant Head	0	0	0	0	0	0	0	0	0
	Pumpage	-2,104	-1,836	269	-2,104	0	-2,104	0	-1,836	269
	Drains	0	0	0	0	0	0	0	0	0
	Recharge	796	796	0	796	0	796	0	796	0
	Lake Seepage	0	0	0	0	0	0	0	0	0
	Groundwater Flow									
	Cal Water	650	328	-323	641	-9	642	-9	323	-327
	Bay Plain/Bay	190	167	-23	191	1	191	1	168	-22
	Millbrae	484	437	-46	485	1	485	1	438	-45
	Thornton Beach	3	3	0	3	0	3	0	3	0
Lake Merced/GGP	Storage	-155	-181	-26	-672	-517	-630	-475	-556	-401
	Constant Head	0	0	0	0	0	0	0	0	0
	Pumpage	-1,618	-1,618	0	-4,990	-3,372	-4,906	-3,289	-4,906	-3,289
	Drains	0	0	0	0	0	0	0	0	0
	Recharge	5,979	5,979	0	5,979	0	5,979	0	5,979	0
	Lake Seepage	446	402	-45	559	112	630	184	767	320
	Groundwater Flow									
	Daly City	-2,104	-1,859	245	-1,907	198	-1,910	194	-1,523	581
	Ocean	-2,882	-3,104	-222	-344	2,538	-453	2,429	-895	1,987
	Thornton Beach	23	20	-3	30	7	30	7	23	-1

Notes: (1) Water balance components represent annual average values on a water year basis, from October to September. The first three months of the simulation period, which represent July through September conditions, are omitted from the annual averages because they represent only a partial water year. The volumes presented represent the 47 complete water years for the simulation period.
(2) Relative values represent average annual net volumetric changes for a given scenario relative to Scenario 1.
(3) Negative storage values represent losses of storage from the aquifer, while positive storage values represent gains in storage in the aquifer.
(4) Recharge is the model-simulated combined recharge from deep percolation of rainfall, irrigation, and leaky pipes and sewers, as well as recharge from lakes and ponds in Golden Gate Park (for Lake Merced/GGP subarea).
(5) Positive Lake Seepage simulated values for the Lake Merced/GGP subarea represent groundwater flow from Lake Merced to the groundwater basin; and negative Lake Merced Seepage simulated values represent groundwater flow out of the groundwater basin into Lake Merced.
(6) Positive simulated values for Groundwater Flow components represent groundwater flow entering the subarea (i.e., inflow); and negative simulated values for Groundwater Flow components represent groundwater flow leaving the subarea (i.e., outflow).

Table 10.4-8: Comparison of Historic and Model-Simulated Groundwater Elevations

Historic Groundwater Level Elevations		Model-Simulated Groundwater Elevations				
Well Location (Period of Record)		**Model Equivalent Location**	**Scenario 1 - Existing Conditions**	**Scenario 2 - GSR Only**	**Scenario 3a - SFGW Only**	**Scenario 4 - Cumulative (GSR & SFGW)**
Shallow Aquifer	**Approx. Elev. Range (ft) (NGVD 29)**	Model Layer 1	**Approx. Elev. Range (ft) (NGVD 29)**			
South Windmill MW-57 (2006-2009)	-4 to 15	SWM-GS-M	6 to 15	6 to 15	-3 to 14	-3 to 11
Taraval MW-145 (2004-2009)	6 to 10	Taraval MW	4 to 9	4 to 9	-1 to 6	0 to 6
LMMW-3S (1996-2009)	2 to 14	LMMW-3S	2 to 20	2 to 21	-13 to 20	1 to 18
LMMW-4S (2003-2009)	11 to 15	LMMW-4S	10 to 25	11 to 25	-4 to 22	5 to 21
Primary Production Aquifer		Model Layer 4				
West Sunset Playground Well (1996-2009)	13 to 24	W-Sunset-PG	-2 to 4	-3 to 4	-14 to 3	-12 to 3
LMMW-2D (1996-2009)	6 to 14	LMMW-2D	-17 to -3	-25 to 6	-44 to -4	-40 to -4
DC-1 Westlake (2002-2009)	-121 to -68	Westlake-DC-1	-120 to -72	-198 to -28	-140 to -72	-181 to -30
MW-CUP-23-515 (08/09-10/09)	-167 to -135	CUP-23	-159 to -111	-289 to -86	-165 to -111	-289 to -87
Cal Water SS1-02 (2002-2009)	-172 to -108	SSF1-02	-206 to -141	-333 to -108	-210 to -141	-336 to -109
MW-CUP-36-1-585 (11/08-10/09)	-175 to -161	CUP-36	-194 to -134	-320 to -107	-198 to -134	-322 to -107
SB-12 Elm Avenue (2004-2009)	-198 to -181	SB-12	-260 to -210	-350 to -138	-262 to -210	-351 to -138

FUGRO CONSULTANTS, INC.

1000 Broadway, Suite 440
Oakland, California 94607
Tel: (510) 268-0461
Fax: (510) 268-0137

May 7, 2012

Project No. 04.B0103128

TECHNICAL MEMORANDUM

To: Mr. Greg Bartow and Mr. Jeff Gilman
San Francisco Public Utilities Commission

From: Peter Leffler, C.Hg.; Ron Bajuniemi, P.E., G.E.

Subject: **Subsidence Analysis for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project**

INTRODUCTION

This Technical Memorandum (TM) was prepared to document work performed by Fugro and as part of contract CS-879A with Kennedy/Jenks Consultants (Kennedy/Jenks) for the San Francisco Public Utilities Commission (SFPUC) pursuant to the amended Task Order authorizations CUW30103-TO-1.12 of the Regional Groundwater Storage and Recovery (GSR) Project and CUW30102-TO-2.7 of the San Francisco Groundwater Supply (SFGW) Project. These projects are funded by the SFPUC's Water System Improvement Program (WSIP).

The San Francisco Public Utilities Commission (SFPUC) is conducting environmental review for the proposed Groundwater Storage and Recovery (GSR) project in the South Westside Groundwater Basin in northern San Mateo County and the San Francisco Groundwater Supply (SFGW) project in the North Westside Groundwater Basin in the City and County of San Francisco. The proposed GSR project involves a partnership between SFPUC and the City of Daly City, California Water Service Company (Cal Water), and the City of San Bruno. The study area encompasses a portion of San Mateo County located between Millbrae and Daly City. Each of the Partner Agencies (Daly City, Cal Water, and San Bruno) has historically obtained municipal water supplies from a combination of groundwater and SFPUC surface water. In the proposed project, the SFPUC would provide a greater allocation of surface water to Partner Agencies during average and wet years in order to allow Partner Agencies to reduce groundwater pumping. The project would create in-lieu groundwater recharge, which would be tapped during drought cycles via new wells installed by the SFPUC between Millbrae and Daly City.

The proposed SFGW project involves groundwater extraction of 3 to 4 million gallons per day (MGD) from four to six new wells installed in the vicinity of Lake Merced, the Sunset District, and Golden Gate Park. The study area encompasses the western portion of San Francisco between the San Francisco/San Mateo county line and Golden Gate Park. The scope of the proposed project (3 or 4 MGD) would depend upon whether or not recycled water would replace a portion of irrigation pumping in Golden Gate Park. If the recycled water project is implemented, two existing irrigation wells at the west end of Golden Gate Park would be converted to municipal supply wells, and four additional municipal supply wells would be brought online to pump a total of 4 MGD from six wells. If the recycled water project is not implemented, the two Golden Gate Park irrigation wells would continue irrigation pumping, and only the four new municipal supply wells would be used to pump 3 MGD for the SFGW project.

Purpose of Study

The proposed GSR project in northern San Mateo County would only extract groundwater up to the amount stored via in-lieu recharge. However, due to potential for localized effects (i.e., greater drawdown in the vicinity of proposed GSR wells), this study is being conducted to evaluate potential for subsidence that may be caused by localized areas of water level drawdowns that may exceed historic lows and exceed future expected groundwater levels without the proposed project(s).

This study addresses the following technical issues:

- The geologic setting of the area (presence of semi-consolidated, fine-grained deposits) with regard to the potential for subsidence.
- Compilation of historical survey and monument data for the study area that could document the existence of and nature of historical subsidence in the area. If data allow – evaluate if subsidence has occurred or is occurring, where it is occurring, and the causes.
- The historical range of water level variations in the principal aquifer units in the study area related to groundwater withdrawal.
- Evaluation of the potential for subsidence related to several proposed scenarios of in-lieu recharge and groundwater extraction in the Westside Basin.

For the purpose of this study, the area evaluated includes the Westside Groundwater Basin in San Francisco and northern San Mateo counties as generally defined by Luhdorff & Scalmanini (2010) and the “model domain” used by Kennedy/Jenks (2012). The area of study is shown on Figure 1, which also shows the approximate location of survey benchmarks with vertical elevation control data from the National Geodetic Survey (NGS).

Background and Previous Studies

A previous study conducted by CH2M Hill (1996) evaluated subsidence associated with potential development of new municipal groundwater supply wells in the Golden Gate Park, Sunset District, North Lake Merced, and South Lake Merced areas. The results estimated total subsidence of up to one foot in the Golden Gate Park area, 0.8 foot in the Sunset District, and 1.4 feet for continuous 5-year pumping rates of 1,400 gpm (approximately 2 MGD) in each respective area. The study did not identify any clay layers of significance in the South Lake Merced area; hence, it was assumed no subsidence would occur in this area. The CH2M Hill study effectively assumes all project pumping comes from one well.

The CH2M Hill study states that subsidence generally occurs in confined aquifers with compressible clay layers, whereas the Westside Basin is generally described as unconfined to semi-confined. Although not explicitly stated in terms of soil compressibility values used in the CH2M Hill subsidence model, it appears that compressible clay values were used based upon data from Santa Clara Valley and Central Valley. Nonetheless, the CH2M Hill study assumes the Westside Basin in San Francisco is confined with compressible clay layers.

The study based the head changes on analytical calculations of drawdown from a well pumping at various discharge rates, with the maximum rate being 1,400 gpm. This calculation resulted in drawdowns (and head changes for subsidence calculations) in excess of 200 feet, and essentially assumes that historic lows are exceeded by greater than 200 feet. The transmissivity value used in the drawdown calculations (13,280 gpd/ft) is too low for the higher pumping rates (e.g., 1,000 and 1,400 gpm) used in the study, and results in excessive drawdown being used in the calculations. Typical pumping rates associated with a T value of 13,280 would be less than 800 gpm. Review of study results for a more realistic individual well pumping rate (relative to a T value of 13,280 gpd/ft) range from 0 to 0.6 feet for a 500 gpm well.

Clay properties used in the calculations were not explicitly stated in the CH2M Hill study; however, two figures provided in the study indicated that clays were assumed to have high compressibility as derived from unconsolidated Santa Clara Valley and Central Valley clay deposits. The semi-consolidated nature of the Westside Basin Merced Formation means its clay units are much less compressible than more recently deposited alluvial clays in Santa Clara Valley and the Central Valley. Furthermore, the CH2M Hill study assumes that all clay layers have the same head change, whereas the current study is based on the different head changes that occur at different depths in clay layers.

The current study that is the subject of this TM uses more realistic soil compressibility parameters and drawdown estimates (especially relative to preconsolidation stresses), as compared to the CH2M Hill study, and thus the results of the current study are more realistic and applicable. It should be further noted that all the areas addressed in the CH2M Hill Subsidence Study currently have or historically have had significant groundwater pumping that will require substantially lower water levels in the future to have any potential of subsidence. For example, the Lake Merced area has historically had significant pumping at nearby golf course irrigation wells that was largely replaced by recycled water in 2005. The Sunset region had an extensive well field in the 1930s and likely much lower water levels at that time compared to today. Irrigation wells have operated historically and continue presently in Golden Gate Park.

A calibrated transient numerical groundwater flow model of the Westside Groundwater Basin, developed by HydroFocus (2011) and applied by Kennedy/Jenks (2012), predicts the extent and magnitude of water level declines in five model layers under various scenarios of in-lieu recharge and groundwater extraction. The Technical Memo completed for Task 10-1 provides a discussion of the HydroFocus model and how it was applied for Task 10 studies (Kennedy/Jenks, 2012). The maximum model-predicted drawdowns in the South Westside Basin related to the GSR project occur at the end of the Design Drought. The maximum model predicted drawdowns in the North Westside Basin related to the SFGW project generally occur at the end of the model run (47 years), which also happens to generally coincide with the Design Drought sequence. The magnitude and extent of the predicted water level declines would theoretically control the extent of potential subsidence and are appropriate to use in the analysis, subject to the discussion provided below. These predicted water level fluctuations are provided in Appendix A – Groundwater Model Results.

Luhdorff and Scalmanini completed a study that documents the hydrogeologic setting of the Westside Basin (TM1: Hydrologic Setting of Westside Basin; Luhdorff and Scalmanini, 2010). The geologic setting of the Westside Basin has been characterized as containing semi-consolidated, unconfined to confined aquifers with variable percentages of interbedded fine-grained deposits depending on location in the basin. Several geologic cross-sections included in this study were utilized in evaluation of well locations selected for subsidence calculations.

Water level declines that would be created from the GSR project or SFGW project may have the potential to cause aquitard (i.e., clay layer) compaction, leading to ground subsidence. This study was conducted to evaluate the potential for ground subsidence related to the proposed GSR and SFGW projects, as well as other reasonable foreseeable future projects ("cumulative scenario").

SUBSIDENCE CONCEPTUAL MODEL

Theory and Cause of Subsidence Related to Fluid Withdrawal

Causes of subsidence and the mechanics of aquifer system responses to fluid withdrawals have been the subject of considerable research in California, largely due to the pioneering efforts of Dr. Joseph Poland. AEG Special Publication No. 8 (Borchers, 1998) provides a wealth of information on subsidence in California caused by groundwater withdrawal. The forces acting on a clay layer at depth include the weight/mass of the overlying sediments and water acting in a downward direction (total stress), balanced by the intergranular skeleton (effective stress) and pore pressures (pore fluid stress) acting in an upward direction (Galloway, et.al., 1999). As the upward forces must balance the downward forces, a decrease in the pore pressure increases the effective stress borne by the soil skeleton. In the case of unconsolidated and semi-consolidated clays, an increase in the effective stress may cause compaction of the clay layers and subsidence at the land surface. Coarse-grained layers would tend to experience some compaction as well, but generally at one to two orders of magnitude less than clay layers. Furthermore, the slight compaction of coarse-grained layers is often elastic and can be reversed when pumping stops or is decreased.

As pore pressures are reduced in a sequence of interbedded aquifers and aquitards due to pumping, compaction of the sequence can only occur as rapidly as excess pore pressures dissipate or reach equilibrium. In aquitard deposits (clay and silt beds) such as those that exist in the Westside Groundwater Basin, the time required for pore pressures to reach equilibrium (i.e., maximum consolidation) can be a slow process requiring several months or even years. Our analysis assumes that the drawdown condition is maintained long enough for residual excess pore pressures to fully dissipate (i.e., steady-state conditions) resulting in the maximum consolidation of the aquitards.

Aquitard values of specific storage (elastic and inelastic) and/or properties of compressibility are required to calculate the theoretical compaction of fine-grained deposits. Knowledge of such values is limited and often imprecise, and hence so are predictions of ultimate aquitard consolidation. Site-specific laboratory test results were not available for this study. We assumed typical soil compressibility values and estimates of the stress history of the Merced Formation, as discussed in other sections of this TM.

Unconsolidated confined aquifers (and aquitards) even at great depth are sensitive to changes in effective stress; small stress changes may cause permanent, widespread compaction. Semi-consolidated aquifers and aquitards (such as exist in the Westside groundwater basin) are generally less susceptible to subsidence due to greater pre-existing consolidation of the sediments. Nonetheless some potential for subsidence may exist for semi-consolidated aquifers/aquitards depending on the magnitude of the changes in hydraulic head (pore pressures) and soil properties.

Groundwater level declines, such as predicted in the numerical model, are an estimate of effective stress changes that would occur in the aquifer system. Aquifer/aquitard compaction may be either recoverable (elastic) or irrecoverable (inelastic) based on the degree of effective stress change and the characteristics of the deposits (compressibility, stress history). During the first cycle of groundwater withdrawal, much of the pumped water comes from the unrecoverable compaction of the aquifer system. In the study area, substantial historical groundwater extractions have occurred by such entities as the San Francisco Water Department in the Sunset area of San Francisco (in the 1930s), San Francisco Zoo, Golden Gate Park, Daly City, Cal-Water Service in the South San Francisco area, the City of San Bruno, various golf courses, and the Colma cemeteries. In cases where well field yields and transient drawdowns were relatively large, such “first cycle of pumped water” may already have occurred, with resultant subsidence. During subsequent cycles of water level declines or to the extent the proposed SFPUC groundwater withdrawals result in water level declines greater than the historical range, the aquifer system preconsolidation stresses again would be exceeded, resulting in renewed potential for layer compaction and land subsidence.

Conceptual Analysis Evaluation

It should be noted that historic subsidence in the Westside Groundwater Basin study area has not occurred (or at least it has not been documented) as it has further south in the area from Redwood City to San Jose. The fact that extensive historic groundwater extraction has resulted in associated declines in groundwater levels, but without any apparent substantial subsidence, suggests that the semi-consolidated Merced Formation sediments have limited compressibility. Therefore, based on a conceptual understanding of the mechanisms required for land subsidence and the apparent lack of historic subsidence in the study area, the potential for future subsidence even with additional lowering of groundwater levels below historic lows is likely limited due to low compressibility of semi-consolidated Merced Formation sediments.

DATA COLLECTION AND REVIEW

Geologic/Hydrogeologic Setting and Selection of Representative Well Locations

The hydrogeologic investigations of the study area conducted by Luhdorff & Scalmanini (2010), Kennedy/Jenks (2009 and 2010), and others provide detailed information on the geologic setting and aquifer/aquitard variability and characteristics. Luhdorff & Scalmanini has prepared geologic cross-sections for the Westside Groundwater Basin extending from Golden Gate Park in the north to Millbrae in the south. Clay and sandy clay layers are present at variable depths in most areas of the basin. Two prominent clay layers present in the Lake Merced area include the X clay and the W clay. The W clay is regionally continuous and extends south through Daly City and Colma. Other clay layers are present in South San Francisco and San Bruno as well.

North Westside Basin

The north-south geologic cross-section prepared by Luhdorff & Scalmanini (2010) extends from Golden Gate Park in the north through Millbrae on the south. This cross-section shows the general location of the predominant clay layers in the groundwater basin. In particular, prominent clay layers identified around the Lake Merced and Sunset areas in San Francisco include the -100 foot clay, X Clay, and W Clay. The two representative locations selected from among the SFGW Project wells were the South Sunset Playground (South Sunset well) and Lake Merced Pump Station (LMPS well). Wells from these two areas were selected over a site in Golden Gate Park due to the greater prevalence of clay layers in the Sunset/Lake Merced areas compared to Golden Gate Park.

The LMPS well has substantial clay layers present both above (333 to 390 feet below ground surface (bgs)) and below (454 to 542 feet bgs) the proposed pumped zone. The more confined nature of the LMPS well might be expected to result in greater head declines, and its location in the southern portion of San Francisco would experience some contribution to head losses from the GSR project in addition to the primary groundwater level declines related to the SFGW project. Therefore, the LMPS location may be considered more susceptible to project-related subsidence effects than a location in Golden Gate Park.

The South Sunset Well has a shallow sandy clay layer within the upper 100 feet, several intermediate depth clay layers between 290 and 390 feet, and a deeper clay layer below 500 feet. In addition, review of the geophysical and geologic logs show that clayey sand (and sand with clay) layers present at 320-335, 340-348, 430-447, 450-476, and 514-570 feet bgs display similar characteristics to layers logged as clay and sandy clay on the geologic log. Therefore, clayey sand and sand with clay layers in the geologic log were treated as clay layers for the subsidence analysis. The South Sunset well is located between the LMPS well on the south and West Sunset well to the north, both of which should add some mutual interference drawdown to the South Sunset well location (which would tend to result in a more conservative analysis).

South Westside Basin

Geologic cross-sections and well data were reviewed for the South Westside Groundwater Basin to select two representative locations for analysis of subsidence. In general, the selected locations should emphasize basin areas with greater thicknesses of clay layers and anticipated lower groundwater elevations since these characteristics create more potential for subsidence. Review of geologic cross-sections indicates clay layers are less prevalent in the north (Daly City area) and more prevalent in the central to southern portion of the basin (in the Colma area and further south). The Colma and South San Francisco areas were selected over the San Bruno/Millbrae areas further south due to the concentration of proposed GSR wells in the Colma and South San Francisco areas compared to the San Bruno/Millbrae areas.

In terms of the South Westside Groundwater Basin, the shallow (-100 foot clay) and intermediate (X Clay) layers appear to pinch out in the Daly City area – thus reducing the potential for subsidence. An intermediate depth clay layer occurs again in the Colma area along with continuing presence of the deeper W Clay. Due to the comprehensive nature of boring data collected as part of the GSR monitoring well installation program (geologists log, geophysical log, drillers log) (Kennedy/Jenks, 2009 and 2010), the SFPUC nested well data were reviewed to select representative locations.

Consistent with the overall geology shown in the Luhdorff & Scalmanini cross-sections, CUP- 6, 7, and 10A (locations shown in Figure 2) in the Daly City area generally had greater prevalence of sand over clay compared to areas further south and were not selected. CUP-18, 19, 22A, and 23 (locations shown in Figure 2) were reviewed as a group, and CUP-19 was selected to be representative the Colma area. CUP-19 appears to have clay layers that are representative of other well locations in the Colma area. The proposed CUP-19 well site has both intermediate depth and deep clay layers. In addition, CUP-19 provides a location that should be representative of the extensive Take pumping proposed for this area. The combination of clay layers and the amount of proposed pumping in this area make CUP-19 a good selection for calculation of subsidence potential.

Further to the south along the Luhdorff & Scalmanini axial cross-section in South San Francisco it is apparent that the deeper W clay pinches out; however, a much thicker intermediate clay layer is present along with a shallow clay layer. A thinner deep clay layer also is present at the location of proposed CUP 41-4. Therefore, the fourth site selected for subsidence analysis was the proposed CUP-41-4 well location based on the presence of the clay layers discussed above. In addition, CUP-41-4 was selected over a location in San Bruno due to the greater influence of Take-year pumping on groundwater levels around CUP-41-4 compared to sites in the City of San Bruno. The location/thickness of clay layers and the potential head declines are thought to create more potential for project-related subsidence effects at CUP-41-4 than in San Bruno. Although the San Bruno area has a lot of clay at shallow to intermediate depths, there is less groundwater extraction from proposed GSR wells in the area and thus head changes would be smaller than other areas.

Survey Data

Sources of information on the location of survey monuments and the history of vertical measurements of elevation changes within the study area are limited. Review of the National Geodetic Survey's (NGS) database (http://www.ngs.noaa.gov/cgi-bin/datasheet.prl) indicates that benchmark data are available for 57 stations within the study area. For the most part, all survey data from these benchmarks represent one or two time measurements performed by the National Geodetic Survey (NGS) and others. Printouts of the station reports that are typical of the limited history for vertical elevation measurements in the area are provided in Appendix B - NGS Survey Data.

Although the available survey data do not allow for any conclusions to be reached with regard to historic subsidence due to lack of enough measurements at any given location, the data are provided in this study for documentation purposes and possible use as baseline data to compare against future measurements.

Review of Historic Groundwater Level Data

Historical water level data for the study area were obtained from SFPUC and Partner Agencies. As previously discussed, compaction of interbedded aquifer and aquitard materials can occur only as rapidly as pore pressures in the materials are reduced as a result of lower water levels. Past groundwater extractions in the area have resulted in sustained lowered water levels (and increase in effective stress) in the various aquifers. Land subsidence due to such groundwater withdrawal in the area would be expected to have already occurred if the area were susceptible; however, no historic subsidence has been documented.

Groundwater level elevation hydrographs for 11 wells (which are limited to South Westside Basin locations due to the general lack of groundwater level data prior to the 1980s in the North Westside Basin) of various depths with the longest historic records in the study area are provided in Appendix C – Groundwater Hydrographs. Table 1 provides a summary of historical groundwater level data from the wells included in Appendix C and several additional wells from the North and South Westside Basins with shorter periods of record. A few wells in the South Westside Basin have water level records extending back to the 1940s or 50s and provide a limited representation of static water level variations since that time. A map showing the distribution of wells in the study area for which hydrographs have been prepared is included in Figure 2. The data contained in Appendix C and summarized in Table 1 indicate the hydrograph records are quite variable in terms of the number and temporal span of water level measurements. To the extent that data on the perforated interval is available, it is provided in Table 1.

Although essentially no wells in the North Westside Basin have water level data extending back to the 1940s to 1970s, it is known that an extensive well field was developed in the Sunset District from 1930 to 1935. The historic Sunset Well Field consisted of 21 wells along 43rd and 44th Avenue between Kirkham and Taraval streets. The average depth of the wells was 250 feet and the total pumping capacity of the wells was about 6.5 MGD (4,500 gpm). The wells were operated from October 1930 to October 1935. Documented monthly pumping totals from May to October 1931 showing water production of 165 to 186 million gallons per month from the Sunset Well Field (3,850 to 4,200 gpm) (San Francisco Water Department, 1931).

Given that historic groundwater pumping from this well field is estimated at up to 6.5 MGD, it is likely that substantial groundwater level decline occurred that would have caused a proportional amount of subsidence in the area (again assuming clays have substantial compressibility), if the area were susceptible. However, given the lack of documentation of historic lows during the 1930-35 time period, this era of groundwater extraction in San Francisco was not used as a basis for historic lows in the Sunset District. Golden Gate Park also has an extensive history of pumping groundwater for irrigation, but little water level data prior to the late 1980s are available; thus, possible pre-1980s groundwater levels lower than recent historic lows are discounted.

Groundwater level data for wells located in San Francisco are generally limited to the time period from the late 1980s until present, and most available historic data are from the last 10 years. Thus, it is unlikely that historic lows have been captured in the available measured groundwater level data. Nonetheless, groundwater level data that are available from selected wells extending from Golden Gate Park in the north to Lake Merced in the south of San Francisco were reviewed with respect to lowest recorded groundwater levels. The shallow aquifer at the North and South Windmill wells has historic low groundwater level measurements ranging from -6 to 7 feet NGVD 29, whereas the deeper zone has a historic low of -26 feet NGVD 29. Since the time it was installed in 1993, the lowest measured historical groundwater level at the West Sunset Well was 14 feet NGVD 29 in 1995. Groundwater level data collected in the last few years show low groundwater levels of -9 feet NGVD 29 and -99 feet NGVD 29 in the primary and deep aquifers at Lake Merced Pump Station nested monitoring wells. The deepest recorded level at the Olympic Club Well 1 was -47 feet NGVD 29.

Inspection of the hydrographs with long histories of water level data extending back to the 1950's or earlier in the South Westside Basin (DC-1, DC-8, DC-9, SS1-14, SS1-17, SS1-18) generally shows water levels declining until the early 1970s. Since the early 1970s water levels have tended to fluctuate around an average level without much of a net rise or decline until the In-Lieu Recharge Demonstration Study was implemented in 2002. Since 2002 the hydrographs with water level data available from 2000 to 2009 (DC-1, DC-8, SS1-02, and SB-12) show substantial rises in water level (although SB-12 subsequently declined back to its 2002 level after normal pumping resumed from 2005 to 2008). Based on these water level variations, subsidence due to historic groundwater extractions would be expected to have already occurred in proportion to historic lows to the extent that fine-grained aquitard layers may be present within the associated depth intervals and to the extent that semi-consolidated clays of the Merced Formation are compressible.

Screen interval data are only available for one of the three Daly City wells (DC-1, DC-8, and DC-9) with long-term water level records. However, the range of historic lows (-142 to -154 feet NGVD 29) and available screen data indicate these water levels are likely most representative of the shallow to intermediate depth aquifer zones.

Cal-Water wells SS1-14 through SS1-18 are more representative of shallow aquifer zones based on screen intervals, and SS1-21 is representative primarily of the deeper more confined aquifer that has been the primary municipal aquifer pumped in recent years. Historic lows in the Cal-Water area represented by shallow-screened wells ranged from -150 to -169 feet NGVD 29, whereas the one well screened in the deeper confined aquifer has a historic low of -229 feet NGVD 29. Of the two other Cal-Water wells (SS1-19 and SS1-20) with more intermediate depth upper screen zones, SS1-19 has a historic low more consistent with shallow screened wells whereas SS1-20 has a historic low more consistent with the deeper screened well. Overall, historic low water levels in Cal-Water wells are generally consistent with the observations from nested monitoring wells in the basin that show lower groundwater elevations with increasing screen depths. This vertical downward gradient is likely a function of most existing municipal and irrigation wells being screened in and pumping from the deeper aquifers (i.e., screened at depths below 350 feet).

Historical groundwater level data for San Bruno wells prior to 1996 are very limited and no data are available during the last major drought period (1988-1992). Thus, it is difficult to evaluate representative historic lows from measured data in the San Bruno area. Measured historic lows in recent years ranged from -144 to -213 feet NGVD 29 and occurred in the 1999-2001 timeframe.

With respect to groundwater level declines indicated by historic data, WRIME has evaluated the issue of historical subsidence as part of their work in preparing a draft groundwater management plan for the South Westside Basin (WRIME, October 2011). WRIME states the following with respect to subsidence south of the study area, "There are no available records of historical subsidence in the South Westside Basin. Significant studies have been performed to the south in the Santa Clara Valley, due to extensive subsidence in that area. Those studies show that the extent of subsidence in the area is focused on Santa Clara, where land subsided 8 ft from 1934 to 1967. To the north, subsidence is more limited, with less than 1 foot of subsidence in the Palo Alto area and approximately an inch of subsidence in the Redwood City area (Poland and Ireland, 1988). Studies have not been performed farther north, likely due to a lack of evidence of active subsidence." WRIME further states the following with regard to the study area itself, "There has been no evidence of historical land subsidence, even though water levels have declined significantly from pre-development levels. Land subsidence is most rapid immediately after the initial dewatering of sediments. Thus, land subsidence is not anticipated from sediments that have been historically dewatered. Should water levels decline in the future, it is unlikely that subsidence would occur as these materials are similar to those historically dewatered and would likely exhibit the same limited compressibility."

GROUNDWATER MODEL RESULTS

Introduction

The numerical groundwater flow model for the Westside Basin was developed over a period of time from 2003 to 2011 by HydroFocus and Gus Yates, who were retained by Daly City (2007, 2009, and 2011). It was a collaborative effort sponsored by Daly City with review by the SFPUC, Cal Water, San Bruno and their respective consultants. The Project EIR efforts being conducted by the SFPUC for the SFGW and GSR projects have utilized the calibrated Westside Basin Groundwater-Flow Model as one of the tools for evaluating potential project effects. Kennedy/Jenks Consultants have been the lead in applying the existing model to future project scenarios for the respective EIR efforts (with review and input by Luhdorff & Scalmanini and Fugro). The following sections describe groundwater levels derived from model results of the HydroFocus (2011) calibration run (historic results), and groundwater levels predicted by the model over various future project scenario runs performed by Kennedy/Jenks (2012).

Historic Results from 1959-2009

The historic model results over the 1959 to 2009 time frame are used to supplement the available record of actual historic groundwater level measurements described in the previous section of this report. Historic low groundwater levels from model results for selected wells are provided in Tables 2 through 5. The limited availability of historic groundwater level measurements and screening over multiple layers of many wells with historic data make the use of model-estimated historic groundwater levels very important in the subsidence analysis. The model results provide a predicted continuous (monthly) record of groundwater levels by discrete depth zones (model layers). Review of the historic model results allows for selection of a more representative historic low due to the continuous record (limited historic measurements likely missed the historic low from a timing standpoint) and output of groundwater levels by model layer (many wells with historic measurements are screened across multiple aquifers or model layers). Because the historic model-predicted groundwater levels are calibrated to the limited available measured data, model-based historic lows should provide a reasonable approximation of actual historic lows. At a minimum the groundwater model provides the best means available to derive historic lows.

Model-derived historic lows for the area around CUP-19 for two well locations (Cypress 2 and Holy Cross 2) for the various model layers ranged from -53 to -61 feet NGVD 29 in model layer 1 to -170 to -179 in model layer 5. The proposed municipal well at CUP-19 is planned to be screened in model layers 3, 4, and 5, where model historic lows at nearby wells range from -111 to -179 feet NGVD 29 (Table 2). The measured historic low for Holy Cross 1 was -162 feet NGVD 29 in June 2000 based upon a limited number of measurements since 1986.

Model-derived historic lows for the area around CUP-41-4 for three well locations (California Golf Club 6, SSF-02, and SB-12) for the various model layers ranged from -71 to -84 feet NGVD 29 in model layer 1 to -226 feet NGVD 29 in model layer 4. The proposed municipal well at CUP-41-4 is planned to be screened in model layers 4 and 5, where model historic lows from nearby wells range from -171 to -226 feet NGVD 29 (Table 3). Measured historic lows for SSF-02 and SB-12 are -131 and -210 feet NGVD 29, respectively.

Model-derived historic lows for the area around Lake Merced Pump Station Well at three nearby well locations (Olympic, Harding Park, Higuera) for the various model layers ranged from -8 to 13 feet NGVD 29 in model layer 1 to -70 to -146 feet NGVD 29 in model layer 5. The Lake Merced Pump Station Well is screened in model layer 4, where model historic lows at nearby wells range from -22 to -68 feet NGVD 29 (Table 4). Measured historic lows for the Olympic Club Well 1 and Olympic Club MW range from -56 to -5 feet NGVD 29.

Model-derived historic lows for the area around the South Sunset Well at three well locations (LMMW-4, LMMW-5, and Santiago) for the various model layers ranged from 9 to 26 feet NGVD 29 in Model Layer 1 to -31 feet NGVD 29 in Model Layer 5. The South Sunset Well is screened in model layers 1 through 4, where model historic lows at three surrounding well locations range from -11 to 26 feet NGVD 29 (Table 5). The West Sunset Well had a measured historic low of 14 feet NGVD 29 based on limited data.

Future Results from 2009-2056

The model scenarios run to simulate future project conditions were used to assess the likelihood of historic low groundwater levels being exceeded and, if exceeded, the approximate magnitude and duration by which historic lows may be exceeded. The results of this analysis provide key input data to the subsidence calculations presented later in this report.

The future groundwater model scenarios are described in detail by Kennedy/Jenks (2012). The subsidence analysis evaluated scenarios 1, 2, 3a, 3b, and 4, which are described below. All scenarios are 47.25-year runs based in part on historical hydrology but also including a Design Drought. The Design Drought ends with the 1976-77 drought added onto the end of the 1987-92 drought, to simulate a 7.5-year drought. Scenario 1 includes existing pumping conditions and no proposed SFPUC projects, and begins with June 2009 basin groundwater levels.

Scenario 2 is based on implementation of the proposed GSR project. Scenarios 3a and 3b simulate implementation of the proposed SFGW project with total pumping of 3 MGD (3a) and 4 MGD (3b). Scenario 3a includes 3 MGD of SFGW project pumping via four wells located in central Golden Gate Park, the Sunset District, and at the Lake Merced Pump Station, while maintaining irrigation pumping at the western Golden Gate Park irrigation wells. Scenario 3b includes 4 MGD of SFGW project pumping from six wells in Golden Gate Park, the Sunset

District, and the Lake Merced Pump Station. Scenarios 3a and 3b start with June 2009 groundwater levels (consistent with scenario 1).

Scenario 4 represents a cumulative scenario and includes simulation of both the proposed GSR and SFGW projects together. In addition, scenario 4 includes other reasonably foreseeable future projects such as implementation of supplemental water to help maintain Lake Merced surface water levels, and expansion of the Holy Cross Cemetery with an associated increase in irrigation pumping.

CUP-19

The Cypress 2 Well in the groundwater model was used as the basis for historic lows in groundwater levels for comparison to future model-predicted groundwater levels at CUP-19. The results are tabulated in Table 2 (and Appendix D). Under the existing conditions model scenario (1), historic lows would be exceeded by 3 to 18 feet in model layers 1 through 3 and by 24 feet in model layer 5. Under model scenario 2, historic lows are estimated to be exceeded by 49 to 118 feet for model layers 1 through 4 and by 173 feet for model layer 5.

However, the best comparison to evaluate actual project effects is to compare model scenario 2 (and 4) to model scenario 1, which represents that incremental head drop caused by the project. Comparison of scenario 2 to 1 shows incremental head decreases of 31 to 125 feet for model layers 1 through 4 and 149 feet for model layer 5. Scenario 4 heads were 3 to 7 feet higher than heads for scenario 2, possibly related to slight differences between scenarios 2 and 4 with respect to locations of municipal (existing vs. replacement) well(s) along with the general lack of impact from scenario 3 at this location.

CUP-41-4

There were no adjacent wells to CUP-41-4 in the historical groundwater model run to use for assessment of model-predicted historical groundwater levels. Therefore, an average of three wells (CGC-6, SSSF-02, and SB-12) was used as a basis for comparison to future model-predicted groundwater levels at CUP-41-4. The results are tabulated in Table 3 (and Appendix D). Groundwater elevations under the existing conditions model run (model scenario 1) were higher than historic lows in model layers 1 through 3. Historic lows were exceeded by 10 to 23 feet in model layers 4 and 5. Under model scenario 2, historic lows were not exceeded in model layers 1 and 2, but were exceeded by 50 to 174 feet for model layers 3 through 5.

As stated above, actual project effects are best evaluated by comparing model scenario 2 (and 4) to model scenario 1, which represents the incremental head drop caused by the project. Comparison of scenario 2 to 1 shows incremental head decreases of 0 to 153 feet for model layers 1 through 4 and 151 feet for model layer 5. Scenario 4 shows negligible differences as compared to results of scenario 2 at CUP-41-4, likely due to the substantial distance between the proposed CUP-41-4 well and the proposed SFGW project wells.

Lake Merced Pump Station (LMPS) Well

There are three wells in close proximity to the LMPS Well in the historical groundwater model run that were used for assessment of model-predicted historical groundwater levels (Olympic, Harding Park, and Higuera). Higuera was used as the basis for comparison to future model-predicted groundwater levels at the LMPS Well due to its close proximity. The results are tabulated in Table 4 (and Appendix D). Under the existing conditions model run (1), historic lows would be exceeded by 3 to 4 feet in model layers 1 and 2, but not exceeded in layers 3 through 5. Under model scenario 2, historic lows are estimated to be exceeded by 4 to 10 feet for model layers 1 through 4 and by 58 feet for model layer 5. Under model scenarios 3a and 3b, historic lows are estimated to be exceeded by 18 to 57 feet in model layers 1 through 4 and by 5 feet in model layer 5.

Scenario 4 exceeds historic lows by 6 to 56 feet in model layers 1 through 5. Scenario 4 groundwater elevation lows were higher than scenario 3 lows for model layers 1 through 3. This is likely due to incorporation of supplemental water for Lake Merced in Scenario 4, which was not included in Scenario 3 (a and b).

Again, actual project effects are best evaluated by comparing model scenario 2 (and 3a, 3b, 4) to model scenario 1, which represents the incremental head drop caused by the project. Comparison of scenario 2 to 1 shows incremental head decreases of 0 to 15 feet for model layers 1 through 4 and 63 feet for model layer 5. Comparison of scenario 3a/3b to 1 shows incremental head decreases of 10 to 21 feet for model layers 1, 2, 3, and 5, and a 62 feet incremental head decrease for model layer 4. Comparison of scenario 4 to 1 shows incremental head decreases of 2 to 16 feet for model layers 1 through 3 and 59 to 61 feet for model layers 4 and 5.

South Sunset Well

There are three wells surrounding the South Sunset Well in the historical groundwater model run that were used for assessment of model-predicted historical groundwater levels. The average of three wells (LMMW-4, LMMW-5, and Santiago) was used as a basis for comparison to future model-predicted groundwater levels at South Sunset Well. The results are tabulated in Table 5 (and Appendix D). Under the existing conditions model run (1), historic lows were exceeded only by 1 to 2 feet. Under model scenario 3a, historic lows are estimated to be exceeded by 22 to 33 feet for model layers 1 through 4 and by 7 feet for model layer 5. The amount by which historic lows would be exceeded under scenario 3b is 21 to 31 feet for model layers 1 through 4 and by 7 feet for layer 5. The amounts by which historic lows are exceeded under scenario 4 are slightly less than under scenarios 3a and 3b (16 to 26 feet for model layers 1 through 4 and 14 feet in model layer 5); the likely reason for this prediction is that Lake Merced supplemental water was included in scenario 4 but not in scenarios 3a/3b (see Kennedy/Jenks, 2012).

Actual project effects are best evaluated by comparing model scenario 3a (and 3b, 4) to model scenario 1, which represents that incremental head drop caused by the project. Comparison of scenario 3a to scenario 1 shows incremental head decreases of 21 to 32 feet for model layers 1 through 4 (6 feet for model layer 5). The amount by which scenario 1 lows would be exceeded under scenario 3b is 1 to 2 feet less than under scenario 3a. Comparison of scenario 4 to scenario 1 shows incremental head decreases of 15 to 25 feet for model layers 1 through 4 and 13 feet for layer 5.

SUBSIDENCE CALCULATIONS

As discussed above, substantial land subsidence is not known to have occurred in the study area even with documented historic declines in groundwater levels over 200 feet below the ground surface. Nonetheless, based on the data analysis described above, it is apparent that withdrawals of groundwater under the two proposed projects being considered by the SFPUC has some potential to create land subsidence due to compaction of fine-grained deposits within and adjacent to the pumped aquifer. The groundwater model results predict relatively substantial drawdowns and exceedence of historic low groundwater levels in the pumped aquifer over a broad geographic area under the various proposed project scenarios.

Potential subsidence was estimated using an analytical equation for various proposed scenarios using representative subsurface profiles at the four well locations described above (CUP-19, CUP-41-4, LMPS, and South Sunset). The detailed assumptions and results of the subsidence calculations are presented in Appendix E. Initial groundwater levels were derived from historic model runs (with some validation by measured water levels) and from model scenario 1 (existing conditions with no proposed projects). Final groundwater levels at each of the four well locations were taken as the lowest predicted future groundwater elevations under each respective scenario. Subsidence estimates are provided for the area in the general vicinity of the pumping well analyzed in each of the four cases, but can be considered to be a representative but conservative estimate of broader areas around the wells.

The amount of subsidence was estimated using the following equation:

$$S = C_{ec} \times H \times \log(\sigma'_f/\sigma'_i)$$

Where:

- S = subsidence
- C_{ec} = compression ratio (or C_{er} – recompression ratio)
- H = layer thickness
- σ'_i = initial effective stress
- $\sigma'f$ = final effective stress

Site-specific field/lab compressibility data for the Merced Formation were not available. Therefore, the compression ratios used in the subsidence estimates were from areas of known land subsidence based on our interpretation of available geologic/geophysical logs, published information from the Santa Clara Valley subsidence studies (Poland, 1971; Poland and Ireland, 1988), and our engineering judgment. This approach is conservative because the compression ratios used are based on younger and less consolidated sediments with known land subsidence compared to Merced Formation sediments.

The USGS (Poland, 1971) reported virgin compression ratios of approximately 0.17 to 0.2 for clays in the Santa Clara Valley. For clay layers, we assumed a virgin compression ratio of 0.18 and a re-compression ratio of 0.03 (approximately one-sixth of the compression ratio). We also assigned compression ratios of 0.01 to 0.005 for sand layers in virgin compression and re-compression, respectively (Pestana and Whittle, 1995; Mitchell and Soga, 2005). It should be noted that Santa Clara Valley clay deposits are considered to be of a more recent age and unconsolidated nature compared to the older semi-consolidated Pliocene to Pleistocene age Merced Formation clay layers. Thus, it would be expected that Santa Clara Valley clay compression ratios should be greater than Merced Formation clay compression ratios (resulting in a more conservative analysis).

Many factors affect the compressibility of geologic materials. The primary factors are: the previous loading history caused by deposition and subsequent erosion of sediments, and fluctuations in groundwater levels. Secondary factors include: desiccation due to wetting and drying cycles, freezing and thawing cycles, chemical changes caused by precipitation and/or oxidation, and cementation or interparticle bonding. Due to the geologic age of the Plio-Pleistocene Merced Formation, we assumed that the soils would be in recompression under the proposed pumping conditions. This assumption is considered valid because the proposed pumping conditions would result in a maximum increase in effective stress of no more than 30%.

Pore pressures were computed for individual layers using initial groundwater levels (either historic low or scenario 1 low) and final groundwater levels (lowest groundwater elevation for the given project scenario) for each scenario. Our analysis assumes that the lowest groundwater elevation in each scenario is maintained long enough for residual excess pore pressures to fully dissipate (i.e., steady-state conditions) resulting in the maximum consolidation of the aquitards. Effective stresses were estimated by subtracting pore pressures from total stresses. The increase in effective stress due to the proposed groundwater pumping was generally less that 30 percent of the current effective stress condition.

Subsidence estimates are summarized in Table 6. Appendix E includes spreadsheets showing the assumptions and results of the calculations performed. Overall, the estimates of subsidence range from 1.5 to 3.5 inches when comparing to historical low groundwater elevations, depending on the location and scenario. The subsidence estimates for the project scenarios compared to scenario 1 ranged from 1.0 to 3.5 inches. The settlement estimates include compression of both aquitard (clay) and aquifer (sand). Permanent (inelastic) subsidence (assumed to be equal to estimated compaction of clay layers) would likely be on the order of two-thirds the estimates presented Table 6. Thus, based on the parameters and assumptions used for this analysis, the estimated potential permanent subsidence attributable to the proposed project(s) is less than 3 inches.

In the South Westside Basin, subsidence estimates are about 3 inches compared to historical lows for the two locations evaluated (CUP-19 and CUP-41-4). In terms of potential project impacts (i.e., comparison to Scenario 1), the estimated subsidence at CUP-41-4 is about 3.5 inches compared to about 2.9 inches at CUP-19. The fact that subsidence estimated at CUP-41-4 is slightly greater compared to Scenario 1 than compared to historical lows is likely related to model predictions of rising groundwater levels in the future (scenario 1) in some model layers at this location. Also, the similar to slightly greater overall subsidence estimates at CUP-41-4 compared to CUP-19 despite a lower GSR pumping rate at CUP-41-4 (220 gpm vs. 400 gpm) are likely related to a greater total thickness of clay at the CUP-41-4 location. This slight difference in potential project impacts also occurs despite the greater concentration of GSR project wells in the Colma vicinity (around CUP-19) as compared to the South San Francisco/San Bruno area (around CUP-41-4). In general, it is expected that calculation of potential subsidence based upon groundwater levels at GSR well locations will result in equal or greater amounts of predicted subsidence as compared to locations in between GSR well locations due to cones of depressions that typically occur around pumping wells.

In the North Westside Basin, subsidence estimates for scenarios 3a, 3b, and 4 range from about 1.7 to 3.4 inches compared to historical lows (and 1.5 inches for scenario 2 at LMPS). The subsidence estimates at the Lake Merced Pump Station Well are slightly greater than for the South Sunset Well for a given scenario due to overall greater groundwater level fluctuations at the LMPS Well. The greater groundwater level fluctuations at the LMPS Well may be attributable in part to the more confined nature of the primary production zone at this location, and possibly its closer proximity to the GSR project (relative to scenario 4). In terms of potential project impacts (i.e., comparison to Scenario 1), the estimated subsidence at South Sunset Well (1.5 to 1.9 inches) is similar to but slightly less than the range estimated for LMPS Well (2.8 to 3.0 inches) for scenarios 3a, 3b, and 4. In general, it is expected that calculation of potential subsidence based upon groundwater levels at SFGW project well locations will result in equal or greater amounts of predicted subsidence as compared to locations in between SFGW project well locations due to cones of depressions that typically occur around pumping wells.

DISCUSSION OF RESULTS

It is important to recognize that there can be a substantial time lag between the drop in head (effective stress) created by pumping and the slow drainage and compaction of the aquitard deposits. The proposed (and modeled) scenario for the SFPUC GSR project assumes that GSR pumping during the major (design) drought period extends for a relatively long duration (7.5 years of continuous pumping). The subsidence estimates are based on the lowest model-estimated future groundwater elevations at any time during this drought period (or at any other time during the model simulation), and from that perspective, represent conservative estimates in that lag times are not considered. The calculations described above assume steady-state conditions (i.e., their ultimate compaction if excess pore pressures fully dissipate). Because of the transient nature of the proposed groundwater conditions (especially for the GSR project), the calculations of potential subsidence that have been presented are likely overestimated with respect to (lack of) time lag considerations.

The greatest uncertainty in the subsidence analysis is likely the clay properties with respect to compression ratios. As noted above, the subsidence estimates are based on assumed compression ratios from review of geologic/geophysical logs, literature review, and engineering judgment. From the standpoint of the sensitivity of this assumption, it is worth noting that even if clay compression ratios were assumed to fall on the virgin compression curve as opposed to the recompression curve (resulting in an approximately 6 times greater compression ratio for clay layers), estimated total subsidence would not exceed 16 inches compared to the estimated range of 1.0 to 3.5 inches given above. The subsidence estimates described in this study of less than 4 inches are consistent with the lack of historic subsidence despite past groundwater pumping and dewatering of sediments.

Several other factors that may make the subsidence calculations conservative include:

1. Use of groundwater levels from proposed project production wells,
2. Selection of representative well locations intended to emphasize areas of greater presence of clay and/or greater drawdowns, and

3. Not factoring in probable lower historical groundwater levels in the North Westside Basin related to operation of the Sunset well field in the 1930s and extensive historic pumping for Golden Gate Park irrigation, due to lack of available historic groundwater level data for these areas and time periods.

In terms of use of production well water levels, the typical pattern of cones of depression around pumping wells would be expected to result in greater drawdowns at these locations compared to locations in between production wells. Thus, estimated subsidence would be expected to be somewhat less than presented in this TM at locations in between proposed production wells. As described in this TM, hydrogeologic cross-sections, boring logs, and geophysical logs were reviewed in conjunction with overall distribution of proposed project wells to select four representative well locations for subsidence calculations. It is anticipated that this methodology for well selection would tend to emphasize locations with equal or greater potential for subsidence compared to other proposed well locations. Historical documents and data indicate that substantial groundwater pumping (on the order of 5 MGD) occurred at a well field in the Sunset District from 1930 to 1935; thus, it is likely that historic low groundwater levels in this area were lower than those used in the current study. If historic groundwater elevations were lower in the 1930s the amount of potential subsidence calculated in this study would be lower. Similarly, historic groundwater pumping in Golden Gate Park likely generated lower historic lows than were captured in the available historic groundwater level data records used in the current study.

With respect to Item 1 above regarding the use of groundwater levels at proposed production wells, these estimated subsidence results are still expected to be generally representative (while being somewhat greater as described above) of areas in between the selected wells in both the North and South Westside Basins. The reason for this is that these in-between areas will experience overlapping drawdowns (similar to mutual interference) from multiple wells such that there will be some amount of regional groundwater level decline related to the proposed project(s).

SUMMARY AND CONCLUSIONS

The proposed GSR and SFGW projects have a potential to cause subsidence if a sufficient thickness of compressible clay layers is present and pore pressures of those clay layers are decreased below historic low groundwater elevations. Given data and/or assumptions about soil properties and changes in groundwater levels caused by the proposed project(s), the estimated amount of subsidence due to the proposed project(s) can be calculated. This study included:

1. Review of available data on the geologic setting with regard to subsidence potential, and selection of four representative well locations;
2. Evaluation and assignment of soil compressibility properties for Merced Formation clay and sand layers;
3. Review of historic measured groundwater level data to obtain historic low groundwater elevations;

4. Review of Westside Basin Groundwater-Flow Model historic and future model scenario results to obtain estimates of historic low and anticipated future groundwater elevations both with and without the proposed SFPUC projects; and
5. Application of an analytical equation to calculate the amount of subsidence that is estimated to occur under various scenarios related to the proposed SFPUC projects.

Based upon review of the South Westside Basin geologic setting and locations of proposed pumping wells for the GSR project, the two locations selected for subsidence calculations were CUP-19 (to be representative of the Colma area) and CUP-41-4 (to be representative of the South San Francisco area). Based upon review of the North Westside Basin geologic setting and locations of proposed pumping wells for the SFGW project, the two locations selected for subsidence calculations were the South Sunset Well (to be representative of the Sunset District) and LMPS Well (to be representative of the Lake Merced area). These two well locations were selected over a Golden Gate Park location due largely to the presence of more clay layers at the South Sunset and LMPS well locations. Permanent (inelastic) subsidence (assumed to be equal to estimated compaction of clay layers) would likely be on the order of two-thirds the estimates presented Table 6. Thus, based on the parameters and assumptions used for this analysis, the estimated potential permanent subsidence attributable to the proposed project(s) is less than 3 inches.The total subsidence (compaction of clay and sand layers) estimate for the proposed project(s) is less than 4 inches.

Site-specific soil compressibility data were not available for this study. Based upon review of literature for the Santa Clara Valley and Central Valley, soil compressibility data from Santa Clara Valley were used to estimate clay compressibility values for the Merced Formation. Other literature sources were used to estimate sand layer compressibility values. Due to the fact that the Merced Formation is older than Santa Clara Valley sediments responsible for subsidence in that area and due to the more semi-consolidated nature of Merced Formation sediments (compared to the younger more unconsolidated Santa Clara Valley sediments), assignment of clay compressibility values from Santa Clara Valley soil data should be more conservative (i.e., tend to result in higher estimates of subsidence). The clay layer compressibility ratios were 0.18 for virgin compression and 0.03 for recompression, whereas sand layer compressibility ratios were 0.01 for virgin compression and 0.005 for recompression. Given the geologic age of the Merced Formation (Plio-Pleistocene) and the potential magnitude of increase in effective stress, it was assumed that clay layers would be in recompression.

The number of wells with a good record of historic groundwater levels is very limited. Essentially no wells in the North Westside Basin have groundwater level records extending back prior to the late 1980s. In the South Westside Basin, a few wells in Daly City and South San Francisco had historic groundwater levels extending back to the 1950s or earlier. In general, groundwater levels in the South Westside Basin declined over time from the 1940s/1950s through the 1970s due to increased groundwater pumping for municipal and irrigation purposes. Beginning in the 1970s the Partner Agencies (Daly City, Cal Water, San Bruno) were able to obtain increased amounts of surface water from the SFPUC so that their groundwater pumping could be somewhat reduced and stabilized. The increased use of surface water slowed the rate of groundwater level decline and generally helped stabilize groundwater levels from the 1970s through about 2002. Implementation of the In-Lieu Recharge Demonstration Study beginning in 2002 has led to general increases in groundwater levels in the South Westside Basin.

Due to the sparse measured historic groundwater level data, the groundwater model results were used to help estimate both historic low groundwater elevations and anticipated future low groundwater elevations related to several potential scenarios for implementation of the GSR and SFGW projects. Comparisons (and subsidence calculations) were made between future model-predicted lows with the proposed project(s) and historic lows, and between future model-predicted lows with the proposed project(s) compared to future model-predicted lows without the proposed projects. The calculations performed for this study provided estimates of subsidence that are less than 4 inches for the various scenarios at the four well locations.

Finally, several factors should be noted that likely make the subsidence calculations presented in this TM conservative including: using the lowest predicted groundwater levels without regard to lag time to reach equilibrium in aquitards, use of a conservative consolidation factor, the use of groundwater levels from proposed project production wells, selection of representative well locations intended to emphasize areas of greater presence of clay and/or greater drawdowns, and not factoring in probable lower historical groundwater levels in the North Westside Basin related to operation of the Sunset well field in the 1930s and extensive historic pumping for Golden Gate Park irrigation, due to lack of available historic groundwater level data for these areas and time periods. Consideration of these factors would likely result in lower estimates of potential subsidence.

Attachments: Tables 1 through 6
Figures 1 and 2
Appendices A through E

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List of Tables

List of Figures

Appendices

Table 1. Summary of Historical Groundwater Level Data

Well I.D.	Screen Interval (feet, bgs) [1]	Period of Record	Measured Historic Low Date	Measured Historic Low GW Elevation (feet, NAVD88) [2]
N.Windmill (Windmill NE)		1987-1992	May 1988	7.6 NGVD [3]
Windmill NW		1987-1992; 2001-	May 1990	11.5 NGVD
S.Windmill (SWM-GS-S) (also known as S. Windmill MW-57)	30-50	1989-1993; 2001-2002; 2006-	July 2009	-3
S. Windmill (SWM-GS-M) (also known as S. Windmill MW-140)	118-138	1989-1993; 2001-2002; 2006-	June 2008	-19
S. Windmill (SWM-GS-D)	372-387	1989-1990; 2001-2002	Oct. 1989	-26 NGVD
W. Sunset Playground	150-330	1995-1996;2000-2009	1995	14 NGVD
LMPS-440	410-430	2005-2009	Sept. 2008	-6
LMPS-575	555-565	2004-2009	Sept. 2008	-96
LMMW-3D	180-200	2002-2009	June 2002	-33
Olympic MW	36-46	1990-1993	Sept. 1992	-2
Olympic Club 1		1959, 1971, 1988-1993	Jan. 1988	-53
San Francisco Golf Club No. 1		1951; 1990-1992	Sept. 1991	-36 NGVD
San Francisco Golf Club No. 2		1985; 1989-1990, 1993	May 1990	-74 NGVD
DC-1	190-370	1954-2009	August 1988	-151
DC-8	N/A; TD=479	1958-2009	April 1996	-139
DC-9	N/A, TD=476	1958-2003	July 1996	-150
Holy Cross - 1	368-458; 478-668	1986; 1989-1991; 1998-2001; 2010	June 2000	-162 NGVD
SS1-02	N/A; TD=249	1950-2009	September 1982	-131
SS1-14	69-560	1952-1997	July 1985	-147

Well I.D.	Screen Interval (feet, bgs) [1]	Period of Record	Measured Historic Low Date	Measured Historic Low GW Elevation (feet, NAVD88) [2]
SS1-15	128-535	1965-1997	October 1975	-166
SS1-17	150-460	1939-2003	October 1982 October 1987	-158
SS1-18	160-557	1942-2003	August 1980	-147
SS1-19	216-528	1954-2003	January 1963	-143
SS1-20	220-580	1973-2008	August 1977	-209
SS1-21	370-580	1977-1997	August 1990	-226
Linear Park MW-440	360-370; 420-430	2007-2009	July 2009	-175
Linear Park MW-520	500-510	2007-2009	July 2009	-180
SB-12	146-482	1971; 1996-2009	April 2001	-210
SB-13	185-500	1998-2005	November 2000	-210
SB-14	TD=434	1998-2005	December 2001	279 (DTW)
SB-15	300-500	1998-2005	December 1999	-141

NOTES:

1 – bgs below ground surface

2 – Groundwater elevations are referenced to North American Vertical Datum 1988 (NAVD88) unless otherwise indicated

3 – NGVD29 National Geodetic Vertical Datum 1929

4 – TD total depth

Table 2. CUP-19 Groundwater Level Data Analysis

Table 2a. Lowest Model-Predicted Groundwater Elevations (Feet, NGVD 29)

	Model Historic Lows			Scenario 1		Scenario 2		Scenario 4	
Model Layer	Cypress 2	Holy Cross 2	Historic Low Average	CUP-19	CUP-23	CUP-19	CUP-23	CUP-19	CUP-23
1	-61	-53	-57	-79	-51	-110	-63	-107	-62
2	-73	-63	-68	-87	-60	-122	-75	-118	-74
3	-112	-111	-112	-115	-113	-207	-190	-200	-189
4	-143	-156	-150	-136	-159	-261	-289	-255	-289
5	-170	-179	-175	-194	-190	-343	-317	-338	-318

Table 2b. Difference Between Model Scenario Lows and Model Historic Lows (Feet)

	Model Historic Lows			Scenario 1		Scenario 2		Scenario 4	
Model Layer	Cypress 2	Holy Cross 2	Average	CUP-19	CUP-23	CUP-19	CUP-23	CUP-19	CUP-23
1				-18	2	-49	-10	-46	-9
2				-14	3	-49	-12	-45	-11
3				-3	-2	-95	-79	-88	-78
4				7	-3	-118	-133	-112	-133
5				-24	-11	-173	-138	-168	-139

Table 2c. Difference Between Project Model Scenario Lows and Existing Conditions Model Scenario 1 Lows (Feet)

	Model Historic Lows			Scenario 1		Scenario 2		Scenario 4	
Model Layer	Cypress 2	Holy Cross 2	Average	CUP-19	CUP-23	CUP-19	CUP-23	CUP-19	CUP-23
1						-31	-12	-28	-11
2						-35	-15	-31	-14
3						-92	-77	-85	-76
4						-125	-130	-119	-130
5						-149	-127	-144	-128

Table 2d. Top and Bottom Elevations of Model Layers and Clay Layers and Thickness of Clay Layers
in each Model Layer at CUP-19

	CUP-19			Clay Layers		Clay Thickness		
Model Layer	Top Elev	Bot Elev	Model Layer Thickness (Feet)	Top Elev	Bot Elev	Interval (Feet)	Layer Total (Feet)	Scenario 2 compared to historic lows
1	114	-162	276	-156		6	6	6 feet has pore pressure drop of 49 feet
2	-162	-231	69		-181	19	19	19 feet has pore pressure head drop of 49 feet
3	-231	-300	69			0	0	
4	-300	-474	174	-366	-396	30		
				-411	-421	10		
				-471		3	43	43 feet has pore pressure head drop of 116 feet
5	-474	-700	226		-481	7	7	7 feet has pore pressure head drop of 173 feet

Note: Top Elev and Bot Elev are Top Elevation and Bottom Elevation in Feet, NGVD.

Table 3. CUP-41-4 Groundwater Level Data Analysis

Table 3a. Lowest Model-Predicted Groundwater Elevations (Feet, NGVD 29)

	Model Historic Lows				Scenario 1		Scenario 2		Scenario 4	
Model Layer	CGC-6	SSF-02	SB-12	Historic Low Average	CUP 41-4	SB-12	CUP 41-4	SB-12	CUP 41-4	SB-12
1	-71	-84	-84	-80	-26	-9	-26	-9	-26	-9
2	-82	-110	-108	-100	-47	-27	-58	-27	-58	-27
3	-115	-127	-140	-127	-121	-118	-177	-157	-177	-157
4	-171	-185	-226	-194	-204	-260	-357	-350	-358	-350
5	-176	-189	NA	-183	-205	NA	-356	NA	-358	NA

Table 3b Difference Between Model Scenario Lows and Model Historic Lows (Feet)

	Model Historic Lows				Scenario 1		Scenario 2		Scenario 4	
Model Layer	CGC-6	SSF-02	SB-12	Average	CUP 41-4	SB-12	CUP 41-4	SB-12	CUP 41-4	SB-12
1					54	75	54	75	54	75
2					53	81	42	81	42	81
3					6	22	-50	-17	-50	-17
4					-10	-34	-163	-124	-164	-124
5					-23	NA	-174	NA	-176	NA

Table 3c. Difference Between Project Model Scenario Lows and Existing Conditions Model Scenario 1 Lows (Feet)

	Model Historic Lows				Scenario 1		Scenario 2		Scenario 4	
Model Layer	CGC-6	SSF-02	SB-12	Average	CUP 41-4	SB-12	CUP 41-4	SB-12	CUP 41-4	SB-12
1							0	0	0	0
2							-11	0	-11	0
3							-56	-39	-56	-39
4							-153	-90	-154	-90
5							-151	NA	-153	NA

Table 3d. Top and Bottom Elevations of Model Layers and Clay Layers and Thickness of Clay Layers in each Model Layer at CUP-41-4

	CUP 41-4			Clay Layers		Clay Thickness		
Model Layer	Top Elev	Bot Elev	Model Layer Thickness (Feet)	Top Elev	Bot Elev	Interval (Feet)	Layer Total (Feet)	Scenario 2 compared to Scenario 1
1	24	-164	188	24	7	17		
				-67	-73	6		
				-130	-134	4	27	27 feet has no change in pore pressure
2	-164	-232	68	-174	-176	2		
				-220		12	14	14 feet has pore pressure head decrease of 11 feet
3	-232	-300	68		-284	52		
				-295		5	57	57 feet has pore pressure head drop of 56 feet
4	-300	-460	160		-316	16		
				-364	-376	12		
				-446	-460	14	42	42 feet has pore pressure head drop of 153 feet
5	-460	-556	96			0	0	

Note: Top Elev and Bot Elev are Top Elevation and Bottom Elevation in Feet, NGVD.

Table 4. Lake Merced Pump Station Well Groundwater Level Data Analysis

Table 4a. Lowest Model-Predicted Groundwater Elevations (Feet, NGVD 29)

	Model Historic Lows				1	2	3a	3b	4
Model Layer	Olympic	Harding Park	Higuera	Historic Low Average	LMPS	LMPS	LMPS	LMPS	LMPS
1	-8	11	13	5	9	9	-5	-5	7
2	-17	10	10	1	7	6	-8	-8	4
3	-40	-7	-16	-21	-15	-25	-36	-35	-31
4	-68	-22	-35	-42	-30	-45	-92	-92	-91
5	-146	-70	-97	-104	-92	-155	-102	-102	-151

Table 4b. Difference Between Model Scenario Lows and Model Historic Lows (Feet)

	Model Historic Lows				1	2	3a	3b	4
Model Layer	Olympic	Harding Park	Higuera	Average	LMPS	LMPS	LMPS	LMPS	LMPS
1					-4	-4	-18	-18	-6
2					-3	-4	-18	-18	-6
3					1	-9	-20	-19	-15
4					5	-10	-57	-57	-56
5					5	-58	-5	-5	-54

Table 4c. Difference Between Project Model Scenario Lows and Existing Conditions Model Scenario 1 Lows (Feet)

	Model Historic Lows				1	2	3a	3b	4
Model Layer	Olympic	Harding Park	Higuera	Average	LMPS	LMPS	LMPS	LMPS	LMPS
1						0	-14	-14	-2
2						-1	-15	-15	-3
3						-10	-21	-20	-16
4						-15	-62	-62	-61
5						-63	-10	-10	-59

Table 4d. Top and Bottom Elevations of Model Layers and Clay Layers and Thickness of Clay Layers in each Model Layer at LMPS Well

	LMPS			Clay Layers		Clay Thickness		
Model Layer	Top Elev	Bot Elev	Model Layer Thickness (Feet)	Top Elev	Bot Elev	Interval (Feet)	Layer Total (Feet)	Scenario 4 compared to Scenario 1
1	43	-28	71			0	0	
2	-28	-150	122			0	0	
3	-150	-300	150	-290	-300	10	10	10 feet has pore pressure head drop of 10 feet
4	-300	-496	196	-300	-347	47		
				-411	-496	85	132	132 feet has pore pressure head drop of 49 feet
5	-496	-572	76	-496	-499	3	3	3 feet has pore pressure had drop of 47 feet

Note: Top Elev and Bot Elev are Topo Elevation and Bottom Elevation in Feet, NGVD.

Table 5. South Sunset Well Groundwater Level Data Analysis

Table 5a. Lowest Model-Predicted Groundwater Elevations (Feet, NGVD 29)

	Model Historic Lows				Scenario 1		Scenario 3a		Scenario 3b		Scenario 4	
Model Layer	LMMW-4S	LMMW-5S	Santiago-S	Historic Low Average	South Sunset	West Sunset	South Sunset	West Sunset	South Sunset	West Sunset	South Sunset	West Sunset
1	9	26	11	15	14	14	-7	-24	-6	-21	-1	-19
2	8	23	10	14	13	13	-19	-23	-17	-21	-12	-19
3	-1	6	2	2	0	4	-28	-16	-27	-15	-23	-12
4	-11	NA	-5	-8	-10	-2	-37	-14	-36	-14	-34	-12
5	-31	NA	-8	-20	-20	-5	-26	-12	-26	-12	-33	-13

Table 5b. Difference Between Model Scenario Lows and Model Historic Lows (Feet)

	Model Historic Lows				Scenario 1		Scenario 3a		Scenario 3b		Scenario 4	
Model Layer	LMMW-4S	LMMW-5S	Santiago-S	Average	South Sunset	West Sunset	South Sunset	West Sunset	South Sunset	West Sunset	South Sunset	West Sunset
1					-1	3	-22	-35	-21	-32	-16	-30
2					-1	3	-33	-33	-31	-31	-26	-29
3					-2	2	-30	-18	-29	-17	-25	-14
4					-2	3	-29	-9	-28	-9	-26	-7
5					-1	3	-7	-4	-7	-4	-14	-5

Table 5c. Difference Between Project Model Scenario Lows and Existing Conditions Model Scenario 1 Lows (Feet)

	Model Historic Lows				Scenario 1		Scenario 3a		Scenario 3b		Scenario 4	
Model Layer	LMMW-4S	LMMW-5S	Santiago-S	Average	South Sunset	West Sunset	South Sunset	West Sunset	South Sunset	West Sunset	South Sunset	West Sunset
1							-21	-38	-20	-35	-15	-33
2							-32	-36	-30	-34	-25	-32
3							-28	-20	-27	-19	-23	-16
4							-27	-12	-26	-12	-24	-10
5							-6	-7	-6	-7	-13	-8

Table 5d. Top and Bottom Elevations of Model Layers and Clay Layers and Thickness of Clay Layers in each Model Layer at South Sunset Well

	South Sunset			Clay Layers		Clay Thickness		
Model Layer	Top Elev	Bot Elev	Model Layer Thickness (Feet)	Top Elev	Bot Elev	Interval (Feet)	Layer Total (Feet)	Scenario 3a compared to historic lows
1	83	-152	235	41	9	32		6 feet dewatered
				-127	-129	2	34	2 feet has pore pressure head drop of 22 feet
2	-152	-226	74	-207	-217	10	10	10 feet has pore pressure head drop of 33 feet
3	-226	-300	74	-237	-252	15		
				-257	-265	8		
				-279	-287	8	31	31 feet has pore pressure head drop of 30 feet
4	-300	-454	154	-300	-304	4		
				-347	-393	46		
				-417	-454	37	87	87 feet has pore pressure head drop of 29 feet
5	-454	-463	9	-454	-487	33	33	33 feet has pore pressure head drop of 7 feet

Note: Top Elev and Bot Elev are Top Elevation and Bottom Elevation in Feet, NGVD.

Table 6. Summary of Subsidence Estimates

Well CUP-19	Subsidence (inches)		
Scenario	Sand Layers	Clay Layers	Total
2 to HL	1.54	1.55	3.09
4 to HL	1.48	1.47	2.95
2 to 1	1.43	1.46	2.89
4 to 1	1.36	1.38	2.74

Well CUP-41-4	Subsidence (inches)		
Scenario	Sand Layers	Clay Layers	Total
2 to HL	0.87	1.90	2.77
4 to HL	0.88	1.90	2.78
2 to 1	1.17	2.27	3.44
4 to 1	1.17	2.28	3.45

LMPS Well	Subsidence (inches)		
Scenario	Sand Layers	Clay Layers	Total
2 to HL	0.59	0.95	1.54
3a to HL	0.99	2.54	3.53
3b to HL	0.98	2.54	3.52
4 to HL	0.83	2.52	3.35
2 to 1	0.34	0.61	0.95
3a to 1	0.75	2.21	2.96
3b to 1	0.74	2.20	2.94
4 to 1	0.59	2.18	2.77

South Sunset Well	Subsidence (inches)		
Scenario	Sand Layers	Clay Layers	Total
3a to HL	0.76	1.23	1.99
3b to HL	0.73	1.19	1.92
4 to HL	0.60	1.07	1.67
3a to 1	0.72	1.15	1.87
3b to 1	0.69	1.10	1.79
4 to 1	0.56	0.99	1.55

Note: HL is Historical Low Groundwater Elevation

FIGURES

Path: Z:\Projects\SFPUC_ConjUse_CER\Events\Task_10\Task_10.5\2012050212_TM\01_NGS_Locations.mxd

Aerial Photo Source: World Imagery from ESRI. Copyright:© 2009 ESRI, AND, TANA, UNEP-WCMC

Note:
See Appendix B for more information on the NGS monuments,

Legend

- National Geodetic Survey Monument Locations (NAD83)
- North Westside Groundwater Basin
- South Westside Groundwater Basin

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

STUDY AREA MAP AND NATIONAL GEODETIC SURVEY MONUMENT LOCATIONS

Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Figure 1

Date May 2012

Path: Z:\Projects\SFPUC_ConjUse_CER\Events\Task_10\Task_10.5\2012050212_TM\02_WellsLocationMap.mxd

Aerial Photo Source: World Imagery from ESRI. Copyright:© 2009 ESRI, AND, TANA, UNEP-WCMC

Legend

Selected Groundwater Model Wells	Cal Water Municipal Wells	North Westside Groundwater Basin
GSR Project Proposed Municipal Wells	Daly City Municipal Wells	South Westside Groundwater Basin
SFGW Project Proposed Municipal Wells	San Bruno Municipal Wells	

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

WELL LOCATION MAP

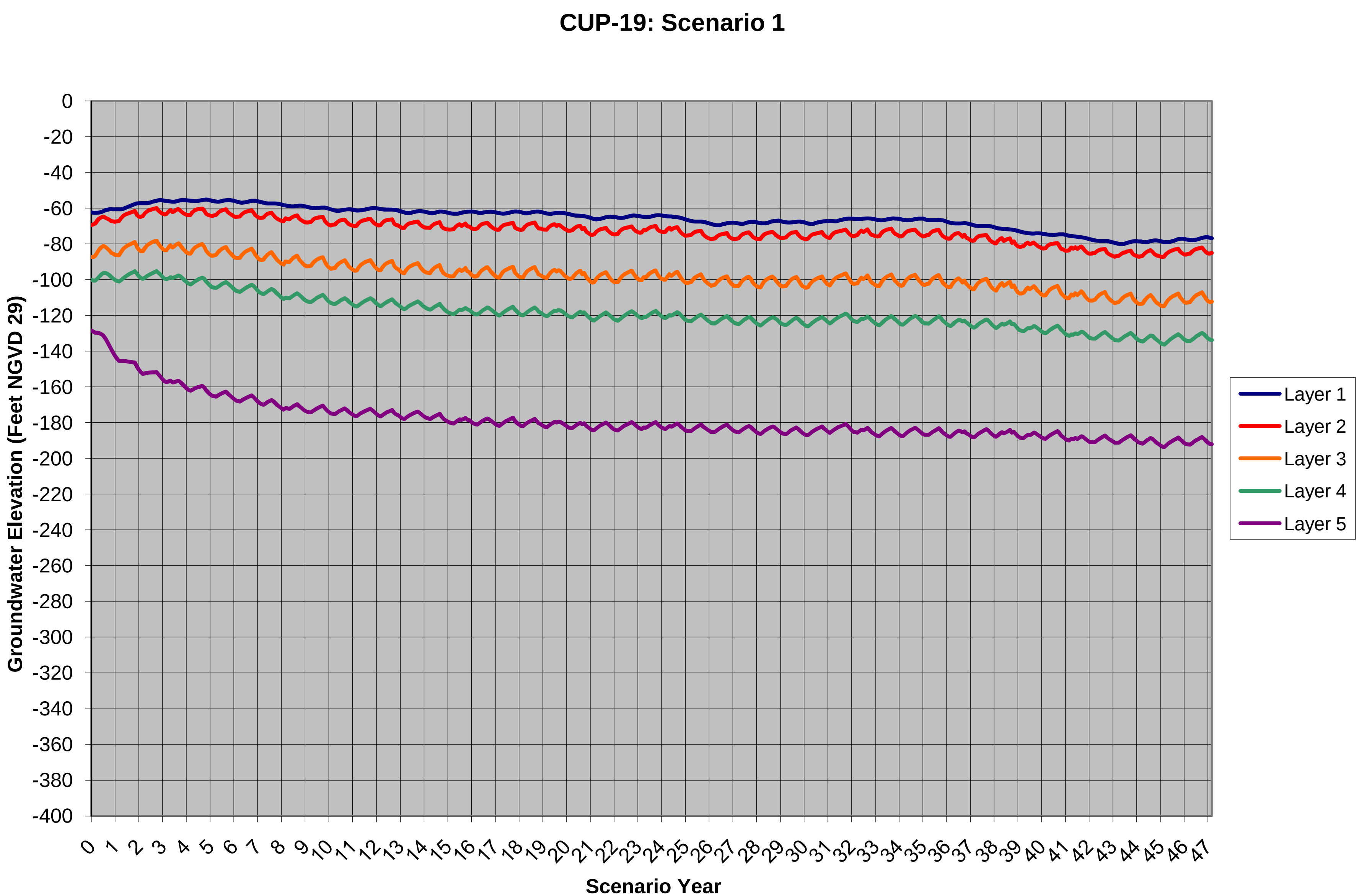
Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Figure
2

Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project

Date
May 2012

APPENDIX A


CUP-19: Scenario 1
Groundwater Elevation (Feet NGVD 29)
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-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
-320
-340
-360
-380
-400
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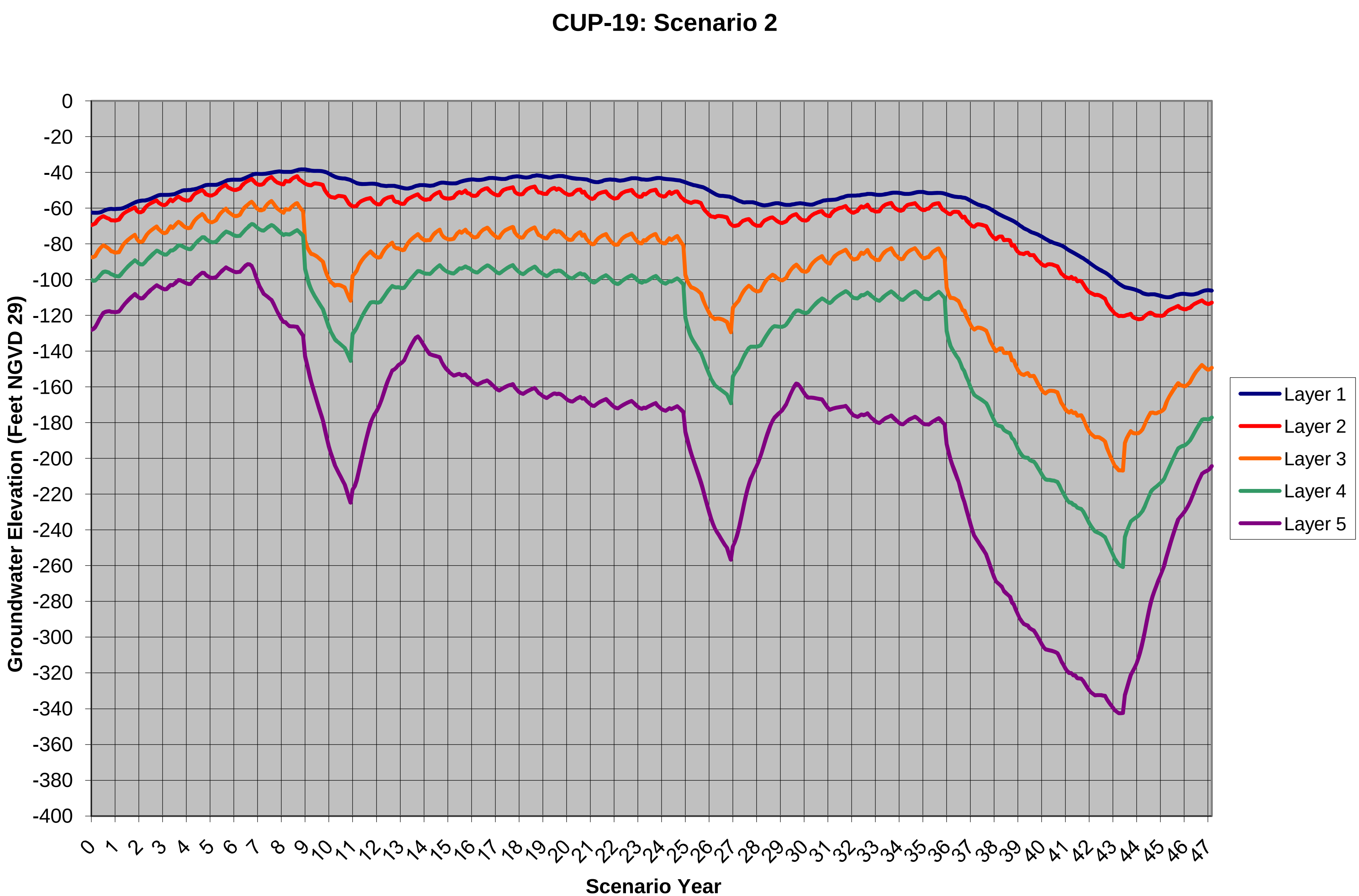
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



CUP-19: Scenario 2
Groundwater Elevation (Feet NGVD 29)
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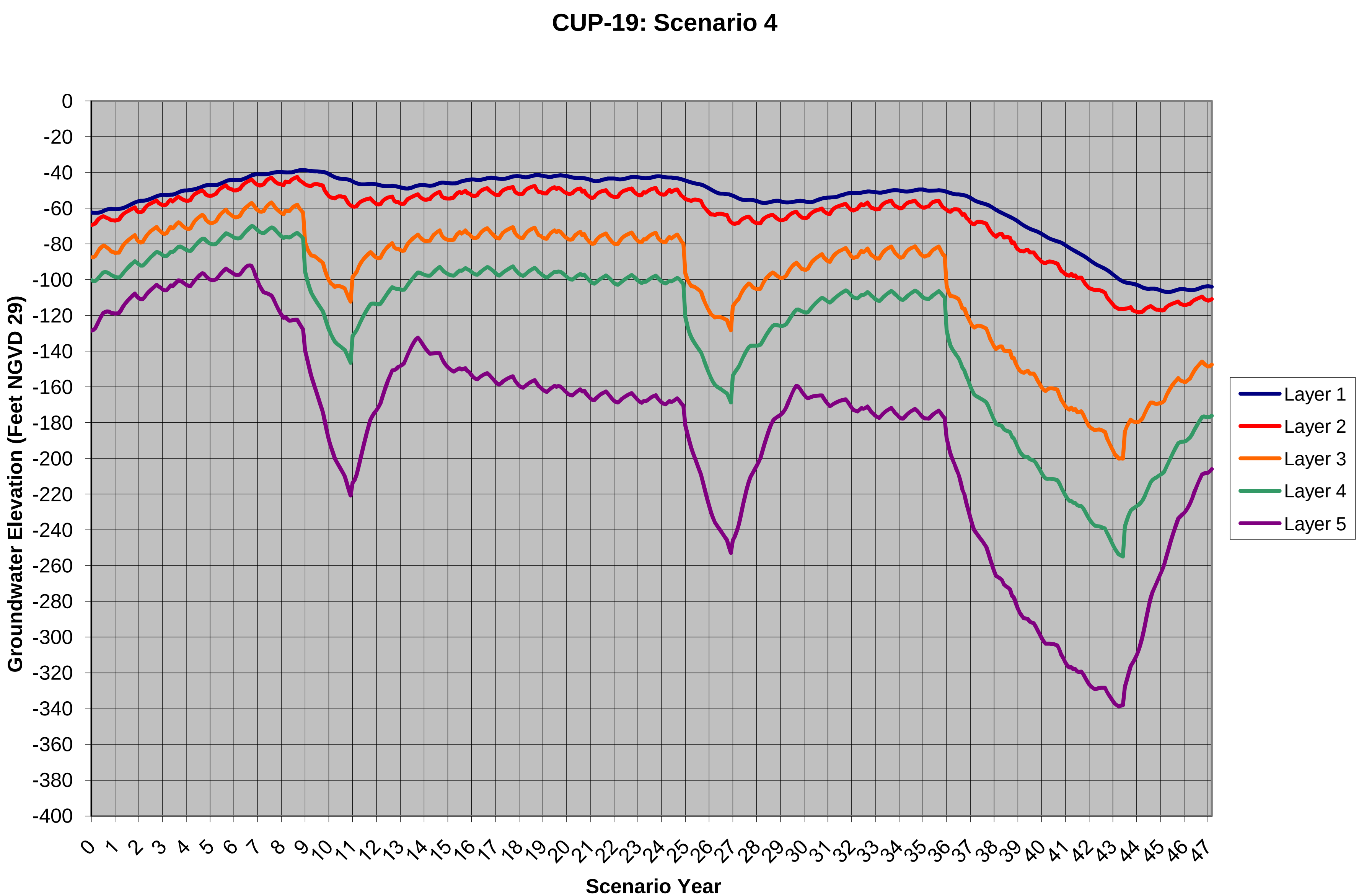
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
-320
-340
-360
-380
-400
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


CUP-19: Scenario 4
Groundwater Elevation (Feet NGVD 29)
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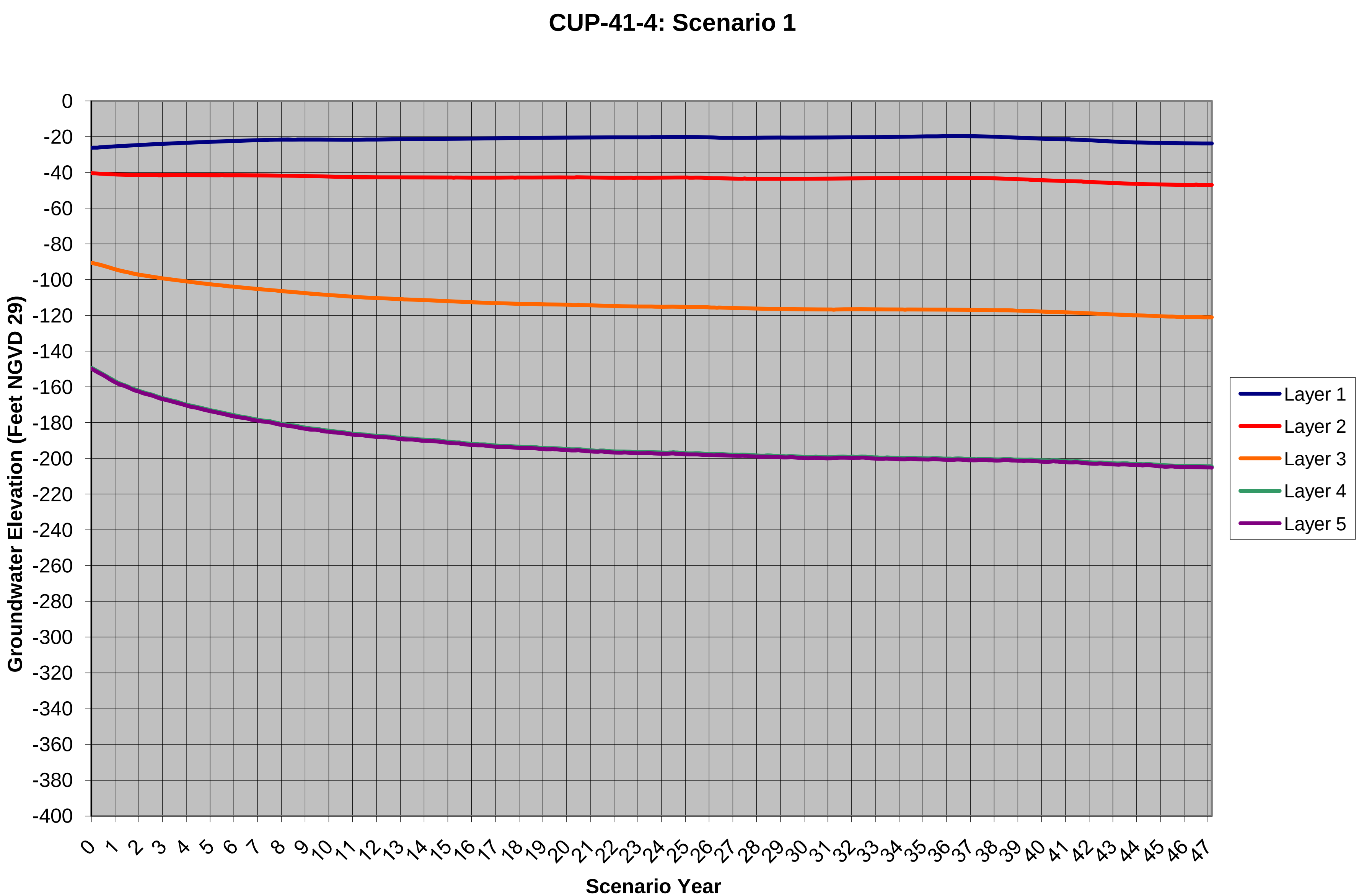
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
-320
-340
-360
-380
-400
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


CUP-41-4: Scenario 1
Groundwater Elevation (Feet NGVD 29)
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-20
-40
-60
-80
-100
-120
-140
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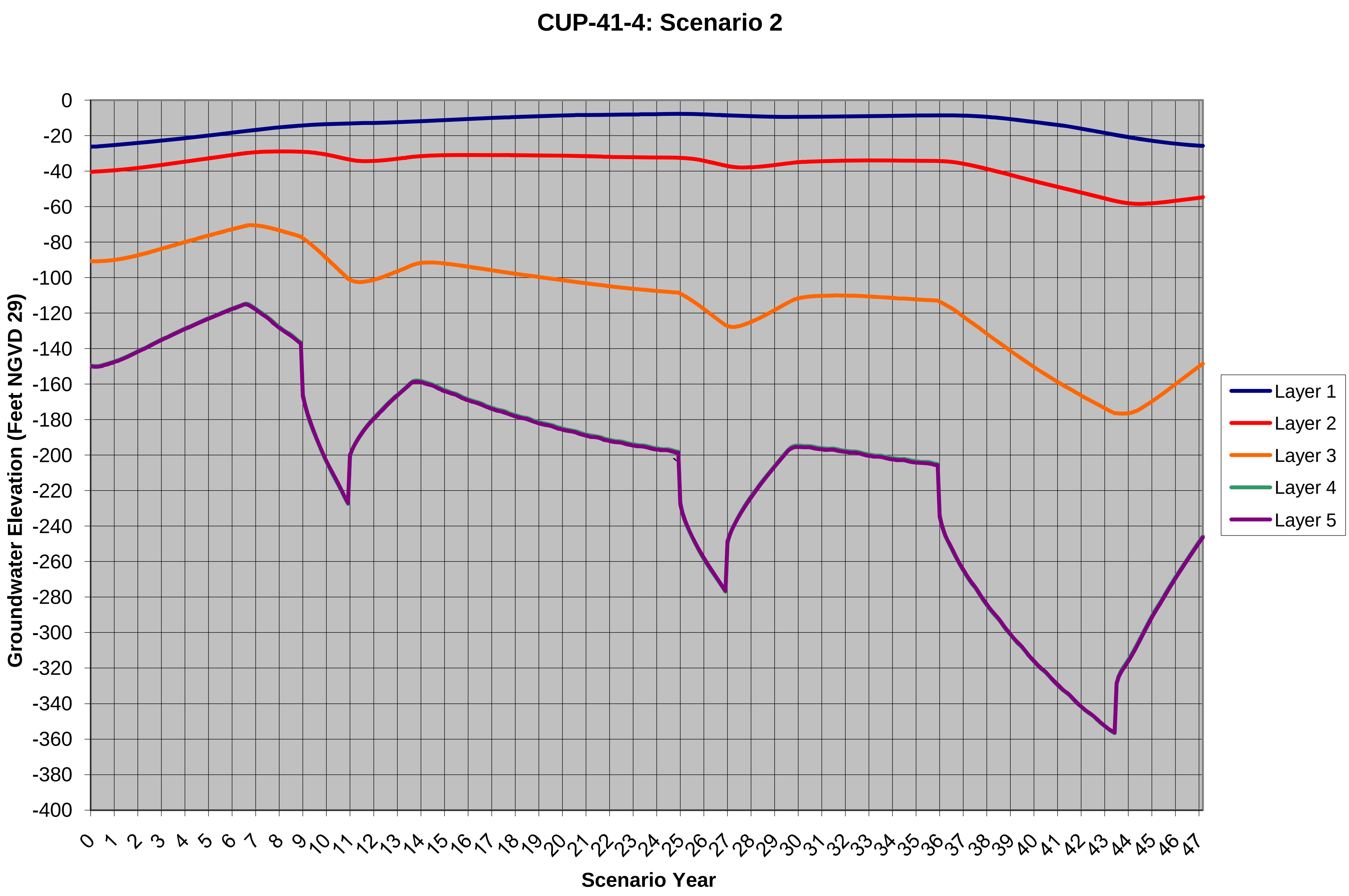
-180
-200
-220
-240
-260
-280
-300
-320
-340
-360
-380
-400
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


CUP-41-4: Scenario 2
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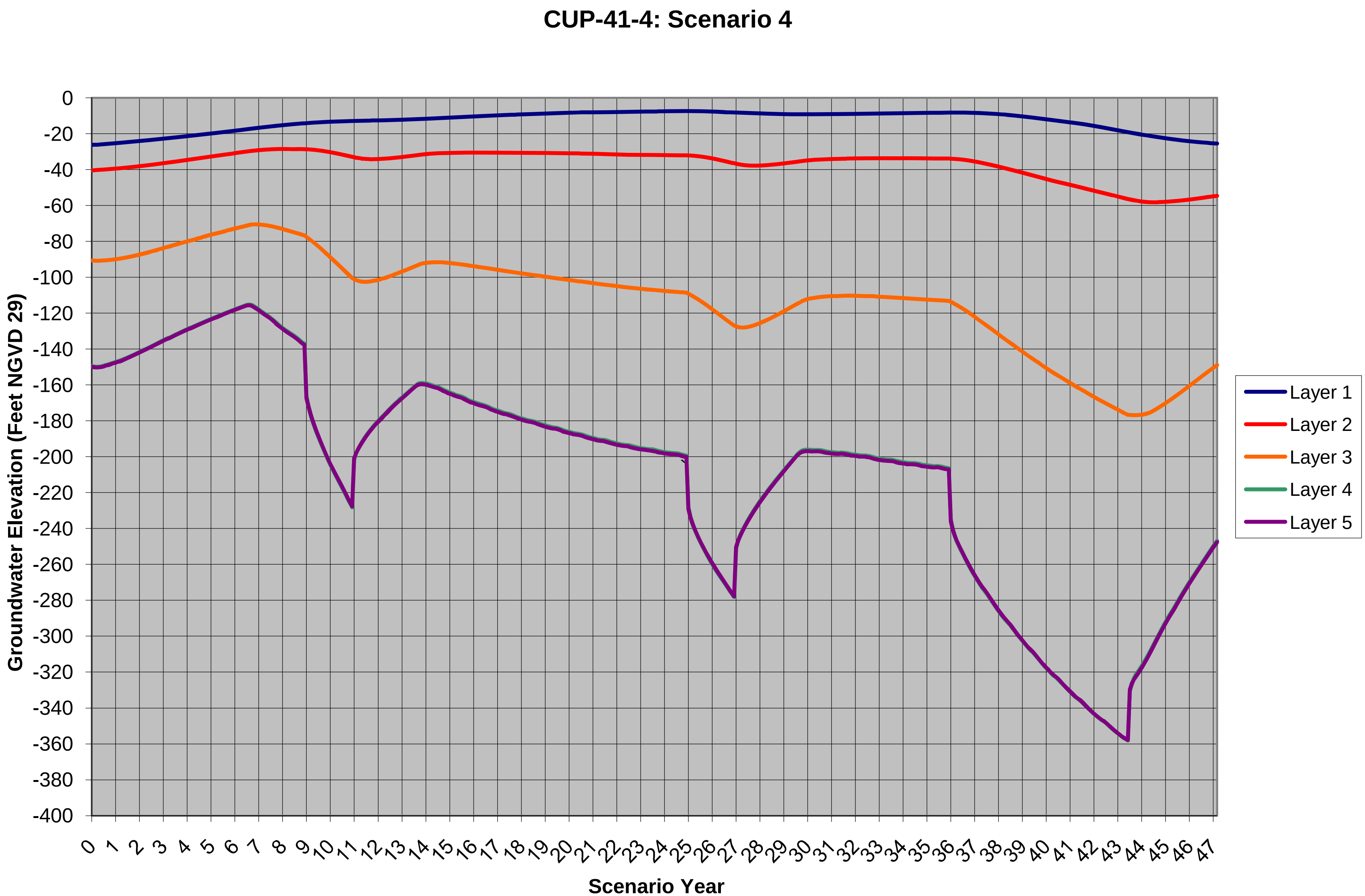
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
-320
-340
-360
-380
-400
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



CUP-41-4: Scenario 4
Groundwater Elevation (Feet NGVD 29)
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-60
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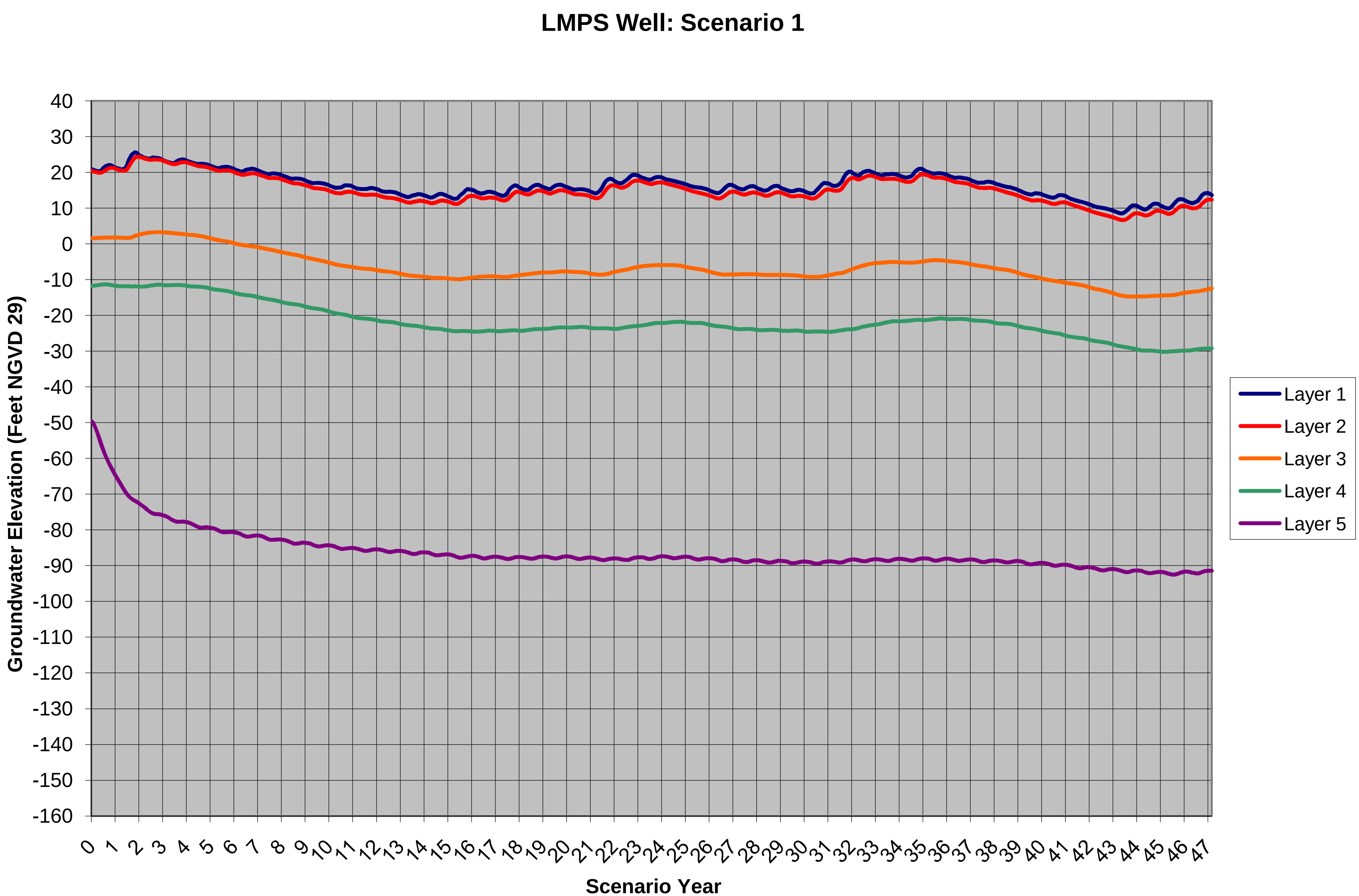
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
-320
-340
-360
-380
-400
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



LMPS Well: Scenario 1
Groundwater Elevation (Feet NGVD 29)
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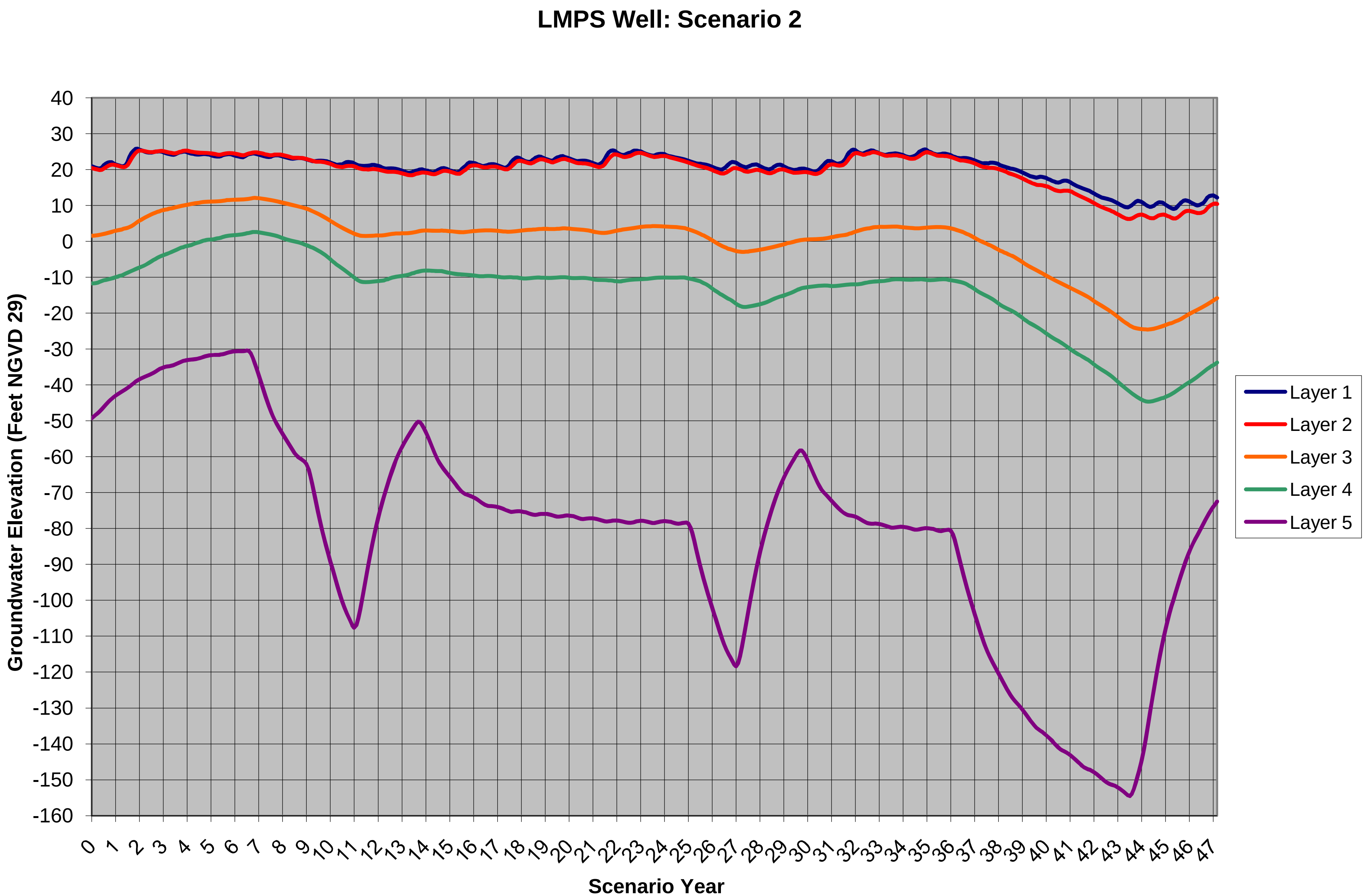
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



LMPS Well: Scenario 2
Groundwater Elevation (Feet NGVD 29)
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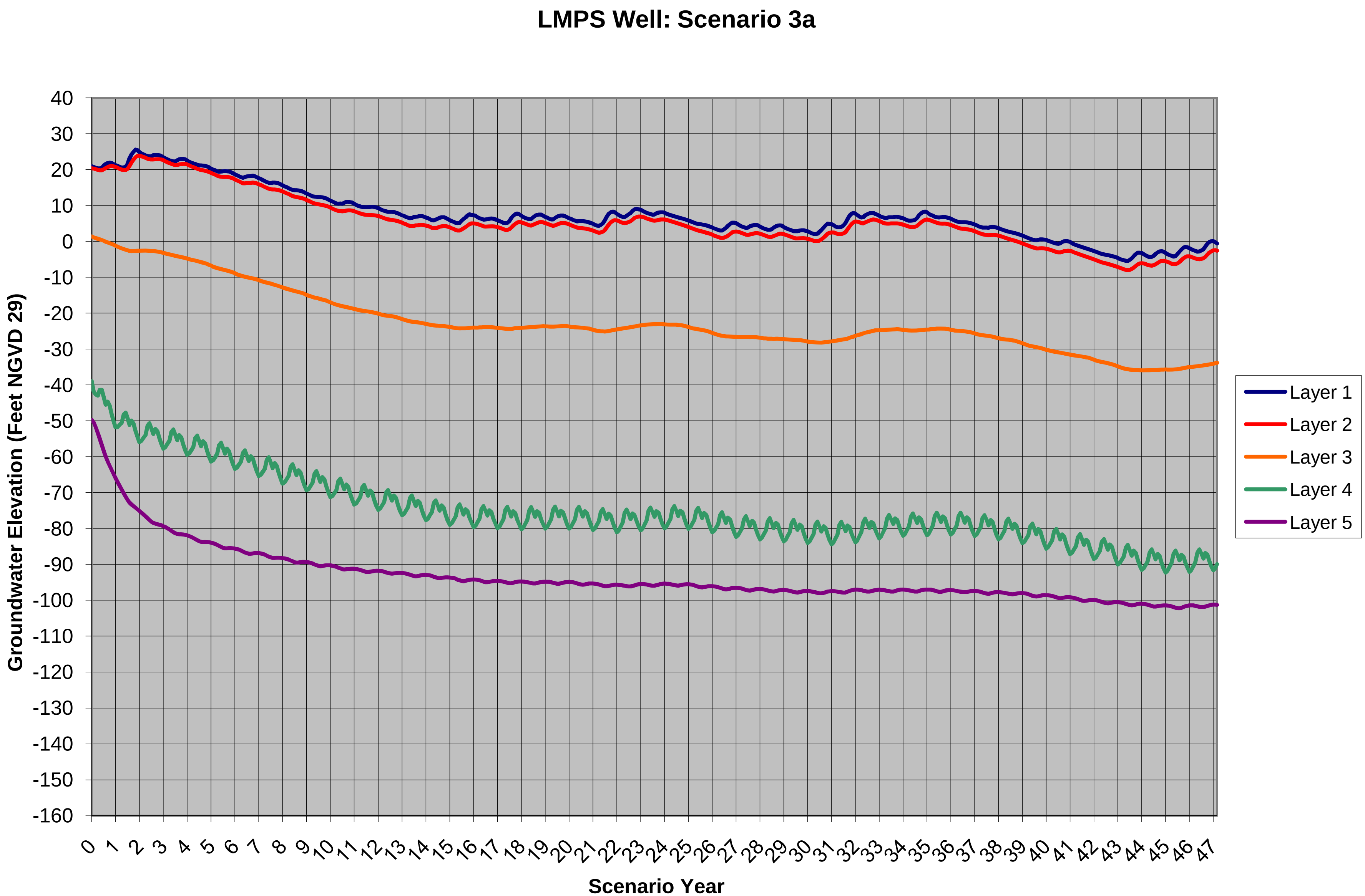
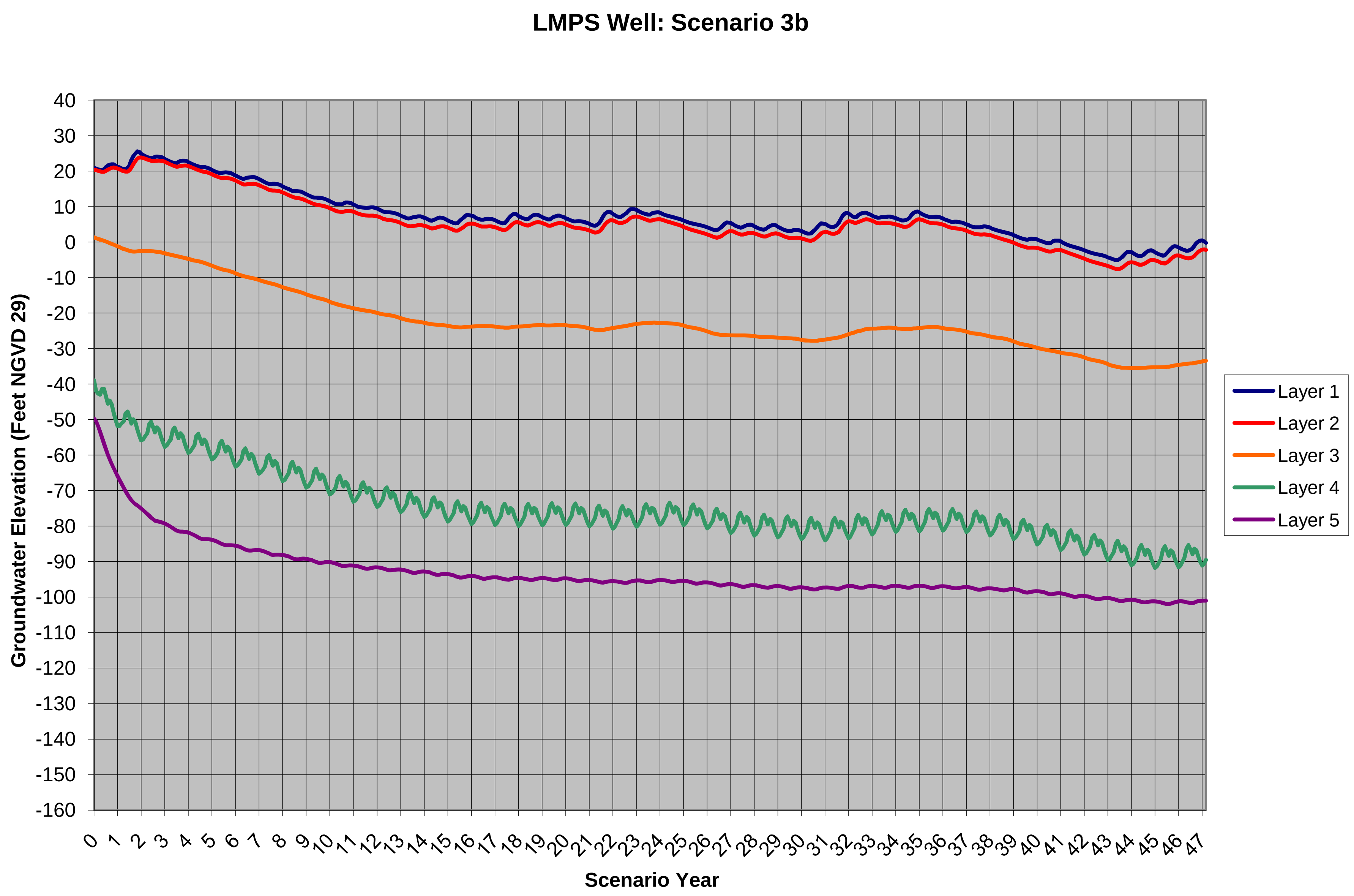
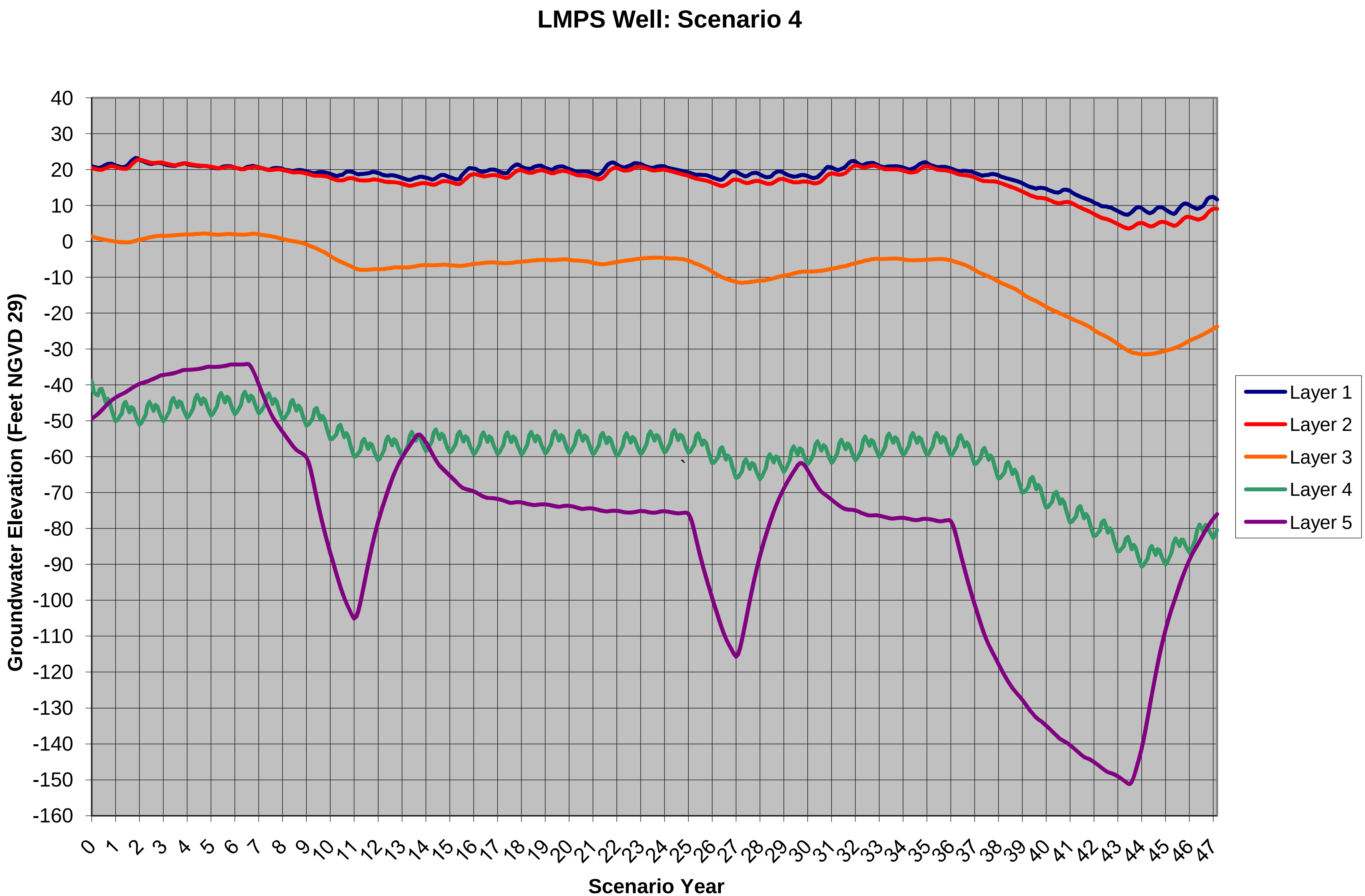
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



LMPS Well: Scenario 3a
Groundwater Elevation (Feet NGVD 29)
Scenario Year
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



LMPS Well: Scenario 3b
Groundwater Elevation (Feet NGVD 29)
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5



LMPS Well: Scenario 4
Groundwater Elevation (Feet NGVD 29)
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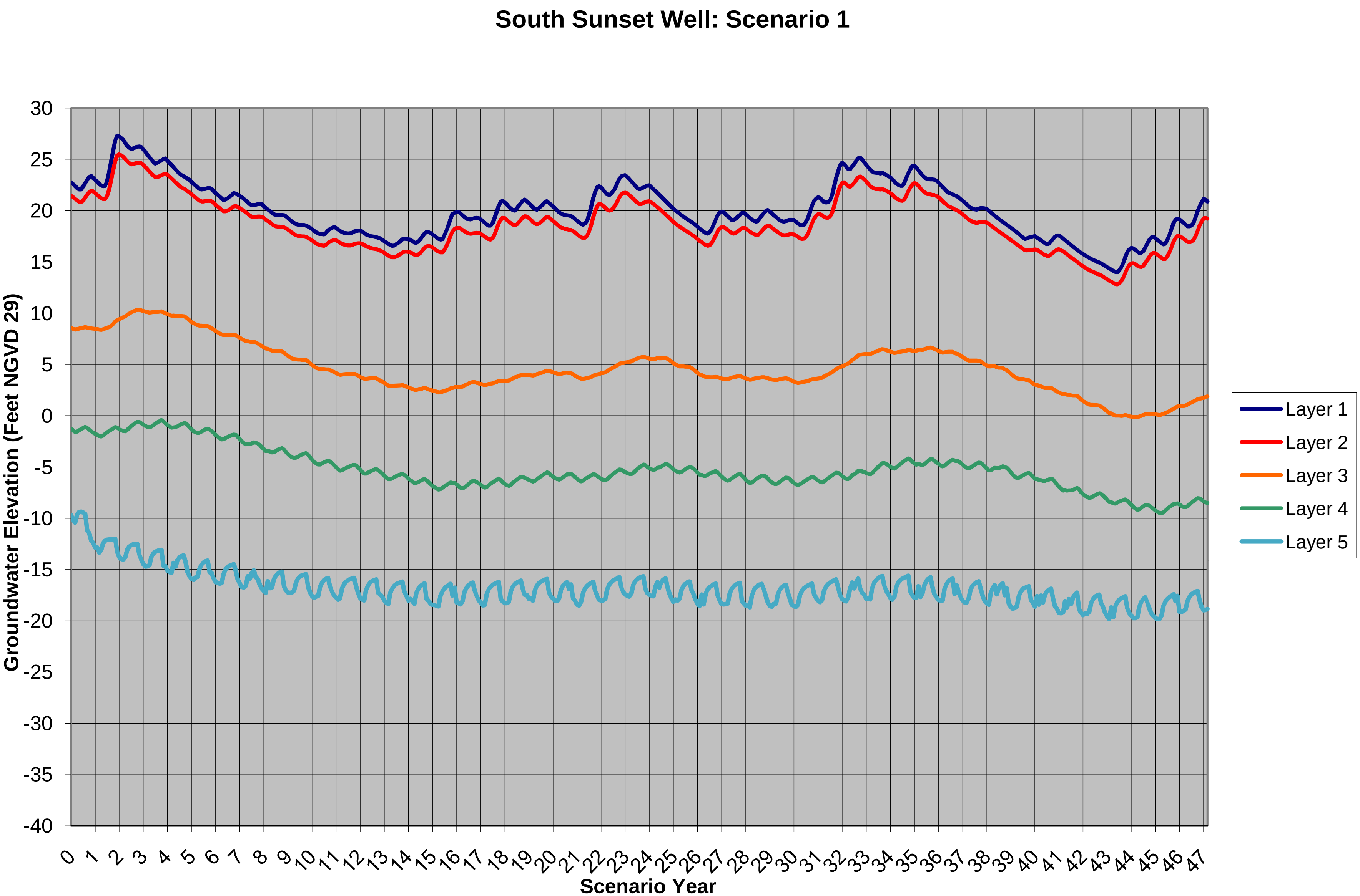
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


South Sunset Well: Scenario 1
Groundwater Elevation (Feet NGVD 29)
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25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
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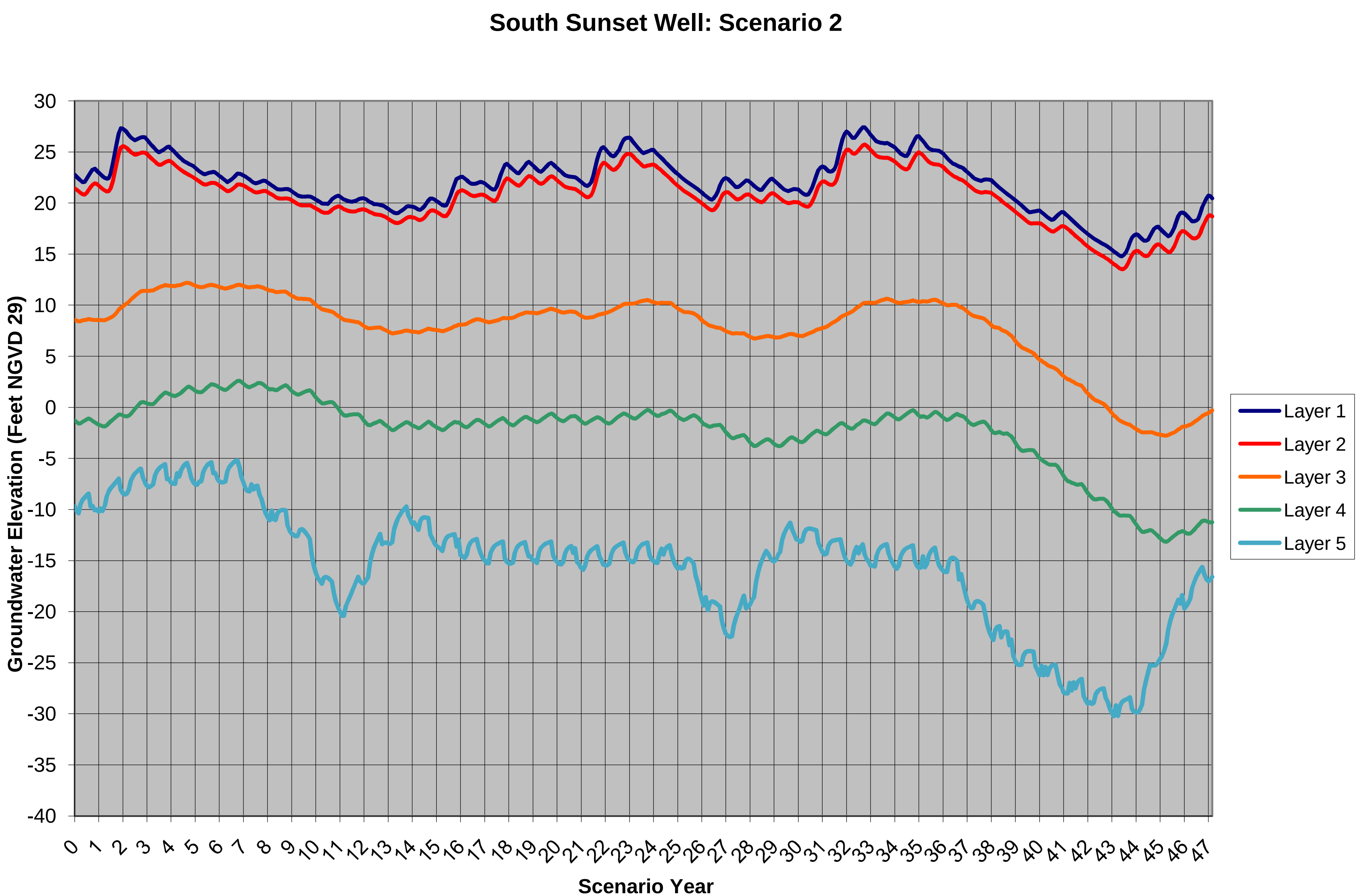
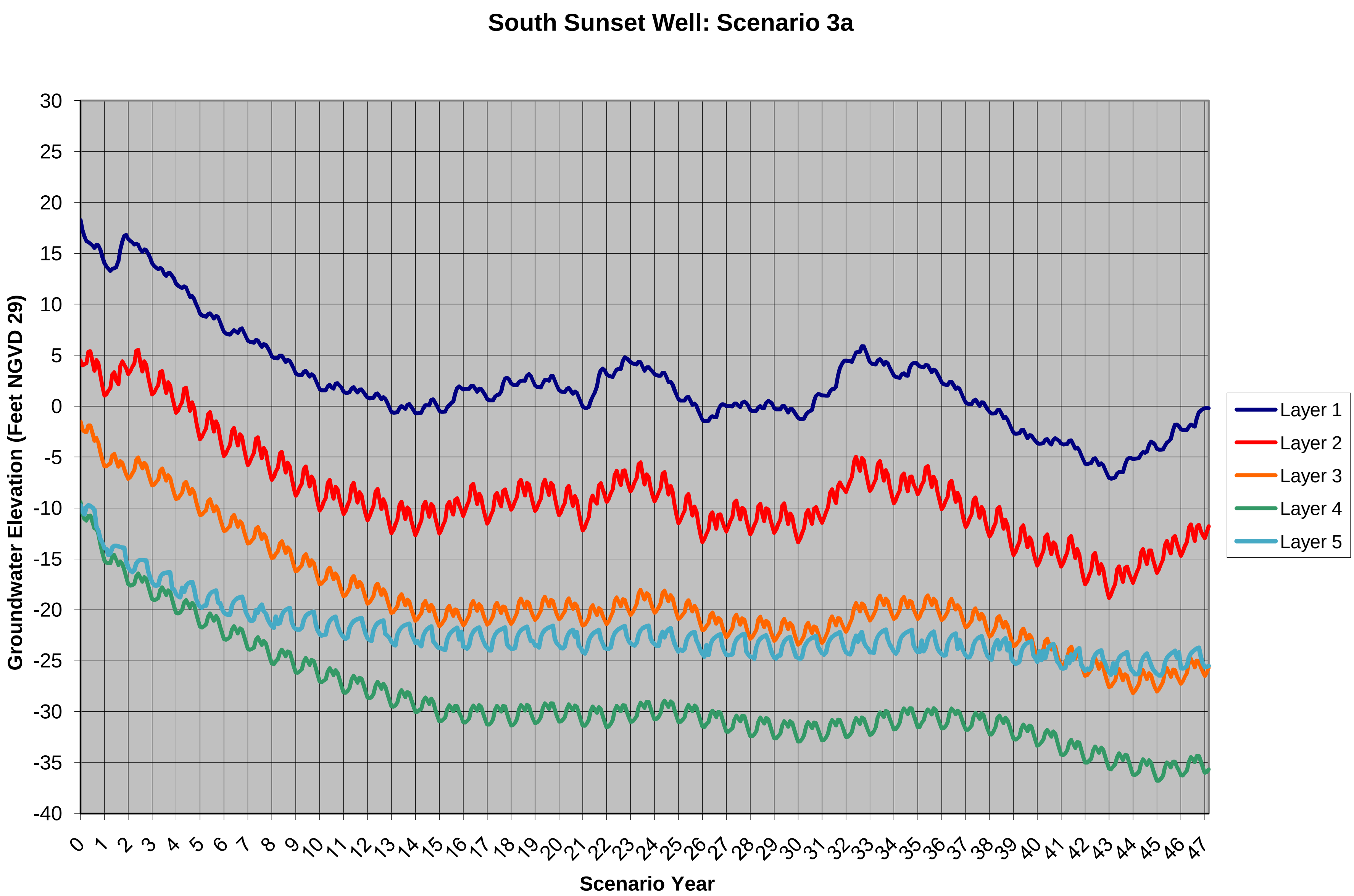
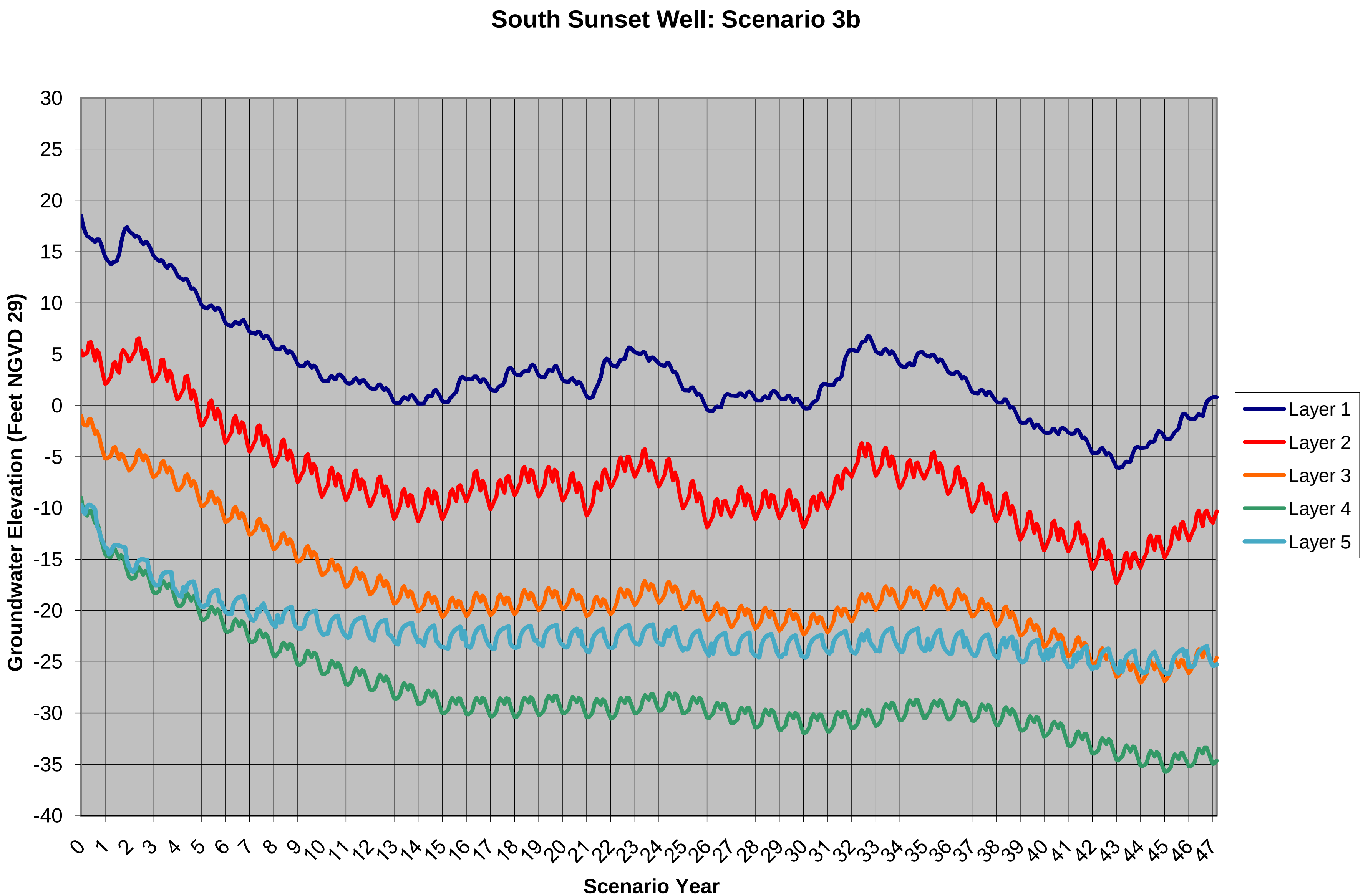
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

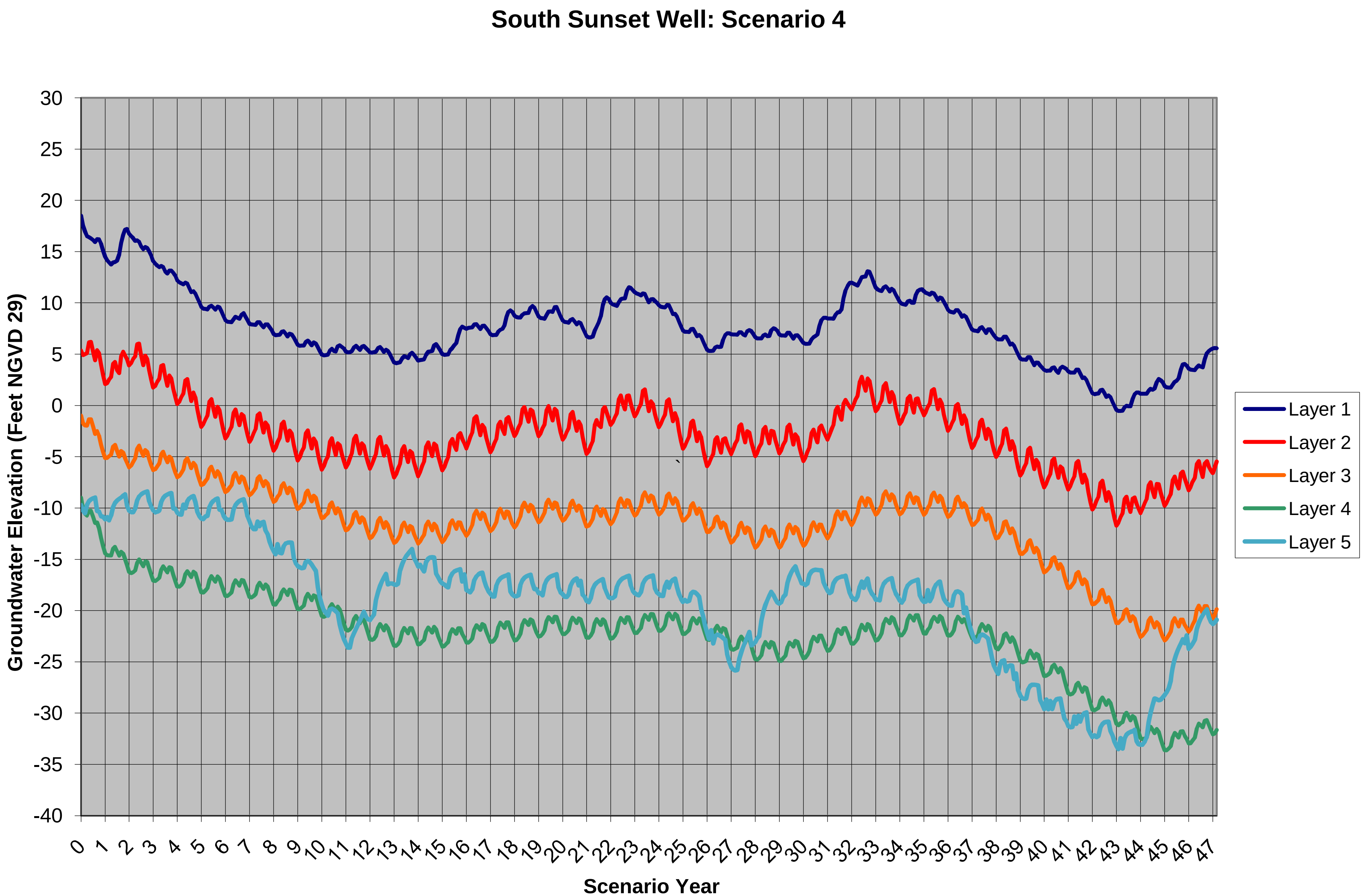
South Sunset Well: Scenario 2





South Sunset Well: Scenario 3a
Groundwater Elevation (Feet NGVD 29)
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


South Sunset Well: Scenario 3b
Groundwater Elevation (Feet NGVD 29)
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5


South Sunset Well: Scenario 4
Groundwater Elevation (Feet NGVD 29)
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47
Scenario Year
Layer 1
Layer 2
Layer 3
Layer 4
Layer 5

APPENDIX B

NGS Monuments within Study Area

PID[1]	Latitude (N)[2]			Longitude (W)		
AB7677	37	44	0.33344	122	29	49.03035
HT0600	37	42	30	122	29	9
HT0602	37	43	8.00	122	30	1.00
HT2271	37	43	47.00	122	28	30
HT1841	37	43	47.00	122	30	10
HT1842	37	44	10.00	122	30	33
HT1843	37	45	3.00	122	30	30
HT2267	37	45	56.00	122	28	37
HT2268	37	45	25.32	122	28	36.35587
HT2269	37	44	49.00	122	28	34
HT1848	37	46	28.00	122	30	39
HT1847	37	46	20.00	122	30	29
HT1846	37	46	19.00	122	30	28
HT2270	37	44	15.72	122	28	31.9305
HT2272	37	43	17.00	122	28	32
HT2273	37	42	48.00	122	28	18
HT0519	37	42	29.00	122	28	6
HT0521	37	41	36.00	122	28	15
HT0520	37	42	18.00	122	28	16
HT0481	37	41	9.43	122	28	56.41929
HT0483	37	41	5.00	122	28	18
HT0523	37	40	56.00	122	27	46
HT0540	37	37	16.00	122	22	39
HT0541	37	37	9.00	122	22	23
HT0544	37	37	32.00	122	22	34
HT0557	37	34	48.00	122	20	42
HT0641	37	39	4.00	122	22	59
HT0642	37	39	2.00	122	22	47
HT0532	37	38	0.00	122	23	51
HT0554	37	35	20.00	122	21	55
HT0543	37	37	32.00	122	22	34
HT3821	37	39	33.00	122	24	4
HT0542	37	37	28.00	122	22	31
HT0638	37	39	15.00	122	24	26
HT0639	37	39	15.00	122	23	47
HT0645	37	38	58.00	122	24	36
HT0647	37	38	32.00	122	24	47
HT0527	37	38	18.00	122	24	58
HT0537	37	37	20.00	122	23	29
HT0552	37	35	43	122	22	50
DG6888	37	38	6.88788	122	23	8.17798
HT0525	37	39	28	122	26	13
HT0644	37	39	2	122	22	47
HT0640	37	39	3	122	23	17
HT0643	37	39	2	122	22	47
HT0526	37	38	46	122	25	19
HT0556	37	34	50.73	122	20	41.37
HT0558	37	34	39	122	20	18
HT0524	37	40	7	122	26	56

[1]Point ID

[2]Latitude and Longitude in NAD83 coordinates

HT2430	37	36	42.8427	122	32	32.93442
HT0528	37	37	44	12	24	39
HT0551	37	35	55	122	23	6
HT0566	37	34	19	122	20	21
HT0538	37	37	20	122	23	29
HT0547	37	37	8	122	24	15
HT0534	37	37	30	122	23	36
HT0548	37	36	48	122	23	59

DSDATA.TXT

```
"@(#)dsdata.txt 1.20 - 2009/04/14 15:05:54"
**********************************************************************
*                         dsdata.txt                                 *
**********************************************************************

OVERVIEW:

Information about survey monuments on record with the National Geodetic
Survey (NGS) is published in a Digital Survey DATA (DSDATA) format.
The format consists of fixed field records in an 80 column ASCII text file.
The authoritative source for digital survey data format is the NGS bluebook.
This document is an extract of the bluebook for public convenience.

An individual DSDATA record of a monument is called a datasheet.  Datasheets
are sorted alphanumerically by station designation within a DSDATA file.

The last line of a correctly retrieved DSDATA file is:
***retrieval complete.

The first line of each datasheet is:
1        NATIONAL GEODETIC SURVEY,   Retrieval Date =
followed by the date the data was extracted from the NGS database.

The second line of each datasheet begins with the PID in column 2,
then is followed by a row of asterisks that begins in column 9.

Most other data items are identified by the data identifier text in cc 10-22.
Data identifier text text is characterised by a hyphen(-) in column 22.

The following data items are exceptions that require the use of cc 10-22,
and are identified by the following codes, all which start in column 8.
Note that projection data items are identified by codes in cc 8-11:

  Identifier     Data Item

      *          Current Survey Control

      .          Data Determination Text

      ;SPC       SPC Data

      ;UTM       UTM Data

      :          Primary Azimuth Object

      |          Box Score (Reference Objects)

      _          Mark Setting Information

      +          Mark Setting Information Continued
```

```
SUMMARY OF DATA ITEMS:

                               ***
 DATA ITEM: Special Control Station Header
 DISPLAYED: Only when station is one of those types listed under EXAMPLES.
 COMMENTS :
 EXAMPLES :________________________________________________________________
 AA3495  CORS         -  This is a GPS Continuously Operating Reference Station.
 HV8128  FBN          -  This is a Federal Base Network Control Station.
 HV9260  CBN          -  This is a Cooperative Base Network Control Station.
 RF0849  PACS         -  This is a Primary Airport Control Station.
 RF0850  SACS         -  This is a Secondary Airport Control Station.
 CJ0500  TIDAL BM     -  This is a Tidal Bench Mark

                               ***
 DATA ITEM: Designation
 DISPLAYED: Always
 COMMENTS : Usually the DESIGNATION does not match exactly with the STAMPING.
 EXAMPLES :________________________________________________________________
 AA3495  DESIGNATION -  GAITHERSBURG CORS L1 PHASE CENTER
 RF0849  DESIGNATION -  CARIPORT
 CA0570  DESIGNATION -  MP 77-5015
 AA8531  DESIGNATION -  66-26

                               ***
 DATA ITEM: CORS Identifier
 DISPLAYED: When Station is a Continuously Operational Reference Station
 COMMENTS :
 EXAMPLES :________________________________________________________________
 AW5607  CORS_ID      -  HOUS
 ER0702  CORS_ID      -  PIE1
 AA3495  CORS_ID      -  GAIT

                               ***
 DATA ITEM: Station Permanent Identifier (PID)
 DISPLAYED: Always
 COMMENTS : The PID is also found on the left side of each datasheet record.
            The PID is always 2 upper case letters followed by 4 numbers.
 EXAMPLES :________________________________________________________________
 AA3495  PID          -  AA3495
 RF0849  PID          -  RF0849
 TV0007  PID          -  TV0007

                               ***
 DATA ITEM: STATE/COUNTY
 DISPLAYED: Always, but County may be blank.
 COMMENTS : Bououghs may be used for Alaska; Parishes are used for Louisiana
 EXAMPLES :________________________________________________________________
 FV1057  STATE/COUNTY-  CA/SAN LUIS OBISPO
 BW0029  STATE/COUNTY-  LA/POINTE COUPEE
 TT0026  STATE/COUNTY-  AK/
 TT4608  STATE/COUNTY-  AK/MATANUSKA-SUSITNA

                               ***
 DATA ITEM: USGS Quad
 DISPLAYED: Always, but may be blank
 COMMENTS : This is the name of the USGS 7.5 minute series map sheet which
            shows the area of the station.  The station may or may not appear
            as a map feature.  NGS sometimes publishes data according to the
            USGS quadrangle (quad) system, for which the USGS quad sheet
            name is used as a reference.
 EXAMPLES :________________________________________________________________
 AA3495  USGS QUAD   -  GAITHERSBURG (1986)
 FA3038  USGS QUAD   -  ELLENDALE (1973)
 TV1290  USGS QUAD   -
 FV1057  USGS QUAD   -  CYPRESS MOUNTAIN (1979)
```

```
                           ***
DATA ITEM: Current Survey Control
DISPLAYED: Always, but the HEIGHT may be blank if the station
           is a horizontal control station only.
COMMENTS : Current Survey Control is identified by a '*' in cc8
           and comes under the heading "*CURRENT SURVEY CONTROL"

           The horizontal datum in use is the North American Datum of 1983 (NAD 83).
           This datum also defines ellipsoid vertical height. The orthometric vertical
           datum in use in the conterminous United States and Alaska is the North American
           Vertical Datum of 1988 (NAVD 88).  The orthometric vertical datum in Hawaii is
           referenced as Local Tidal.  This tag also applies to all orthometric heights in
           the United States territories that were determined prior to the establishment
           of the vertical datums listed below

           American Samoa: American Samoa Vertical Datum of 2002 (ASVD 02)
           Guam: Guam Vertical Datum of 2004 (GUVD 04)
           Northern Marianas: Northern Marianas Vertical Datum of 2003 (NMVD 03)
           Puerto Rico: Puerto Rico Vertical Datum of 2002 (PRVD 02)
           U.S. Virgin Islands: Virgin Islands Vertical Datum of 2009 (VIVD 09)

           NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
           Care should be taken not to "mix" current datum(s) with
           past datum(s) within a project.

           NAD83 (1986) indicates positions on the NAD83 datum for the
           North American Adjustment, completed in 1986.
           NAD83 (nnnn) indicates positions on the NAD83 datum for the
           North American Adjustment, but readjusted to a State High
           Accuracy Reference Network (HARN) on the date shown in (nnnn).
           NAD83 (CORS) indicates positions which are part of the CORS
           network.

           There are various Horizontal Control sources, as specified below:

           ADJUSTED = Least squares adjustment.
                      (Rounded to 5 decimal places.)

           HD_HELD1 = Differentially corrected hand held GPS observations.
                      (Rounded to 2 decimal places.)

           HD_HELD2 = Autonomous hand held GPS observations.
                      (Rounded to 1 decimal places.)

           SCALED   = Scaled from a topographic map.
                      (Rounded to 0 decimal places.)


           NAVD 88 orthometric heights are displayed where available.
           If there was a height for the station on the National Geodetic
           Vertical Datum of 1929 (NGVD 29), then that height will be
           displayed under SUPERSEDED SURVEY CONTROL.

           There are various Vertical Control sources, as specified below:

           ADJUSTED = Direct Digital Output from Least Squares Adjustment
                      of Precise Leveling.
                      (Rounded to 3 decimal places.)

           ADJ UNCH = Manually Entered (and NOT verified) Output of
                      Least Squares Adjustment of Precise Leveling.
                      (Rounded to 3 decimal places.)

           POSTED   = Pre-1991 Precise Leveling Adjusted to
                      the NAVD 88 Network After Completion of
```

```
                the NAVD 88 General Adjustment of 1991.
                (Rounded to 3 decimal places.)

     READJUST = Precise Leveling Readjusted as Required
                by Crustal Motion or Other Cause.
                (Rounded to 2 decimal places.)

     N HEIGHT = Computed from Precise Leveling Connected
                at Only One Published Bench Mark.
                (Rounded to 2 decimal places.)

     RESET    = Reset Computation of Precise Leveling.
                (Rounded to 2 decimal places.)

     COMPUTED = Computed from Precise Leveling Using
                Non-rigorous Adjustment Technique.
                  (Rounded to 2 decimal places.)

     GPSCONLV = Leveled Orthometric Height tied to GPS
                HT_MOD Orthometric Height.
                (Rounded to 2 decimal places.)

     LEVELING = Precise Leveling Performed by Horizontal
                Field Party.
                 (Rounded to 2 decimal places.)

     H LEVEL  = Level between control points not connected
                to bench mark.
                 (Rounded to 1 decimal places.)

     GPS OBS  = Computed from GPS Observations.
                (Rounded to 1 decimal places.)

     VERT ANG = Computed from Vertical Angle Observations.
                (Rounded to 1 decimal place;
                 If No Check, to 0 decimal places.)

     SCALED   = Scaled from a Topographic Map.
                (Rounded to 0 decimal places.)

     U HEIGHT = Unvalidated height from precise leveling
                connected at only one NSRS point.
                (Rounded to 2 decimal places.)

     VERTCON  = The NAVD 88 height was computed by applying the
                VERTCON shift value to the NGVD 29 height.
                (Rounded to 0 decimal places.)


     NOTE:    NAVD 88 and NGVD 29 heights in meters are
              converted to U.S. Survey Feet by using the
              conversion factor:
                U.S. Survey Feet = (39.37 / 12.00) x meters
              Height in feet is rounded to 1 less decimal
              place than the corresponding height in meters.

 EXAMPLES :________________________________________________________________
 AA0000                    *CURRENT SURVEY CONTROL
 AA0000
```

NGS has adopted a realization of NAD83 called NAD83(NSRS2007) for the distribution of coordinates at approximately 70,000 passive geodetic control monuments. This realization approximates (but is not, and can never be, equivalent to) the more rigorously defined NAD 83 (CORS96) realization in which Continuously Operating Reference Sstations (CORS) coordinates are distributed.

NAD 83 (NSRS2007) was created by adjusting GPS data collected during various campaign-style geodetic surveys performed between the mid-1980's and 2005. For this adjustment, NAD 83 (CORS96) positional coordinates for approximately 700 CORS were held fixed (predominately at the 2002.0 epoch for the stable north American plate, but 2007.0 in Alaska and western CONUS) to obtain consistent positional coordinates for the approximately 70,000 passive marks, as described by Vorhauer [2007]. Derived NAD 83(NSRS2007) positional coordinates should be consistent with corresponding NAD 83(CORS96) positional coordinates to within the accuracy of the GPS data used in the adjustment and the accuracy of the corrections applied to these data for systematic errors, such as refraction. In particular, there were no corrections made to the observations for vertical crustal motion when converting from the epoch of the GPS survey into the epoch of the adjustment, while the NAD 83(CORS96) coordinates do reflect motion in all three directions at CORS sites. For this reason alone, there can never be total equivalency between NAD 83(NSRS2007) and NAD 83(CORS96).

Note: NGS has not computed NAD83 (NSRS2007) velocities for any of the apprroximately 70,000 passive marks involved in this adjustment. Also, the positional coordinates of a passive mark will make reference to an "epoch date". Epoch dates are the date for which the positional coordinates were adjusted, and are therefore considered "valid" (within the tolerance of not applying vertical crustal motion). because a mark's positional coordinates will change due to the dynamic nature of the earth's crust, the coordinates of a mark on epochs different than the listed "epoch date" can only be accurately known if a 3-dimensional velocity has been computed and applied to that mark.

Loading of the National Readjustment data commenced on September 14, 2007. Before this the format of the position and elevation lines appeared as follows:

```
 AA3495* NAD 83(CORS)-  39 08 02.34046(N)    077 13 15.51884(W)     ADJUSTED
 AA3495* NAVD 88     -       140.76   (meters)     461.8    (feet)  GPS OBS
```

After the readjustment, the position and elevation lines on a datasheet will appear in a slightly modified format to accomodate the larger datum tag field (i.e. NSRS2007) as shown in the below examples.

```
______________________________________________________________
 DF9012* NAD 83(NSRS2007)-  42 56 15.39233(N) 071 26 19.03487(W)    ADJUSTED
 AA3495* NAD 83(CORS)    -  39 08 02.34046(N) 077 13 15.51884(W)    ADJUSTED
 RF0849* NAD 83(NSRS2007)-  46 52 08.05186(N) 068 00 53.02328(W)    ADJUSTED
 TA0047* NAD 83(1986)    -  48 04 54.20   (N) 090 45 48.42   (W)    HD_HELD1
 AC3384* NAD 83(1986)    -  25 57 14.7    (N) 081 43 29.2    (W)    HD_HELD2
 HV0454* NAD 83(1986)    -  38 20 52.     (N) 076 13 39.     (W)    SCALED
 DX3756* NAD 83(NSRS2007)-  33 38 08.42412(N) 117 05 10.37961(W)    ADJUSTED
 FQ0856* NAD 83(1986)    -  35 47 36.     (N) 111 52 56.     (W)    SCALED
 DB0356* NAVD 88         -       -11.886  (meters)  -39.00  (feet)  READJUSTED
 DC2131* NAVD 88         -      1096.93   (meters) 3598.8   (feet)  N HEIGHT
 AI5086* NAVD 88         -       123.68   (meters)  405.8   (feet)  GPS OBS
 GP0162* NAVD 88         -      1456.97   (meters) 4780.1   (feet)  RESET
 DE3069* NAVD 88         -        38.25   (meters)  125.5   (feet)  GPS OBS
 GP0641* NAVD 88         -      1831.8    (meters) 6010.    (feet)  GPS OBS
 BW0768* NAVD 88         -        59.70   (+/-2cm)  195.9   (feet)  VERTCON
 BW2469* NAVD 88         -       125.     (meters)  410.    (feet)  SCALED
 FG1799* NAVD 88         -
 TV0377* LOCAL TIDAL     -         7.2    (meters)   24.    (feet)  VERT ANG
```

***

DATA ITEM: Epoch Date
DISPLAYED: When Horizontal Position Requires
COMMENTS : The epoch date is used for stations in regions of episodic and/or continuous horizontal crustal motion where the position changes in time. The epoch date indicates the time the published horizontal coordinates are valid.

All stations with an adjusted horizontal position that falls within

```
          a designated crustal motion region will have an epoch date displayed
          on the datasheet.  Stations outside of these regions will not have
          an epoch date.  As the crustal motion effect tapers to zero before
          reaching a region's boundary, stations immediately inside that
          boundary and having an epoch date will normally have consistant
          positions with stations outside that boundary with no epoch date.

          To aid users with changing coordinates through epochs, NGS has
          developed software package HTDP to model changes in California
          and parts of Alaska.  HTDP is available from the NGS Information
          Services Branch.
EXAMPLES :________________________________________________________________
AA3495  EPOCH DATE  -        1996.00
EV3471  EPOCH DATE  -        1991.35

                               ***
DATA ITEM: X, Y, Z
DISPLAYED: When adjusted Horizontal Position and Ellipsoid Height are available.
COMMENTS : These values represent earth-centered earth-fixed coordinates,
          where the X axis follows zero degrees longitude, the Z axis follows
          positive 90 degrees latitude and the Y axis completes a right hand
          system.
EXAMPLES :________________________________________________________________
AA3495  X           -   1,095,790.787 (meters)                   COMP
AA3495  Y           -  -4,831,328.133 (meters)                   COMP
AA3495  Z           -   4,003,934.481 (meters)                   COMP

                               ***
DATA ITEM: Laplace Correction
DISPLAYED: For stations that have an adjusted position and that are
          within areas that have a geoid model with a derived
          vertical deflection model.
COMMENTS : The Laplace correction is the quantity which, when added to an
          astronomic azimuth, yields a geodetic azimuth.

          The simplified Laplace equation, which assumes horizontal lines
          of sight (cotangent of zenith angle ~ zero) and which assumes a
          clockwise reference frame during model development is:

          LAPLACE CORR = (a - A)
                       = (eta) * tan(geodetic latitude)
          where:
          a    =  Geodetic azimuth
          A    =  Astronomic azimuth
          eta  =  Deflection of the vertical in the prime-vertical plane,
                  an east-west component.

          The reader is cautioned that the Laplace equation has also been
          derived by others using a counterclockwise reference frame,
          which leads to subtracting the Laplace correction from the
          astronomic azimuth to yield a geodetic azimuth:
                Laplace corr = (A - a).
          However, NGS uses a clockwise reference frame.
EXAMPLES :________________________________________________________________
RF0849  LAPLACE CORR-           3.14  (seconds)                  USDV2009
EV3471  LAPLACE CORR-           0.60  (seconds)                  USDV2009
TV1290  LAPLACE CORR-           0.12  (seconds)                  USDV2009
EZ4149  LAPLACE CORR-          -3.23  (seconds)                  USDV2009

                               ***
DATA ITEM: Ellipsoid Height
DISPLAYED: When available
COMMENTS : The ellipsoid height is the elevation of the station above the
          reference ellipsoid for horizontal datum, currently the NAD83
          ellipsoid.  The ellipsoid is a reference surface for how the
          world appears, with respect to physical location.
```

```
            As a very close approximation:

                     h = H + N
            where
               h  =  ellipsoid height
               H  =  orthometric height
               N  =  geoid height

            In theory this equation is not exact because the ellipsoid height
            is normal to the ellipsoid, orthometric height is normal to the
            geoid, and these two surfaces are not necessarily parallel.
            In practice these three data item quantities will not usually
            satisfy the above equation since they were derived from seperate
            sources.  The above equation assumes a model where the geoid
            is above the ellipsoid, and terrain above the geoid.
            The date (mm/dd/yy) attached to the ellipsoid height is the date
            when the ellipsoid height was adjusted.  If the day is unknown
            then it is filled with "??".
EXAMPLES :________________________________________________________________
AA3495  ELLIP HEIGHT-         109.047 (meters)          (03/??/02) GPS OBS
HV8128  ELLIP HEIGHT-         -24.700 (meters)          (02/12/02) GPS OBS
FT1606  ELLIP HEIGHT-         974.023 (meters)          (03/??/02) GPS OBS

                                 ***
DATA ITEM: Geoid Height
DISPLAYED: For areas covered by the 'GEOID' software.
COMMENTS : The geoid height is the elevation of the geoid above the horizontal
           datum's reference ellipsoid.  The geoid is a specific equi-
           geopotential surface (geop), that best fits global mean sea level.
           The geoid is a reference surface for how the world acts,
           with respect to the geopotential force of gravity.
           The majority of the conterminous United States shows a negative
           geoid height, indicating that the geoid is below the ellipsoid.
EXAMPLES :________________________________________________________________
RF0849  GEOID HEIGHT-         -23.39  (meters)                     GEOID96
TU0165  GEOID HEIGHT-         -28.00  (meters)                     GEOID96
TV0007  GEOID HEIGHT-         -40.70  (meters)                     GEOID96

                                 ***

DATA ITEM: Dynamic Height
DISPLAYED: For stations with an NAVD88 height and Modeled Gravity.
COMMENTS : The dynamic height of a benchmark is the height at
           a reference latitude of the geopotential surface through the
           benchmark.  This value is of interest because two stations with
           different orthometric heights may have similar geopotential,
           due to undulations of the geopotential reference surface (geoid).
           The source of a dynamic height is always computed.
           The reference latitude for the United States is North 45 degrees.

           Dynamic heights were computed from geopotential heights
           (geopotential numbers) which were obtained for all bench marks
           in the general adjustment of the North American Vertical
           Datum of 1988 (NAVD88).  A dynamic height referenced to the
           International Great Lakes Datum of 1985 is then obtained by
           dividing the adjusted NAVD88 geopotential height of a
           bench mark by the normal gravity value (G) computed on the
           Geodetic Reference System of 1980 (GRS 80) ellipsoid
           at 45 degrees latitude (G = 980.6199 gal).

           A related unit for measuring geopotential is the geopotential
           number (C), which was adopted by the IAG in 1955.
           The geopotential number equals the dynamic height multiplied by
           the normal gravity at the reference latitude:
                         C = H(dynamic) * gamma(ref).
           The geopotential number (C) is measured in geopotential units
```

```
          (g.p.u.), where:
                1 g.p.u. = 1 kgal meter = 1000 gal meter.

          Since local gravity near sea level is approximately 0.98 kgal,
          the magnitude of geopotential numbers (C) are approximately
          that of orthometric height in meters, which leads to better
          intuitive understanding.
EXAMPLES :________________________________________________________________
DB0356  DYNAMIC HT  -        -11.870 (meters)    -38.94   (feet)  COMP
HV0454  DYNAMIC HT  -          1.026 (meters)      3.37   (feet)  COMP
DC0409  DYNAMIC HT  -       1055.66  (meters)   3463.4    (feet)  COMP

                              ***
DATA ITEM: Modeled Gravity
DISPLAYED: When available.
COMMENTS : The interpolated gravity value which was used in the NAVD 88
           general adjustment.
EXAMPLES :________________________________________________________________
HV8128  MODELED GRAV-     980,028.4   (mgal)                        NAVD 88
EV3471  MODELED GRAV-     979,412.1   (mgal)                        NAVD 88
CA0570  MODELED GRAV-     979,272.6   (mgal)                        NAVD 88

                              ***
DATA ITEM: Survey Control Order and Class
DISPLAYED: For Adjusted Control Only
COMMENTS : The Order will be 'HORZ ORDER', 'VERT ORDER' or 'ELLIP ORDER'
           depending on whether it refers to Horizontal control,
           Vertical Orthometric control or Vertical Ellipsoid control.

           ORDER AND CLASS: HORIZONTAL
           ***************************

           With the conclusion of the national readjustment, we will no
           longer publish horizontal order and class.  Instead we will
           publish network and local accuracies.

           For publication purposes, the network accuracy of a control
           point is a value that represents the uncertainty of its
           coordinates with respect to the geodetic datum at the 95
           percent confidence level.  Since the datum is considered to
           be best expressed by the Continuous Operating Reference
           Stations (CORS), which are held fixed during the adjustment.
           Local and Network accuracy values at CORS sites are considered
           to be infinitesimal (approach zero).  The Local Accuracy of a
           control point is a value that represents the uncertainly of its
           coordinates relative to other directly connected, adjacent
           control points at the 95-percent confidence level.  This value
           represents the relative positional error which surveyors can
           expect between survey marks in a locality.  It also represents
           an approximate average of the indicudual local accuracy values
           between this control point and other observed control points
           used to establish its coordinates although, in general, all
           of the immediately surrounding stations will not necessarily
           have been used in teh survey which established the original
           coordinates.

           These accuracies have been implemented with the publication
           of the National Readjustment.

           Note: CORS stations that are NOT part of the National CORS
           program in NGS (e.g. California CORS) will show both network
           and local accuracies.  This is because they are in a separate
           program from that National CORS and thereby are not constricted
           to the rules of the National CORS on NGS datasheets.
```

ORDER AND CLASS: ORTHOMETRIC VERTICAL
****

Vertical station order and class for first-, second-, and third-order stations are defined in the Federal Geodetic Control Committee publication "Standards and Specifications for Geodetic Control Networks". In addition:

Normal bench marks with unknown order will display a '?'. Vertical control which were determined only for the purpose of supplying a height for Horizontal Distance Reductions are assigned an order of 'THIRD'. If these types of heights do not have supporting observations then the Order is displayed as 'THIRD ?'.

Class 0 is used for special cases of orthometric vertical control as follows:

Vertical Order/Class		Tolerance Factor
FIRST	CLASS 0	2.0 mm or less
SECOND	CLASS 0	8.4 mm or less
THIRD	CLASS 0	12.0 mm or less

"Posted bench marks" are vertical control points in the NGS data base which were excluded from the NAVD 88 general adjustment. Some of the bench marks were excluded due to large adjustment residuals, possibly caused by vertical movement of the bench marks during the time interval between different leveling epochs. Adjusted NAVD 88 are computed for posted bench marks by supplemental adjustments.

A range of mean distribution rate corrections is listed for each posted bench mark in the data portion of the publication. A summary table of the mean distribution rates and their codes is listed below. The mean distribution rate corrections which were applied to the original leveling observations is a good indication of the usefulness of the posted bench marks' adjusted NAVD 88 heights.

Distribution Rate Code	Distribution Rate Correction
"a"	0.0 thru 1.0 mm/km
"b"	1.1 thru 2.0 "
"c"	2.1 thru 3.0 "
"d"	3.1 thru 4.0 "
"e"	4.1 thru 8.0 "
"f"	greater than 8.0 mm/km

POSTED BENCH MARKS SHOULD BE USED WITH CAUTION. As is the case for all leveling projects, the manditory FGCS check leveling two-mark or three-mark tie procedure will usually detect any isolated movement (or other problem) at an individual bench mark. Of course, regional movement affecting all the marks equally is not detected by the two- or three-mark tie procedure.

GPS CONSTRAINED LEVELED HEIGHT. The height was determined by differential leveling referenced to only one NSRS GPS Height Mod determined height. Therefore this height should be used with CAUTION.

ORDER AND CLASS: ELLIPSOID VERTICAL
****

The following ellipsoid height order and class relative accuracy standards have not yet been adopted by the Federal Geodetic Control Subcommittee, but are currently in use by NGS:

```
     Ellipsoid Height                   Maximum Height
      Classification                  Difference Accuracy
    ------------------                -------------------
    FIRST      CLASS 1                 0.5 (mm)/sqrt(km)
    FIRST      CLASS 2                 0.7
    SECOND     CLASS 1                 1.0
    SECOND     CLASS 2                 1.3
    THIRD      CLASS 1                 2.0
    THIRD      CLASS 2                 3.0
    FOURTH     CLASS 1                 6.0
    FOURTH     CLASS 2                15.0
    FIFTH      CLASS 1                30.0
    FIFTH      CLASS 2                60.0

The ellipsoid height difference accuracy (b) is computed from a
a minimally constrained correctly weighted least squares adjustment
by:
     b = s / sqrt(d)

where
     b = height difference accuracy
     s = propagated standard deviation of ellipsoid height
         difference in millimeters between control points
         obtained from the least squares adjustment.
     d = horizontal distance between control points in kilometers
```

```
 EXAMPLES :________________________________________________________________
 AA3495  HORZ ORDER  -  SPECIAL (CORS)
 HV8128  HORZ ORDER  -  A
 HV9260  HORZ ORDER  -  B
 AA0169  HORZ ORDER  -  FIRST
 FG1796  HORZ ORDER  -  SECOND
 FG1797  HORZ ORDER  -  THIRD

 HV8128  VERT ORDER  -  FIRST     CLASS II
 HU0680  VERT ORDER  -  SECOND    CLASS 0
 FG0846  VERT ORDER  -  THIRD (See Below)
 GP0162  VERT ORDER  -  THIRD
 HH0701  VERT ORDER  -  THIRD     CLASS 0
 LX7164  VERT ORDER  -  THIRD ?
 FG0744  VERT ORDER  -  ?
 FQ0849  VERT ORDER  -  * POSTED, Code a , SEE BELOW
 GP0241  VERT ORDER  -  * POSTED, Code b , SEE BELOW
 FR0070  VERT ORDER  -  * POSTED, Code c , SEE BELOW
 TF1074  VERT ORDER  -  * POSTED, Code d , SEE BELOW
 TF1144  VERT ORDER  -  * POSTED, Code e , SEE BELOW
 TF0916  VERT ORDER  -  * POSTED, Code f , SEE BELOW
 FR0371  VERT ORDER  -  * POSTED, Code NC , SEE BELOW
 EV3471  VERT ORDER  -  * READJUSTED, Code A , SEE BELOW
 AA3495  ELLP ORDER  -  SPECIAL (CORS)

 TV1290  ELLP ORDER  -  FIRST     CLASS II
 RF0849  ELLP ORDER  -  THIRD     CLASS I
 HV8128  ELLP ORDER  -  FOURTH    CLASS I

                                ***
 DATA ITEM: Text regarding Horizontal Control
 DISPLAYED: As required when explaining source of data values.
 COMMENTS :
 EXAMPLES :________________________________________________________________
AA0000.The horizontal coordinates were established by classical geodetic methods
AA0000.and adjusted by the National Geodetic Survey in June, 1995.

AA0000.The horizontal coordinates were established by classical geodetic methods
AA0000.and adjusted by the National Geodetic Survey.
```

```
AA0000.The horizontal coordinates were established by GPS observations
AA0000.and adjusted by the National Geodetic Survey in June, 1995.

AA0000.The horizontal coordinates were established by GPS observations
AA0000.and adjusted by the National Geodetic Survey.

AA0000.The horizontal coordinates were established by VLBI observations
AA0000.and local terrestrial surveys and adjusted by the National Geodetic
AA0000.Survey in June, 1995.

AA0000.The horizontal coordinates were established by VLBI observations
AA0000.and local terrestrial surveys and adjusted by the National Geodetic
AA0000.Survey.

AA0000.The horizontal coordinates were scaled from a topographic map and have
AA0000.an estimated accuracy of +/- 6 seconds.

AA0000.No horizontal observational check was made to the station.

AA0000.This is a SPECIAL STATUS position.  See SPECIAL STATUS under the
AA0000.DATUM ITEM on the data sheet items page.

AA0000.The horizontal coordinates are valid at the epoch date displayed above.
AA0000.The epoch date for horizontal control is a decimal equivalence
AA0000.of Year/Month/Day.

                                ***
 DATA ITEM: Text regarding Vertical Control
 DISPLAYED: As required when explaining source of data values.
 COMMENTS :
 EXAMPLES :________________________________________________________________
AA0000.The orthometric height was determined by differential leveling
AA0000.and adjusted by the National Geodetic Survey in June, 1990.

AA0000.The orthometric height was determined by differential leveling
AA0000.and adjusted by the National Geodetic Survey.

AA0000.The orthometric height was computed from unverified reset data.

AA0000.The orthometric height was key entered from printed documents
AA0000.and not key verified.

AA0000.The approximate orthometric height was determined by applying
AA0000.unadjusted height differences to other nearby adjusted values.

AA0000.The orthometric height was determined by differential leveling.
AA0000.The vertical network tie was performed by a horz. field party for horz.
AA0000.obs reductions. Reset procedures were used to establish the elevation.

AA0000.The orthometric height was determined by vertical angle observations.

AA0000.The orthometric height was determined by GPS observations.

AA0000.The orthometric height was scaled from a topographic map.
AA0000.The NAVD 88 height was computed by applying the VERTCON shift value to
AA0000.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)

AA0000.No vertical observational check was made to the station.

AA0000.* This is a POSTED BENCH MARK height.  Code A indicates a distribution
AA0000.rate of 0.0 thru 1.0 mm/km.

AA0000.* This is a READJUSTED BENCH MARK height.  Code NC indicates the bench
AA0000.mark was located on a no-check spur therefore a value was not computed.

AA0000.The height was derived from older observations constrained to new
```

```
AA0000.heights in a crustal motion area.  The height is approximate in
AA0000.relation to other heights in its vicinity.

AA0000.The height was determined by precise leveling from only one NGRS
AA0000.bench mark.  This was not adequate "tie leveling" to NGRS and was
AA0000.allowed ONLY to validate the GPS-derived height.

AA0000.WARNING-GPS observations at this control monument resulted in a GPS
AA0000.derived orthometric height which differed from the leveled height by
AA0000.more than one decimeter (0.1 meter).

AA0000.WARNING-Repeat measurements at this control monument indicate possible
AA0000.vertical movement.

CJ0500.This mark is designated as VM 4064 in the Oceanographic Products
CJ0500.and Services Division Tidal Bench Mark database.
       NOTE: If a web browser is used to retrieve an NGS bench mark that is
       also a tidal bench mark, the words "Oceanographic Products" will be
       highlighted and will provide a link to the series of descriptions and
       tide height references in the Oceanographic Products and Services
       Division (OPSD) Tidal Bench Mark database that includes the bench mark.
       The specific bench mark is uniquely identified by a corresponding
       tide station number and state, which are provided at an intermediate
       web page, where a link to the OPSD Home Page is also available
       for further tidal bench mark information.

                                 ***
 DATA ITEM: Text regarding Other Data Control
 DISPLAYED: As required when explaining source of data values.
 COMMENTS :
 EXAMPLES :________________________________________________________________
 AA0000.The XYZ, and position/ellipsoidal ht. are equivalent.
 AA0000.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 AA0000.The Laplace correction was computed from DEFLEC93 derived deflections.
 AA0000.The ellipsoidal height was determined by GPS observations
 AA0000.and is referenced to NAD 83.
 AA0000.The geoid height was determined by GEOID93.
 AA0000.The dynamic height is computed by dividing the NAVD 88
 AA0000.geopotential number by the normal gravity value computed on the
 AA0000.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 AA0000.degrees latitude (G = 980.6199 gals).
 AA0000.The modeled gravity was interpolated from observed gravity values.
 AA3495.No superseded survey control is available for this station.
 AA0000.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 AA0000.See file format.dat to determine how the superseded data were derived.
 AA0170.The vertical order pertains to the superseded datum.

                                 ***
 DATA ITEM: Grid Coordinate Systems:
            State Plane Coordinate System of 1983 (SPC)
            Universal Transverse Mercator (UTM)
 DISPLAYED: SPC coordinates are shown where zones where available.
            UTM zones are available worldwide, but coordinates are shown only
            for those stations with horizontal control.
 COMMENTS : UTM units are always in meters(MT).  In addition to meters,
            SPC units may also be expressed in U.S. Survey Foot(sFT), or
            International Foot(iFT), where:

            U.S. Survey Foot   :=  39.37 inches = 1 meter, exactly
            International Foot :=        1 inch = 2.54 centimeters, exactly

            All azimuths are referenced clockwise from north.
            Stations near zone limits may report positions for each zone.
            Scale Factor multiplied by ellipsoid distance equals grid distance.
            Convergence is also known as the mapping angle.
            Convergence plus grid azimuth yields geodetic azimuth.
```

```
          The second-term correction known as the Arc-to-Chord correction
          has not been included in the convergence.

          Scaled SPC values that are provided for stations which do not
          have adjusted horizontal control have no digits to the right
          of the decimal.  Scaled SPC do not report a Scale Factor or
          Convergence, but report an Estimated Accuracy.

          A Grid Coordinate record contains:
                     |   Northing |   Easting  |Units|  Scale   | Convergence
                     |            |            |     |  Factor  | (d mm ss.s)
         Type,Zone-
EXAMPLES :________________________________________________________________
RF0849;SPC ME E     -   355,965.757   336,994.238   MT  0.99991682 +0 21 14.9
HV8128;SPC MD       -   257,462.59  1,245,959.54   sFT  0.99998804 -0 08 43.1
CK3919;SPC SC       -   342,482.46  2,008,965.76   iFT  0.99991459 +0 00 58.2
FB2124;SPC TN       -   186,810.      805,260.      MT  (+/- 180 meters Scaled)
RF0849;UTM  19      - 5,191,067.175   575,088.597   MT  0.99966930 +0 43 08.7
FT1606;UTM  11      - 3,919,831.845   510,241.833   MT  0.99960129 +0 03 55.4
FV1057;UTM  10      - 3,937,617.155   689,693.779   MT  1.00004345 +1 13 03.9

                            ***

DATA ITEM: Grid Azimuth for Primary Reference Object
DISPLAYED: When Box Score is available.
COMMENTS : The grid azimuth applies to the specified map projection only.
EXAMPLES :________________________________________________________________
RF0849:SPC ME E     -   CARIPORT AZ MK                           338 16 51.1
RF0849:UTM  19      -   CARIPORT AZ MK                           337 54 57.3

                            ***

DATA ITEM: Box Score
DISPLAYED: When available for Old Horizontal Control marks.
COMMENTS : Distance may be blank;  PID may be blank.
           There may be unadjusted marks not shown that are
           in the vicinity of the Old Horizontal Control mark.
           Contact NGS regarding their information.
EXAMPLES :________________________________________________________________
MC0588|---------------------------------------------------------------------|
MC0588| PID    Reference Object                     Distance      Geod. Az  |
MC0588|                                                           dddmmss.s |
MC0588| MC1379 WESTON MUNICIPAL TANK               APPROX.14.8 KM 0024913.8 |
MC0588| MC0587 FRANK RM 1                            36.576 METERS 10109     |
MC0588|        HOYTVILLE N BALT GRAIN ELEV         APPROX. 3.0 KM 1400111.8 |
MC0588| MC1373 MC COMB MUNICIPAL TANK              APPROX.11.7 KM 1753525.4 |
MC0588| MC0586 FRANK AZ MK                                        1800257.9 |
MC0588| MC0592 FRANK AZ MK 2                                      2563259.8 |
MC0588| MC1376 DESHLER MUNICIPAL TANK              APPROX. 7.9 KM 2694631.8 |
MC0588| MC0589 FRANK RM 2                            34.759 METERS 34452     |
MC0588|---------------------------------------------------------------------|

                            ***

DATA ITEM: Superseded Survey Control
DISPLAYED: When available.
COMMENTS : Superceded control are previously published data control values
           that are obsolete but reprinted for continuity of records.
           Format is similar to 'Current Survey Control',
           but is not marked with '*' in cc 8.
           AD means ADJUSTED, referring to horizontal position.
           GP means GPS_OBS,  referring to GPS derived ellipsoidal height.
           This is followed by an epoch date (if available).
           This is followed by Order (if available, Horizontal or Vertical),
           then is followed by Class (if available, Vertical only).

           A horizontal Order of 'c' is used for CORS stations.
           Superseded elevations have no epoch date but the
           Order and Class are displayed for bench mark heights.
```

```
          The determination text used for superseded elevations
          is identical to that used for the current survey control.
EXAMPLES :__________________________________________________________________
AA0000                      SUPERSEDED SURVEY CONTROL
AA0000
AB6382  NAD 83(CORS)-  31 52 26.11223(N)   102 18 54.55641(W) AD(1996.00) c
FV1057  NAD 83(1992)-  35 33 50.72286(N)   120 54 24.79262(W) AD(1991.35) 1
HW3152  NAD 83(1986)-  38 26 14.08939(N)   079 49 54.57180(W) AD(       ) 3
HW3152  NAD 27      -  38 26 13.66570(N)   079 49 55.35309(W) AD(       ) 3
TV1290  PR          -  18 28 33.07855(N)   066 48 04.76640(W) AD(       ) 2
TU3368  OLD HI      -  21 12 45.75000(N)   156 58 20.86500(W) AD(       ) 3
RF0849  ELLIP HT    -       164.56   (m)           (04/19/96) GP(1995.00) 3 1
HV9260  ELLIP HT    -       131.19   (m)           (06/29/94) GP(       ) 4 1
HV0454  NGVD 29     -         1.266  (m)           4.15    (f) ADJUSTED    1 2
GW1440  NGVD 29     -       304.876  (m)        1000.25    (f) ADJ UNCH    2 0
AA4380  NGVD 29     -       175.86   (m)         577.0     (f) LEVELING    3
FE2754  NGVD 29     -        84.07   (m)         275.8     (f) N HEIGHT    3
FV1057  NGVD 29     -       564.37   (m)        1851.6     (f) RESET       3
CA0570  NGVD 29     -       545.10   (m)        1788.4     (f) COMPUTED    1 2
AA8531  NGVD 29     -        75.8    (m)         249.      (f) GPS OBS
UV2087  NGVD 29     -         6.8    (m)          22.      (f) VERT ANG
LX3119.No superseded survey control is available for this station.

                               ***
DATA ITEM: U.S. NATIONAL GRID SPATIAL ADDRESS
DISPLAYED: When available.
COMMENTS : The U.S. National Grid System is an alpha-numeric reference
           system that overlays the UTM coordinate system. It is a
           Federal Geographic Data Committee (FGDC) standard
           developed to improve public safety, commerce,
           as well as aid the casual GPS user.
           The USNG provides an easy to use geoaddress system for
           identifying and determining locations with the help of a
           USNG gridded map and/or a USNG enabled GPS system.

           To learn how to read USNG coordinates see:
           http://www.fgdc.gov/usng/how-to-read-usng/index_html
           and follow the link "US National Grid (USNG)"
           in the second paragraph.

           For further information about the U.S. National Grid System,
           see the Federal Geographic Data Committee's Standard
           for the United States Nation Grid at:
           http://www.fgdc.gov/usng
           and select paper fgdc_std_011_2001_usng.pdf
EXAMPLES :_______________________________________________________________
KF0798_U.S. NATIONAL GRID SPATIAL ADDRESS: 14SPJ8660324404(NAD 83)
HV0454_U.S. NATIONAL GRID SPATIAL ADDRESS: 18SUH927451(NAD 83)

                               ***
DATA ITEM: Mark Setting Information
DISPLAYED: When available.
COMMENTS : _ is used as an identifier for the data record.
           + is used as an identifier for a record continuation.
EXAMPLES :_______________________________________________________________
RF0849_MARKER: DH = HORIZONTAL CONTROL DISK
RF0849_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT (ROUND)
RF0849_STAMPING: CARIPORT 1985
RF0849_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
RF0849+STABILITY: SURFACE MOTION

RF0849_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
RF0849+SATELLITE: SATELLITE OBSERVATIONS - October 15, 1995

PU1648_SATELLITE: THE SITE LOCATION WAS REPORTED AS NOT SUITABLE FOR
PU1648+SATELLITE: SATELLITE OBSERVATIONS - August 19, 1991
```

```
                              ***
DATA ITEM: Recovery History Records
DISPLAYED: Always.
COMMENTS : Landmarks will say 'FIRST OBSERVERED' rather than 'MONUMENTED'
           The Month/Day are displayed if available.
           Refer to the bluebook for recovery agency acronyms.
EXAMPLES :______________________________________________________________
MC0588  HISTORY     - Date      Condition        Recov. By
MC0588  HISTORY     - 1943      MONUMENTED       CGS
MC0588  HISTORY     - 1968      GOOD             NGS
MC0588  HISTORY     - 1968      GOOD             CGS
MC0588  HISTORY     - 1984      MARK NOT FOUND   USPSQD
MC0588  HISTORY     - 19940826 GOOD              OH-063

                              ***
DATA ITEM: Description and Recovery text
DISPLAYED: When available.
COMMENTS : Displayed chronologically.  The description format has evolved
           through time.  The authoritative reference for descriptions is
           the NGS bluebook, chapter three.  A current format is as follows.
           The phrases "DESCRIBED BY... " and "RECOVERY BY..." are inserted
           by NGS during processing.
           The first paragraph gives the general location of the station and
           the landowner and/or the person to contact for station access.
           The second paragraph gives a "to-reach". The to-reach begins at a
           well-known location that will remain through time, such as the
           junction of state, federal or interstate highways.   Legs along the
           the route are given as right or left turn, compass direction
           followed, road name if any, distance traveled in kilometers (miles),
           and leg terminating feature. The to-reach ends with the phrase,
           "TO THE STATION ON THE RIGHT/LEFT."
           The third paragraph first details the survey mark that is observed,
           then the monument in which the mark is set, then ties are given
           FROM features in the vicinity of the station TO the station, with
           horizontal distances reported to the closest 0.1 m (0.1 ft).
           A vertical tie is encouraged to assist with recovery of stations
           that may become buried.
           A fourth paragraph may be added to include notes, such as
           obstructions to GPS visibility or hazards of station occupation.
EXAMPLES :______________________________________________________________
HU0680                         STATION DESCRIPTION
HU0680
HU0680 DESCRIBED BY COAST AND GEODETIC SURVEY 1942
HU0680 1.5 MI SE FROM SALEM.
HU0680 THIS MARK IS ABOUT 1.5 MILES SOUTHEAST OF THE JUNCTION WITH
HU0680 HIGHWAY U.S. 50 ALONG A GRAVEL ROAD FROM SALEM, DORCHESTER COUNTY,
HU0680 0.25 MILE NORTHEAST ALONG A DIRT ROAD TO THE FARM HOUSE, ABOUT
HU0680 100 FEET NORTH OF THE STATION, 20 FEET NORTHEAST OF THE NORTHEAST
HU0680 CORNER OF THE HOUSE, 1 FOOT WEST OF A WIRE FENCE ROW, AND IS A
HU0680 STANDARD REFERENCE DISK SET IN THE TOP OF A CONCRETE POST.
HU0680
HU0680                         STATION RECOVERY (1988)
HU0680
HU0680 RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1988
HU0680 THE MARK IS LOCATED ABOUT 1.9 KM (1.20 MI) SOUTH OF THE SMALL COMUNITY
HU0680 OF SALEM.  OWNERSHIP--EDGAR S. GORE, RD 1 BOX 85, VIENNA, MD. 21869.
HU0680 PHONE (301) 228-2862.
HU0680 TO REACH THE STATION FROM THE POST OFFICE IN LINKWOOD, GO SOUTHEAST ON
HU0680 U.S. HIGHWAY 50 FOR 3.55 KM (2.20 MI) TO A SIDE ROAD RIGHT.  TURN
HU0680 RIGHT AND GO SOUTHEAST ON SALEM ROAD FOR 0.85 KM (0.55 MI) TO A SIDE
HU0680 ROAD RIGHT.  TURN RIGHT AND GO SOUTH ON RAVENWOOD ROAD FOR 1.90 KM
HU0680 (1.20 MI) TO A SIDE ROAD LEFT.  TURN LEFT AND GO EAST ON A DIRT
HU0680 DRIVEWAY FOR 0.42 KM (0.25 MI) TO THE MARK ON THE LEFT.
HU0680 THE MARK IS A CGS TRIANGULATION DISK SET IN THE TOP OF A 0.3 M (1.0 FT)
HU0680 SQUARE CONCRETE POST PROJECTING 0.13 M (0.4 FT) ABOVE THE GROUND.  THE
```

```
HU0680 STATION IS LOCATED 15.7 M (51.5 FT) SOUTHWEST FROM THE SOUTHWEST EDGE
HU0690 OF A CULTIVATED FIELD, 8.1 M (26.6 FT) SOUTH-SOUTHEAST FROM A 0.25 M
HU0690 (0.8 FT) CHERRY TREE, 7.7 M (25.3 FT) NORTHEAST FROM THE NORTHEAST
HU0690 CORNER OF A TWO STORY HOUSE AND 7.0 M (23.0 FT) NORTH FROM THE NORTH
HU0690 CORNER OF A BLOCK BUILDING.

                              ***
```

The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
DATABASE =  ,PROGRAM = datasheet, VERSION = 7.85
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0566 ***********************************************************************
 HT0566  DESIGNATION -  XX 109
 HT0566  PID         -  HT0566
 HT0566  STATE/COUNTY-  CA/SAN MATEO
 HT0566  USGS QUAD   -  SAN MATEO (1997)
 HT0566
 HT0566                         *CURRENT SURVEY CONTROL
 HT0566  ___________________________________________________________________
 HT0566* NAD 83(1986)-  37 34 19.     (N)    122 20 21.     (W)     SCALED
 HT0566* NAVD 88     -        15.10   (+/-2cm)      49.5    (feet)  VERTCON
 HT0566  ___________________________________________________________________
 HT0566  GEOID HEIGHT-         -32.59  (meters)                     GEOID09
 HT0566  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0566
 HT0566.The horizontal coordinates were scaled from a topographic map and have
 HT0566.an estimated accuracy of +/- 6 seconds.
 HT0566
 HT0566.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0566.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0566.The vertical order pertains to the NGVD 29 superseded value.
 HT0566
 HT0566.The geoid height was determined by GEOID09.
 HT0566
 HT0566;                    North         East    Units  Estimated Accuracy
 HT0566;SPC CA 3     -   620,560.    1,837,550.      MT  (+/- 180 meters Scaled)
 HT0566
 HT0566                          SUPERSEDED SURVEY CONTROL
 HT0566
 HT0566  NGVD 29 (??/??/92)   14.262  (m)           46.79   (f) ADJ UNCH    1 2
 HT0566
 HT0566.Superseded values are not recommended for survey control.
 HT0566.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0566.See file dsdata.txt to determine how the superseded data were derived.
 HT0566
 HT0566_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG583585(NAD 83)
 HT0566_MARKER: DB = BENCH MARK DISK
 HT0566_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT0566_SP_SET: CONCRETE BLOCK
 HT0566_STAMPING: XX 109 1932
 HT0566_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT0566
 HT0566  HISTORY     - Date     Condition        Report By
 HT0566  HISTORY     - 1932     MONUMENTED       CGS
 HT0566  HISTORY     - 1951     GOOD             NGS
 HT0566  HISTORY     - 1967     GOOD             NGS
 HT0566
 HT0566                          STATION DESCRIPTION
 HT0566
 HT0566'DESCRIBED BY NATIONAL GEODETIC SURVEY 1951
 HT0566'AT SAN MATEO.
 HT0566'AT SAN MATEO, IN A SMALL PARK IN A TRIANGLE FORMED BY THE
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 HT0566'JUNCTION OF U.S. HIGHWAY 101 (NORTH EL CAMINO REAL) AND CLARK
 HT0566'DRIVE, 81.9 FEET SOUTHWEST OF SOUTHWEST CURB OF EL CAMINO
 HT0566'REAL, 47.6 FEET EAST OF EAST CURB ON WESTERN LEG OF TRIANGLE, AT THE
 HT0566'APPROXIMATE CENTER OF THE NORTHEAST SIDE OF A SMALL TRIANGULAR CLUMP
 HT0566'OF BUSHES ABOUT 2 FEET HIGHER THAN THE HIGHWAY, IN TOP OF A
 HT0566'3-FOOT BY 3-FOOT CONCRETE BLOCK FLUSH WITH THE GROUND.
 HT0566
 HT0566                          STATION RECOVERY (1967)
 HT0566
 HT0566'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1967
 HT0566'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0558 ***********************************************************************
 HT0558  DESIGNATION -  W 109
 HT0558  PID         -  HT0558
 HT0558  STATE/COUNTY-  CA/SAN MATEO
 HT0558  USGS QUAD   -  SAN MATEO (1997)
 HT0558
 HT0558                         *CURRENT SURVEY CONTROL
 HT0558  ___________________________________________________________________
 HT0558* NAD 83(1986)-  37 34 39.     (N)    122 20 18.     (W)     SCALED
 HT0558* NAVD 88     -         9.83   (+/-2cm)      32.3    (feet)  VERTCON
 HT0558  ___________________________________________________________________
 HT0558  GEOID HEIGHT-        -32.59  (meters)                      GEOID09
 HT0558  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0558
 HT0558.The horizontal coordinates were scaled from a topographic map and have
 HT0558.an estimated accuracy of +/- 6 seconds.
 HT0558
 HT0558.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0558.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0558.The vertical order pertains to the NGVD 29 superseded value.
 HT0558
 HT0558.The geoid height was determined by GEOID09.
 HT0558
 HT0558;                   North         East     Units  Estimated Accuracy
 HT0558;SPC CA 3     -   621,180.    1,837,630.      MT  (+/- 180 meters Scaled)
 HT0558
 HT0558                          SUPERSEDED SURVEY CONTROL
 HT0558
 HT0558  NGVD 29 (??/??/92)    9.000  (m)           29.53    (f) ADJ UNCH    1 2
 HT0558
 HT0558.Superseded values are not recommended for survey control.
 HT0558.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0558.See file dsdata.txt to determine how the superseded data were derived.
 HT0558
 HT0558_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG584591(NAD 83)
 HT0558_MARKER: DB = BENCH MARK DISK
 HT0558_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
 HT0558_SP_SET: CONCRETE POST
 HT0558_STAMPING: W 109 1932
 HT0558_MARK LOGO: CGS
 HT0558_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
 HT0558+STABILITY: SURFACE MOTION
 HT0558
 HT0558  HISTORY     - Date     Condition        Report By
 HT0558  HISTORY     - 1932     MONUMENTED       CGS
 HT0558  HISTORY     - 1952     GOOD             NGS
 HT0558  HISTORY     - 1967     GOOD             NGS
 HT0558  HISTORY     - 1986     GOOD             NGS
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 HT0558
 HT0558                          STATION DESCRIPTION
 HT0558
 HT0558'DESCRIBED BY NATIONAL GEODETIC SURVEY 1952
 HT0558'0.4 MI SE FROM BURLINGAME.
 HT0558'0.4 MILE SOUTHEAST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
 HT0558'FROM THE STATION AT BURLINGAME, AT THE PENINSULAR AVENUE CROSSING,
 HT0558'76.7 FEET NORTHEAST OF THE NORTHEAST RAIL OF THE MAIN TRACK,
 HT0558'21.6 FEET SOUTHWEST OF THE WEST CORNER OF A WIRE FENCE AROUND
 HT0558'THE STANDARD OIL COMPANY YARD, 15.3 FEET SOUTHEAST OF THE
 HT0558'SOUTHEAST CURB OF THE AVENUE, 6 1/2 FEET NORTH OF A LARGE
 HT0558'EUCALYPTUS TREE, 1.3 FEET SOUTHWEST OF A WITNESS POST, ABOUT
 HT0558'LEVEL WITH THE TRACK, AND SET IN THE TOP OF A CONCRETE POST
 HT0558'PROJECTING 0.6 FOOT ABOVE THE GROUND.
 HT0558
 HT0558                          STATION RECOVERY (1967)
 HT0558
 HT0558'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1967
 HT0558'RECOVERED IN GOOD CONDITION.
 HT0558
 HT0558                          STATION RECOVERY (1986)
 HT0558
 HT0558'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0558'RECOVERED IN GOOD CONDITION. THE DESCRIPTION IS ADEQUATE EXCEPT ADD
 HT0558'2.0 METERS (6.5 FT) NORTHWEST OF A LARGE TRIPLE TRUNKED EUCALYPTUS
 HT0558'TREE.
 HT0558'THE MARK IS 0.3 METERS  NW FROM  A WITNESS POST
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0557 ***********************************************************************
 HT0557  DESIGNATION -  B 814
 HT0557  PID         -  HT0557
 HT0557  STATE/COUNTY-  CA/SAN MATEO
 HT0557  USGS QUAD   -  SAN MATEO (1997)
 HT0557
 HT0557                         *CURRENT SURVEY CONTROL
 HT0557  ___________________________________________________________________
 HT0557* NAD 83(1986)-  37 34 48.     (N)    122 20 42.     (W)     SCALED
 HT0557* NAVD 88     -        10.10   (+/-2cm)      33.1    (feet)  VERTCON
 HT0557  ___________________________________________________________________
 HT0557  GEOID HEIGHT-         -32.59  (meters)                     GEOID09
 HT0557  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0557
 HT0557.The horizontal coordinates were scaled from a topographic map and have
 HT0557.an estimated accuracy of +/- 6 seconds.
 HT0557
 HT0557.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0557.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0557.The vertical order pertains to the NGVD 29 superseded value.
 HT0557
 HT0557.The geoid height was determined by GEOID09.
 HT0557
 HT0557;                    North         East    Units  Estimated Accuracy
 HT0557;SPC CA 3     -   621,470.    1,837,050.      MT  (+/- 180 meters Scaled)
 HT0557
 HT0557                          SUPERSEDED SURVEY CONTROL
 HT0557
 HT0557  NGVD 29 (??/??/92)    9.266  (m)           30.40   (f) ADJ UNCH    1 2
 HT0557
 HT0557.Superseded values are not recommended for survey control.
 HT0557.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
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 HT0557.See file dsdata.txt to determine how the superseded data were derived.
 HT0557
 HT0557_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG578594(NAD 83)
 HT0557_MARKER: DB = BENCH MARK DISK
 HT0557_SETTING: 34 = SET IN THE FOOTINGS OF SMALL/MEDIUM STRUCTURES
 HT0557_SP_SET: RAILROAD DEPOT FOUNDATION
 HT0557_STAMPING: B 814 1952
 HT0557_MARK LOGO: CGS
 HT0557_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
 HT0557+STABILITY: SURFACE MOTION
 HT0557
 HT0557  HISTORY     - Date     Condition        Report By
 HT0557  HISTORY     - 1952     MONUMENTED       CGS
 HT0557  HISTORY     - 1956     GOOD             NGS
 HT0557  HISTORY     - 1965     GOOD             NGS
 HT0557  HISTORY     - 1986     GOOD             NGS
 HT0557
 HT0557                          STATION DESCRIPTION
 HT0557
 HT0557'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0557'AT BURLINGAME.
 HT0557'AT BURLINGAME, SET VERTICALLY IN THE NORTHEAST FACE OF THE
 HT0557'CONCRETE FOUNDATION OF THE SOUTHERN PACIFIC COMPANY RAILROAD
 HT0557'STATION, 47.6 FEET SOUTHWEST OF THE SOUTHWEST RAIL, 2.1 FEET
 HT0557'NORTHWEST OF THE EAST CORNER OF THE BUILDING, AND 0.3 FOOT ABOVE
 HT0557'THE SIDEWALK.
 HT0557
 HT0557                          STATION RECOVERY (1965)
 HT0557
 HT0557'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
 HT0557'RECOVERED IN GOOD CONDITION.
 HT0557
 HT0557                          STATION RECOVERY (1986)
 HT0557
 HT0557'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0557'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0556 ***********************************************************************
 HT0556  DESIGNATION -  VV 109
 HT0556  PID         -  HT0556
 HT0556  STATE/COUNTY-  CA/SAN MATEO
 HT0556  USGS QUAD   -  SAN MATEO (1997)
 HT0556
 HT0556                         *CURRENT SURVEY CONTROL
 HT0556  ___________________________________________________________________
 HT0556* NAD 83(1986)-  37 34 50.73   (N)    122 20 41.37   (W)     HD_HELD1
 HT0556* NAVD 88     -         9.39   (+/-2cm)      30.8    (feet)  VERTCON
 HT0556  ___________________________________________________________________
 HT0556  GEOID HEIGHT-         -32.59  (meters)                     GEOID09
 HT0556  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0556
 HT0556.The horizontal coordinates were established by differentially corrected
 HT0556.hand held GPS obs and have an estimated accuracy of +/- 3 meters.
 HT0556
 HT0556.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0556.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0556.The vertical order pertains to the NGVD 29 superseded value.
 HT0556
 HT0556.Photographs are available for this station.
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HT0556.The geoid height was determined by GEOID09.
HT0556
HT0556;                     North         East     Units  Estimated Accuracy
HT0556;SPC CA 3     -   621,549.2   1,837,067.8     MT  (+/- 3 meters HH1 GPS)
HT0556
HT0556                          SUPERSEDED SURVEY CONTROL
HT0556
HT0556  NGVD 29 (??/??/92)    8.565  (m)           28.10   (f) ADJ UNCH    1 2
HT0556
HT0556.Superseded values are not recommended for survey control.
HT0556.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0556.See file dsdata.txt to determine how the superseded data were derived.
HT0556
HT0556_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG5784859502(NAD 83)
HT0556_MARKER: DB = BENCH MARK DISK
HT0556_SETTING: 35 = SET IN A MAT FOUNDATION OR CONCRETE SLAB OTHER THAN
HT0556+WITH SETTING: PAVEMENT
HT0556_SP_SET: FLAGPOLE BASE
HT0556_STAMPING: VV 109 1932
HT0556_MARK LOGO: CGS
HT0556_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
HT0556+STABILITY: SURFACE MOTION
HT0556
HT0556  HISTORY     - Date     Condition        Report By
HT0556  HISTORY     - 1932     MONUMENTED       CGS
HT0556  HISTORY     - 1952     GOOD             NGS
HT0556  HISTORY     - 1965     GOOD             NGS
HT0556  HISTORY     - 1986     GOOD             NGS
HT0556  HISTORY     - 20090111 POOR             GEOCAC
HT0556
HT0556                          STATION DESCRIPTION
HT0556
HT0556'DESCRIBED BY NATIONAL GEODETIC SURVEY 1952
HT0556'AT BURLINGAME.
HT0556'AT BURLINGAME, AT WASHINGTON PARK, ABOUT 100 YARDS NORTH OF AND
HT0556'ACROSS THE TRACKS FROM THE SOUTHERN PACIFIC COMPANY RAILROAD
HT0556'STATION, IN THE TOP OF THE SOUTH CONCRETE BASE FOR A FLAGPOLE,
HT0556'ABOUT 45 YARDS NORTHEAST OF THE APPROXIMATE CENTER OF THE
HT0556'JUNCTION OF CAROLAN AND NORTH LANE AVENUES, 22.5 FEET SOUTHWEST
HT0556'OF THE WEST CORNER OF A WIRE FENCE AROUND A TENNIS COURT, 17.3
HT0556'FEET NORTH OF A STREET LIGHT, AND 1.6 FEET ABOVE THE GROUND.
HT0556
HT0556                          STATION RECOVERY (1965)
HT0556
HT0556'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
HT0556'RECOVERED IN GOOD CONDITION.
HT0556
HT0556                          STATION RECOVERY (1986)
HT0556
HT0556'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
HT0556'RECOVERED IN GOOD CONDITION.
HT0556
HT0556                          STATION RECOVERY (2009)
HT0556
HT0556'RECOVERY NOTE BY GEOCACHING 2009 (RM)
HT0556'THE MARK'S SURFACE IS DAMAGED.  THE DISK'S STAMPING IS DIFFICULT TO
HT0556'READ BUT IS
HT0556'LEGIBLE.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
HT0554 ***********************************************************************
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HT0554  DESIGNATION -  J 553
HT0554  PID         -  HT0554
HT0554  STATE/COUNTY-  CA/SAN MATEO
HT0554  USGS QUAD   -  SAN MATEO (1997)
HT0554
HT0554                         *CURRENT SURVEY CONTROL
HT0554  ___________________________________________________________________
HT0554* NAD 83(1986)-  37 35 20.     (N)    122 21 55.     (W)     SCALED
HT0554* NAVD 88     -         4.72   (+/-2cm)      15.5    (feet)  VERTCON
HT0554  ___________________________________________________________________
HT0554  GEOID HEIGHT-         -32.59  (meters)                     GEOID09
HT0554  VERT ORDER  -  FIRST     CLASS II (See Below)
HT0554
HT0554.The horizontal coordinates were scaled from a topographic map and have
HT0554.an estimated accuracy of +/- 6 seconds.
HT0554
HT0554.The NAVD 88 height was computed by applying the VERTCON shift value to
HT0554.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
HT0554.The vertical order pertains to the NGVD 29 superseded value.
HT0554
HT0554.The geoid height was determined by GEOID09.
HT0554
HT0554;                   North         East     Units  Estimated Accuracy
HT0554;SPC CA 3     -   622,490.    1,835,280.      MT  (+/- 180 meters Scaled)
HT0554
HT0554                          SUPERSEDED SURVEY CONTROL
HT0554
HT0554  NGVD 29 (??/??/92)    3.888  (m)           12.76   (f) ADJ UNCH    1 2
HT0554
HT0554.Superseded values are not recommended for survey control.
HT0554.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0554.See file dsdata.txt to determine how the superseded data were derived.
HT0554
HT0554_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG560603(NAD 83)
HT0554_MARKER: DB = BENCH MARK DISK
HT0554_SETTING: 34 = SET IN THE FOOTINGS OF SMALL/MEDIUM STRUCTURES
HT0554_SP_SET: BUILDING FOUNDATION
HT0554_STAMPING: J 553 1956
HT0554_MARK LOGO: CGS
HT0554_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
HT0554+STABILITY: SURFACE MOTION
HT0554
HT0554  HISTORY     - Date     Condition        Report By
HT0554  HISTORY     - 1956     MONUMENTED       CGS
HT0554  HISTORY     - 1965     GOOD             NGS
HT0554  HISTORY     - 1986     GOOD             NGS
HT0554
HT0554                          STATION DESCRIPTION
HT0554
HT0554'DESCRIBED BY COAST AND GEODETIC SURVEY 1956
HT0554'AT BROADWAY.
HT0554'AT BROADWAY, 0.1 MILE NORTHWEST ALONG THE SOUTHERN PACIFIC
HT0554'COMPANY RAILROAD FROM THE STATION, 1.4 MILES SOUTHWEST OF
HT0554'MILLBRAE, AT THE WEST CORNER OF THE BUILDING OF THE AETNA
HT0554'MANUFACTURING COMPANY, IN THE TOP OF THE NORTHWEST SIDE OF A
HT0554'CONCRETE FOUNDATION FOR THE WEST CORNER OF THE BUILDING, 66.1
HT0554'FEET NORTHEAST OF THE NORTHEAST RAIL OF THE NORTHEAST MAIN TRACK,
HT0554'36 1/2 FEET EAST OF THE THIRD TELEPHONE POLE SOUTHEAST OF
HT0554'MILEPOST 15, 2.5 FEET ABOVE AN ASPHALT PARKING LOT, AND ABOUT
HT0554'1 FOOT HIGHER THAN THE TRACK.
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 HT0554
 HT0554                          STATION RECOVERY (1965)
 HT0554
 HT0554'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
 HT0554'RECOVERED IN GOOD CONDITION.
 HT0554
 HT0554                          STATION RECOVERY (1986)
 HT0554
 HT0554'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0554'RECOVERED IN GOOD CONDITION. THE DESCRIPTION IS ADEQUATE EXCEPT ADD IN
 HT0554'THE FIRST LARGE BUILDING NORTHWEST OF THE BEKINS STORAGE BUILDING.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0552 ***********************************************************************
 HT0552  DESIGNATION -  S 109
 HT0552  PID         -  HT0552
 HT0552  STATE/COUNTY-  CA/SAN MATEO
 HT0552  USGS QUAD   -  MONTARA MOUNTAIN (1997)
 HT0552
 HT0552                         *CURRENT SURVEY CONTROL
 HT0552  ___________________________________________________________________
 HT0552* NAD 83(1986)-  37 35 43.     (N)    122 22 50.     (W)     SCALED
 HT0552* NAVD 88     -         3.40   (+/-2cm)      11.2    (feet)  VERTCON
 HT0552  ___________________________________________________________________
 HT0552  GEOID HEIGHT-         -32.60  (meters)                     GEOID09
 HT0552  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0552
 HT0552.The horizontal coordinates were scaled from a topographic map and have
 HT0552.an estimated accuracy of +/- 6 seconds.
 HT0552
 HT0552.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0552.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0552.The vertical order pertains to the NGVD 29 superseded value.
 HT0552
 HT0552.The geoid height was determined by GEOID09.
 HT0552
 HT0552;                   North         East    Units  Estimated Accuracy
 HT0552;SPC CA 3     -   623,220.    1,833,950.     MT  (+/- 180 meters Scaled)
 HT0552
 HT0552                          SUPERSEDED SURVEY CONTROL
 HT0552
 HT0552  NGVD 29 (??/??/92)    2.567  (m)            8.42   (f) ADJ UNCH    1 2
 HT0552
 HT0552.Superseded values are not recommended for survey control.
 HT0552.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0552.See file dsdata.txt to determine how the superseded data were derived.
 HT0552
 HT0552_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG546610(NAD 83)
 HT0552_MARKER: DB = BENCH MARK DISK
 HT0552_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
 HT0552_SP_SET: SET IN TOP OF CONCRETE MONUMENT
 HT0552_STAMPING: S 109 1932
 HT0552_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
 HT0552+STABILITY: SURFACE MOTION
 HT0552
 HT0552  HISTORY     - Date     Condition        Report By
 HT0552  HISTORY     - 1932     MONUMENTED       CGS
 HT0552  HISTORY     - 1952     GOOD             NGS
 HT0552  HISTORY     - 1965     GOOD             NGS
 HT0552  HISTORY     - 1986     MARK NOT FOUND   NGS
 HT0552
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 HT0552                          STATION DESCRIPTION
 HT0552
 HT0552'DESCRIBED BY NATIONAL GEODETIC SURVEY 1952
 HT0552'0.4 MI SE FROM MILLBRAE.
 HT0552'0.4 MILE SOUTHEAST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
 HT0552'FROM THE STATION AT MILLBRAE, AT A DIRT ROAD CROSSING, 45.2 FEET
 HT0552'NORTHEAST OF THE NORTHEAST RAIL, 40 FEET NORTHWEST OF THE 3RD
 HT0552'TELEGRAPH LINE POLE SOUTHEAST OF MILEPOLE 14, 31.2 FEET SOUTH
 HT0552'OF A BOARD FENCE, 24 1/2 FEET EAST OF THE CENTER LINE OF THE
 HT0552'ROAD, 1.6 FEET WEST OF A WITNESS POST, ABOUT 1 1/2 FEET LOWER
 HT0552'THAN THE TRACK, AND SET IN THE TOP OF A CONCRETE POST PROJECTING
 HT0552'0.2 FOOT ABOVE THE GROUND.
 HT0552
 HT0552                          STATION RECOVERY (1965)
 HT0552
 HT0552'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
 HT0552'RECOVERED IN GOOD CONDITION.
 HT0552
 HT0552                          STATION RECOVERY (1986)
 HT0552
 HT0552'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0552'NOT RECOVERED.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0551 ***********************************************************************
 HT0551  DESIGNATION -  X 984 RESET
 HT0551  PID         -  HT0551
 HT0551  STATE/COUNTY-  CA/SAN MATEO
 HT0551  USGS QUAD   -  MONTARA MOUNTAIN (1997)
 HT0551
 HT0551                         *CURRENT SURVEY CONTROL
 HT0551  ___________________________________________________________________
 HT0551* NAD 83(1986)-  37 35 55.     (N)    122 23 06.     (W)     SCALED
 HT0551* NAVD 88     -         3.63   (+/-2cm)      11.9    (feet)  VERTCON
 HT0551  ___________________________________________________________________
 HT0551  GEOID HEIGHT-         -32.60  (meters)                     GEOID09
 HT0551  VERT ORDER  -  THIRD (See Below)
 HT0551
 HT0551.The horizontal coordinates were scaled from a topographic map and have
 HT0551.an estimated accuracy of +/- 6 seconds.
 HT0551
 HT0551.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0551.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0551.The vertical order pertains to the NGVD 29 superseded value.
 HT0551
 HT0551.The geoid height was determined by GEOID09.
 HT0551
 HT0551;                   North         East     Units  Estimated Accuracy
 HT0551;SPC CA 3     -   623,600.    1,833,560.      MT  (+/- 180 meters Scaled)
 HT0551
 HT0551                          SUPERSEDED SURVEY CONTROL
 HT0551
 HT0551  NGVD 29 (??/??/??)    2.79   (m)            9.2    (f) RESET       3
 HT0551
 HT0551.Superseded values are not recommended for survey control.
 HT0551.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0551.See file dsdata.txt to determine how the superseded data were derived.
 HT0551
 HT0551_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG542614(NAD 83)
 HT0551_MARKER: DB = BENCH MARK DISK
 HT0551_SETTING: 30 = SET IN A LIGHT STRUCTURE
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 HT0551_SP_SET: CONCRETE MANHOLE BOX
 HT0551_STAMPING: X 984 RESET 1969
 HT0551_MARK LOGO: CGS
 HT0551_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0551
 HT0551  HISTORY     - Date     Condition        Report By
 HT0551  HISTORY     - 1969     MONUMENTED       CGS
 HT0551  HISTORY     - 1983     GOOD             USGS
 HT0551  HISTORY     - 1986     GOOD             NGS
 HT0551
 HT0551                          STATION DESCRIPTION
 HT0551
 HT0551'DESCRIBED BY COAST AND GEODETIC SURVEY 1969
 HT0551'AT MILLBRAE.
 HT0551'AT MILLBRAE, ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD, 0.1
 HT0551'MILE SOUTHEAST OF THE STATION, AT A POWERLINE CROSSING, SET IN
 HT0551'THE TOP OF A 6 X 14-FOOT CONCRETE BOX, 49.2 FEET SOUTHWEST OF
 HT0551'A GUYED POWERLINE POLE AT THE CENTER OF THE POWERLINE CROSSING,
 HT0551'13.0 FEET NORTHEAST OF THE NORTHEAST RAIL OF THE NORTHWEST-BOUND
 HT0551'TRACK, 11.7 FEET NORTHWEST OF THE EXTENDED CENTERLINE OF
 HT0551'MURCHISON DRIVE, 2.8 FEET WEST OF THE CENTER OF A 28-INCH
 HT0551'MANHOLE, 0.7 FOOT EAST OF THE WEST CORNER OF THE CONCRETE BOX,
 HT0551'AND ABOUT 2 FEET LOWER THAN THE TRACK.
 HT0551
 HT0551                          STATION RECOVERY (1983)
 HT0551
 HT0551'RECOVERY NOTE BY US GEOLOGICAL SURVEY 1983
 HT0551'RECOVERED IN GOOD CONDITION.
 HT0551
 HT0551                          STATION RECOVERY (1986)
 HT0551
 HT0551'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0551'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT2430 ***********************************************************************
 HT2430  SACS        -  This is a Secondary Airport Control Station.
 HT2430  DESIGNATION -  X 1383
 HT2430  PID         -  HT2430
 HT2430  STATE/COUNTY-  CA/SAN MATEO
 HT2430  USGS QUAD   -  SAN MATEO (1997)
 HT2430
 HT2430                         *CURRENT SURVEY CONTROL
 HT2430  ___________________________________________________________________
 HT2430* NAD 83(2007)-  37 36 42.84271(N)    122 22 32.93442(W)     ADJUSTED
 HT2430* NAVD 88     -         1.84   (meters)       6.0    (feet)  GPS OBS
 HT2430  ___________________________________________________________________
 HT2430  EPOCH DATE  -       2007.00
 HT2430  X           -  -2,708,842.844 (meters)                     COMP
 HT2430  Y           -  -4,272,438.470 (meters)                     COMP
 HT2430  Z           -   3,871,391.091 (meters)                     COMP
 HT2430  LAPLACE CORR-           0.59  (seconds)                    DEFLEC09
 HT2430  ELLIP HEIGHT-         -30.788 (meters)         (02/10/07) ADJUSTED
 HT2430  GEOID HEIGHT-         -32.60  (meters)                     GEOID09
 HT2430
 HT2430  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 HT2430  Type    PID    Designation                      North   East  Ellip
 HT2430  -------------------------------------------------------------------
 HT2430  NETWORK HT2430 X 1383                            0.53   0.74   3.10
 HT2430  -------------------------------------------------------------------
 HT2430
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HT2430.This mark is at San Francisco Intl Airport (SFO)
HT2430
HT2430.The horizontal coordinates were established by GPS observations
HT2430.and adjusted by the National Geodetic Survey in February 2007.
HT2430
HT2430.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
HT2430.See National Readjustment for more information.
HT2430.The horizontal coordinates are valid at the epoch date displayed above.
HT2430.The epoch date for horizontal control is a decimal equivalence
HT2430.of Year/Month/Day.
HT2430
HT2430.The orthometric height was determined by GPS observations and a
HT2430.high-resolution geoid model.
HT2430
HT2430.GPS derived orthometric heights for airport stations designated as
HT2430.PACS or SACS are published to 2 decimal places.  This maintains
HT2430.centimeter relative accuracy between the PACS and SACS.  It does
HT2430.not indicate centimeter accuracy relative to other marks which are
HT2430.part of the NAVD 88 network.
HT2430
HT2430.The X, Y, and Z were computed from the position and the ellipsoidal ht.
HT2430
HT2430.The Laplace correction was computed from DEFLEC09 derived deflections.
HT2430
HT2430.The ellipsoidal height was determined by GPS observations
HT2430.and is referenced to NAD 83.
HT2430
HT2430.The geoid height was determined by GEOID09.
HT2430
HT2430;                   North         East     Units Scale Factor Converg.
HT2430;SPC CA 3     -   625,059.178 1,834,400.390   MT  0.99993211   -1 08 54.4
HT2430;SPC CA 3     - 2,050,714.99  6,018,361.95   sFT  0.99993211   -1 08 54.4
HT2430;UTM  10      - 4,162,939.168   555,089.591   MT  0.99963738   +0 22 51.4
HT2430
HT2430!             -  Elev Factor  x  Scale Factor =   Combined Factor
HT2430!SPC CA 3     -   1.00000483  x   0.99993211  =   0.99993694
HT2430!UTM  10      -   1.00000483  x   0.99963738  =   0.99964221
HT2430
HT2430                          SUPERSEDED SURVEY CONTROL
HT2430
HT2430  NAD 83(1998)-  37 36 42.83405(N)    122 22 32.92625(W) AD(1998.50) 1
HT2430  ELLIP H (05/31/01)  -30.770  (m)                       GP(1998.50) 2 1
HT2430  NAD 83(1992)-  37 36 42.82728(N)    122 22 32.92011(W) AD(1991.35) 3
HT2430  NAD 83(1992)-  37 36 42.82738(N)    122 22 32.92013(W) AD(1991.35) 3
HT2430  ELLIP H (11/17/92)  -30.651  (m)                       GP(1991.35) 5 1
HT2430  NAD 83(1986)-  37 36 42.82510(N)    122 22 32.91626(W) AD(1984.00) 3
HT2430  NGVD 29 (10/13/92)    1.02   (m)            3.3    (f) LEVELING    3
HT2430
HT2430.Superseded values are not recommended for survey control.
HT2430.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT2430.See file dsdata.txt to determine how the superseded data were derived.
HT2430
HT2430_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG5508962939(NAD 83)
HT2430_MARKER: I = METAL ROD
HT2430_SETTING: 49 = STAINLESS STEEL ROD W/O SLEEVE (10 FT.+)
HT2430_SP_SET: STAINLESS STEEL ROD
HT2430_STAMPING: X 1383 1986
HT2430_MARK LOGO: NGS
HT2430_PROJECTION: PROJECTING 1 CENTIMETERS
HT2430_MAGNETIC: N = NO MAGNETIC MATERIAL
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HT2430_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
HT2430_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
HT2430+SATELLITE: SATELLITE OBSERVATIONS - January 29, 2002
HT2430_ROD/PIPE-DEPTH: 19.5 meters
HT2430
HT2430  HISTORY     - Date     Condition        Report By
HT2430  HISTORY     - 1986     MONUMENTED       NGS
HT2430  HISTORY     - 19920618 GOOD             NGS
HT2430  HISTORY     - 20001205 GOOD             NGS
HT2430  HISTORY     - 20020129 GOOD             NGS
HT2430
HT2430                          STATION DESCRIPTION
HT2430
HT2430'DESCRIBED BY NATIONAL GEODETIC SURVEY 1986
HT2430'IN SAN FRANCISCO INTL AIRPORT.
HT2430'THE MARK IS ABOVE LEVEL WITH THE ASPHALT.
HT2430'IN SAN FRANCISCO INTERNATIONAL AIRPORT, ABOUT 1.0 KM (0.6 MI)
HT2430'EAST-SOUTHEAST OF THE CENTER OF THE MAIN TERMINAL PARKING GARAGE, SET
HT2430'THROUGH THE ASPHALT AND NEAR THE CENTER OF THE ASPHALT TRIANGLE
HT2430'INTERSECTION OF TAXIWAY L AND G, 32.6 METERS (107 FT) WEST-NORTHWEST
HT2430'OF THE CENTERLINE OF TAXIWAY L, 3.7 METERS (12.0 FT) EAST-SOUTHEAST OF
HT2430'THE EXTENDED CENTERLINE OF TAXIWAY G, 4.0 METERS (13.0 FT) SOUTHEAST
HT2430'OF THE SOUTH CORNER OF A 4- BY 4-FOOT CATCH BASIN.  NOTE--ACCESS TO
HT2430'DATUM POINT IS HAD THROUGH A 5-INCH LOGO CAP.
HT2430
HT2430                          STATION RECOVERY (1992)
HT2430
HT2430'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1992
HT2430'CALL AT LEAST A WEEK IN ADVANCE TO MAKE ARRANGEMENTS TO BE ESCORTED TO
HT2430'STATION.  NEW FAA SECURITY REQUIREMENTS MAY SPECIFY BADGES, TRUCK TAG
HT2430'NUMBERS, PERSONNEL NAME AND IDENTIFICATION.  EAR PROTECTION IS
HT2430'SUGGESTED.
HT2430'STATION IS LOCATED AT THE SAN FRANCISCO INTERNATIONAL AIRPORT, ABOUT 1
HT2430'KM (0.6 MI) EAST-SOUTHEAST OF THE CONTROL TOWER, IN A PAVED
HT2430'TRIANGULAR-SHAPED PLOT BORDERED BY L TAXI, G TAXI NORTH, AND G TAXI
HT2430'SOUTH.  OWNERSHIP--CITY AND COUNTY OF SAN FRANCISCO, SAN FRANCISCO
HT2430'AIRPORT COMMISSION. SAN FRANCISCO, CA 94102.  CONTACT GLEN BROTMAN,
HT2430'AIRFIELD OPERATIONS, PHONE 415-876-2223 FOR ACCESS.  CHIEF AIRPORT
HT2430'SURVEYOR RAYMOND MASON, PHONE 415-737-7765, IS FAMILIAR WITH THE
HT2430'STATION SITE.
HT2430'STATION MARK IS A PUNCH HOLE TOP CENTER ON A STEEL ROD ENCASED IN A
HT2430'PVC PIPE WITH LOGO CAP PROJECTING 2 CM.  IT IS 1.2 PACE SOUTHWEST OF
HT2430'A FIBERGLASS WITNESS POST, 4 PACES SOUTHEAST OF THE SOUTHEAST CORNER
HT2430'OF A CATCH BASIN, 23 PACES WEST OF THE WEST EDGE OF L TAXI, 34 PACES
HT2430'SOUTHEAST OF THE EDGE OF G TAXI NORTH, AND 30 PACES NORTHEAST OF THE
HT2430'EDGE OF G TAXI SOUTH.
HT2430'DESCRIBED BY G.R.HEID
HT2430
HT2430                          STATION RECOVERY (2000)
HT2430
HT2430'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2000 (BW)
HT2430'THIS STATION IS DESIGNATED AS A SENONDARY AIRPORT CONTROL
HT2430'STATION (SACS).
HT2430'
HT2430'THE STATION IS LOCATED AT THE SAN FRANCISCO INTERNATIONAL AIRPORT
HT2430'IN A TRIANGULAR CONCRETE ISLAND SOUTHEAST OF RUNWAY 1R-19L,
HT2430'BORDERED BY TAXIWAYS L TO THE SOUTHEAST, TAXIWAY G-NORTH, ON THE
HT2430'NORTH, AND G-SOUTH TO THE SOUTH.
HT2430'
HT2430'OWNERSHIP--THE CITY AND COUNTY OS SAN FRANCISCO, SAN FRANCISCO
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 HT2430'AIRPORT COMMISSION, SAN FRANCISCO CA 94102.
 HT2430'FOR ACCESS--CONTACT--AIRFIELD OPERATIONS--GLEN BROTMAN,
 HT2430'PHONE-650-794-3349.  CHIEF AIRPORT SURVEYOR--HUGO TUPAC,
 HT2430'PHONE--650-821-7770, FAX--650-635-2246.  FAA FACILITIES MANAGER--PAUL
 HT2430'CANDELARIE, PHONE--650-876-2839.
 HT2430'
 HT2430'NOTE--CONTACT THE AIRPORT A MINIMUM OF ONE WEEK IN ADVANCE TO
 HT2430'MAKE ARRANGEMENTS FOR AN ESCORT.  BADGES AND VEHICLE PASSES ARE
 HT2430'REQUIRED.   ESCORT BY AN AIRPORT SAFETY OFFICIAL IS MANDITORY WHILE
 HT2430'WORKING AROUND RUNWAYS.  AIRPORT SURVEY PERSONNEL CAN ESCORT
 HT2430'YOU TO ALL STATION ON THE AIRPORT.  EAR PROTECTION IS HIGHLY
 HT2430'ADVISED.
 HT2430'
 HT2430'TO REACH THE STATION FROM THE OVERPASS OF HIGHWAY 101 NORTH AND
 HT2430'MILLBRAE AVENUE.  TAKE THE MILLBRAE EXIT EAST ON MILLBRAE AVENUE
 HT2430'OFF OF HIGHWAY 101 NORTH AND GO 0.3 MILE TO SOUTH MCDANALD
 HT2430'AVENUE.  TURN LEFT, WEST, ONTO SOUTH MCDONALD AVENUE AND
 HT2430'CONTINUE FOR 0.02 MILES TO MILLBRAE GATE.  THERE IS A CALL BOX AT THE
 HT2430'GATE TO CONTACT AIRPORT AUTHORITIES TO OPEN THE GATE AND
 HT2430'PROVIDE ESCORT.  ADVANCED ARRANGEMENTS CAN BE MADE FOR AIRPORT
 HT2430'PERSONNEL TO MEET YOU AT THE GATE AT SPECIFIC TIMES AND ESCORT
 HT2430'YOU ON THE AIRPORT.  PASS THROUGH THE GATE ON ACCESS ROAD (OLD
 HT2430'BAYSHORE ROAD)  AND CONTINUE NORTHWEST FOR 0.05 MILES TO THE
 HT2430'AIRPORT SERVICE ROAD, TURNING RIGHT, NORTHEAST, ON THE SERVICE
 HT2430'ROAD FOR 0.5 MILES TO THE STATION ON THE LEFT.
 HT2430'
 HT2430'THE STATION IS IN THE CENTER OF THE CONCRETE ISLAND, 4 M (13.12 FT)
 HT2430'SOUTHEAST OF THE SOUTHEAST CORNER OF A CATCH BASIN, 22 M (72.18 FT)
 HT2430'WEST OF THE WEST EDGE OF TAXIWAY L, 33 M (108.27 FT) SOUTHEAST OF
 HT2430'THE SOUTHEAST EDGE OF TAXIWAY G-NORTH, 29 M NORTHEAST OF THE
 HT2430'NORTHEAST EDGE OF TAXIWAY G-SOUTH.
 HT2430'
 HT2430'NOTE--SANDBAGS ARE HIGHLY RECOMMENDED FOR ANY TROPOD SETUP
 HT2430'DUE TO CONCRETE BASE AND AIRCRAFT TURBULANCE.
 HT2430'
 HT2430
 HT2430                          STATION RECOVERY (2002)
 HT2430
 HT2430'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2002 (DAH)
 HT2430'RECOVERED AS DESCRIBED
 HT2430'
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0548 ***********************************************************************
 HT0548  DESIGNATION -  Z 813
 HT0548  PID         -  HT0548
 HT0548  STATE/COUNTY-  CA/SAN MATEO
 HT0548  USGS QUAD   -  MONTARA MOUNTAIN (1997)
 HT0548
 HT0548                         *CURRENT SURVEY CONTROL
 HT0548  ___________________________________________________________________
 HT0548* NAD 83(1986)-  37 36 48.     (N)    122 23 59.     (W)     SCALED
 HT0548* NAVD 88     -         2.56   (+/-2cm)       8.4    (feet)  VERTCON
 HT0548  ___________________________________________________________________
 HT0548  GEOID HEIGHT-         -32.62  (meters)                     GEOID09
 HT0548  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0548
 HT0548.The horizontal coordinates were scaled from a topographic map and have
 HT0548.an estimated accuracy of +/- 6 seconds.
 HT0548
 HT0548.The NAVD 88 height was computed by applying the VERTCON shift value to
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 HT0548.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0548.The vertical order pertains to the NGVD 29 superseded value.
 HT0548
 HT0548.The geoid height was determined by GEOID09.
 HT0548
 HT0548;                    North         East     Units  Estimated Accuracy
 HT0548;SPC CA 3     -   625,260.    1,832,290.      MT  (+/- 180 meters Scaled)
 HT0548
 HT0548                          SUPERSEDED SURVEY CONTROL
 HT0548
 HT0548  NGVD 29 (??/??/92)    1.718  (m)           5.64   (f) ADJ UNCH    1 2
 HT0548
 HT0548.Superseded values are not recommended for survey control.
 HT0548.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0548.See file dsdata.txt to determine how the superseded data were derived.
 HT0548
 HT0548_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG529630(NAD 83)
 HT0548_MARKER: DB = BENCH MARK DISK
 HT0548_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT0548_SP_SET: CULVERT
 HT0548_STAMPING: Z 813 1952
 HT0548_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT0548
 HT0548  HISTORY     - Date     Condition        Report By
 HT0548  HISTORY     - 1952     MONUMENTED       CGS
 HT0548  HISTORY     - 1956     GOOD             NGS
 HT0548  HISTORY     - 1965     GOOD             NGS
 HT0548  HISTORY     - 1986     MARK NOT FOUND   NGS
 HT0548
 HT0548                          STATION DESCRIPTION
 HT0548
 HT0548'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0548'1.1 MI NW FROM MILLBRAE.
 HT0548'1.1 MILES NORTHWEST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
 HT0548'FROM THE STATION AT MILLBRAE, 1.4 MILES SOUTHEAST OF THE
 HT0548'STATION AT SAN BRUNO, ABOUT 0.2 MILE NORTHWEST FROM THE CROSSING
 HT0548'OF CENTER STREET, AT 16-INCH IRON PIPE CULVERT NO. 12.52, IN
 HT0548'THE TOP OF THE NORTHWEST END OF THE SOUTHWEST CONCRETE HEAD
 HT0548'WALL, 19.4 FEET SOUTHWEST OF THE SOUTHWEST RAIL OF THE SOUTHWEST
 HT0548'MAIN TRACK, AND ABOUT 6 FEET LOWER THAN THE TRACK.
 HT0548
 HT0548                          STATION RECOVERY (1965)
 HT0548
 HT0548'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
 HT0548'RECOVERED IN GOOD CONDITION.
 HT0548
 HT0548                          STATION RECOVERY (1986)
 HT0548
 HT0548'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0548'NOT RECOVERED.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0547 ***********************************************************************
 HT0547  DESIGNATION -  Y 813
 HT0547  PID         -  HT0547
 HT0547  STATE/COUNTY-  CA/SAN MATEO
 HT0547  USGS QUAD   -  MONTARA MOUNTAIN (1997)
 HT0547
 HT0547                         *CURRENT SURVEY CONTROL
 HT0547  ___________________________________________________________________
 HT0547* NAD 83(1986)-  37 37 08.     (N)    122 24 15.     (W)     SCALED
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HT0547* NAVD 88     -         3.97   (+/-2cm)      13.0    (feet)  VERTCON
HT0547  ________________________________________________________________
HT0547  GEOID HEIGHT-         -32.62  (meters)                     GEOID09
HT0547  VERT ORDER  -  FIRST     CLASS II (See Below)
HT0547
HT0547.The horizontal coordinates were scaled from a topographic map and have
HT0547.an estimated accuracy of +/- 6 seconds.
HT0547
HT0547.The NAVD 88 height was computed by applying the VERTCON shift value to
HT0547.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
HT0547.The vertical order pertains to the NGVD 29 superseded value.
HT0547
HT0547.The geoid height was determined by GEOID09.
HT0547
HT0547;                    North         East    Units  Estimated Accuracy
HT0547;SPC CA 3     -   625,890.    1,831,910.      MT  (+/- 180 meters Scaled)
HT0547
HT0547                          SUPERSEDED SURVEY CONTROL
HT0547
HT0547  NGVD 29 (??/??/92)    3.126  (m)           10.26   (f) ADJ UNCH    1 2
HT0547
HT0547.Superseded values are not recommended for survey control.
HT0547.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0547.See file dsdata.txt to determine how the superseded data were derived.
HT0547
HT0547_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG525636(NAD 83)
HT0547_MARKER: DB = BENCH MARK DISK
HT0547_SETTING: 32 = SET IN A RETAINING WALL OR CONCRETE LEDGE
HT0547_SP_SET: CULVERT HEADWALL
HT0547_STAMPING: Y 813 1952
HT0547_MARK LOGO: CGS
HT0547_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
HT0547+STABILITY: SURFACE MOTION
HT0547_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
HT0547+SATELLITE: SATELLITE OBSERVATIONS - October 31, 2004
HT0547
HT0547  HISTORY     - Date     Condition        Report By
HT0547  HISTORY     - 1952     MONUMENTED       CGS
HT0547  HISTORY     - 1964     GOOD             NGS
HT0547  HISTORY     - 1986     GOOD             NGS
HT0547  HISTORY     - 20041031 GOOD             SMCSS
HT0547  HISTORY     - 20061220 MARK NOT FOUND   CONDOR
HT0547
HT0547                          STATION DESCRIPTION
HT0547
HT0547'DESCRIBED BY NATIONAL GEODETIC SURVEY 1964
HT0547'1 MI SE FROM SAN BRUNO.
HT0547'0.95 MILES SOUTHEAST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
HT0547'FROM THE STATION AT SAN BRUNO, 6 RAILS NORTHWEST ALONG THE
HT0547'RAILROAD FROM THE LOMITA PARK PASSENGER STOP, IN THE TOP OF
HT0547'THE SOUTHEAST END OF THE SOUTHWEST CONCRETE HEAD WALL OF TWIN
HT0547'36-INCH CORRUGATED METAL PIPE CULVERT 11.94, 18.1 FEET SOUTHWEST
HT0547'OF THE SOUTHWEST RAIL OF THE SOUTHWEST MAIN TRACK, AND ABOUT 2
HT0547'FEET LOWER THAN THE TRACK.
HT0547
HT0547                          STATION RECOVERY (1986)
HT0547
HT0547'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
HT0547'RECOVERED IN GOOD CONDITION. THE DESCRIPTION IS ADEQUATE EXCEPT ADD
HT0547'NEAR THE EAST END OF SAN FELIPE AVENUE.
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 HT0547
 HT0547                          STATION RECOVERY (2004)
 HT0547
 HT0547'RECOVERY NOTE BY SMITH AND COMPANY SURVEYING SRV INC 2004 (MW)
 HT0547'RECOVERED IN GOOD CONDITION.
 HT0547
 HT0547                          STATION RECOVERY (2006)
 HT0547
 HT0547'RECOVERY NOTE BY CONDOR TECHNOLOGIES 2006 (DLS)
 HT0547'DESTROYED- SOMEBODY POPPED THAT DISK RIGHT OFF THE HEADWALL- LEFT THE
 HT0547'IMPRINT IN THE CONCRETE
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0541 ***********************************************************************
 HT0541  DESIGNATION -  35
 HT0541  PID         -  HT0541
 HT0541  STATE/COUNTY-  CA/SAN MATEO
 HT0541  USGS QUAD   -  SAN MATEO (1997)
 HT0541
 HT0541                         *CURRENT SURVEY CONTROL
 HT0541  ___________________________________________________________________
 HT0541* NAD 83(1986)-  37 37 09.     (N)    122 22 23.     (W)     SCALED
 HT0541* NAVD 88     -         2.62   (+/-2cm)       8.6    (feet)  VERTCON
 HT0541  ___________________________________________________________________
 HT0541  GEOID HEIGHT-         -32.60  (meters)                     GEOID09
 HT0541  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0541
 HT0541.This mark is at San Francisco Intl Airport (SFO)
 HT0541
 HT0541.The horizontal coordinates were scaled from a topographic map and have
 HT0541.an estimated accuracy of +/- 6 seconds.
 HT0541
 HT0541.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0541.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0541.The vertical order pertains to the NGVD 29 superseded value.
 HT0541
 HT0541.The geoid height was determined by GEOID09.
 HT0541
 HT0541;                    North         East     Units  Estimated Accuracy
 HT0541;SPC CA 3     -   625,860.    1,834,660.      MT   (+/- 180 meters Scaled)
 HT0541
 HT0541                          SUPERSEDED SURVEY CONTROL
 HT0541
 HT0541  NGVD 29 (??/??/92)    1.787  (m)            5.86   (f) ADJ UNCH    1 2
 HT0541
 HT0541.Superseded values are not recommended for survey control.
 HT0541.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0541.See file dsdata.txt to determine how the superseded data were derived.
 HT0541
 HT0541_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG553637(NAD 83)
 HT0541_MARKER: Z = SEE DESCRIPTION
 HT0541_SETTING: 45 = UNSPECIFIED DEEP UNSLEEVED SETTING (10 FT.+)
 HT0541_SP_SET: 60 FT IRON PIPE
 HT0541_MARK LOGO: USE
 HT0541_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0541
 HT0541  HISTORY     - Date     Condition        Report By
 HT0541  HISTORY     - 1956     MONUMENTED       DOD
 HT0541  HISTORY     - 1972     GOOD             NGS
 HT0541  HISTORY     - 1977     GOOD             NGS
 HT0541  HISTORY     - 1986     GOOD             NGS
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 HT0541
 HT0541                          STATION DESCRIPTION
 HT0541
 HT0541'DESCRIBED BY US DEPARTMENT OF DEFENSE 1956
 HT0541'AT SAN FRANCISCO AIRPORT.
 HT0541'AT THE SAN FRANCISCO INTERNATIONAL AIRPORT, ABOUT 0.5 MILE
 HT0541'NORTHEAST OF THE NEW TERMINAL BUILDING, AT THE CROSSING AND
 HT0541'ON THE WEST EDGE OF RUNWAY 19-L 1-R, BETWEEN RUNWAYS 28 R 10 L
 HT0541'AND 28 L 10 R, 294 FEET NORTH OF THE NORTH EDGE OF RUNWAY
 HT0541'28 L 10 R, 250 FEET EAST OF THE T.V.O.R BUILDING (C.A.A.), 219
 HT0541'FEET SOUTH OF THE SOUTH EDGE OF RUNWAY 28 R 10 L, 24.1 FEET
 HT0541'NORTHEAST OF RUNWAY LIGHT NO. D 57, AND ABOUT 1 1/2 FEET LOWER
 HT0541'THAN THE RUNWAY.  NOTE-- THE TOP OF A 1-INCH IRON PIPE DROVE
 HT0541'60-FEET INTO THE GROUND, ACCESS TO WHICH IS HAD THROUGH AN
 HT0541'8-INCH CLAY PIPE WITH A CONCRETE LID.
 HT0541
 HT0541                          STATION RECOVERY (1972)
 HT0541
 HT0541'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1972
 HT0541'RECOVERED IN GOOD CONDITION.
 HT0541
 HT0541                          STATION RECOVERY (1977)
 HT0541
 HT0541'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1977
 HT0541'RECOVERED IN GOOD CONDITION.
 HT0541
 HT0541                          STATION RECOVERY (1986)
 HT0541
 HT0541'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0541'RECOVERED IN GOOD CONDITION EXCEPT THAT THE MARK IS THE TOP OF THE
 HT0541'1-INCH IRON PIPE.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0540 ***********************************************************************
 HT0540  DESIGNATION -  34
 HT0540  PID         -  HT0540
 HT0540  STATE/COUNTY-  CA/SAN MATEO
 HT0540  USGS QUAD   -  MONTARA MOUNTAIN (1997)
 HT0540
 HT0540                         *CURRENT SURVEY CONTROL
 HT0540  ___________________________________________________________________
 HT0540* NAD 83(1986)-  37 37 16.     (N)    122 22 39.     (W)     SCALED
 HT0540* NAVD 88     -         2.07   (+/-2cm)       6.8    (feet)  VERTCON
 HT0540  ___________________________________________________________________
 HT0540  GEOID HEIGHT-        -32.61  (meters)                      GEOID09
 HT0540  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0540
 HT0540.This mark is at San Francisco Intl Airport (SFO)
 HT0540
 HT0540.The horizontal coordinates were scaled from a topographic map and have
 HT0540.an estimated accuracy of +/- 6 seconds.
 HT0540
 HT0540.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0540.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0540.The vertical order pertains to the NGVD 29 superseded value.
 HT0540
 HT0540.The geoid height was determined by GEOID09.
 HT0540
 HT0540;                   North         East    Units  Estimated Accuracy
 HT0540;SPC CA 3     -   626,080.    1,834,270.      MT  (+/- 180 meters Scaled)
 HT0540
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HT0540                          SUPERSEDED SURVEY CONTROL
HT0540
HT0540  NGVD 29 (??/??/92)    1.242  (m)             4.07   (f) ADJ UNCH    1 2
HT0540
HT0540.Superseded values are not recommended for survey control.
HT0540.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0540.See file dsdata.txt to determine how the superseded data were derived.
HT0540
HT0540_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG549639(NAD 83)
HT0540_MARKER: Z = SEE DESCRIPTION
HT0540_SETTING: 45 = UNSPECIFIED DEEP UNSLEEVED SETTING (10 FT.+)
HT0540_SP_SET: 60 FT IRON PIPE
HT0540_MARK LOGO: USE
HT0540_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
HT0540
HT0540  HISTORY     - Date     Condition        Report By
HT0540  HISTORY     - UNK      MONUMENTED       DOD
HT0540  HISTORY     - 1956     GOOD             NGS
HT0540  HISTORY     - 1977     GOOD             NGS
HT0540  HISTORY     - 1986     GOOD             NGS
HT0540
HT0540                          STATION DESCRIPTION
HT0540
HT0540'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
HT0540'AT SAN FRANCISCO AIRPORT.
HT0540'AT THE SAN FRANCISCO INTERNATIONAL AIRPORT, 0.3 MILE NORTHEAST
HT0540'ACROSS COUNTRY FROM THE NEW TERMINAL BUILDING, AT THE CROSSING
HT0540'OF TAXIWAY NO. 3, BETWEEN RUNWAYS 10L AND 10R, 285 FEET NORTHEAST
HT0540'OF THE NORTHEAST EDGE OF RUNWAY 10R, 213 FEET SOUTHWEST OF THE
HT0540'SOUTHWEST EDGE OF RUNWAY 10L, 91 FEET NORTHWEST OF THE NORTHWEST
HT0540'EDGE OF THE TAXIWAY, 5.5 FEET SOUTHWEST OF A BLACK AND YELLOW
HT0540'STRIPPED 4- BY 4-INCH POST, ABOUT 1 FOOT LOWER THAN THE RUNWAY,
HT0540'AND ABOUT 1 FOOT UNDERGROUND.  NOTE-- THE TOP OF A 1-INCH IRON
HT0540'PIPE DROVE 60-FEET INTO THE GROUND, ACCESS TO WHICH IS HAD
HT0540'THROUGH AN 8-INCH CLAY PIPE WITH A 10-INCH CONCRETE LID.
HT0540
HT0540                          STATION RECOVERY (1977)
HT0540
HT0540'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1977
HT0540'AT THE SAN FRANCISCO INTL AIRPORT, 0.3 MILE NORTHEAST ACROSS COUNTRY
HT0540'FROM THE NEW TERMINAL BUILDING, AT THE CROSSING OF TAXIWAY NO. E,
HT0540'BETWEEN RUNWAYS 10L AND 10R, 285 FEET NORTHEAST OF THE NORTHEAST EDGE
HT0540'OF RUNWAY 10R, 213 FEET SOUTHWEST OF THE SOUTHWEST EDGE OF RUNWAY
HT0540'10L, 91 FEET NORTHWEST OF THE NORTHWEST EDGE OF THE TAXIWAY NO.E,
HT0540'ABOUT 1 FOOT LOWER THAN THE RUNWAY, AND ABOUT 1 FOOT UNDERGROUND,
HT0540'SOUTH OF TAXIWAY NO. T. NOTE-- THE TOP OF A 1 INCH IRON PIPE DROVE 60
HT0540'FEET INTO THE GROUND, ACCESS TO WHICH IS HAD THROUGH AN 8 INCH CLAY
HT0540'PIPE WITH A 10 INCH CONCRETE LID.
HT0540
HT0540                          STATION RECOVERY (1986)
HT0540
HT0540'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
HT0540'RECOVERED IN GOOD CONDITION. NEW DESCRIPTION FOLLOWS. IN SAN FRANCISCO
HT0540'INTERNATIONAL AIRPORT, ABOUT 1.0 KM (0.6 MI) NORTHEAST OF THE MAIN
HT0540'TERMINAL PARKING GARAGE, 28.1 METERS (92.2 FT) NORTHWEST OF THE
HT0540'NORTHWEST PAINTED EDGE OF TAXIWAY E, 34.5 METERS (113 FT) NORTH OF THE
HT0540'WEST OF A 28L-10R RUNWAY SIGN, 25.1 METERS (82.3 FT) WEST-SOUTHWEST OF
HT0540'THE SOUTHERNMOST 1 OF 5 BLUE TAXI LIGHTS, BETWEEN 2 WITNESS POSTS.
HT0540'NOTE--THE MARK IS THE TOP OF A 1-INCH IRON PIPE SET 60 FT DEEP AND
HT0540'FLUSH WITH THE GROUND.
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 HT0540'THE MARK IS 0.3 METERS  S FROM  A WITNESS POST
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0537 ***********************************************************************
 HT0537  DESIGNATION -  R 737 C OF SF
 HT0537  PID         -  HT0537
 HT0537  STATE/COUNTY-  CA/SAN MATEO
 HT0537  USGS QUAD   -  MONTARA MOUNTAIN (1997)
 HT0537
 HT0537                         *CURRENT SURVEY CONTROL
 HT0537  ___________________________________________________________________
 HT0537* NAD 83(1986)-  37 37 20.     (N)    122 23 29.     (W)     SCALED
 HT0537* NAVD 88     -         1.73   (+/-2cm)       5.7    (feet)  VERTCON
 HT0537  ___________________________________________________________________
 HT0537  GEOID HEIGHT-         -32.61  (meters)                     GEOID09
 HT0537  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0537
 HT0537.This mark is at San Francisco Intl Airport (SFO)
 HT0537
 HT0537.The horizontal coordinates were scaled from a topographic map and have
 HT0537.an estimated accuracy of +/- 6 seconds.
 HT0537
 HT0537.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0537.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0537.The vertical order pertains to the NGVD 29 superseded value.
 HT0537
 HT0537.The geoid height was determined by GEOID09.
 HT0537
 HT0537;                   North         East     Units  Estimated Accuracy
 HT0537;SPC CA 3     -   626,230.    1,833,050.      MT  (+/- 180 meters Scaled)
 HT0537
 HT0537                          SUPERSEDED SURVEY CONTROL
 HT0537
 HT0537  NGVD 29 (??/??/92)    0.891  (m)           2.92   (f) ADJ UNCH    1 2
 HT0537
 HT0537.Superseded values are not recommended for survey control.
 HT0537.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0537.See file dsdata.txt to determine how the superseded data were derived.
 HT0537
 HT0537_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG537640(NAD 83)
 HT0537_MARKER: DD = SURVEY DISK
 HT0537_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0537_SP_SET: BUILDING
 HT0537_STAMPING: R 737 1944
 HT0537_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0537
 HT0537  HISTORY     - Date     Condition        Report By
 HT0537  HISTORY     - 1944     MONUMENTED       CA3290
 HT0537  HISTORY     - 1968     GOOD             NGS
 HT0537  HISTORY     - 1972     GOOD             NGS
 HT0537
 HT0537                          STATION DESCRIPTION
 HT0537
 HT0537'DESCRIBED BY NATIONAL GEODETIC SURVEY 1968
 HT0537'AT SAN FRANCISCO INTL AIRPORT.
 HT0537'AN UPDATED DESCRIPTION FOLLOWS-- AT THE SAN FRANCISCO INTERNATIONAL
 HT0537'AIRPORT, AT THE WEST CORNER OF A CONCRETE SHOP BUILDING OF
 HT0537'QANTAS AIRLINE, IN THE TOP OF A CONCRETE PROJECTION OF THE WEST
 HT0537'CORNER OF THE CONCRETE FOUNDATION, 59.2 FEET SOUTHWEST OF BENCH
 HT0537'MARK Y 736, 52.6 FEET EAST OF AND ACROSS A DRIVEWAY FROM
 HT0537'FIREHOUSE 1, 5.5 FEET SOUTHEAST OF THE SOUTHEAST CURB OF THE
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 HT0537'DRIVEWAY, 0.7 FOOT NORTHWEST OF THE NORTHWEST FACE OF THE
 HT0537'BUILDING AND ABOUT 1 FOOT HIGHER THAN A SIDEWALK.  NOTE-- NUMBERS
 HT0537'5.953 HAVE BEEN PUNCHED ON THE DISK WITH A SHARP OBJECT.
 HT0537
 HT0537                          STATION RECOVERY (1972)
 HT0537
 HT0537'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1972
 HT0537'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0538 ***********************************************************************
 HT0538  DESIGNATION -  Y 736 C OF SF
 HT0538  PID         -  HT0538
 HT0538  STATE/COUNTY-  CA/SAN MATEO
 HT0538  USGS QUAD   -  MONTARA MOUNTAIN (1997)
 HT0538
 HT0538                         *CURRENT SURVEY CONTROL
 HT0538  ___________________________________________________________________
 HT0538* NAD 83(1986)-  37 37 20.     (N)    122 23 29.     (W)     SCALED
 HT0538* NAVD 88     -         1.73   (+/-2cm)       5.7    (feet)  VERTCON
 HT0538  ___________________________________________________________________
 HT0538  GEOID HEIGHT-         -32.61  (meters)                     GEOID09
 HT0538  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0538
 HT0538.This mark is at San Francisco Intl Airport (SFO)
 HT0538
 HT0538.The horizontal coordinates were scaled from a topographic map and have
 HT0538.an estimated accuracy of +/- 6 seconds.
 HT0538
 HT0538.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0538.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0538.The vertical order pertains to the NGVD 29 superseded value.
 HT0538
 HT0538.The geoid height was determined by GEOID09.
 HT0538
 HT0538;                    North         East     Units  Estimated Accuracy
 HT0538;SPC CA 3     -   626,230.    1,833,050.      MT  (+/- 180 meters Scaled)
 HT0538
 HT0538                          SUPERSEDED SURVEY CONTROL
 HT0538
 HT0538  NGVD 29 (??/??/92)    0.896  (m)            2.94   (f) ADJ UNCH    1 2
 HT0538
 HT0538.Superseded values are not recommended for survey control.
 HT0538.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0538.See file dsdata.txt to determine how the superseded data were derived.
 HT0538
 HT0538_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG537640(NAD 83)
 HT0538_MARKER: DD = SURVEY DISK
 HT0538_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0538_SP_SET: BUILDING
 HT0538_STAMPING: Y 736 1944
 HT0538_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0538
 HT0538  HISTORY     - Date     Condition        Report By
 HT0538  HISTORY     - 1944     MONUMENTED       CA3290
 HT0538  HISTORY     - 1968     GOOD             NGS
 HT0538  HISTORY     - 1972     GOOD             NGS
 HT0538
 HT0538                          STATION DESCRIPTION
 HT0538
 HT0538'DESCRIBED BY NATIONAL GEODETIC SURVEY 1968
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 HT0538'AT SAN FRANCISCO AIRPORT.
 HT0538'AN UPDATED DESCRIPTION FOLLOWS-- AT THE SAN FRANCISCO INTERNATIONAL
 HT0538'AIRPORT AT THE NORTHEAST CORNER OF A CONCRETE SHOP BUILDING OF
 HT0538'QANTAS AIRLINE, IN THE TOP OF A PROJECTION OF THE NORTHEAST
 HT0538'CORNER OF THE CONCRETE FOUNDATION, 47.0 FEET SOUTH OF THE
 HT0538'SOUTHEAST CORNER OF FIREHOUSE 1.  IT IS 1.0 FOOT NORTH OF THE
 HT0538'NORTH FACE OF THE SHOP BUILDING, AND ABOUT 1 FOOT HIGHER THAN
 HT0538'THE DRIVEWAY.
 HT0538
 HT0538                          STATION RECOVERY (1972)
 HT0538
 HT0538'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1972
 HT0538'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0542 ***********************************************************************
 HT0542  DESIGNATION -  L 553
 HT0542  PID         -  HT0542
 HT0542  STATE/COUNTY-  CA/SAN MATEO
 HT0542  USGS QUAD   -  SAN MATEO (1997)
 HT0542
 HT0542                         *CURRENT SURVEY CONTROL
 HT0542  ___________________________________________________________________
 HT0542* NAD 83(1986)-  37 37 28.     (N)    122 22 31.     (W)     SCALED
 HT0542* NAVD 88     -         3.02   (+/-2cm)       9.9    (feet)  VERTCON
 HT0542  ___________________________________________________________________
 HT0542  GEOID HEIGHT-         -32.60  (meters)                     GEOID09
 HT0542  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0542
 HT0542.This mark is at San Francisco Intl Airport (SFO)
 HT0542
 HT0542.The horizontal coordinates were scaled from a topographic map and have
 HT0542.an estimated accuracy of +/- 6 seconds.
 HT0542
 HT0542.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0542.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0542.The vertical order pertains to the NGVD 29 superseded value.
 HT0542
 HT0542.The geoid height was determined by GEOID09.
 HT0542
 HT0542;                   North         East     Units  Estimated Accuracy
 HT0542;SPC CA 3     -   626,450.    1,834,480.      MT  (+/- 180 meters Scaled)
 HT0542
 HT0542                          SUPERSEDED SURVEY CONTROL
 HT0542
 HT0542  NGVD 29 (??/??/92)    2.192  (m)           7.19   (f) ADJ UNCH    1 2
 HT0542
 HT0542.Superseded values are not recommended for survey control.
 HT0542.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0542.See file dsdata.txt to determine how the superseded data were derived.
 HT0542
 HT0542_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG551643(NAD 83)
 HT0542_MARKER: DB = BENCH MARK DISK
 HT0542_SETTING: 34 = SET IN THE FOOTINGS OF SMALL/MEDIUM STRUCTURES
 HT0542_SP_SET: BUILDING FOUNDATION
 HT0542_STAMPING: L 553 1956
 HT0542_MARK LOGO: CGS
 HT0542_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
 HT0542+STABILITY: SURFACE MOTION
 HT0542
 HT0542  HISTORY     - Date     Condition        Report By
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 HT0542  HISTORY     - 1956     MONUMENTED       CGS
 HT0542  HISTORY     - 1972     GOOD             NGS
 HT0542  HISTORY     - 1983     GOOD             USGS
 HT0542  HISTORY     - 1986     GOOD             NGS
 HT0542  HISTORY     - 20060129 GOOD             GEOCAC
 HT0542
 HT0542                          STATION DESCRIPTION
 HT0542
 HT0542'DESCRIBED BY COAST AND GEODETIC SURVEY 1956
 HT0542'AT SAN FRANCISCO AIRPORT.
 HT0542'AT THE SAN FRANCISCO INTERNATIONAL AIRPORT, AT FIREHOUSE NO.
 HT0542'3, IN THE TOP OF THE SOUTHEAST EDGE OF THE CONCRETE FOUNDATION
 HT0542'AND AT THE EAST CORNER OF THE BUILDING, 0.5 FOOT SOUTH OF THE
 HT0542'EAST CORNER OF THE BUILDING, 0.3 FOOT NORTHEAST OF THE NORTHEAST
 HT0542'EDGE OF A CONCRETE DRAIN BOX, 0.4 FOOT ABOVE THE GROUND, AND
 HT0542'ABOUT 0.6 FOOT HIGHER THAN A DRIVEWAY.
 HT0542
 HT0542                          STATION RECOVERY (1972)
 HT0542
 HT0542'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1972
 HT0542'RECOVERED IN GOOD CONDITION.
 HT0542
 HT0542                          STATION RECOVERY (1983)
 HT0542
 HT0542'RECOVERY NOTE BY US GEOLOGICAL SURVEY 1983
 HT0542'RECOVERED IN GOOD CONDITION.
 HT0542
 HT0542                          STATION RECOVERY (1986)
 HT0542
 HT0542'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0542'RECOVERED IN GOOD CONDITION. THE DESCRIPTION IS ADEQUATE EXCEPT ADD AT
 HT0542'FIREHOUSE NUMBER 2 NOT NUMBER 3.
 HT0542
 HT0542                          STATION RECOVERY (2006)
 HT0542
 HT0542'RECOVERY NOTE BY GEOCACHING 2006 (SW)
 HT0542'OLD FIREHOUSE IS NOW USED BY A TENANT AS A GARAGE FOR VEHICLE
 HT0542'MAINTENANCE.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0534 ***********************************************************************
 HT0534  DESIGNATION -  Z 736 C OF SF
 HT0534  PID         -  HT0534
 HT0534  STATE/COUNTY-  CA/SAN MATEO
 HT0534  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0534
 HT0534                         *CURRENT SURVEY CONTROL
 HT0534  ___________________________________________________________________
 HT0534* NAD 83(1986)-  37 37 30.     (N)    122 23 36.     (W)     SCALED
 HT0534* NAVD 88     -         1.03   (+/-2cm)       3.4    (feet)  VERTCON
 HT0534  ___________________________________________________________________
 HT0534  GEOID HEIGHT-        -32.61  (meters)                      GEOID09
 HT0534  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0534
 HT0534.This mark is at San Francisco Intl Airport (SFO)
 HT0534
 HT0534.The horizontal coordinates were scaled from a topographic map and have
 HT0534.an estimated accuracy of +/- 6 seconds.
 HT0534
 HT0534.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0534.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
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HT0534.The vertical order pertains to the NGVD 29 superseded value.
HT0534
HT0534.The geoid height was determined by GEOID09.
HT0534
HT0534;                    North         East     Units  Estimated Accuracy
HT0534;SPC CA 3     -   626,540.    1,832,880.      MT  (+/- 180 meters Scaled)
HT0534
HT0534                          SUPERSEDED SURVEY CONTROL
HT0534
HT0534  NGVD 29 (??/??/92)    0.197  (m)           0.65   (f) ADJ UNCH    1 2
HT0534
HT0534.Superseded values are not recommended for survey control.
HT0534.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0534.See file dsdata.txt to determine how the superseded data were derived.
HT0534
HT0534_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG535643(NAD 83)
HT0534_MARKER: DD = SURVEY DISK
HT0534_SETTING: 30 = SET IN A LIGHT STRUCTURE
HT0534_SP_SET: CULVERT
HT0534_STAMPING: Z 736 1944
HT0534_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
HT0534
HT0534  HISTORY     - Date     Condition        Report By
HT0534  HISTORY     - 1944     MONUMENTED       CA3290
HT0534  HISTORY     - 1956     GOOD             NGS
HT0534  HISTORY     - 1968     MARK NOT FOUND   NGS
HT0534
HT0534                          STATION DESCRIPTION
HT0534
HT0534'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
HT0534'AT SAN FRANCISCO AIRPORT.
HT0534'AT THE SAN FRANCISCO INTERNATIONAL AIRPORT, AT THE FORMER MAIN
HT0534'ENTRANCE, IN THE TOP OF THE CONCRETE HEAD WALL OF A CULVERT
HT0534'(BURIED BY A FILL) 270.0 FEET WEST OF THE SOUTHWEST CORNER OF
HT0534'THE FORMER ADMINISTRATION BUILDING, 84.0 FEET NORTHWEST OF A
HT0534'FIRE PLUG, 81.1 FEET SOUTHEAST OF BENCH MARK W 736, 23 FEET
HT0534'SOUTH OF THE SOUTH CURB OF THE EAST BOUND TRAFFIC LANES, 19 1/2
HT0534'FEET EAST OF THE CENTER LINE OF A PRIVATE ROAD LEADING SOUTH
HT0534'TO THE NEW ADMINISTRATION BUILDING, 1.3 FEET NORTH OF A WITNESS
HT0534'POST, AND ABOUT 2 1/2 FEET LOWER THAN THE ROAD.  NOTE-- ACCESS
HT0534'IS HAD TO MARK THROUGH A 6-INCH CLAY PIPE WITH A 10-INCH WOODEN
HT0534'COVER.
HT0534
HT0534                          STATION RECOVERY (1968)
HT0534
HT0534'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1968
HT0534'MARK NOT FOUND.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
HT0544 ***********************************************************************
HT0544  DESIGNATION -  42 C OF SF
HT0544  PID         -  HT0544
HT0544  STATE/COUNTY-  CA/SAN MATEO
HT0544  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
HT0544
HT0544                         *CURRENT SURVEY CONTROL
HT0544  ___________________________________________________________________
HT0544* NAD 83(1986)-  37 37 32.     (N)    122 22 34.     (W)     SCALED
HT0544* NAVD 88     -         3.63   (+/-2cm)      11.9    (feet)  VERTCON
HT0544  ___________________________________________________________________
HT0544  GEOID HEIGHT-        -32.61  (meters)                      GEOID09
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 HT0544  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0544
 HT0544.This mark is at San Francisco Intl Airport (SFO)
 HT0544
 HT0544.The horizontal coordinates were scaled from a topographic map and have
 HT0544.an estimated accuracy of +/- 6 seconds.
 HT0544
 HT0544.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0544.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0544.The vertical order pertains to the NGVD 29 superseded value.
 HT0544
 HT0544.The geoid height was determined by GEOID09.
 HT0544
 HT0544;                    North         East    Units  Estimated Accuracy
 HT0544;SPC CA 3     -   626,580.    1,834,410.      MT  (+/- 180 meters Scaled)
 HT0544
 HT0544                          SUPERSEDED SURVEY CONTROL
 HT0544
 HT0544  NGVD 29 (??/??/92)    2.807  (m)           9.21   (f) ADJ UNCH    1 2
 HT0544
 HT0544.Superseded values are not recommended for survey control.
 HT0544.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0544.See file dsdata.txt to determine how the superseded data were derived.
 HT0544
 HT0544_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG550644(NAD 83)
 HT0544_MARKER: Z = SEE DESCRIPTION
 HT0544_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT0544_SP_SET: STEEL LEG CONCRETE FOUNDATION
 HT0544_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT0544
 HT0544  HISTORY     - Date     Condition        Report By
 HT0544  HISTORY     - UNK      MONUMENTED       CA3290
 HT0544  HISTORY     - 1956     GOOD             NGS
 HT0544
 HT0544                          STATION DESCRIPTION
 HT0544
 HT0544'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0544'AT SAN FRANCISCO AIRPORT.
 HT0544'AT THE SAN FRANCISCO INTERNATIONAL AIRPORT, AT THE RADAR TOWER,
 HT0544'ON THE TOP OF THE EAST CORNER OF THE NORTHEAST CONCRETE
 HT0544'FOUNDATION OF THE NORTHEAST STEEL LEG, 17.7 FEET EAST OF BENCH
 HT0544'MARK K 553 1956, ABOUT 1 1/2 FEET HIGHER THAN THE GROUND, AND
 HT0544'MARKED WITH WHITE PAINTED LETTERS AND NUMBERS B M 42.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0543 ***********************************************************************
 HT0543  DESIGNATION -  K 553
 HT0543  PID         -  HT0543
 HT0543  STATE/COUNTY-  CA/SAN MATEO
 HT0543  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0543
 HT0543                         *CURRENT SURVEY CONTROL
 HT0543  ___________________________________________________________________
 HT0543* NAD 83(1986)-  37 37 32.     (N)    122 22 34.     (W)     SCALED
 HT0543* NAVD 88     -         3.63   (+/-2cm)      11.9    (feet)  VERTCON
 HT0543  ___________________________________________________________________
 HT0543  GEOID HEIGHT-         -32.61  (meters)                     GEOID09
 HT0543  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0543
 HT0543.This mark is at San Francisco Intl Airport (SFO)
 HT0543
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 HT0543.The horizontal coordinates were scaled from a topographic map and have
 HT0543.an estimated accuracy of +/- 6 seconds.
 HT0543
 HT0543.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0543.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0543.The vertical order pertains to the NGVD 29 superseded value.
 HT0543
 HT0543.The geoid height was determined by GEOID09.
 HT0543
 HT0543;                    North         East     Units  Estimated Accuracy
 HT0543;SPC CA 3     -   626,580.    1,834,410.      MT  (+/- 180 meters Scaled)
 HT0543
 HT0543                          SUPERSEDED SURVEY CONTROL
 HT0543
 HT0543  NGVD 29 (??/??/92)    2.807  (m)            9.21   (f) ADJ UNCH    1 2
 HT0543
 HT0543.Superseded values are not recommended for survey control.
 HT0543.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0543.See file dsdata.txt to determine how the superseded data were derived.
 HT0543
 HT0543_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG550644(NAD 83)
 HT0543_MARKER: DB = BENCH MARK DISK
 HT0543_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT0543_SP_SET: STEP
 HT0543_STAMPING: K 553 1956
 HT0543_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT0543
 HT0543  HISTORY     - Date     Condition        Report By
 HT0543  HISTORY     - 1956     MONUMENTED       CGS
 HT0543  HISTORY     - 1968     GOOD             NGS
 HT0543
 HT0543                          STATION DESCRIPTION
 HT0543
 HT0543'DESCRIBED BY COAST AND GEODETIC SURVEY 1956
 HT0543'AT SAN FRANCISCO AIRPORT.
 HT0543'AT THE SAN FRANCISCO INTERNATIONAL AIRPORT, AT THE RADAR TOWER,
 HT0543'IN THE TOP OF THE WEST SIDE OF A CONCRETE FOUNDATION FOR THE
 HT0543'WEST LEG AND THE STEEL STEPS OF THE TOWER, 5.0 FEET EAST OF THE
 HT0543'NORTH CORNER OF THE C.A.A. BUILDING, AND ABOUT 1 1/2 FEET HIGHER
 HT0543'THAN THE GROUND.
 HT0543
 HT0543                          STATION RECOVERY (1968)
 HT0543
 HT0543'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1968
 HT0543'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0528 ***********************************************************************
 HT0528  DESIGNATION -  X 813
 HT0528  PID         -  HT0528
 HT0528  STATE/COUNTY-  CA/SAN MATEO
 HT0528  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0528
 HT0528                         *CURRENT SURVEY CONTROL
 HT0528  ___________________________________________________________________
 HT0528* NAD 83(1986)-  37 37 44.     (N)    122 24 39.      (W)     SCALED
 HT0528* NAVD 88     -         5.78   (+/-2cm)      19.0    (feet)   VERTCON
 HT0528  ___________________________________________________________________
 HT0528  GEOID HEIGHT-         -32.63  (meters)                      GEOID09
 HT0528  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0528
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 HT0528.The horizontal coordinates were scaled from a topographic map and have
 HT0528.an estimated accuracy of +/- 6 seconds.
 HT0528
 HT0528.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0528.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0528.The vertical order pertains to the NGVD 29 superseded value.
 HT0528
 HT0528.The geoid height was determined by GEOID09.
 HT0528
 HT0528;                    North         East     Units  Estimated Accuracy
 HT0528;SPC CA 3     -   627,010.    1,831,350.      MT  (+/- 180 meters Scaled)
 HT0528
 HT0528                          SUPERSEDED SURVEY CONTROL
 HT0528
 HT0528  NGVD 29 (??/??/92)    4.942  (m)           16.21   (f) ADJ UNCH    1 2
 HT0528
 HT0528.Superseded values are not recommended for survey control.
 HT0528.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0528.See file dsdata.txt to determine how the superseded data were derived.
 HT0528
 HT0528_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG519648(NAD 83)
 HT0528_MARKER: DB = BENCH MARK DISK
 HT0528_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0528_SP_SET: ABUTMENT
 HT0528_STAMPING: X 813 1952
 HT0528_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0528
 HT0528  HISTORY     - Date     Condition        Report By
 HT0528  HISTORY     - 1952     MONUMENTED       CGS
 HT0528  HISTORY     - 1956     GOOD             NGS
 HT0528  HISTORY     - 1965     GOOD             NGS
 HT0528  HISTORY     - 1986     MARK NOT FOUND   NGS
 HT0528
 HT0528                          STATION DESCRIPTION
 HT0528
 HT0528'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0528'AT SAN BRUNO.
 HT0528'AT SAN BRUNO, 0.15 MILE SOUTHEAST ALONG THE SOUTHERN PACIFIC
 HT0528'COMPANY RAILROAD FROM THE STATION, 0.2 MILE SOUTHEAST OF MILEPOST
 HT0528'11, AT WOODEN BRIDGE NO. 11.21, IN THE TOP OF THE SOUTHWEST
 HT0528'END OF THE NORTHWEST CONCRETE ABUTMENT, 6.6 FEET SOUTHWEST OF
 HT0528'THE SOUTHWEST RAIL OF THE SOUTHWEST MAIN TRACK, AND ABOUT 1 1/2
 HT0528'FEET LOWER THAN THE TRACK.
 HT0528
 HT0528                          STATION RECOVERY (1965)
 HT0528
 HT0528'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
 HT0528'RECOVERED IN GOOD CONDITION.
 HT0528
 HT0528                          STATION RECOVERY (1986)
 HT0528
 HT0528'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0528'NOT RECOVERED, BRIDGE HAS BEEN REMOVED.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0532 ***********************************************************************
 HT0532  DESIGNATION -  H 553
 HT0532  PID         -  HT0532
 HT0532  STATE/COUNTY-  CA/SAN MATEO
 HT0532  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0532
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HT0532                         *CURRENT SURVEY CONTROL
HT0532  ___________________________________________________________________
HT0532* NAD 83(1986)-  37 38 00.     (N)    122 23 51.     (W)     SCALED
HT0532* NAVD 88     -         2.33   (+/-2cm)       7.6    (feet)  VERTCON
HT0532  ___________________________________________________________________
HT0532  GEOID HEIGHT-         -32.62  (meters)                     GEOID09
HT0532  VERT ORDER  -  FIRST     CLASS II (See Below)
HT0532
HT0532.The horizontal coordinates were scaled from a topographic map and have
HT0532.an estimated accuracy of +/- 6 seconds.
HT0532
HT0532.The NAVD 88 height was computed by applying the VERTCON shift value to
HT0532.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
HT0532.The vertical order pertains to the NGVD 29 superseded value.
HT0532
HT0532.The geoid height was determined by GEOID09.
HT0532
HT0532;                    North         East     Units  Estimated Accuracy
HT0532;SPC CA 3     -   627,480.    1,832,540.      MT  (+/- 180 meters Scaled)
HT0532
HT0532                          SUPERSEDED SURVEY CONTROL
HT0532
HT0532  NGVD 29 (??/??/92)    1.500  (m)            4.92   (f) ADJ UNCH    1 2
HT0532
HT0532.Superseded values are not recommended for survey control.
HT0532.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0532.See file dsdata.txt to determine how the superseded data were derived.
HT0532
HT0532_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG531653(NAD 83)
HT0532_MARKER: DB = BENCH MARK DISK
HT0532_SETTING: 36 = SET IN A MASSIVE STRUCTURE
HT0532_SP_SET: BUILDING
HT0532_STAMPING: H 553 1956
HT0532_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
HT0532
HT0532  HISTORY     - Date     Condition        Report By
HT0532  HISTORY     - 1956     MONUMENTED       CGS
HT0532  HISTORY     - 1968     GOOD             NGS
HT0532  HISTORY     - 1986     MARK NOT FOUND   NGS
HT0532
HT0532                          STATION DESCRIPTION
HT0532
HT0532'DESCRIBED BY COAST AND GEODETIC SURVEY 1956
HT0532'0.8 MI E FROM SAN MATEO.
HT0532'0.8 MILE EAST ALONG SAN BRUNO AVENUE FROM THE SOUTHERN PACIFIC
HT0532'COMPANY RAILROAD STATION AT SAN BRUNO, AT THE UNITED AIR LINES
HT0532'MAINTENANCE BASE OF THE SAN FRANCISCO INTERNATIONAL AIRPORT,
HT0532'SET VERTICALLY IN THE SOUTHWEST FACE OF A CONCRETE WALL AND
HT0532'DOOR COLUMN, 1.4 FEET NORTHWEST OF THE SOUTH CORNER OF THE
HT0532'BUILDING, 0.3 FOOT SOUTHEAST OF THE SOUTHEAST EDGE OF A CONCRETE
HT0532'AND METAL DOOR GUARD, AND ABOUT 1 FOOT ABOVE THE DRIVE.
HT0532
HT0532                          STATION RECOVERY (1968)
HT0532
HT0532'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1968
HT0532'RECOVERED IN GOOD CONDITION.
HT0532
HT0532                          STATION RECOVERY (1986)
HT0532
HT0532'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
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 HT0532'NOT RECOVERED. THE DESCRIBED BUILDING IS NOT LOCATED ON THE CURRENT
 HT0532'UNITED AIRLINES PROPERTY.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 DG6888 ***********************************************************************
 DG6888  HT_MOD       -  This is a Height Modernization Survey Station.
 DG6888  DESIGNATION -  SEAPLANE
 DG6888  PID         -  DG6888
 DG6888  STATE/COUNTY-  CA/SAN MATEO
 DG6888  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 DG6888
 DG6888                         *CURRENT SURVEY CONTROL
 DG6888  ___________________________________________________________________
 DG6888* NAD 83(2007)-  37 38 06.88788(N)    122 23 08.17798(W)     ADJUSTED
 DG6888* NAVD 88     -         3.00    (meters)       9.8    (feet)  GPS OBS
 DG6888  ___________________________________________________________________
 DG6888  EPOCH DATE  -        2007.00
 DG6888  X           -  -2,708,726.064 (meters)                      COMP
 DG6888  Y           -  -4,270,640.549 (meters)                      COMP
 DG6888  Z           -   3,873,444.070 (meters)                      COMP
 DG6888  LAPLACE CORR-          1.07  (seconds)                      DEFLEC09
 DG6888  ELLIP HEIGHT-         -29.637 (meters)            (02/10/07) ADJUSTED
 DG6888  GEOID HEIGHT-         -32.61  (meters)                      GEOID09
 DG6888
 DG6888  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 DG6888  Type    PID    Designation                      North   East  Ellip
 DG6888  -------------------------------------------------------------------
 DG6888  NETWORK DG6888 SEAPLANE                          0.27   0.29   1.14
 DG6888  -------------------------------------------------------------------
 DG6888
 DG6888.The horizontal coordinates were established by GPS observations
 DG6888.and adjusted by the National Geodetic Survey in February 2007.
 DG6888
 DG6888.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
 DG6888.See National Readjustment for more information.
 DG6888.The horizontal coordinates are valid at the epoch date displayed above.
 DG6888.The epoch date for horizontal control is a decimal equivalence
 DG6888.of Year/Month/Day.
 DG6888
 DG6888.The orthometric height was determined by GPS observations and a
 DG6888.high-resolution geoid model using precise GPS observation and
 DG6888.processing techniques.
 DG6888
 DG6888.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 DG6888
 DG6888.The Laplace correction was computed from DEFLEC09 derived deflections.
 DG6888
 DG6888.The ellipsoidal height was determined by GPS observations
 DG6888.and is referenced to NAD 83.
 DG6888
 DG6888.The geoid height was determined by GEOID09.
 DG6888
 DG6888;                    North         East     Units Scale Factor Converg.
 DG6888;SPC CA 3     -   627,666.988 1,833,588.443   MT  0.99993121   -1 09 15.9
 DG6888;SPC CA 3     - 2,059,270.78  6,015,698.08   sFT  0.99993121   -1 09 15.9
 DG6888;UTM  10      - 4,165,523.614   554,208.587   MT  0.99963619   +0 22 30.6
 DG6888
 DG6888!             -  Elev Factor  x  Scale Factor =   Combined Factor
 DG6888!SPC CA 3     -   1.00000465  x   0.99993121  =   0.99993586
 DG6888!UTM  10      -   1.00000465  x   0.99963619  =   0.99964084
 DG6888
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 DG6888                          SUPERSEDED SURVEY CONTROL
 DG6888
 DG6888  NAD 83(1998)-  37 38 06.88353(N)    122 23 08.17330(W) AD(2002.75) B
 DG6888  ELLIP H (08/23/04)  -29.568  (m)                       GP(       ) 4 1
 DG6888
 DG6888.Superseded values are not recommended for survey control.
 DG6888.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 DG6888.See file dsdata.txt to determine how the superseded data were derived.
 DG6888
 DG6888_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG5420865523(NAD 83)
 DG6888_MARKER: DD = SURVEY DISK
 DG6888_SETTING: 37 = SET IN A MASSIVE RETAINING WALL
 DG6888_SP_SET: THICK CONCRETE WALL
 DG6888_STAMPING: SEAPLANE
 DG6888_MARK LOGO: CSRC
 DG6888_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
 DG6888+STABILITY: SURFACE MOTION
 DG6888_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
 DG6888+SATELLITE: SATELLITE OBSERVATIONS - 2002
 DG6888
 DG6888  HISTORY     - Date     Condition        Report By
 DG6888  HISTORY     - 2002     MONUMENTED       CSRC
 DG6888
 DG6888                          STATION DESCRIPTION
 DG6888
 DG6888'DESCRIBED BY CALIFORNIA SPATIAL REFERENCE CENTER 2002 (RAF)
 DG6888'THE STATION IS 1.7 KM (1.05 MI) EAST-NORTHEAST OF SAN BRUNO, CA. THE
 DG6888'STATION IS ON THE  NORTH SHORE OF THE SEAPLANE HARBOR, NORTH OF SAN
 DG6888'FRANCISCO  AIRPORT, IN SAN BRUNO.
 DG6888'
 DG6888'FROM THE INTERSECTION OF HWY 101 AND HWY 380 (WEST)/NORTH  ACCESS
 DG6888'RD(EAST), EXIT ON NORTH ACCESS ROAD.  DRIVE EAST FOR 1.3 KM (0.8  MI),
 DG6888'FOLLOWING THE ROAD WHEN IT MAKES A SHARP RIGHT TURN.  TURN LEFT  ONTO
 DG6888'CLEARWATER DR AND DRIVE 0.2 KM (0.1 MI), WITH THE CITY COLLEGE OF  SF
 DG6888'AIRCRAFT TECHNICIAN SCHOOL ON THE RIGHT AND THE WATER QUALITY  CONTROL
 DG6888'PLANT ON THE LEFT.  NEAR THE END OF THE ROAD, BEAR RIGHT AND GO  ABOUT
 DG6888'114 M (375 FT) TOWARDS THE OCEAN.  THE STATION IS ABOUT 114 M  (375
 DG6888'FT) SOUTHERLY OF THE INTERSECTION OF NORTH ACCESS ROAD AND  CLEARWATER
 DG6888'DRIVE, 1.1 M (3.5 FT) SOUTHERLY OF THE SOUTHERLY FACE OF A  CONCRETE
 DG6888'SEAWALL, 3.5 M (11.4 FT) EASTERLY OF THE EASTERLY EDGE OF A  CONCRETE
 DG6888'LAUNCH RAMP, 4.0 M (13 FT) EAST-SOUTHEASTERLY OF THE SOUTHEAST  CORNER
 DG6888'OF A 3.0 M (10 FT) HIGH CHAIN LINK FENCE, AND 2.6 M (8.5 FT)  WESTERLY
 DG6888'OF THE WESTERLY EDGE OF A 91 CM (36 IN) DIAMETER STEEL PIPE.   THE
 DG6888'MARK IS AN 8.9 CM (3.5 IN) ALUMINUM CALIFORNIA SPATIAL REFERENCE
 DG6888'CENTER DISK STAMPED 'SEAPLANE 2002', CEMENTED IN A DRILL HOLE IN THE
 DG6888'TOP OF A 30 CM (1 FT) WIDE CONCRETE WALL AT THE NORTHWEST CORNER OF A
 DG6888'2.1 M (7 FT) BY 6.7 M (22 FT) CONCRETE STRUCTURE WITH A 91 CM (36 IN)
 DG6888'DIAMETER STEEL PIPE.
 DG6888'
 DG6888'THIS STATION IS SET NEAR BENCH MARKS FOR TIDE GAGE 941 4413. THIS
 DG6888'STATION WAS OBSERVED AS PART OF THE SOUTH SAN FRANCISCO BAY HEIGHT
 DG6888'MODERNIZATION  PROJECT.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0647 ***********************************************************************
 HT0647  DESIGNATION -  P 571 RESET 1950
 HT0647  PID         -  HT0647
 HT0647  STATE/COUNTY-  CA/SAN MATEO
 HT0647  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0647
 HT0647                         *CURRENT SURVEY CONTROL
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HT0647  ___________________________________________________________________
HT0647* NAD 83(1986)-  37 38 32.     (N)    122 24 47.     (W)     SCALED
HT0647* NAVD 88     -         4.96   (+/-2cm)       16.3    (feet)  VERTCON
HT0647  ___________________________________________________________________
HT0647  GEOID HEIGHT-         -32.63  (meters)                      GEOID09
HT0647  VERT ORDER  -  FIRST     CLASS II (See Below)
HT0647
HT0647.The horizontal coordinates were scaled from a topographic map and have
HT0647.an estimated accuracy of +/- 6 seconds.
HT0647
HT0647.The NAVD 88 height was computed by applying the VERTCON shift value to
HT0647.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
HT0647.The vertical order pertains to the NGVD 29 superseded value.
HT0647
HT0647.The geoid height was determined by GEOID09.
HT0647
HT0647;                    North         East     Units  Estimated Accuracy
HT0647;SPC CA 3     -   628,490.    1,831,180.      MT  (+/- 180 meters Scaled)
HT0647
HT0647                          SUPERSEDED SURVEY CONTROL
HT0647
HT0647  NGVD 29 (??/??/92)    4.123  (m)           13.53    (f) ADJ UNCH    1 2
HT0647
HT0647.Superseded values are not recommended for survey control.
HT0647.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0647.See file dsdata.txt to determine how the superseded data were derived.
HT0647
HT0647_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG517662(NAD 83)
HT0647_MARKER: DB = BENCH MARK DISK
HT0647_SETTING: 30 = SET IN A LIGHT STRUCTURE
HT0647_SP_SET: CULVERT
HT0647_STAMPING: P 571 1939 RESET 1950
HT0647_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
HT0647
HT0647  HISTORY     - Date     Condition        Report By
HT0647  HISTORY     - 1950     MONUMENTED       CGS
HT0647  HISTORY     - 1956     GOOD             NGS
HT0647  HISTORY     - 1965     GOOD             NGS
HT0647
HT0647                          STATION DESCRIPTION
HT0647
HT0647'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
HT0647'1 MI S FROM SAN FRANCISCO.
HT0647'1.0 MILE SOUTH ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD FROM
HT0647'THE STATION AT SOUTH SAN FRANCISCO, AT CROSSING NO. 10.2 OF SOUTH
HT0647'LYNDEN AVENUE, IN THE TOP OF THE EAST END OF THE SOUTH CONCRETE
HT0647'HEAD WALL OF A 12-INCH CONCRETE PIPE CULVERT UNDER THE AVENUE,
HT0647'32.0 FEET WEST OF THE WEST RAIL OF THE WEST MAIN TRACK, 27 1/2
HT0647'FEET SOUTH OF THE CENTER LINE OF THE AVENUE, 18.8 FEET EAST OF
HT0647'THE CURB OF DOLLAR AVENUE, 13.3 FEET EAST OF THE CENTER OF A
HT0647'CROSSING SIGNAL, AND ABOUT 1 FOOT LOWER THAN THE RAILROAD TRACK.
HT0647
HT0647                          STATION RECOVERY (1965)
HT0647
HT0647'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
HT0647'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
HT0526 ***********************************************************************
HT0526  DESIGNATION -  U 813
HT0526  PID         -  HT0526
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HT0526  STATE/COUNTY-  CA/SAN MATEO
HT0526  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
HT0526
HT0526                         *CURRENT SURVEY CONTROL
HT0526  ___________________________________________________________________
HT0526* NAD 83(1986)-  37 38 46.     (N)    122 25 19.     (W)     SCALED
HT0526* NAVD 88     -         7.43   (+/-2cm)       24.4   (feet)  VERTCON
HT0526  ___________________________________________________________________
HT0526  GEOID HEIGHT-        -32.65  (meters)                      GEOID09
HT0526  VERT ORDER  -  FIRST     CLASS II (See Below)
HT0526
HT0526.The horizontal coordinates were scaled from a topographic map and have
HT0526.an estimated accuracy of +/- 6 seconds.
HT0526
HT0526.The NAVD 88 height was computed by applying the VERTCON shift value to
HT0526.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
HT0526.The vertical order pertains to the NGVD 29 superseded value.
HT0526
HT0526.The geoid height was determined by GEOID09.
HT0526
HT0526;                    North         East    Units  Estimated Accuracy
HT0526;SPC CA 3     -   628,940.    1,830,410.      MT  (+/- 180 meters Scaled)
HT0526
HT0526                          SUPERSEDED SURVEY CONTROL
HT0526
HT0526  NGVD 29 (??/??/92)    6.591  (m)           21.62   (f) ADJ UNCH    1 2
HT0526
HT0526.Superseded values are not recommended for survey control.
HT0526.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0526.See file dsdata.txt to determine how the superseded data were derived.
HT0526
HT0526_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG509667(NAD 83)
HT0526_MARKER: DB = BENCH MARK DISK
HT0526_SETTING: 32 = SET IN A RETAINING WALL OR CONCRETE LEDGE
HT0526_SP_SET: CULVERT HEADWALL
HT0526_STAMPING: U 813 1952
HT0526_MARK LOGO: CGS
HT0526_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
HT0526+STABILITY: SURFACE MOTION
HT0526
HT0526  HISTORY     - Date     Condition        Report By
HT0526  HISTORY     - 1952     MONUMENTED       CGS
HT0526  HISTORY     - 1986     GOOD             NGS
HT0526
HT0526                          STATION DESCRIPTION
HT0526
HT0526'DESCRIBED BY COAST AND GEODETIC SURVEY 1952
HT0526'0.5 MI NW FROM TANFORAN.
HT0526'0.5 MILE NORTHWEST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
HT0526'FROM THE STATION AT TANFORAN, AT THE HAZELWOOD DRIVE CROSSING,
HT0526'3.7 MILES SOUTHEAST OF COLMA, IN THE TOP OF THE NORTHWEST END
HT0526'OF THE SOUTHWEST HEAD WALL OF A LARGE STONE ARCH CULVERT, 75
HT0526'FEET NORTHWEST OF THE CENTER LINE OF THE DRIVE, 12.5 FEET
HT0526'SOUTHWEST OF THE SOUTHWEST RAIL, AND ABOUT 6 FEET LOWER THAN
HT0526'THE TRACK.
HT0526
HT0526                          STATION RECOVERY (1986)
HT0526
HT0526'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
HT0526'RECOVERED IN GOOD CONDITION. THE DESCRIPTION IS ADEQUATE EXCEPT ADD
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 HT0526'TANFORAN IS NOW CONSIDERED TO BE PART OF SOUTH SAN FRANCISCO, AND THE
 HT0526'MARK IS AT THE SPRUCE AVENUE CROSSING OF THE SOUTHERN PACIFIC COMPANY
 HT0526'RAILROAD.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0645 ***********************************************************************
 HT0645  DESIGNATION -  N 571
 HT0645  PID         -  HT0645
 HT0645  STATE/COUNTY-  CA/SAN MATEO
 HT0645  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0645
 HT0645                         *CURRENT SURVEY CONTROL
 HT0645  ___________________________________________________________________
 HT0645* NAD 83(1986)-  37 38 58.     (N)    122 24 36.     (W)     SCALED
 HT0645* NAVD 88     -         4.91   (+/-2cm)      16.1    (feet)  VERTCON
 HT0645  ___________________________________________________________________
 HT0645  GEOID HEIGHT-         -32.63  (meters)                     GEOID09
 HT0645  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0645
 HT0645.The horizontal coordinates were scaled from a topographic map and have
 HT0645.an estimated accuracy of +/- 6 seconds.
 HT0645
 HT0645.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0645.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0645.The vertical order pertains to the NGVD 29 superseded value.
 HT0645
 HT0645.The geoid height was determined by GEOID09.
 HT0645
 HT0645;                   North         East     Units  Estimated Accuracy
 HT0645;SPC CA 3     -   629,290.    1,831,470.      MT  (+/- 180 meters Scaled)
 HT0645
 HT0645                          SUPERSEDED SURVEY CONTROL
 HT0645
 HT0645  NGVD 29 (??/??/92)    4.083  (m)           13.40    (f) ADJ UNCH    1 2
 HT0645
 HT0645.Superseded values are not recommended for survey control.
 HT0645.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0645.See file dsdata.txt to determine how the superseded data were derived.
 HT0645
 HT0645_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG520670(NAD 83)
 HT0645_MARKER: DB = BENCH MARK DISK
 HT0645_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0645_SP_SET: ABUTMENT
 HT0645_STAMPING: N 571 1939
 HT0645_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0645
 HT0645  HISTORY     - Date     Condition        Report By
 HT0645  HISTORY     - 1939     MONUMENTED       CGS
 HT0645  HISTORY     - 1956     GOOD             NGS
 HT0645  HISTORY     - 1965     GOOD             NGS
 HT0645
 HT0645                          STATION DESCRIPTION
 HT0645
 HT0645'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0645'0.5 MI SW FROM SAN FRANCISCO.
 HT0645'0.5 MILE SOUTHWEST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
 HT0645'FROM THE STATION AT SOUTH SAN FRANCISCO, AT WOODEN BRIDGE 9.72,
 HT0645'IN THE TOP OF THE SOUTHEAST END OF THE SOUTHWEST CONCRETE ABUTMENT,
 HT0645'33.1 FEET SOUTHEAST OF THE SOUTEAST RAIL OF THE SOUTHEAST MAIN
 HT0645'TRACK, 2 1/2 FEET SOUTHEAST OF THE SOUTHEAST WOODEN GUARDRAIL,
 HT0645'AND ABOUT 1 FOOT LOWER THAN THE MAIN TRACK.
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 HT0645
 HT0645                          STATION RECOVERY (1965)
 HT0645
 HT0645'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
 HT0645'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0642 ***********************************************************************
 HT0642  DESIGNATION -  G 553
 HT0642  PID         -  HT0642
 HT0642  STATE/COUNTY-  CA/SAN MATEO
 HT0642  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0642
 HT0642                         *CURRENT SURVEY CONTROL
 HT0642  ___________________________________________________________________
 HT0642* NAD 83(1986)-  37 39 02.     (N)     122 22 47.     (W)     SCALED
 HT0642* NAVD 88     -         5.24   (+/-2cm)       17.2    (feet)  VERTCON
 HT0642  ___________________________________________________________________
 HT0642  GEOID HEIGHT-        -32.60  (meters)                       GEOID09
 HT0642  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0642
 HT0642.The horizontal coordinates were scaled from a topographic map and have
 HT0642.an estimated accuracy of +/- 6 seconds.
 HT0642
 HT0642.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0642.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0642.The vertical order pertains to the NGVD 29 superseded value.
 HT0642
 HT0642.The geoid height was determined by GEOID09.
 HT0642
 HT0642;                   North         East     Units  Estimated Accuracy
 HT0642;SPC CA 3     -   629,360.    1,834,140.      MT  (+/- 180 meters Scaled)
 HT0642
 HT0642                          SUPERSEDED SURVEY CONTROL
 HT0642
 HT0642  NGVD 29 (??/??/92)    4.416  (m)           14.49   (f) ADJ UNCH    1 2
 HT0642
 HT0642.Superseded values are not recommended for survey control.
 HT0642.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0642.See file dsdata.txt to determine how the superseded data were derived.
 HT0642
 HT0642_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG547672(NAD 83)
 HT0642_MARKER: DB = BENCH MARK DISK
 HT0642_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0642_SP_SET: BUILDING
 HT0642_STAMPING: G 553 1956
 HT0642_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0642
 HT0642  HISTORY     - Date     Condition        Report By
 HT0642  HISTORY     - 1956     MONUMENTED       CGS
 HT0642  HISTORY     - 1973     GOOD             NGS
 HT0642
 HT0642                          STATION DESCRIPTION
 HT0642
 HT0642'DESCRIBED BY COAST AND GEODETIC SURVEY 1956
 HT0642'1.5 MI E FROM SAN FRANCISCO.
 HT0642'0.1 MILE SOUTH ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD FROM
 HT0642'THE STATION AT SOUTH SAN FRANCISCO, THENCE 1.4 MILE EAST ALONG
 HT0642'GRAND AVENUE, AT THE W.P. FULLER PAINT COMPANY YARD, AT THE
 HT0642'SOUTHWEST CORNER OF A LARGE CONCRETE BUILDING, SET VERTICALLY
 HT0642'IN THE SOUTH FACE OF THE SOUTH CONCRETE WALL, 5.4 FEET WEST OF
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 HT0642'THE CENTER OF AN ELEVATOR DOOR, 1.0 FEET EAST OF THE SOUTHWEST
 HT0642'CORNER OF THE BUILDING, 2.3 FEET ABOVE THE ASPHALT AND ABOUT
 HT0642'2 FEET HIGHER THAN THE GROUND.
 HT0642
 HT0642                          STATION RECOVERY (1973)
 HT0642
 HT0642'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1973
 HT0642'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0640 ***********************************************************************
 HT0640  DESIGNATION -  TIDAL 3
 HT0640  PID         -  HT0640
 HT0640  STATE/COUNTY-  CA/SAN MATEO
 HT0640  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0640
 HT0640                         *CURRENT SURVEY CONTROL
 HT0640  ___________________________________________________________________
 HT0640* NAD 83(1986)-  37 39 03.     (N)    122 23 17.     (W)    SCALED
 HT0640* NAVD 88     -         4.31   (+/-2cm)      14.1    (feet)  VERTCON
 HT0640  ___________________________________________________________________
 HT0640  GEOID HEIGHT-        -32.61  (meters)                      GEOID09
 HT0640  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0640
 HT0640.The horizontal coordinates were scaled from a topographic map and have
 HT0640.an estimated accuracy of +/- 6 seconds.
 HT0640
 HT0640.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0640.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0640.The vertical order pertains to the NGVD 29 superseded value.
 HT0640
 HT0640.The geoid height was determined by GEOID09.
 HT0640
 HT0640;                    North         East    Units  Estimated Accuracy
 HT0640;SPC CA 3     -   629,400.    1,833,410.      MT  (+/- 180 meters Scaled)
 HT0640
 HT0640                          SUPERSEDED SURVEY CONTROL
 HT0640
 HT0640  NGVD 29 (??/??/92)    3.482  (m)           11.42   (f) ADJ UNCH    1 2
 HT0640
 HT0640.Superseded values are not recommended for survey control.
 HT0640.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0640.See file dsdata.txt to determine how the superseded data were derived.
 HT0640
 HT0640_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG539672(NAD 83)
 HT0640_MARKER: DB = BENCH MARK DISK
 HT0640_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0640_SP_SET: BUILDING
 HT0640_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0640
 HT0640  HISTORY     - Date     Condition        Report By
 HT0640  HISTORY     - UNK      MONUMENTED       CGS
 HT0640  HISTORY     - 1956     GOOD             NGS
 HT0640
 HT0640                          STATION DESCRIPTION
 HT0640
 HT0640'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0640'1.1 MI E FROM SAN FRANCISCO.
 HT0640'0.1 MILE SOUTH ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD FROM
 HT0640'THE STATION AT SOUTH SAN FRANCISCO, THENCE 1.0 MILE EAST ALONG
 HT0640'GRAND AVENUE, ON POINT SAN BRUNO, AT THE SWIFT COMPANY PACKING
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 HT0640'PLANT, AT THE SOUTHEAST CORNER OF BRICK BUILDING NO 13, SET
 HT0640'VERTICALLY IN THE EAST FACE OF A BRICK WALL, 175 FEET SOUTH
 HT0640'OF THE CENTER LINE OF THE AVENUE, 130.0 FEET WEST OF THE SOUTHWEST
 HT0640'CORNER OF A LARGE BRICK CHIMNEY EAST OF THE BUILDING, 1.0
 HT0640'FEET NORTH OF THE SOUTHEAST CORNER OF THE BUILDING, 2.5 FEET
 HT0640'HIGHER THAN THE GROUND, AND 2 1/2 FEET LOWER THAN THE TOP OF
 HT0640'A LOADING PLATFORM.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0641 ***********************************************************************
 HT0641  DESIGNATION -  BM 5 TIDAL MARK
 HT0641  PID         -  HT0641
 HT0641  STATE/COUNTY-  CA/SAN MATEO
 HT0641  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0641
 HT0641                         *CURRENT SURVEY CONTROL
 HT0641  ___________________________________________________________________
 HT0641* NAD 83(1986)-  37 39 04.     (N)    122 22 59.     (W)     SCALED
 HT0641* NAVD 88     -         3.71   (+/-2cm)       12.2    (feet)  VERTCON
 HT0641  ___________________________________________________________________
 HT0641  GEOID HEIGHT-         -32.61  (meters)                      GEOID09
 HT0641  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0641
 HT0641.The horizontal coordinates were scaled from a topographic map and have
 HT0641.an estimated accuracy of +/- 6 seconds.
 HT0641
 HT0641.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0641.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0641.The vertical order pertains to the NGVD 29 superseded value.
 HT0641
 HT0641.The geoid height was determined by GEOID09.
 HT0641
 HT0641;                    North         East     Units  Estimated Accuracy
 HT0641;SPC CA 3     -   629,420.    1,833,850.      MT   (+/- 180 meters Scaled)
 HT0641
 HT0641                          SUPERSEDED SURVEY CONTROL
 HT0641
 HT0641  NGVD 29 (??/??/92)    2.892  (m)            9.49   (f) ADJ UNCH    1 2
 HT0641
 HT0641.Superseded values are not recommended for survey control.
 HT0641.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0641.See file dsdata.txt to determine how the superseded data were derived.
 HT0641
 HT0641_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG544672(NAD 83)
 HT0641_MARKER: DB = BENCH MARK DISK
 HT0641_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0641_SP_SET: BUILDING
 HT0641_STAMPING: NO 5 1941
 HT0641_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0641
 HT0641  HISTORY     - Date     Condition        Report By
 HT0641  HISTORY     - 1941     MONUMENTED       CGS
 HT0641  HISTORY     - 1956     GOOD             NGS
 HT0641
 HT0641                          STATION DESCRIPTION
 HT0641
 HT0641'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0641'1.4 MI E FROM SAN FRANCISCO.
 HT0641'0.1 MILE SOUTHEAST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
 HT0641'FROM THE STATION AT SOUTH SAN FRANCISCO, THENCE 1.3 MILE EAST
 HT0641'ALONG GRAND AVENUE, 375 FEET SOUTHWEST OF THE SOUTHWEST CORNER
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 HT0641'OF THE W.P. FULLER INDUSTRIAL BUILDING, AT A CONCRETE STORAGE
 HT0641'BUILDING (INSIDE OF A FENCE) FOR INFLAMMABLE MATERIAL, IN THE
 HT0641'TOP OF THE CENTER OF A LARGE CONCRETE BASE FOUNDATION WHICH
 HT0641'PROJECTS 1 FOOT ABOVE THE GROUND, 270 FEET SOUTH OF THE CENTER
 HT0641'LINE OF THE AVENUE, 23.5 FEET SOUTH OF THE NORTHWEST CORNER
 HT0641'OF THE FENCE, 2.0 FEET EAST OF THE FENCE, AND ABOUT 3 1/2 FEET
 HT0641'LOWER THAN THE STREET.  NOTE-- THIS MARK WILL BE DESTROYED BY
 HT0641'A FILL, A W.P. FULLER AND COMPANY ENGINEER WILL NOTIFY THE COAST
 HT0641'AND GEODETIC SURVEY AS TO WHEN THE FILL WILL BE CONSTRUCTED.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0638 ***********************************************************************
 HT0638  DESIGNATION -  L 571 RESET 1948
 HT0638  PID         -  HT0638
 HT0638  STATE/COUNTY-  CA/SAN MATEO
 HT0638  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0638
 HT0638                         *CURRENT SURVEY CONTROL
 HT0638  ___________________________________________________________________
 HT0638* NAD 83(1986)-  37 39 15.     (N)    122 24 26.     (W)     SCALED
 HT0638* NAVD 88     -         6.60   (+/-2cm)      21.7    (feet)  VERTCON
 HT0638  ___________________________________________________________________
 HT0638  GEOID HEIGHT-         -32.63  (meters)                     GEOID09
 HT0638  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0638
 HT0638.The horizontal coordinates were scaled from a topographic map and have
 HT0638.an estimated accuracy of +/- 6 seconds.
 HT0638
 HT0638.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0638.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0638.The vertical order pertains to the NGVD 29 superseded value.
 HT0638
 HT0638.The geoid height was determined by GEOID09.
 HT0638
 HT0638;                    North         East     Units  Estimated Accuracy
 HT0638;SPC CA 3     -   629,810.    1,831,720.      MT  (+/- 180 meters Scaled)
 HT0638
 HT0638                          SUPERSEDED SURVEY CONTROL
 HT0638
 HT0638  NGVD 29 (??/??/92)    5.770  (m)           18.93   (f) ADJ UNCH    1 2
 HT0638
 HT0638.Superseded values are not recommended for survey control.
 HT0638.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0638.See file dsdata.txt to determine how the superseded data were derived.
 HT0638
 HT0638_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG522676(NAD 83)
 HT0638_MARKER: DB = BENCH MARK DISK
 HT0638_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0638_SP_SET: PIER
 HT0638_STAMPING: L 571 RESET 1948 1939
 HT0638_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0638
 HT0638  HISTORY     - Date     Condition        Report By
 HT0638  HISTORY     - 1939     MONUMENTED       CGS
 HT0638  HISTORY     - 1956     GOOD             NGS
 HT0638  HISTORY     - 1965     GOOD             NGS
 HT0638
 HT0638                          STATION DESCRIPTION
 HT0638
 HT0638'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0638'AT SAN FRANCISCO.
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 HT0638'AT SOUTH SAN FRANCISCO, AT THE CROSSING OF GRAND AVENUE, INSIDE
 HT0638'OF THE STATE HIGHWAY YARDS, IN THE TOP OF THE CENTER OF THE
 HT0638'FOURTH CONCRETE PIER NORTH OF THE SOUTH END OF THE WEST U.S.
 HT0638'101 BAYSHORE HIGHWAY OVERPASS, 106.9 FEET SOUTH OF THE SOUTH
 HT0638'CURB OF THE AVENUE, 100.2 FEET NORTHWEST OF THE WEST RAIL OF THE
 HT0638'WEST MAIN TRACK OF THE SOUTHERN PACIFIC COMPANY RAILROAD, AND
 HT0638'ABOUT 4 1/2 FEET HIGHER THAN THE TRACK.
 HT0638
 HT0638                          STATION RECOVERY (1965)
 HT0638
 HT0638'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
 HT0638'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0639 ***********************************************************************
 HT0639  DESIGNATION -  M 571
 HT0639  PID         -  HT0639
 HT0639  STATE/COUNTY-  CA/SAN MATEO
 HT0639  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0639
 HT0639                         *CURRENT SURVEY CONTROL
 HT0639  ___________________________________________________________________
 HT0639* NAD 83(1986)-  37 39 15.     (N)    122 23 47.     (W)     SCALED
 HT0639* NAVD 88     -         5.81   (+/-2cm)      19.1    (feet)  VERTCON
 HT0639  ___________________________________________________________________
 HT0639  GEOID HEIGHT-        -32.62  (meters)                      GEOID09
 HT0639  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0639
 HT0639.The horizontal coordinates were scaled from a topographic map and have
 HT0639.an estimated accuracy of +/- 6 seconds.
 HT0639
 HT0639.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0639.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0639.The vertical order pertains to the NGVD 29 superseded value.
 HT0639
 HT0639.The geoid height was determined by GEOID09.
 HT0639
 HT0639;                   North         East     Units  Estimated Accuracy
 HT0639;SPC CA 3     -   629,790.    1,832,680.      MT  (+/- 180 meters Scaled)
 HT0639
 HT0639                          SUPERSEDED SURVEY CONTROL
 HT0639
 HT0639  NGVD 29 (??/??/92)    4.980  (m)           16.34   (f) ADJ UNCH    1 2
 HT0639
 HT0639.Superseded values are not recommended for survey control.
 HT0639.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0639.See file dsdata.txt to determine how the superseded data were derived.
 HT0639
 HT0639_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG532676(NAD 83)
 HT0639_MARKER: DB = BENCH MARK DISK
 HT0639_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT0639_SP_SET: WALL
 HT0639_STAMPING: M 571 1939
 HT0639_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT0639
 HT0639  HISTORY     - Date     Condition        Report By
 HT0639  HISTORY     - 1939     MONUMENTED       CGS
 HT0639  HISTORY     - 1956     GOOD             NGS
 HT0639
 HT0639                          STATION DESCRIPTION
 HT0639
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 HT0639'DESCRIBED BY NATIONAL GEODETIC SURVEY 1956
 HT0639'AT SAN FRANCISCO.
 HT0639'AT SOUTH SAN FRANCISCO, 0.1 MILE SOUTH ALONG THE SOUTHERN PACIFIC
 HT0639'COMPANY RAILROAD, THENCE 0.5 MILE EAST ALONG GRAND AVENUE,
 HT0639'ON THE OUTSIDE OF A CURVE, AT THE CONCRETE BUILDING OF THE SOUTH
 HT0639'SAN FRANCISCO COLD STORAGE COMPANY, SET VERTICALLY IN THE SOUTH
 HT0639'FACE OF THE SOUTH CONCRETE WALL, 64.5 FEET EAST OF THE SOUTHWEST
 HT0639'CORNER OF THE SOUTH SAN FRANCISCO FIRE HOUSE STATION, 54 FEET
 HT0639'NORTH OF THE CENTER LINE OF THE AVENUE, 49.5 FEET EAST OF THE
 HT0639'SOUTHWEST CORNER OF THE BUILDING, 3 1/2 FEET EAST OF THE CENER
 HT0639'OF A SMALL DOOR TO AN OFFICE, 3.2 FEET HIGHER THAN THE CONCRETE
 HT0639'AND WOODEN SIDEWALK, AND ABOUT 3 1/2 FEET HIGHER THAN THE AVENUE.
 HT0639'NOTE-- IT WAS REPORTED IN 1960 THAT THE SOUTH SAN FRANCISCO COLD
 HT0639'STORAGEG CO. IS NOW THE GENERAL COLD STORAGE CO.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0525 ***********************************************************************
 HT0525  DESIGNATION -  T 813
 HT0525  PID         -  HT0525
 HT0525  STATE/COUNTY-  CA/SAN MATEO
 HT0525  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0525
 HT0525                         *CURRENT SURVEY CONTROL
 HT0525  ___________________________________________________________________
 HT0525* NAD 83(1986)-  37 39 28.     (N)    122 26 13.     (W)     SCALED
 HT0525* NAVD 88     -        14.45   (+/-2cm)      47.4    (feet)  VERTCON
 HT0525  ___________________________________________________________________
 HT0525  GEOID HEIGHT-         -32.67  (meters)                     GEOID09
 HT0525  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0525
 HT0525.The horizontal coordinates were scaled from a topographic map and have
 HT0525.an estimated accuracy of +/- 6 seconds.
 HT0525
 HT0525.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0525.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0525.The vertical order pertains to the NGVD 29 superseded value.
 HT0525
 HT0525.The geoid height was determined by GEOID09.
 HT0525
 HT0525;                    North         East    Units  Estimated Accuracy
 HT0525;SPC CA 3     -   630,260.    1,829,110.      MT  (+/- 180 meters Scaled)
 HT0525
 HT0525                          SUPERSEDED SURVEY CONTROL
 HT0525
 HT0525  NGVD 29 (??/??/92)   13.602  (m)           44.63   (f) ADJ UNCH    1 2
 HT0525
 HT0525.Superseded values are not recommended for survey control.
 HT0525.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0525.See file dsdata.txt to determine how the superseded data were derived.
 HT0525
 HT0525_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG496679(NAD 83)
 HT0525_MARKER: DB = BENCH MARK DISK
 HT0525_SETTING: 32 = SET IN A RETAINING WALL OR CONCRETE LEDGE
 HT0525_SP_SET: DITCH RETAINING WALL
 HT0525_STAMPING: T 813 1952
 HT0525_MARK LOGO: CGS
 HT0525_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
 HT0525+STABILITY: SURFACE MOTION
 HT0525
 HT0525  HISTORY     - Date     Condition        Report By
 HT0525  HISTORY     - 1952     MONUMENTED       CGS
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 HT0525  HISTORY     - 1986     GOOD             NGS
 HT0525
 HT0525                          STATION DESCRIPTION
 HT0525
 HT0525'DESCRIBED BY COAST AND GEODETIC SURVEY 1952
 HT0525'2.7 MI SE FROM COLMA.
 HT0525'2.7 MILES SOUTHEAST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
 HT0525'FROM THE STATION AT COLMA, 0.1 MILE SOUTH OF THE GRAND AVENUE
 HT0525'CROSSING, IN THE TOP OF THE NORTHEAST END OF THE NORTHWEST
 HT0525'CONCRETE RETAINING WALL FOR A LARGE DRAINAGE DITCH, 58.5 FEET
 HT0525'SOUTHWEST OF THE SOUTHWEST RAIL, 52 1/2 FEET SOUTHWEST OF THE
 HT0525'NORTHWEST CORNER OF A TRESTLE, 9.0 FEET SOUTH OF A POWER LINE
 HT0525'POLE, 0.7 FOOT SOUTHWEST OF THE NORTHEAST END OF THE WALL,
 HT0525'AND ABOUT 1 1/2 FEET LOWER THAN THE TRACK.
 HT0525
 HT0525                          STATION RECOVERY (1986)
 HT0525
 HT0525'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0525'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT3821 ***********************************************************************
 HT3821  TIDAL BM     -  This is a Tidal Bench Mark.
 HT3821  DESIGNATION -  K 571 RESET
 HT3821  PID         -  HT3821
 HT3821  STATE/COUNTY-  CA/SAN MATEO
 HT3821  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT3821
 HT3821                         *CURRENT SURVEY CONTROL
 HT3821  ___________________________________________________________________
 HT3821* NAD 83(1986)-  37 39 33.     (N)    122 24 04.     (W)     SCALED
 HT3821* NAVD 88     -         5.87   (+/-2cm)      19.3    (feet)  VERTCON
 HT3821  ___________________________________________________________________
 HT3821  GEOID HEIGHT-        -32.62  (meters)                      GEOID09
 HT3821  VERT ORDER  -  THIRD (See Below)
 HT3821
 HT3821.The horizontal coordinates were scaled from a topographic map and have
 HT3821.an estimated accuracy of +/- 6 seconds.
 HT3821
 HT3821.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT3821.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT3821.The vertical order pertains to the NGVD 29 superseded value.
 HT3821
 HT3821.This Tidal Bench Mark is designated as VM 17230
 HT3821.by the CENTER FOR OPERATIONAL OCEANOGRAPHIC PRODUCTS AND SERVICES.
 HT3821
 HT3821.The geoid height was determined by GEOID09.
 HT3821
 HT3821;                   North         East     Units  Estimated Accuracy
 HT3821;SPC CA 3     -   630,350.    1,832,270.      MT  (+/- 180 meters Scaled)
 HT3821
 HT3821                          SUPERSEDED SURVEY CONTROL
 HT3821
 HT3821  NGVD 29 (08/19/04)    5.04   (m)           16.5    (f) RESET       3
 HT3821
 HT3821.Superseded values are not recommended for survey control.
 HT3821.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT3821.See file dsdata.txt to determine how the superseded data were derived.
 HT3821
 HT3821_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG528681(NAD 83)
 HT3821_MARKER: DV = VERTICAL CONTROL DISK
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 HT3821_SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
 HT3821_SP_SET: CONCRETE POST
 HT3821_STAMPING: K 571 RESET 1982
 HT3821_MARK LOGO: NGS
 HT3821_MAGNETIC: N = NO MAGNETIC MATERIAL
 HT3821_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
 HT3821+STABILITY: SURFACE MOTION
 HT3821
 HT3821  HISTORY     - Date     Condition        Report By
 HT3821  HISTORY     - 1982     MONUMENTED       NGS
 HT3821
 HT3821                          STATION DESCRIPTION
 HT3821
 HT3821'DESCRIBED BY NATIONAL GEODETIC SURVEY 1982
 HT3821'0.5 KM (0.30 MI) NORTHEAST ALONG INDUSTRIAL WAY FROM EAST GRAND
 HT3821'AVENUE, 6.25 METERS (20.51 FT) WEST FROM THE CENTER OF INDUSTRIAL
 HT3821'WAY, 20.4 METERS (66.9 FT) SOUTHWEST FROM A FIRE HYDRANT, 22 METERS
 HT3821'(72.2 FT) NORTHWEST FROM A ENTRANCE TO US STEEL PARKING LOT, 3.1
 HT3821'METERS (10.2 FT) EAST OF AN ANGLE IRON RAIL, 0.9 METERS (3.0 FT)
 HT3821'NORTH OF A TELEPHONE POLE, 0.3 METERS (1.0 FT) SOUTH OF A PLASTIC
 HT3821'WITNESS POST, FLUSH WITH THE SURFACE, NEAR THE SOUTH END OF A NARROW
 HT3821'PARKING AREA, ABOUT 20 FEET (6.1 M) EAST OF THE EAST RAIL OF THE
 HT3821'SOUTHERN PACIFIC RAILROAD, ABOUT 6 FEET (1.8 M) HIGHER THAN THE
 HT3821'RAILROAD, ABOUT 0.2 KM (0.10 MI) EAST OF US HIGHWAY 101, SET IN THE
 HT3821'TOP OF A CONCRETE POST FLUSH WITH THE GROUND.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0524 ***********************************************************************
 HT0524  DESIGNATION -  W 6
 HT0524  PID         -  HT0524
 HT0524  STATE/COUNTY-  CA/SAN MATEO
 HT0524  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0524
 HT0524                         *CURRENT SURVEY CONTROL
 HT0524  ___________________________________________________________________
 HT0524* NAD 83(1986)-  37 40 07.     (N)    122 26 56.     (W)     SCALED
 HT0524* NAVD 88     -        27.63   (+/-2cm)      90.6    (feet)  VERTCON
 HT0524  ___________________________________________________________________
 HT0524  GEOID HEIGHT-         -32.69  (meters)                     GEOID09
 HT0524  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0524
 HT0524.The horizontal coordinates were scaled from a topographic map and have
 HT0524.an estimated accuracy of +/- 6 seconds.
 HT0524
 HT0524.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0524.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0524.The vertical order pertains to the NGVD 29 superseded value.
 HT0524
 HT0524.The geoid height was determined by GEOID09.
 HT0524
 HT0524;                    North         East     Units  Estimated Accuracy
 HT0524;SPC CA 3     -   631,480.    1,828,080.      MT   (+/- 180 meters Scaled)
 HT0524
 HT0524                          SUPERSEDED SURVEY CONTROL
 HT0524
 HT0524  NGVD 29 (??/??/92)   26.784  (m)           87.87   (f) ADJ UNCH    1 2
 HT0524
 HT0524.Superseded values are not recommended for survey control.
 HT0524.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0524.See file dsdata.txt to determine how the superseded data were derived.
 HT0524
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 HT0524_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG486691(NAD 83)
 HT0524_MARKER: DB = BENCH MARK DISK
 HT0524_SETTING: 66 = SET IN ROCK OUTCROP
 HT0524_SP_SET: ROCK
 HT0524_MARK LOGO: CGS
 HT0524_STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD
 HT0524+STABILITY: POSITION/ELEVATION WELL
 HT0524
 HT0524  HISTORY     - Date     Condition        Report By
 HT0524  HISTORY     - 1952     MONUMENTED       CGS
 HT0524  HISTORY     - 1965     GOOD             NGS
 HT0524  HISTORY     - 1986     GOOD             NGS
 HT0524
 HT0524                          STATION DESCRIPTION
 HT0524
 HT0524'DESCRIBED BY COAST AND GEODETIC SURVEY 1952
 HT0524'1.7 MI SE FROM COLMA.
 HT0524'1.7 MILES SOUTHEAST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD
 HT0524'FROM THE STATION AT COLMA, AT THE HOLY CROSS CEMETERY, BETWEEN
 HT0524'THE RAILROAD AND THE OLD MISSION ROAD, SET VERTICALLY IN THE
 HT0524'NORTHEAST FACE OF A 3-FOOT HIGH CONICAL ROCK IN SHRUBBERY,
 HT0524'81.7 FEET EAST OF THE EAST RAIL, 66.4 FEET NORTHWEST OF THE
 HT0524'NORTHEAST CORNER OF THE OFFICE BUILDING, 36 1/2 FEET SOUTHWEST
 HT0524'OF THE CENTER LINE OF THE ROAD, AND ABOUT 2 FEET HIGHER THAN
 HT0524'THE ROAD.
 HT0524
 HT0524                          STATION RECOVERY (1965)
 HT0524
 HT0524'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1965
 HT0524'RECOVERED IN GOOD CONDITION.
 HT0524
 HT0524                          STATION RECOVERY (1986)
 HT0524
 HT0524'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0524'RECOVERED IN GOOD CONDITION. THE DESCRIPTION IS ADEQUATE EXCEPT ADD
 HT0524'THE OFFICE BUILDING IS NOW MACHINIST UNION LOCAL NUMBER 68.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0523 ***********************************************************************
 HT0523  DESIGNATION -  P 109
 HT0523  PID         -  HT0523
 HT0523  STATE/COUNTY-  CA/SAN MATEO
 HT0523  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0523
 HT0523                         *CURRENT SURVEY CONTROL
 HT0523  ___________________________________________________________________
 HT0523* NAD 83(1986)-  37 40 56.     (N)    122 27 46.     (W)     SCALED
 HT0523* NAVD 88     -        46.89   (+/-2cm)     153.8    (feet)  VERTCON
 HT0523  ___________________________________________________________________
 HT0523  GEOID HEIGHT-         -32.72  (meters)                     GEOID09
 HT0523  VERT ORDER  -  FIRST     CLASS II (See Below)
 HT0523
 HT0523.The horizontal coordinates were scaled from a topographic map and have
 HT0523.an estimated accuracy of +/- 6 seconds.
 HT0523
 HT0523.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0523.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0523.The vertical order pertains to the NGVD 29 superseded value.
 HT0523
 HT0523.The geoid height was determined by GEOID09.
 HT0523
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 HT0523;                    North         East     Units  Estimated Accuracy
 HT0523;SPC CA 3     -   633,020.    1,826,890.      MT  (+/- 180 meters Scaled)
 HT0523
 HT0523                          SUPERSEDED SURVEY CONTROL
 HT0523
 HT0523  NGVD 29 (??/??/92)   46.037  (m)         151.04   (f) ADJ UNCH    1 2
 HT0523
 HT0523.Superseded values are not recommended for survey control.
 HT0523.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0523.See file dsdata.txt to determine how the superseded data were derived.
 HT0523
 HT0523_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG473706(NAD 83)
 HT0523_MARKER: DB = BENCH MARK DISK
 HT0523_SETTING: 38 = SET IN THE ABUTMENT OR PIER OF A LARGE BRIDGE
 HT0523_SP_SET: BRIDGE ABUTMENT
 HT0523_STAMPING: P 109 1932
 HT0523_MARK LOGO: CGS
 HT0523_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
 HT0523
 HT0523  HISTORY     - Date     Condition        Report By
 HT0523  HISTORY     - 1932     MONUMENTED       CGS
 HT0523  HISTORY     - 1952     GOOD             NGS
 HT0523  HISTORY     - 1962     GOOD             NGS
 HT0523  HISTORY     - 1986     GOOD             NGS
 HT0523
 HT0523                          STATION DESCRIPTION
 HT0523
 HT0523'DESCRIBED BY NATIONAL GEODETIC SURVEY 1952
 HT0523'0.5 MI SE FROM COLMA.
 HT0523'0.5 MILE SOUTHEAST ALONG THE SOUTHERN PACIFIC COMPANY RAILROAD FROM
 HT0523'THE STATION AT COLMA, AT THE OVERPASS CROSSING OVER U.S. HIGHWAY
 HT0523'101, IN THE TOP OF THE NORTHWEST CORNER OF THE SOUTH CONCRETE
 HT0523'ABUTMENT AND JUST OUTSIDE THE HAND RAIL, 9 1/4 RAILS SOUTHEAST
 HT0523'OF MILE POST 9, 6.2 FEET SOUTHWEST OF THE SOUTHWEST RAIL, AND
 HT0523'ABOUT LEVEL WITH THE TRACK.
 HT0523
 HT0523                          STATION RECOVERY (1962)
 HT0523
 HT0523'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1962
 HT0523'RECOVERED IN GOOD CONDITION.
 HT0523
 HT0523                          STATION RECOVERY (1986)
 HT0523
 HT0523'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0523'RECOVERED IN GOOD CONDITION. NEW DESCRIPTION FOLLOWS. IN COLMA, AT THE
 HT0523'JUNCTION OF EL CAMINO REAL (STATE HIGHWAY 82) AND F STREET, IN TOP OF
 HT0523'THE NORTHWEST CORNER OF THE SOUTH CONCRETE ABUTMENT FOR A RAILROAD
 HT0523'BRIDGE THAT HAS BEEN REMOVED FROM THE EAST SIDE OF THE HIGHWAY, JUST
 HT0523'OUTSIDE THE IRON HANDRAIL.
 HT0523'THE MARK IS 4.6 M ABOVE HIGHWAY 82.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0483 ***********************************************************************
 HT0483  DESIGNATION -  M 1241
 HT0483  PID         -  HT0483
 HT0483  STATE/COUNTY-  CA/SAN MATEO
 HT0483  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0483
 HT0483                         *CURRENT SURVEY CONTROL
 HT0483  ___________________________________________________________________
 HT0483* NAD 83(1986)-  37 41 05.     (N)    122 28 18.     (W)     SCALED
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HT0483* NAVD 88     -        71.210  (meters)     233.63   (feet)  ADJUSTED
HT0483  ___________________________________________________________________
HT0483  GEOID HEIGHT-         -32.74  (meters)                     GEOID09
HT0483  DYNAMIC HT  -          71.162 (meters)     233.47  (feet)  COMP
HT0483  MODELED GRAV-     979,952.4   (mgal)                       NAVD 88
HT0483  OBS GRAVITY -     979,955.9   (mgal)                       GRAV_OBS
HT0483
HT0483  VERT ORDER  -  FIRST     CLASS I
HT0483
HT0483.The horizontal coordinates were scaled from a topographic map and have
HT0483.an estimated accuracy of +/- 6 seconds.
HT0483
HT0483.The orthometric height was determined by differential leveling and
HT0483.adjusted in June 1991.
HT0483
HT0483.The geoid height was determined by GEOID09.
HT0483
HT0483.The dynamic height is computed by dividing the NAVD 88
HT0483.geopotential number by the normal gravity value computed on the
HT0483.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
HT0483.degrees latitude (g = 980.6199 gals.).
HT0483
HT0483.The modeled gravity was interpolated from observed gravity values.
HT0483.The observed gravity was obtained from relative gravimeter ties
HT0483.to the IGSN71 gravity network.
HT0483
HT0483;                    North         East     Units  Estimated Accuracy
HT0483;SPC CA 3     -   633,310.    1,826,110.      MT  (+/- 180 meters Scaled)
HT0483
HT0483                          SUPERSEDED SURVEY CONTROL
HT0483
HT0483  NGVD 29 (10/21/93)   70.364  (m)         230.85   (f) ADJUSTED    1 1
HT0483
HT0483.Superseded values are not recommended for survey control.
HT0483.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0483.See file dsdata.txt to determine how the superseded data were derived.
HT0483
HT0483_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG465709(NAD 83)
HT0483_MARKER: DB = BENCH MARK DISK
HT0483_SETTING: 31 = SET IN A PAVEMENT SUCH AS STREET, SIDEWALK, CURB, ETC.
HT0483_SP_SET: CONCRETE GUARDRAIL
HT0483_STAMPING: M 1241 1972
HT0483_MARK LOGO: NGS
HT0483_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
HT0483
HT0483  HISTORY     - Date     Condition        Report By
HT0483  HISTORY     - 1972     MONUMENTED       NGS
HT0483  HISTORY     - 1977     GOOD             NGS
HT0483  HISTORY     - 1986     GOOD             NGS
HT0483
HT0483                          STATION DESCRIPTION
HT0483
HT0483'DESCRIBED BY NATIONAL GEODETIC SURVEY 1972
HT0483'AT DALY CITY.
HT0483'AT THE JUNCTION OF EASTMOOR AVENUE AND SULLIVAN AVENUE AT DALY
HT0483'CITY, IN THE TOP AND 5.0 FEET EAST OF THE WEST END OF THE NORTH
HT0483'CONCRETE GUARDRAIL BASE OF EASTMOOR AVENUE BRIDGE 35-181 OVER
HT0483'INTERSTATE HIGHWAY 280, 6.0 FEET NORTH OF THE NORTH CURB OF
HT0483'EASTMOOR AVENUE, 39 FEET EAST OF THE EAST CURB LINE OF SULLIVAN
HT0483'AVENUE, 5.3 FEET EAST OF THE EAST END OF A CYCLONE FENCE, AND ABOUT
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 HT0483'2 1/2 FEET HIGHER THAN THE AVENUES.
 HT0483
 HT0483                          STATION RECOVERY (1977)
 HT0483
 HT0483'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1977
 HT0483'RECOVERED IN GOOD CONDITION.
 HT0483
 HT0483                          STATION RECOVERY (1986)
 HT0483
 HT0483'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0483'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0481 ***********************************************************************
 HT0481  DESIGNATION -  L 1241
 HT0481  PID         -  HT0481
 HT0481  STATE/COUNTY-  CA/SAN MATEO
 HT0481  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0481
 HT0481                         *CURRENT SURVEY CONTROL
 HT0481  ___________________________________________________________________
 HT0481* NAD 83(2007)-  37 41 09.43316(N)    122 28 56.41929(W)     ADJUSTED
 HT0481* NAVD 88     -       123.180  (meters)     404.13   (feet)  ADJUSTED
 HT0481  ___________________________________________________________________
 HT0481  EPOCH DATE  -        2007.00
 HT0481  X           -  -2,714,136.777 (meters)                     COMP
 HT0481  Y           -  -4,263,240.759 (meters)                     COMP
 HT0481  Z           -   3,877,972.784 (meters)                     COMP
 HT0481  LAPLACE CORR-           5.60  (seconds)                    DEFLEC09
 HT0481  ELLIP HEIGHT-          90.400 (meters)         (02/10/07) ADJUSTED
 HT0481  GEOID HEIGHT-         -32.77  (meters)                     GEOID09
 HT0481  DYNAMIC HT  -         123.095 (meters)     403.85  (feet)  COMP
 HT0481
 HT0481  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 HT0481  Type    PID    Designation                      North   East  Ellip
 HT0481  -------------------------------------------------------------------
 HT0481  NETWORK HT0481 L 1241                            0.29   0.31   1.18
 HT0481  -------------------------------------------------------------------
 HT0481  MODELED GRAV-     979,941.0   (mgal)                       NAVD 88
 HT0481
 HT0481  VERT ORDER  -  FIRST     CLASS I
 HT0481
 HT0481.The horizontal coordinates were established by GPS observations
 HT0481.and adjusted by the National Geodetic Survey in February 2007.
 HT0481
 HT0481.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
 HT0481.See National Readjustment for more information.
 HT0481.The horizontal coordinates are valid at the epoch date displayed above.
 HT0481.The epoch date for horizontal control is a decimal equivalence
 HT0481.of Year/Month/Day.
 HT0481
 HT0481.The orthometric height was determined by differential leveling and
 HT0481.adjusted in June 1991.
 HT0481
 HT0481.The X, Y, and Z were computed from the position and the ellipsoidal ht.
 HT0481
 HT0481.The Laplace correction was computed from DEFLEC09 derived deflections.
 HT0481
 HT0481.The ellipsoidal height was determined by GPS observations
 HT0481.and is referenced to NAD 83.
 HT0481
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HT0481.The geoid height was determined by GEOID09.
HT0481
HT0481.The dynamic height is computed by dividing the NAVD 88
HT0481.geopotential number by the normal gravity value computed on the
HT0481.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
HT0481.degrees latitude (g = 980.6199 gals.).
HT0481
HT0481.The modeled gravity was interpolated from observed gravity values.
HT0481
HT0481;                    North         East     Units Scale Factor Converg.
HT0481;SPC CA 3     -   633,469.732 1,825,171.781   MT  0.99992982   -1 12 49.1
HT0481;SPC CA 3     - 2,078,308.61  5,988,084.42   sFT  0.99992982   -1 12 49.1
HT0481;UTM  10      - 4,171,097.909   545,642.570   MT  0.99962566   +0 18 59.3
HT0481
HT0481!             -  Elev Factor  x  Scale Factor =   Combined Factor
HT0481!SPC CA 3     -   0.99998581  x   0.99992982  =   0.99991564
HT0481!UTM  10      -   0.99998581  x   0.99962566  =   0.99961148
HT0481
HT0481                        SUPERSEDED SURVEY CONTROL
HT0481
HT0481  NAD 83(1998)-  37 41 09.42923(N)    122 28 56.41440(W) AD(2002.75) B
HT0481  ELLIP H (08/23/04)   90.474  (m)                       GP(       ) 4 1
HT0481  NAD 83(1992)-  37 41 09.42414(N)    122 28 56.41045(W) AD(1997.30) 1
HT0481  ELLIP H (07/10/98)   90.413  (m)                       GP(1997.30) 4 1
HT0481  NAD 83(1992)-  37 41 09.42198(N)    122 28 56.40906(W) AD(1995.42) 1
HT0481  ELLIP H (12/22/97)   90.473  (m)                       GP(1995.42) 4 1
HT0481  NAVD 88 (12/22/97)  123.18   (m)          404.1    (f) LEVELING    3
HT0481  NGVD 29 (??/??/92)  122.330  (m)          401.34   (f) ADJ UNCH    1 1
HT0481
HT0481.Superseded values are not recommended for survey control.
HT0481.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0481.See file dsdata.txt to determine how the superseded data were derived.
HT0481
HT0481_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG4564271097(NAD 83)
HT0481_MARKER: DB = BENCH MARK DISK
HT0481_SETTING: 31 = SET IN A PAVEMENT SUCH AS STREET, SIDEWALK, CURB, ETC.
HT0481_SP_SET: CONCRETE CATCH BASIN
HT0481_STAMPING: L 1241 1972
HT0481_MARK LOGO: NGS
HT0481_MAGNETIC: N = NO MAGNETIC MATERIAL
HT0481_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
HT0481_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
HT0481+SATELLITE: SATELLITE OBSERVATIONS - September 28, 2002
HT0481
HT0481  HISTORY     - Date     Condition        Report By
HT0481  HISTORY     - 1972     MONUMENTED       NGS
HT0481  HISTORY     - 1977     GOOD             NGS
HT0481  HISTORY     - 1986     GOOD             NGS
HT0481  HISTORY     - 19950915 GOOD             NGS
HT0481  HISTORY     - 200209   GOOD             JOHFRA
HT0481  HISTORY     - 20020928 GOOD             INDIV
HT0481
HT0481                        STATION DESCRIPTION
HT0481
HT0481'DESCRIBED BY NATIONAL GEODETIC SURVEY 1972
HT0481'AT DALY CITY.
HT0481'AT THE JUNCTION OF EASTMOOR AVENUE AND AN ASPHALT STREET SOUTH
HT0481'TO THE WESTMOOR HIGH SCHOOL PARKING LOT AT DALY CITY, IN THE TOP
HT0481'AND AT THE NORTHEAST CORNER OF A CONCRETE CATCH BASIN AT THE WEST
HT0481'CURB OF THE STREET, 18 FEET SOUTH OF THE SOUTH CURB LINE OF THE
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 HT0481'AVENUE, 155 FEET WEST OF THE EXTENDED CENTER LINE OF TERRACE
 HT0481'VIEW COURT, 255 FEET WEST OF THE EXTENDED CENTER LINE OF GILMAN
 HT0481'DRIVE, 0.8 FOOT WEST OF THE WEST CURB OF THE STREET TO THE
 HT0481'PARKING LOT, AND ABOUT 1 FOOT HIGHER THAN THE STREET AND AVENUE.
 HT0481
 HT0481                          STATION RECOVERY (1977)
 HT0481
 HT0481'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1977
 HT0481'RECOVERED IN GOOD CONDITION.
 HT0481
 HT0481                          STATION RECOVERY (1986)
 HT0481
 HT0481'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0481'RECOVERED IN GOOD CONDITION. THE DESCRIPTION IS ADEQUATE EXCEPT ADD
 HT0481'7.0 METERS (23.0 FT) EAST-NORTHEAST OF AN IRON ENTRANCE SIGN TO THE
 HT0481'SCHOOL, AND 8.5 METERS (28.0 FT) NORTH OF A 15 MPH STREET SIGN.
 HT0481
 HT0481                          STATION RECOVERY (1995)
 HT0481
 HT0481'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1995 (JDD)
 HT0481'THE STATION WAS RECOVERED.  TO REACH THE STATION FROM THE INTERSECTION
 HT0481'OF INTERSTATE HIGHWAY 280 AND EASTMOOR AVENUE IN DALY CITY, GO WEST ON
 HT0481'EASTMOOR AVENUE FOR 0.6 MI (1.0 KM) TO A PAVED SIDE ROAD LEFT, THE
 HT0481'ENTRANCE TO WESTMOOR HIGH SCHOOL AND THE STATION ON THE LEFT IN THE
 HT0481'SOUTHWEST QUADRANT.
 HT0481
 HT0481                          STATION RECOVERY (2002)
 HT0481
 HT0481'RECOVERY NOTE BY JOHNSON-FRANK 2002 (MSP)
 HT0481'RECOVERED AS DESCRIBED. FROM THE INTERSECTION OF HWY 1 AND HWY
 HT0481'35/SKYLINE BLVD, DRIVE NORTH ON HWY 35 FOR 1 MI.   EXIT ON WESTMOOR
 HT0481'AVE, TURN RIGHT AND DRIVE EAST FOR 0.4 MI AS THE ROAD STARTS TO CURVE
 HT0481'LEFT (NORTH).  CONTINUE FOR 0.1 MI TO THE ENTRANCE TO WESTMOOR HIGH
 HT0481'SCHOOL AND THE  STATION ON THE RIGHT AS PREVIOUSLY DESCRIBED. THIS
 HT0481'STATION WAS OBSERVED AS PART OF THE SOUTH SAN FRANCISCO BAY HEIGHT
 HT0481'MODERNIZATION  PROJECT.
 HT0481
 HT0481                          STATION RECOVERY (2002)
 HT0481
 HT0481'RECOVERY NOTE BY INDIVIDUAL CONTRIBUTORS 2002 (DBT)
 HT0481'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0521 ***********************************************************************
 HT0521  DESIGNATION -  N 1241
 HT0521  PID         -  HT0521
 HT0521  STATE/COUNTY-  CA/SAN MATEO
 HT0521  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0521
 HT0521                         *CURRENT SURVEY CONTROL
 HT0521  ___________________________________________________________________
 HT0521* NAD 83(1986)-  37 41 36.     (N)    122 28 15.     (W)     SCALED
 HT0521* NAVD 88     -        58.520  (meters)     191.99   (feet)  ADJUSTED
 HT0521  ___________________________________________________________________
 HT0521  GEOID HEIGHT-         -32.73  (meters)                     GEOID09
 HT0521  DYNAMIC HT  -          58.480 (meters)     191.86  (feet)  COMP
 HT0521  MODELED GRAV-     979,952.7   (mgal)                       NAVD 88
 HT0521
 HT0521  VERT ORDER  -  FIRST     CLASS I
 HT0521
 HT0521.The horizontal coordinates were scaled from a topographic map and have
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 HT0521.an estimated accuracy of +/- 6 seconds.
 HT0521
 HT0521.The orthometric height was determined by differential leveling and
 HT0521.adjusted in June 1991.
 HT0521
 HT0521.The geoid height was determined by GEOID09.
 HT0521
 HT0521.The dynamic height is computed by dividing the NAVD 88
 HT0521.geopotential number by the normal gravity value computed on the
 HT0521.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 HT0521.degrees latitude (g = 980.6199 gals.).
 HT0521
 HT0521.The modeled gravity was interpolated from observed gravity values.
 HT0521
 HT0521;                    North         East     Units  Estimated Accuracy
 HT0521;SPC CA 3     -   634,270.    1,826,200.      MT  (+/- 180 meters Scaled)
 HT0521
 HT0521                          SUPERSEDED SURVEY CONTROL
 HT0521
 HT0521  NGVD 29 (??/??/92)   57.676  (m)          189.23   (f) ADJ UNCH    1 1
 HT0521
 HT0521.Superseded values are not recommended for survey control.
 HT0521.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0521.See file dsdata.txt to determine how the superseded data were derived.
 HT0521
 HT0521_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG466719(NAD 83)
 HT0521_MARKER: DB = BENCH MARK DISK
 HT0521_SETTING: 31 = SET IN A PAVEMENT SUCH AS STREET, SIDEWALK, CURB, ETC.
 HT0521_SP_SET: BRIDGE GUARDRAIL
 HT0521_STAMPING: N 1241 1972
 HT0521_MARK LOGO: NGS
 HT0521_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT0521
 HT0521  HISTORY     - Date     Condition        Report By
 HT0521  HISTORY     - 1972     MONUMENTED       NGS
 HT0521  HISTORY     - 1977     GOOD             NGS
 HT0521  HISTORY     - 1986     GOOD             NGS
 HT0521
 HT0521                          STATION DESCRIPTION
 HT0521
 HT0521'DESCRIBED BY NATIONAL GEODETIC SURVEY 1972
 HT0521'AT DALY CITY.
 HT0521'AT THE NORTHEAST CORNER OF THE JUNCTION OF JUNIPERO SERRA
 HT0521'BOULEVARD AND SCHOOL STREET AT DALY CITY, 5.2 FEET EAST OF THE
 HT0521'WEST END OF THE NORTH CONCRETE GUARDRAIL BASE OF SCHOOL STREET
 HT0521'BRIDGE 35-183 OVER INTERSTATE HIGHWAY 280, 38 FEET EAST OF THE
 HT0521'EAST CURB LINE OF THE BOULEVARD, 26 FEET NORTH OF THE CENTER
 HT0521'LINE OF SCHOOL STREET, ABOUT 1 1/2 FEET HIGHER THAN THE CONCRETE
 HT0521'WALK WAY, AND 2 1/2 FEET HIGHER THAN THE STREET.
 HT0521
 HT0521                          STATION RECOVERY (1977)
 HT0521
 HT0521'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1977
 HT0521'RECOVERED IN GOOD CONDITION.
 HT0521
 HT0521                          STATION RECOVERY (1986)
 HT0521
 HT0521'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1986
 HT0521'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
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HT0520 ***********************************************************************
HT0520  DESIGNATION -  P 1241
HT0520  PID         -  HT0520
HT0520  STATE/COUNTY-  CA/SAN MATEO
HT0520  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
HT0520
HT0520                          *CURRENT SURVEY CONTROL
HT0520  ___________________________________________________________________
HT0520* NAD 83(1986)-  37 42 18.     (N)    122 28 16.     (W)     SCALED
HT0520* NAVD 88     -        73.250  (meters)     240.32   (feet)  ADJUSTED
HT0520  ___________________________________________________________________
HT0520  GEOID HEIGHT-         -32.72  (meters)                      GEOID09
HT0520  DYNAMIC HT  -          73.201 (meters)     240.16  (feet)  COMP
HT0520  MODELED GRAV-     979,957.4   (mgal)                        NAVD 88
HT0520
HT0520  VERT ORDER  -  FIRST     CLASS I
HT0520
HT0520.The horizontal coordinates were scaled from a topographic map and have
HT0520.an estimated accuracy of +/- 6 seconds.
HT0520
HT0520.The orthometric height was determined by differential leveling and
HT0520.adjusted in June 1991.
HT0520
HT0520.The geoid height was determined by GEOID09.
HT0520
HT0520.The dynamic height is computed by dividing the NAVD 88
HT0520.geopotential number by the normal gravity value computed on the
HT0520.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
HT0520.degrees latitude (g = 980.6199 gals.).
HT0520
HT0520.The modeled gravity was interpolated from observed gravity values.
HT0520
HT0520;                    North         East     Units  Estimated Accuracy
HT0520;SPC CA 3     -   635,560.    1,826,210.      MT   (+/- 180 meters Scaled)
HT0520
HT0520                          SUPERSEDED SURVEY CONTROL
HT0520
HT0520  NGVD 29 (??/??/92)   72.407  (m)          237.56   (f) ADJ UNCH    1 1
HT0520
HT0520.Superseded values are not recommended for survey control.
HT0520.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT0520.See file dsdata.txt to determine how the superseded data were derived.
HT0520
HT0520_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG466732(NAD 83)
HT0520_MARKER: DB = BENCH MARK DISK
HT0520_SETTING: 36 = SET IN A MASSIVE STRUCTURE
HT0520_SP_SET: BRIDGE
HT0520_STAMPING: P 1241 1972
HT0520_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
HT0520
HT0520  HISTORY     - Date     Condition        Report By
HT0520  HISTORY     - 1972     MONUMENTED       NGS
HT0520  HISTORY     - 1977     GOOD             NGS
HT0520
HT0520                          STATION DESCRIPTION
HT0520
HT0520'DESCRIBED BY NATIONAL GEODETIC SURVEY 1972
HT0520'AT DALY CITY.
HT0520'AT THE SOUTHWEST CORNER OF THE JUNCTION OF JUNIPERO SERRA
HT0520'BOULEVARD AND KNOWLES AVENUE AT DALY CITY, IN THE TOP AND 5.0
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 HT0520'FEET NORTH OF THE SOUTH END OF THE SOUTH CONCRETE GUARDRAIL
 HT0520'BASE OF KNOWLES AVENUE BRIDGE 35-172 OVER INTERSTATE HIGHWAY 280,
 HT0520'5.9 FEET WEST OF THE WEST CURB OF THE BOULEVARD, 70 FEET SOUTH
 HT0520'OF THE SOUTH LANES OF THE AVENUE, 1 1/2 FEET HIGHER THAN THE
 HT0520'CONCRETE WALK WAY, 2 1/2 FEET HIGHER THAN THE BOULEVARD.
 HT0520
 HT0520                          STATION RECOVERY (1977)
 HT0520
 HT0520'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1977
 HT0520'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0519 ***********************************************************************
 HT0519  DESIGNATION -  N 109 RESET 1964
 HT0519  PID         -  HT0519
 HT0519  STATE/COUNTY-  CA/SAN MATEO
 HT0519  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0519
 HT0519                         *CURRENT SURVEY CONTROL
 HT0519  ___________________________________________________________________
 HT0519* NAD 83(1986)-  37 42 29.     (N)    122 28 06.     (W)     SCALED
 HT0519* NAVD 88     -        82.137  (meters)     269.48   (feet)  ADJUSTED
 HT0519  ___________________________________________________________________
 HT0519  GEOID HEIGHT-         -32.71  (meters)                     GEOID09
 HT0519  DYNAMIC HT  -          82.082 (meters)     269.30  (feet)  COMP
 HT0519  MODELED GRAV-     979,956.5   (mgal)                       NAVD 88
 HT0519
 HT0519  VERT ORDER  -  FIRST     CLASS I
 HT0519
 HT0519.The horizontal coordinates were scaled from a topographic map and have
 HT0519.an estimated accuracy of +/- 6 seconds.
 HT0519
 HT0519.The orthometric height was determined by differential leveling and
 HT0519.adjusted in June 1991.
 HT0519
 HT0519.The geoid height was determined by GEOID09.
 HT0519
 HT0519.The dynamic height is computed by dividing the NAVD 88
 HT0519.geopotential number by the normal gravity value computed on the
 HT0519.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 HT0519.degrees latitude (g = 980.6199 gals.).
 HT0519
 HT0519.The modeled gravity was interpolated from observed gravity values.
 HT0519
 HT0519;                    North         East     Units  Estimated Accuracy
 HT0519;SPC CA 3     -   635,900.    1,826,460.      MT  (+/- 180 meters Scaled)
 HT0519
 HT0519                          SUPERSEDED SURVEY CONTROL
 HT0519
 HT0519  NGVD 29 (??/??/92)   81.292  (m)          266.71   (f) ADJ UNCH    1 1
 HT0519
 HT0519.Superseded values are not recommended for survey control.
 HT0519.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0519.See file dsdata.txt to determine how the superseded data were derived.
 HT0519
 HT0519_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG468735(NAD 83)
 HT0519_MARKER: DD = SURVEY DISK
 HT0519_SETTING: 36 = SET IN A MASSIVE STRUCTURE
 HT0519_SP_SET: BRIDGE
 HT0519_STAMPING: N 109 RESET 1964
 HT0519_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
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 HT0519
 HT0519  HISTORY     - Date     Condition        Report By
 HT0519  HISTORY     - 1964     MONUMENTED       CADH
 HT0519  HISTORY     - 1972     GOOD             NGS
 HT0519  HISTORY     - 1977     GOOD             NGS
 HT0519
 HT0519                          STATION DESCRIPTION
 HT0519
 HT0519'DESCRIBED BY NATIONAL GEODETIC SURVEY 1972
 HT0519'AT DALY CITY.
 HT0519'AT THE ST. CHARLES AVENUE BRIDGE, OVER INTERSTATE HIGHWAY 280,
 HT0519'TO A BART STATION AT DALY CITY, 0.2 MILE SOUTHEAST ALONG ST.
 HT0519'CHARLES AVENUE FROM THE JUNCTION OF ALEMANY BOULEVARD, 0.05 MILE
 HT0519'SOUTHEAST ALONG ST. CHARLES AVENUE FROM THE JUNCTION OF BELLE
 HT0519'AVENUE, IN THE TOP AND 13.0 FEET NORTHWEST OF THE SOUTHEAST END
 HT0519'OF THE NORTHEAST CONCRETE WALK WAY OF THE BRIDGE, 3.0 FEET
 HT0519'SOUTHWEST OF THE SOUTHWEST FACE OF THE NORTHEAST CONCRETE
 HT0519'GUARDRAIL BASE, AND ABOUT 1 FOOT HIGHER THAN THE AVENUE.
 HT0519
 HT0519                          STATION RECOVERY (1977)
 HT0519
 HT0519'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1977
 HT0519'RECOVERED IN GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT0600 ***********************************************************************
 HT0600  DESIGNATION -  L 568
 HT0600  PID         -  HT0600
 HT0600  STATE/COUNTY-  CA/SAN MATEO
 HT0600  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT0600
 HT0600                         *CURRENT SURVEY CONTROL
 HT0600  ___________________________________________________________________
 HT0600* NAD 83(1986)-  37 42 30.     (N)    122 29 09.     (W)     SCALED
 HT0600* NAVD 88     -        29.80   (+/-2cm)      97.8    (feet)  VERTCON
 HT0600  ___________________________________________________________________
 HT0600  GEOID HEIGHT-         -32.77  (meters)                     GEOID09
 HT0600  VERT ORDER  -  SECOND    CLASS 0 (See Below)
 HT0600
 HT0600.The horizontal coordinates were scaled from a topographic map and have
 HT0600.an estimated accuracy of +/- 6 seconds.
 HT0600
 HT0600.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT0600.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT0600.The vertical order pertains to the NGVD 29 superseded value.
 HT0600
 HT0600.The geoid height was determined by GEOID09.
 HT0600
 HT0600;                    North         East    Units  Estimated Accuracy
 HT0600;SPC CA 3     -   635,960.    1,824,920.      MT  (+/- 180 meters Scaled)
 HT0600
 HT0600                          SUPERSEDED SURVEY CONTROL
 HT0600
 HT0600  NGVD 29 (??/??/92)   28.960  (m)           95.01   (f) ADJ UNCH    2 0
 HT0600
 HT0600.Superseded values are not recommended for survey control.
 HT0600.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0600.See file dsdata.txt to determine how the superseded data were derived.
 HT0600
 HT0600_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG453735(NAD 83)
 HT0600_MARKER: DB = BENCH MARK DISK
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 HT0600_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT0600_SP_SET: CULVERT
 HT0600_STAMPING: L 568 1939
 HT0600_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT0600
 HT0600  HISTORY     - Date     Condition        Report By
 HT0600  HISTORY     - 1939     MONUMENTED       CGS
 HT0600  HISTORY     - 1958     GOOD             NGS
 HT0600  HISTORY     - 1958     MARK NOT FOUND   NGS
 HT0600
 HT0600                          STATION DESCRIPTION
 HT0600
 HT0600'DESCRIBED BY NATIONAL GEODETIC SURVEY 1958
 HT0600'0.9 MI W FROM DALY CITY.
 HT0600'0.9 MILE WEST ALONG STATE HIGHWAY 1 FROM THE WEST CITY LIMITS
 HT0600'OF DALY CITY, SAN MATEO COUNTY, OPPOSITE THE EAST END OF THE
 HT0600'TRIANGLE FORMED AT THE Y-JUNCTION OF LAKE MERCED BOULEVARD,
 HT0600'AT A CULVERT UNDER STATE HIGHWAY 1, IN THE TOP OF THE SOUTHEAST
 HT0600'CORNER OF THE SOUTH CONCRETE HEADWALL, 35 FEET SOUTH OF THE
 HT0600'CENTERLINE OF THE HIGHWAY, AND 14 FEET WEST OF THE CENTERLINE
 HT0600'OF A FARM ROAD.  A STANDARD DISK, STAMPED L 568 1939.  NOTE-- THERE
 HT0600'IS NOW A SIX-LANE HIGHWAY AT THIS LOCATION AND NO CONCRETE
 HT0600'HEADWALL.
 HT0600
 HT0600                          STATION RECOVERY (1958)
 HT0600
 HT0600'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1958
 HT0600'MARK NOT FOUND.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT2273 ***********************************************************************
 HT2273  DESIGNATION -  W 1320
 HT2273  PID         -  HT2273
 HT2273  STATE/COUNTY-  CA/SAN FRANCISCO
 HT2273  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT2273
 HT2273                         *CURRENT SURVEY CONTROL
 HT2273  ___________________________________________________________________
 HT2273* NAD 83(1986)-  37 42 48.     (N)    122 28 18.     (W)     SCALED
 HT2273* NAVD 88     -        58.189  (meters)     190.91   (feet)  ADJUSTED
 HT2273  ___________________________________________________________________
 HT2273  GEOID HEIGHT-         -32.71  (meters)                     GEOID09
 HT2273  DYNAMIC HT  -          58.150 (meters)     190.78  (feet)  COMP
 HT2273  MODELED GRAV-     979,963.4   (mgal)                       NAVD 88
 HT2273  OBS GRAVITY -     979,965.8   (mgal)                       GRAV_OBS
 HT2273
 HT2273  VERT ORDER  -  FIRST     CLASS I
 HT2273
 HT2273.The horizontal coordinates were scaled from a topographic map and have
 HT2273.an estimated accuracy of +/- 6 seconds.
 HT2273
 HT2273.The orthometric height was determined by differential leveling and
 HT2273.adjusted in June 1991.
 HT2273
 HT2273.The geoid height was determined by GEOID09.
 HT2273
 HT2273.The dynamic height is computed by dividing the NAVD 88
 HT2273.geopotential number by the normal gravity value computed on the
 HT2273.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 HT2273.degrees latitude (g = 980.6199 gals.).
 HT2273
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HT2273.The modeled gravity was interpolated from observed gravity values.
HT2273.The observed gravity was obtained from relative gravimeter ties
HT2273.to the IGSN71 gravity network.
HT2273
HT2273;                    North         East    Units  Estimated Accuracy
HT2273;SPC CA 3     -   636,490.    1,826,180.      MT  (+/- 180 meters Scaled)
HT2273
HT2273                          SUPERSEDED SURVEY CONTROL
HT2273
HT2273  NGVD 29 (10/21/93)   57.345  (m)          188.14   (f) ADJUSTED    1 1
HT2273
HT2273.Superseded values are not recommended for survey control.
HT2273.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT2273.See file dsdata.txt to determine how the superseded data were derived.
HT2273
HT2273_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG465741(NAD 83)
HT2273_MARKER: DB = BENCH MARK DISK
HT2273_SETTING: 30 = SET IN A LIGHT STRUCTURE
HT2273_SP_SET: CURB
HT2273_STAMPING: W 1320 1977
HT2273_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
HT2273
HT2273  HISTORY     - Date     Condition        Report By
HT2273  HISTORY     - 1977     MONUMENTED       NGS
HT2273
HT2273                          STATION DESCRIPTION
HT2273
HT2273'DESCRIBED BY NATIONAL GEODETIC SURVEY 1977
HT2273'IN SAN FRANCISCO.
HT2273'AT SAN FRANCISCO, SET IN THE CURB ON THE WEST SIDE OF JUNIPERO
HT2273'SERRA BLVD, JUST NORTH OF WHERE IT CROSSES BROTHERHOOD WAY.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
HT0602 ***********************************************************************
HT0602  DESIGNATION -  M 568 RESET 1955
HT0602  PID         -  HT0602
HT0602  STATE/COUNTY-  CA/SAN FRANCISCO
HT0602  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
HT0602
HT0602                         *CURRENT SURVEY CONTROL
HT0602  ___________________________________________________________________
HT0602* NAD 83(1986)-  37 43 08.     (N)    122 30 01.     (W)     SCALED
HT0602* NAVD 88     -        12.67   (+/-2cm)      41.6    (feet)  VERTCON
HT0602  ___________________________________________________________________
HT0602  GEOID HEIGHT-         -32.80  (meters)                     GEOID09
HT0602  VERT ORDER  -  THIRD (See Below)
HT0602
HT0602.The horizontal coordinates were scaled from a topographic map and have
HT0602.an estimated accuracy of +/- 6 seconds.
HT0602
HT0602.The NAVD 88 height was computed by applying the VERTCON shift value to
HT0602.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
HT0602.The vertical order pertains to the NGVD 29 superseded value.
HT0602
HT0602.The geoid height was determined by GEOID09.
HT0602
HT0602;                    North         East    Units  Estimated Accuracy
HT0602;SPC CA 3     -   637,160.    1,823,670.      MT  (+/- 180 meters Scaled)
HT0602
HT0602                          SUPERSEDED SURVEY CONTROL
HT0602
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 HT0602  NGVD 29 (??/??/??)   11.83   (m)          38.8    (f) RESET       3
 HT0602
 HT0602.Superseded values are not recommended for survey control.
 HT0602.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT0602.See file dsdata.txt to determine how the superseded data were derived.
 HT0602
 HT0602_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG440747(NAD 83)
 HT0602_MARKER: DB = BENCH MARK DISK
 HT0602_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT0602_SP_SET: FLAGPOLE CONCRETE BASE
 HT0602_STAMPING: M 568 RESET 1955
 HT0602_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT0602
 HT0602  HISTORY     - Date     Condition        Report By
 HT0602  HISTORY     - 1955     MONUMENTED       CGS
 HT0602
 HT0602                          STATION DESCRIPTION
 HT0602
 HT0602'DESCRIBED BY COAST AND GEODETIC SURVEY 1955
 HT0602'IN SAN FRANCISCO.
 HT0602'ABOUT 0.8 MILE NORTH ALONG SKYLINE BLVD. FROM THE SOUTH CITY
 HT0602'LIMITS OF SAN FRANCISCO, ON THE WEST SHORE OF LAKE MERCED.
 HT0602'SET IN A DRILL HOLE IN THE CONCRETE BASE OF THE FLAG POLE IN FRONT
 HT0602'OF THE SAN FRANCISCO POLICE PISTOL RANGE BUILDING.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT2272 ***********************************************************************
 HT2272  DESIGNATION -  V 1320
 HT2272  PID         -  HT2272
 HT2272  STATE/COUNTY-  CA/SAN FRANCISCO
 HT2272  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT2272
 HT2272                         *CURRENT SURVEY CONTROL
 HT2272  ___________________________________________________________________
 HT2272* NAD 83(1986)-  37 43 17.     (N)    122 28 32.     (W)     SCALED
 HT2272* NAVD 88     -        49.702  (meters)     163.06   (feet)  ADJUSTED
 HT2272  ___________________________________________________________________
 HT2272  GEOID HEIGHT-         -32.71  (meters)                     GEOID09
 HT2272  DYNAMIC HT  -          49.669 (meters)      162.96  (feet)  COMP
 HT2272  MODELED GRAV-     979,968.2   (mgal)                       NAVD 88
 HT2272
 HT2272  VERT ORDER  -  FIRST     CLASS I
 HT2272
 HT2272.The horizontal coordinates were scaled from a topographic map and have
 HT2272.an estimated accuracy of +/- 6 seconds.
 HT2272
 HT2272.The orthometric height was determined by differential leveling and
 HT2272.adjusted in June 1991.
 HT2272
 HT2272.The geoid height was determined by GEOID09.
 HT2272
 HT2272.The dynamic height is computed by dividing the NAVD 88
 HT2272.geopotential number by the normal gravity value computed on the
 HT2272.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 HT2272.degrees latitude (g = 980.6199 gals.).
 HT2272
 HT2272.The modeled gravity was interpolated from observed gravity values.
 HT2272
 HT2272;                   North         East     Units  Estimated Accuracy
 HT2272;SPC CA 3     -   637,390.    1,825,850.      MT  (+/- 180 meters Scaled)
 HT2272
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 HT2272                          SUPERSEDED SURVEY CONTROL
 HT2272
 HT2272  NGVD 29 (10/21/93)   48.860  (m)          160.30   (f) ADJUSTED    1 1
 HT2272
 HT2272.Superseded values are not recommended for survey control.
 HT2272.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT2272.See file dsdata.txt to determine how the superseded data were derived.
 HT2272
 HT2272_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG462750(NAD 83)
 HT2272_MARKER: DB = BENCH MARK DISK
 HT2272_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT2272_SP_SET: CURB
 HT2272_STAMPING: V 1320 1977
 HT2272_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT2272
 HT2272  HISTORY     - Date     Condition        Report By
 HT2272  HISTORY     - 1977     MONUMENTED       NGS
 HT2272
 HT2272                          STATION DESCRIPTION
 HT2272
 HT2272'DESCRIBED BY NATIONAL GEODETIC SURVEY 1977
 HT2272'IN SAN FRANCISCO.
 HT2272'AT SAN FRANCISCO, ON THE CAMPUS OF CALIFORNIA STATE UNIVERSITY IN THE
 HT2272'SOUTHWEST PART OF THE CITY , SET IN THE TOP OF A CONCRETE
 HT2272'BORDER OF THE
 HT2272'H H L ENERGY CONSERVATION BUILDING AT THE NORTHEAST CORNER, JUST NORTH
 HT2272'OF A 15 MINUTE PARKING ZONE, AND 0.6 FOOT WEST OF THE SIDEWALK.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT2271 ***********************************************************************
 HT2271  DESIGNATION -  M 6 C OF SF
 HT2271  PID         -  HT2271
 HT2271  STATE/COUNTY-  CA/SAN FRANCISCO
 HT2271  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT2271
 HT2271                         *CURRENT SURVEY CONTROL
 HT2271  ___________________________________________________________________
 HT2271* NAD 83(1986)-  37 43 47.     (N)    122 28 30.     (W)     SCALED
 HT2271* NAVD 88     -        63.620  (meters)     208.73   (feet)  ADJUSTED
 HT2271  ___________________________________________________________________
 HT2271  GEOID HEIGHT-         -32.70  (meters)                     GEOID09
 HT2271  DYNAMIC HT  -          63.578 (meters)     208.59  (feet)  COMP
 HT2271  MODELED GRAV-     979,966.0   (mgal)                       NAVD 88
 HT2271
 HT2271  VERT ORDER  -  FIRST     CLASS I
 HT2271
 HT2271.The horizontal coordinates were scaled from a topographic map and have
 HT2271.an estimated accuracy of +/- 6 seconds.
 HT2271
 HT2271.The orthometric height was determined by differential leveling and
 HT2271.adjusted in June 1991.
 HT2271
 HT2271.The geoid height was determined by GEOID09.
 HT2271
 HT2271.The dynamic height is computed by dividing the NAVD 88
 HT2271.geopotential number by the normal gravity value computed on the
 HT2271.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 HT2271.degrees latitude (g = 980.6199 gals.).
 HT2271
 HT2271.The modeled gravity was interpolated from observed gravity values.
 HT2271
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 HT2271;                    North         East     Units  Estimated Accuracy
 HT2271;SPC CA 3     -   638,310.    1,825,920.      MT  (+/- 180 meters Scaled)
 HT2271
 HT2271                          SUPERSEDED SURVEY CONTROL
 HT2271
 HT2271  NGVD 29 (10/21/93)   62.779  (m)          205.97   (f) ADJUSTED    1 1
 HT2271
 HT2271.Superseded values are not recommended for survey control.
 HT2271.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT2271.See file dsdata.txt to determine how the superseded data were derived.
 HT2271
 HT2271_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG462759(NAD 83)
 HT2271_MARKER: DD = SURVEY DISK
 HT2271_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT2271_SP_SET: SIDEWALK
 HT2271_STAMPING: M 6 1974
 HT2271_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT2271
 HT2271  HISTORY     - Date     Condition        Report By
 HT2271  HISTORY     - 1974     MONUMENTED       CA3290
 HT2271  HISTORY     - 1977     GOOD             NGS
 HT2271
 HT2271                          STATION DESCRIPTION
 HT2271
 HT2271'DESCRIBED BY NATIONAL GEODETIC SURVEY 1977
 HT2271'IN SAN FRANCISCO.
 HT2271'AT SAN FRANCISCO, ON 19 TH AVE AT STONETOWN MALL, A DISK SET IN THE
 HT2271'SIDEWALK IN THE CENTER OF A PAINTED WHITE CROSS, 10 FEET SOUTH OF
 HT2271'THE STEPS LEADING TO THE MALL AT THE NORTH END, AND 5 FEET WEST OF THE
 HT2271'WEST CURB OF 19 TH AVE.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT1841 ***********************************************************************
 HT1841  DESIGNATION -  N 568
 HT1841  PID         -  HT1841
 HT1841  STATE/COUNTY-  CA/SAN FRANCISCO
 HT1841  USGS QUAD   -
 HT1841
 HT1841                         *CURRENT SURVEY CONTROL
 HT1841  ___________________________________________________________________
 HT1841* NAD 83(1986)-  37 43 47.     (N)    122 30 10.     (W)     SCALED
 HT1841* NAVD 88     -        17.71   (+/-2cm)      58.1    (feet)  VERTCON
 HT1841  ___________________________________________________________________
 HT1841  GEOID HEIGHT-         -32.79  (meters)                     GEOID09
 HT1841  VERT ORDER  -  SECOND    CLASS 0 (See Below)
 HT1841
 HT1841.The horizontal coordinates were scaled from a topographic map and have
 HT1841.an estimated accuracy of +/- 6 seconds.
 HT1841
 HT1841.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT1841.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT1841.The vertical order pertains to the NGVD 29 superseded value.
 HT1841
 HT1841.The geoid height was determined by GEOID09.
 HT1841
 HT1841;                    North         East     Units  Estimated Accuracy
 HT1841;SPC CA 3     -   638,370.    1,823,470.      MT  (+/- 180 meters Scaled)
 HT1841
 HT1841                          SUPERSEDED SURVEY CONTROL
 HT1841
 HT1841  NGVD 29 (??/??/92)   16.874  (m)           55.36   (f) ADJ UNCH    2 0
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 HT1841
 HT1841.Superseded values are not recommended for survey control.
 HT1841.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT1841.See file dsdata.txt to determine how the superseded data were derived.
 HT1841
 HT1841_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG438759(NAD 83)
 HT1841_MARKER: DB = BENCH MARK DISK
 HT1841_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT1841_SP_SET: WALL
 HT1841_STAMPING: N 568 1939
 HT1841_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT1841_SATELLITE: THE SITE LOCATION WAS REPORTED AS NOT SUITABLE FOR
 HT1841+SATELLITE: SATELLITE OBSERVATIONS - January 11, 2009
 HT1841
 HT1841  HISTORY     - Date     Condition        Report By
 HT1841  HISTORY     - 1939     MONUMENTED       CGS
 HT1841  HISTORY     - 1973     GOOD             NGS
 HT1841  HISTORY     - 20090109 GOOD             GEOCAC
 HT1841  HISTORY     - 20090111 GOOD             GEOCAC
 HT1841
 HT1841                          STATION DESCRIPTION
 HT1841
 HT1841'DESCRIBED BY NATIONAL GEODETIC SURVEY 1973
 HT1841'AT SAN FRANCISCO.
 HT1841'AT SAN FRANCISCO, SAN FRANCISCO COUNTY, AT THE NORTHEAST CORNER
 HT1841'OF FORT FUNSTON, 78 FEET SOUTH OF THE CENTER OF THE ENTRANCE, 20.7
 HT1841'FEET SOUTHWEST OF A FENCE, IN THE CONCRETE WALL OF A PUMP HOUSE,
 HT1841'8 INCHES FROM THE NORTHWEST CORNER, AND ABOUT 4 FEET ABOVE THE
 HT1841'GROUND.  A STANDARD DISK, STAMPED N 568 1939 AND SET VERTICALLY.
 HT1841
 HT1841                          STATION RECOVERY (2009)
 HT1841
 HT1841'RECOVERY NOTE BY GEOCACHING 2009 (RM)
 HT1841'RECOVERED BENCHMARK IN GOOD CONDITION.  NGS DESCRIPTION (1973) IS
 HT1841'ADEQUATE.
 HT1841
 HT1841                          STATION RECOVERY (2009)
 HT1841
 HT1841'RECOVERY NOTE BY GEOCACHING 2009 (RM)
 HT1841'PERMISSION WAS GRANTED TO PROCEED THROUGH THE SAN FRANCISCO ZOO GATES
 HT1841'TO
 HT1841'ACCESS THE PUMPHOUSE FROM THE NORTHWEST WHERE THE STATION WAS
 HT1841'RECOVERED IN
 HT1841'GOOD CONDITION.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 AB7677 ***********************************************************************
 AB7677  DESIGNATION -  HPGN D CA 04 GE
 AB7677  PID         -  AB7677
 AB7677  STATE/COUNTY-  CA/SAN FRANCISCO
 AB7677  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 AB7677
 AB7677                         *CURRENT SURVEY CONTROL
 AB7677  ___________________________________________________________________
 AB7677* NAD 83(2007)-  37 44 00.33344(N)    122 29 49.03035(W)     ADJUSTED
 AB7677* NAVD 88     -        23.69   (meters)      77.7    (feet)  LEVELING
 AB7677  ___________________________________________________________________
 AB7677  EPOCH DATE  -        2007.00
 AB7677  X           -  -2,713,450.334 (meters)                     COMP
 AB7677  Y           -  -4,259,763.765 (meters)                     COMP
 AB7677  Z           -   3,882,080.400 (meters)                     COMP
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AB7677  LAPLACE CORR-          6.47  (seconds)                        DEFLEC09
AB7677  ELLIP HEIGHT-         -9.035 (meters)             (02/10/07) ADJUSTED
AB7677  GEOID HEIGHT-        -32.76  (meters)                        GEOID09
AB7677
AB7677  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
AB7677  Type    PID    Designation                      North   East  Ellip
AB7677  -------------------------------------------------------------------
AB7677  NETWORK AB7677 HPGN D CA 04 GE                   0.71   1.16   5.84
AB7677  -------------------------------------------------------------------
AB7677  VERT ORDER  -  THIRD ?
AB7677
AB7677.The horizontal coordinates were established by GPS observations
AB7677.and adjusted by the National Geodetic Survey in February 2007.
AB7677
AB7677.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
AB7677.See National Readjustment for more information.
AB7677.The horizontal coordinates are valid at the epoch date displayed above.
AB7677.The epoch date for horizontal control is a decimal equivalence
AB7677.of Year/Month/Day.
AB7677
AB7677.The orthometric height was determined by differential leveling.
AB7677.The vertical network tie was performed by a horz. field party for horz.
AB7677.obs reductions. Reset procedures were used to establish the elevation.
AB7677
AB7677.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AB7677
AB7677.The Laplace correction was computed from DEFLEC09 derived deflections.
AB7677
AB7677.The ellipsoidal height was determined by GPS observations
AB7677.and is referenced to NAD 83.
AB7677
AB7677.The geoid height was determined by GEOID09.
AB7677
AB7677;                   North         East     Units Scale Factor Converg.
AB7677;SPC CA 3     -   638,764.560 1,823,995.524   MT  0.99992923   -1 13 21.4
AB7677;SPC CA 3     - 2,095,680.06  5,984,225.31   sFT  0.99992923   -1 13 21.4
AB7677;UTM  10      - 4,176,357.833   544,325.733   MT  0.99962420   +0 18 28.3
AB7677
AB7677!             -  Elev Factor  x  Scale Factor =   Combined Factor
AB7677!SPC CA 3     -   1.00000142  x   0.99992923  =   0.99993065
AB7677!UTM  10      -   1.00000142  x   0.99962420  =   0.99962562
AB7677
AB7677                          SUPERSEDED SURVEY CONTROL
AB7677
AB7677  NAD 83(1992)-  37 44 00.31877(N)    122 29 49.01603(W) AD(1991.35) 1
AB7677  ELLIP H (10/31/96)   -8.940  (m)                        GP(       ) 4 1
AB7677
AB7677.Superseded values are not recommended for survey control.
AB7677.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AB7677.See file dsdata.txt to determine how the superseded data were derived.
AB7677
AB7677_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG4432576357(NAD 83)
AB7677_MARKER: DD = SURVEY DISK
AB7677_SETTING: 50 = ALUMINUM ALLOY ROD W/O SLEEVE (10 FT.+)
AB7677_STAMPING: CA-HPGN-DENSIFICATION STA. 04-GE 1994
AB7677_MARK LOGO: CADT
AB7677_PROJECTION: FLUSH
AB7677_MAGNETIC: M = MARKER EQUIPPED WITH BAR MAGNET
AB7677_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
AB7677_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
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 AB7677+SATELLITE: SATELLITE OBSERVATIONS - 1994
 AB7677_ROD/PIPE-DEPTH: 7.8  meters
 AB7677
 AB7677  HISTORY     - Date     Condition        Report By
 AB7677  HISTORY     - 1994     MONUMENTED       CADT
 AB7677
 AB7677                          STATION DESCRIPTION
 AB7677
 AB7677'DESCRIBED BY CALTRANS 1994 (DAN)
 AB7677'THE STATION IS LOCATED NEAR THE INTERSECTION OF SKYLINE BLVD (STATE
 AB7677'HIGHWAY 35) AND SLOAT BLVD AT THE NORTHEAST CORNER OF THE SAN
 AB7677'FRANCISCO ZOO, ABOUT 6 MI (9.7 KM) SOUTHWEST OF DOWNTOWN SAN
 AB7677'FRANCISCO.  TO REACH THE STATION FROM THE INTERSECTION OF SLOAT BLVD
 AB7677'(STATE HIGHWAY 35) AND 19TH AVE (STATE HIGHWAY 1) , GO WEST ON SLOAT
 AB7677'BLVD, CROSSING OVER SUNSET BLVD, FOR 1.2 MI (1.9 KM) TO THE
 AB7677'Y-INTERSECTION WITH SKYLINE BLVD (STATE HIGHWAY 35) .  BEAR LEFT AND
 AB7677'GO SOUTHWEST ON SKYLINE BLVD FOR ABOUT 165 FT (50.3 M) TO THE STATION
 AB7677'ON THE LEFT IN THE RAISED MEDIAN ISLAND AT POST MILE 1.8.  THE STATION
 AB7677'IS A SURVEY DISK ENCASED IN PVC PIPE WITH ACCESS COVER SET IN CONCRETE
 AB7677'FLUSH WITH THE SURFACE OF THE RAISED MEDIAN ISLAND, ABOUT 165 FT (50.3
 AB7677'M) SOUTHWEST OF THE INTERSECTION OF SKYLINE BLVD AND SLOAT BLVD, 118.5
 AB7677'FT (36.1 M) NORTHWEST OF THE NORTHWEST CORNER OF THE HOUSE AT 379
 AB7677'SKYLINE BLVD, 96.4 FT (29.4 M) NORTHEAST OF A LIGHT POST AT THE SOUTH
 AB7677'END OF THE MEDIAN ISLAND, 74.3 FT (22.6 M) SOUTHWEST OF LIGHT POST
 AB7677'E0/1 AT THE NORTH END OF THE MEDIAN ISLAND, 65.0 FT (19.8 M) WEST OF
 AB7677'AND ACROSS THE NORTH-BOUND LANES OF SKYLINE BLVD FROM LIGHT POST 0/6,
 AB7677'18.4 FT (5.6 M) EAST OF THE WEST CURB OF THE MEDIAN ISLAND AND 7.3 FT
 AB7677'(2.2 M) WEST OF THE EAST CURB OF THE MEDIAN ISLAND.  THE DISK IS 0.3
 AB7677'FT (0.1 M) BELOW THE LID OF THE ACCESS COVER.  THIS STATION WAS
 AB7677'OCCUPIED AS PART OF A CALIFORNIA HPGN DENSIFICATION SURVEY IN 1994.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT1842 ***********************************************************************
 HT1842  DESIGNATION -  P 568
 HT1842  PID         -  HT1842
 HT1842  STATE/COUNTY-  CA/SAN FRANCISCO
 HT1842  USGS QUAD   -
 HT1842
 HT1842                         *CURRENT SURVEY CONTROL
 HT1842  ___________________________________________________________________
 HT1842* NAD 83(1986)-  37 44 10.     (N)    122 30 23.     (W)     SCALED
 HT1842* NAVD 88     -        10.20   (+/-2cm)      33.5    (feet)  VERTCON
 HT1842  ___________________________________________________________________
 HT1842  GEOID HEIGHT-         -32.79  (meters)                      GEOID09
 HT1842  VERT ORDER  -  SECOND    CLASS 0 (See Below)
 HT1842
 HT1842.The horizontal coordinates were scaled from a topographic map and have
 HT1842.an estimated accuracy of +/- 6 seconds.
 HT1842
 HT1842.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT1842.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT1842.The vertical order pertains to the NGVD 29 superseded value.
 HT1842
 HT1842.The geoid height was determined by GEOID09.
 HT1842
 HT1842;                   North         East    Units  Estimated Accuracy
 HT1842;SPC CA 3     -   639,080.    1,823,170.      MT  (+/- 180 meters Scaled)
 HT1842
 HT1842                          SUPERSEDED SURVEY CONTROL
 HT1842
 HT1842  NGVD 29 (??/??/92)    9.361  (m)           30.71   (f) ADJ UNCH    2 0
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 HT1842
 HT1842.Superseded values are not recommended for survey control.
 HT1842.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT1842.See file dsdata.txt to determine how the superseded data were derived.
 HT1842
 HT1842_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG434766(NAD 83)
 HT1842_MARKER: DB = BENCH MARK DISK
 HT1842_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT1842_SP_SET: CULVERT
 HT1842_STAMPING: P 568 1939
 HT1842_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT1842
 HT1842  HISTORY     - Date     Condition         Report By
 HT1842  HISTORY     - 1939     MONUMENTED        CGS
 HT1842  HISTORY     - 1973     GOOD              NGS
 HT1842
 HT1842                          STATION DESCRIPTION
 HT1842
 HT1842'DESCRIBED BY NATIONAL GEODETIC SURVEY 1973
 HT1842'AT SAN FRANCISCO.
 HT1842'AT SAN FRANCISCO, SAN FRANCISCO COUNTY, ON GREAT HIGHWAY, AT THE
 HT1842'FOOT OF WAWONA STREET, 75 FEET SOUTH OF A COMFORT STATION, 39
 HT1842'FEET EAST OF THE EAST BOUNDARY OF THE MIDDLE LANE, AT THE EAST
 HT1842'END OF A CULVERT UNDER THE HIGHWAY, AND IN THE TOP OF A SOUTH
 HT1842'HEADWALL.  A STANDARD DISK, STAMPED P 568 1939.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT2270 ***********************************************************************
 HT2270  DESIGNATION -  U 1320
 HT2270  PID         -  HT2270
 HT2270  STATE/COUNTY-  CA/SAN FRANCISCO
 HT2270  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT2270
 HT2270                         *CURRENT SURVEY CONTROL
 HT2270  ___________________________________________________________________
 HT2270* NAD 83(2007)-  37 44 15.72379(N)    122 28 31.93050(W)     ADJUSTED
 HT2270* NAVD 88     -        83.942  (meters)     275.40   (feet)  ADJUSTED
 HT2270  ___________________________________________________________________
 HT2270  EPOCH DATE  -        2007.00
 HT2270  X           -  -2,711,727.558 (meters)                     COMP
 HT2270  Y           -  -4,260,572.965 (meters)                     COMP
 HT2270  Z           -   3,882,492.556 (meters)                     COMP
 HT2270  LAPLACE CORR-           5.70  (seconds)                    DEFLEC09
 HT2270  ELLIP HEIGHT-          51.257 (meters)          (02/10/07) ADJUSTED
 HT2270  GEOID HEIGHT-         -32.68  (meters)                     GEOID09
 HT2270  DYNAMIC HT  -          83.886 (meters)     275.22  (feet)  COMP
 HT2270
 HT2270  ------- Accuracy Estimates (at 95% Confidence Level in cm) --------
 HT2270  Type    PID    Designation                     North   East  Ellip
 HT2270  -------------------------------------------------------------------
 HT2270  NETWORK HT2270 U 1320                           0.49   0.84   4.31
 HT2270  -------------------------------------------------------------------
 HT2270  MODELED GRAV-     979,961.5   (mgal)                       NAVD 88
 HT2270  OBS GRAVITY -     979,965.1   (mgal)                       GRAV_OBS
 HT2270
 HT2270  VERT ORDER  -  FIRST     CLASS I
 HT2270
 HT2270.The horizontal coordinates were established by GPS observations
 HT2270.and adjusted by the National Geodetic Survey in February 2007.
 HT2270
 HT2270.The datum tag of NAD 83(2007) is equivalent to NAD 83(NSRS2007).
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HT2270.See National Readjustment for more information.
HT2270.The horizontal coordinates are valid at the epoch date displayed above.
HT2270.The epoch date for horizontal control is a decimal equivalence
HT2270.of Year/Month/Day.
HT2270
HT2270.The orthometric height was determined by differential leveling and
HT2270.adjusted in June 1991.
HT2270
HT2270.The X, Y, and Z were computed from the position and the ellipsoidal ht.
HT2270
HT2270.The Laplace correction was computed from DEFLEC09 derived deflections.
HT2270
HT2270.The ellipsoidal height was determined by GPS observations
HT2270.and is referenced to NAD 83.
HT2270
HT2270.The geoid height was determined by GEOID09.
HT2270
HT2270.The dynamic height is computed by dividing the NAVD 88
HT2270.geopotential number by the normal gravity value computed on the
HT2270.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
HT2270.degrees latitude (g = 980.6199 gals.).
HT2270
HT2270.The modeled gravity was interpolated from observed gravity values.
HT2270.The observed gravity was obtained from relative gravimeter ties
HT2270.to the IGSN71 gravity network.
HT2270
HT2270;                    North         East     Units Scale Factor Converg.
HT2270;SPC CA 3     -   639,198.858 1,825,892.844   MT  0.99992921   -1 12 34.2
HT2270;SPC CA 3     - 2,097,104.92  5,990,450.11   sFT  0.99992921   -1 12 34.2
HT2270;UTM  10      - 4,176,842.504   546,210.203   MT  0.99962630   +0 19 15.6
HT2270
HT2270!             -  Elev Factor  x  Scale Factor =   Combined Factor
HT2270!SPC CA 3     -   0.99999196  x   0.99992921  =   0.99992117
HT2270!UTM  10      -   0.99999196  x   0.99962630  =   0.99961826
HT2270
HT2270                          SUPERSEDED SURVEY CONTROL
HT2270
HT2270  NAD 83(1992)-  37 44 15.71536(N)    122 28 31.92128(W) AD(1997.30) 1
HT2270  ELLIP H (07/10/98)   51.275  (m)                       GP(1997.30) 4 1
HT2270  NAD 83(1992)-  37 44 15.71326(N)    122 28 31.91994(W) AD(1995.42) 1
HT2270  ELLIP H (12/22/97)   51.336  (m)                       GP(        ) 4 1
HT2270  NAVD 88 (12/22/97)   83.94   (m)          275.4    (f) LEVELING    3
HT2270  NGVD 29 (10/21/93)   83.101  (m)          272.64   (f) ADJUSTED    1 1
HT2270
HT2270.Superseded values are not recommended for survey control.
HT2270.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
HT2270.See file dsdata.txt to determine how the superseded data were derived.
HT2270
HT2270_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG4621076842(NAD 83)
HT2270_MARKER: DB = BENCH MARK DISK
HT2270_SETTING: 30 = SET IN A LIGHT STRUCTURE
HT2270_SP_SET: CONCRETE CATCH BASIN
HT2270_STAMPING: U 1320 1977
HT2270_MARK LOGO: NGS
HT2270_MAGNETIC: N = NO MAGNETIC MATERIAL
HT2270_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
HT2270_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
HT2270+SATELLITE: SATELLITE OBSERVATIONS - September 15, 1995
HT2270
HT2270  HISTORY     - Date     Condition        Report By
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 HT2270  HISTORY     - 1977     MONUMENTED       NGS
 HT2270  HISTORY     - 19950915 GOOD             NGS
 HT2270
 HT2270                          STATION DESCRIPTION
 HT2270
 HT2270'DESCRIBED BY NATIONAL GEODETIC SURVEY 1977
 HT2270'IN SAN FRANCISCO.
 HT2270'AT SAN FRANCISCO, ON THE WEST SIDE OF 19TH AVE, IN THE SOUTH END OF
 HT2270'LARSEN PARK, SET IN THE TOP OF A CATCH BASIN JUST NORTH OF A SET OF
 HT2270'STEPS LEADING TO THE ENTRANCE OF AN INDOOR SWIMMING POOL.
 HT2270
 HT2270                          STATION RECOVERY (1995)
 HT2270
 HT2270'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1995 (JDD)
 HT2270'THE STATION WAS RECOVERED.  TO REACH THE STATION FROM THE INTERSECTION
 HT2270'OF LINCOLN AND AND STATE HIGHWAY 1, 19TH STREET, AT THE SOUTH END OF
 HT2270'GOLDEN GATE PARK GO SOUTH ON 19TH STREET FOR 1.95 MI (3.14 KM) TO THE
 HT2270'STATION ON THE RIGHT.$THE STATION IS NEAR THE ENTRANCE TO THE CHARLIE
 HT2270'SAVA SWIMMING POOL IN LARSEN PARK.  IT IS 27.6 M (90.6 FT) NORTH OF
 HT2270'THE CENTERLINE OF WAWONA, 20.3 M (66.6 FT) WEST OF THE CENTERLINE OF
 HT2270'19TH STREET, 7.3 M (24.0 FT) NORTHEAST OF A FLAG POLE, 4.4 M (14.4 FT)
 HT2270'EAST OF THE SOUTHEAST CORNER OF THE SWIMMING POOL BUILDING AND 1.1 M
 HT2270'(3.6 FT) NORTH OF THE CENTERLINE OF A CONCRETE STAIRWAY.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT2269 ***********************************************************************
 HT2269  DESIGNATION -  T 1320
 HT2269  PID         -  HT2269
 HT2269  STATE/COUNTY-  CA/SAN FRANCISCO
 HT2269  USGS QUAD   -  SAN FRANCISCO SOUTH (1995)
 HT2269
 HT2269                         *CURRENT SURVEY CONTROL
 HT2269  ___________________________________________________________________
 HT2269* NAD 83(1986)-  37 44 49.     (N)    122 28 34.     (W)     SCALED
 HT2269* NAVD 88     -       128.511  (meters)     421.62   (feet)  ADJUSTED
 HT2269  ___________________________________________________________________
 HT2269  GEOID HEIGHT-         -32.67  (meters)                     GEOID09
 HT2269  DYNAMIC HT  -         128.425 (meters)     421.34  (feet)  COMP
 HT2269  MODELED GRAV-     979,957.5   (mgal)                       NAVD 88
 HT2269
 HT2269  VERT ORDER  -  FIRST     CLASS I
 HT2269
 HT2269.The horizontal coordinates were scaled from a topographic map and have
 HT2269.an estimated accuracy of +/- 6 seconds.
 HT2269
 HT2269.The orthometric height was determined by differential leveling and
 HT2269.adjusted in June 1991.
 HT2269
 HT2269.The geoid height was determined by GEOID09.
 HT2269
 HT2269.The dynamic height is computed by dividing the NAVD 88
 HT2269.geopotential number by the normal gravity value computed on the
 HT2269.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 HT2269.degrees latitude (g = 980.6199 gals.).
 HT2269
 HT2269.The modeled gravity was interpolated from observed gravity values.
 HT2269
 HT2269;                   North         East     Units  Estimated Accuracy
 HT2269;SPC CA 3     -   640,230.    1,825,860.      MT  (+/- 180 meters Scaled)
 HT2269
 HT2269                          SUPERSEDED SURVEY CONTROL
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 HT2269
 HT2269  NGVD 29 (10/21/93)  127.671  (m)          418.87   (f) ADJUSTED    1 1
 HT2269
 HT2269.Superseded values are not recommended for survey control.
 HT2269.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
 HT2269.See file dsdata.txt to determine how the superseded data were derived.
 HT2269
 HT2269_U.S. NATIONAL GRID SPATIAL ADDRESS: 10SEG461778(NAD 83)
 HT2269_MARKER: DB = BENCH MARK DISK
 HT2269_SETTING: 30 = SET IN A LIGHT STRUCTURE
 HT2269_SP_SET: CURB
 HT2269_STAMPING: T 1320 1977
 HT2269_STABILITY: D = MARK OF QUESTIONABLE OR UNKNOWN STABILITY
 HT2269
 HT2269  HISTORY     - Date     Condition        Report By
 HT2269  HISTORY     - 1977     MONUMENTED       NGS
 HT2269
 HT2269                          STATION DESCRIPTION
 HT2269
 HT2269'DESCRIBED BY NATIONAL GEODETIC SURVEY 1977
 HT2269'IN SAN FRANCISCO.
 HT2269'AT SAN FRANCISCO, SET IN THE NORTHWEST CURB AT THE INTERSECTION OF
 HT2269'19TH AVE AND RIVERA STREET.
1        National Geodetic Survey,   Retrieval Date = JUNE  2, 2010
 HT1843 ***********************************************************************
 HT1843  DESIGNATION -  Q 568
 HT1843  PID         -  HT1843
 HT1843  STATE/COUNTY-  CA/SAN FRANCISCO
 HT1843  USGS QUAD   -  POINT BONITA (1993)
 HT1843
 HT1843                         *CURRENT SURVEY CONTROL
 HT1843  ___________________________________________________________________
 HT1843* NAD 83(1986)-  37 45 03.     (N)    122 30 30.     (W)     SCALED
 HT1843* NAVD 88     -         7.56   (+/-2cm)      24.8    (feet)  VERTCON
 HT1843  ___________________________________________________________________
 HT1843  GEOID HEIGHT-        -32.77  (meters)                      GEOID09
 HT1843  VERT ORDER  -  SECOND    CLASS 0 (See Below)
 HT1843
 HT1843.The horizontal coordinates were scaled from a topographic map and have
 HT1843.an estimated accuracy of +/- 6 seconds.
 HT1843
 HT1843.The NAVD 88 height was computed by applying the VERTCON shift value to
 HT1843.the NGVD 29 height (displayed under SUPERSEDED SURVEY CONTROL.)
 HT1843.The vertical order pertains to the NGVD 29 superseded va
```
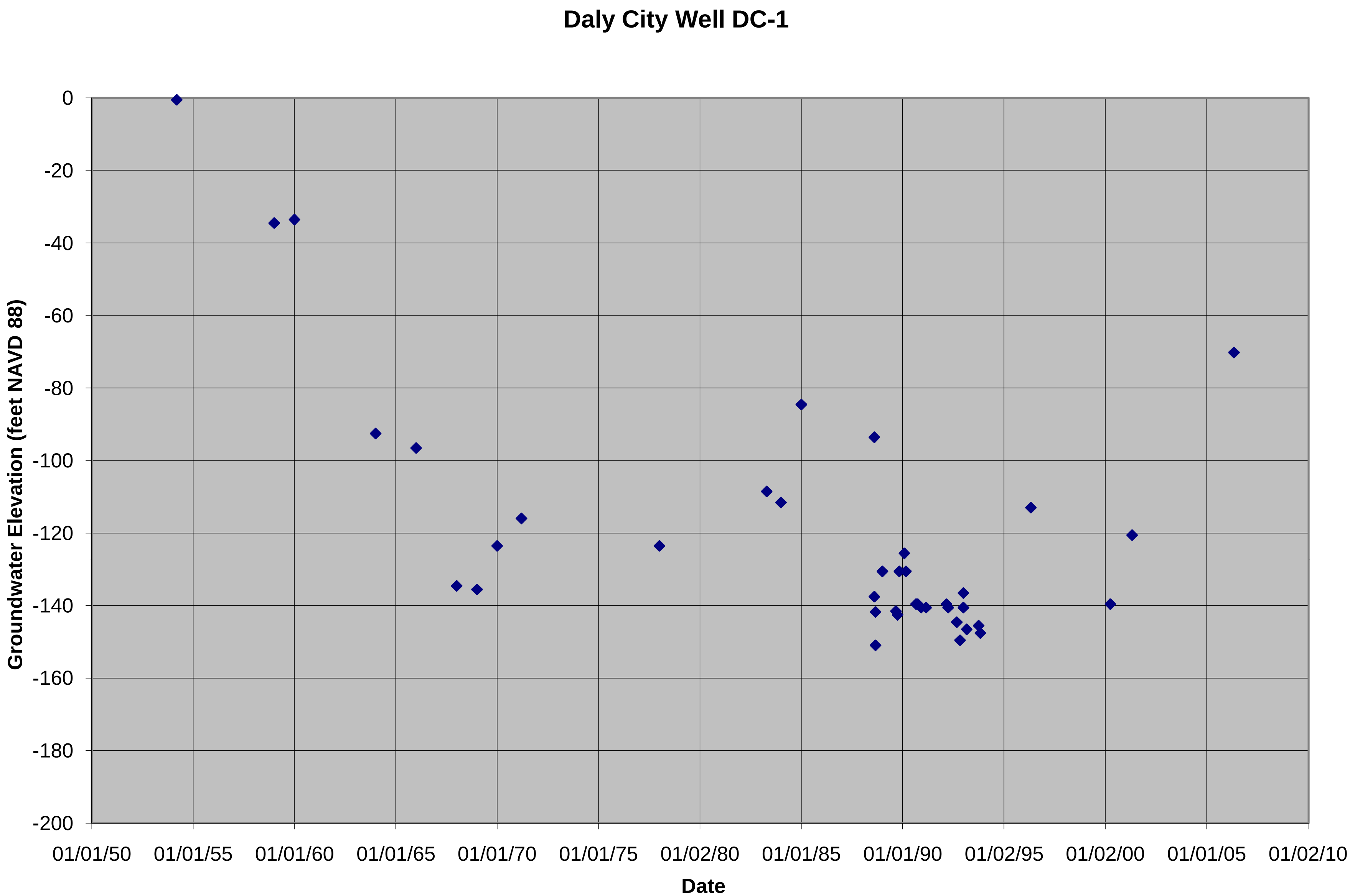
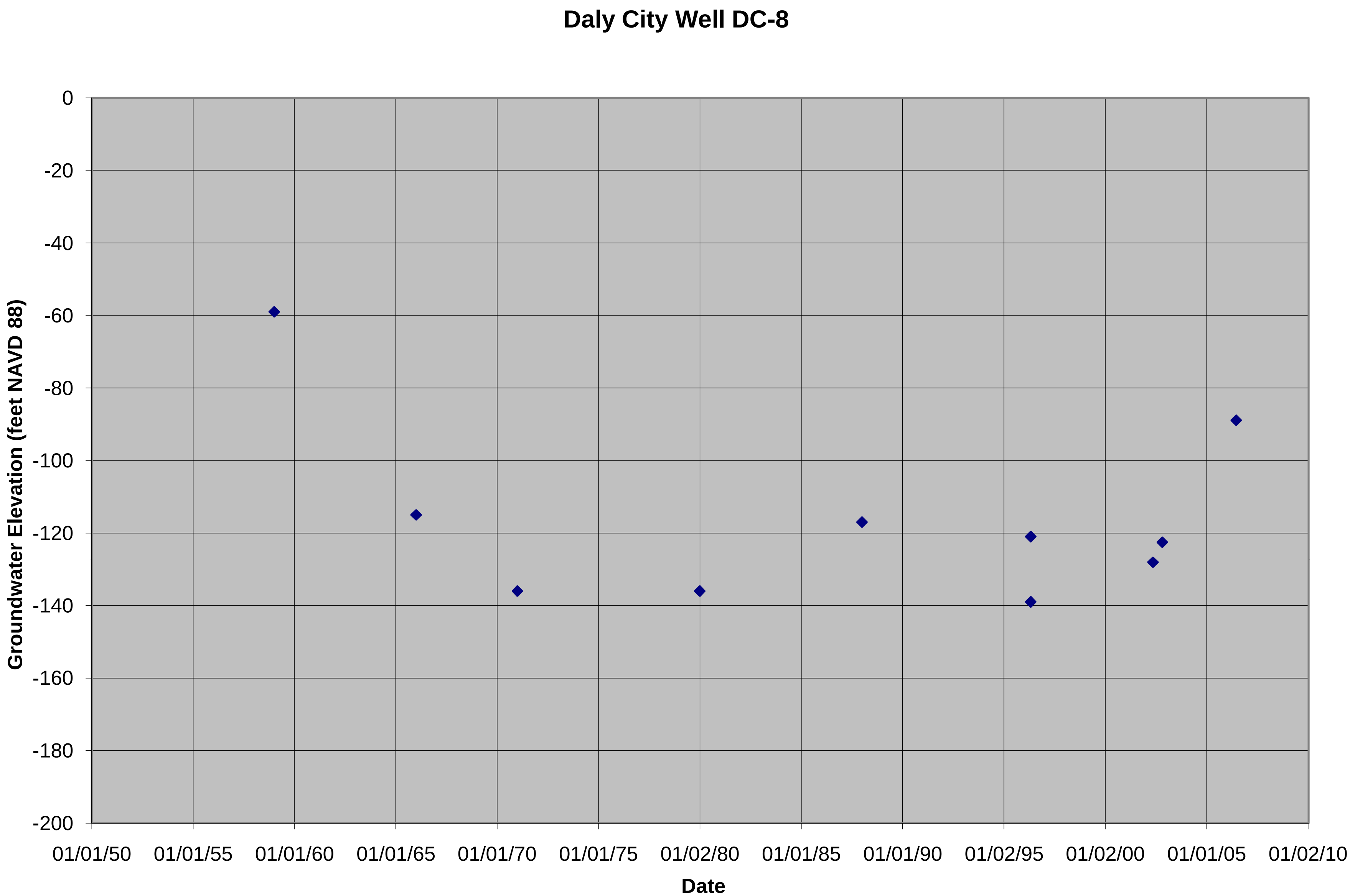
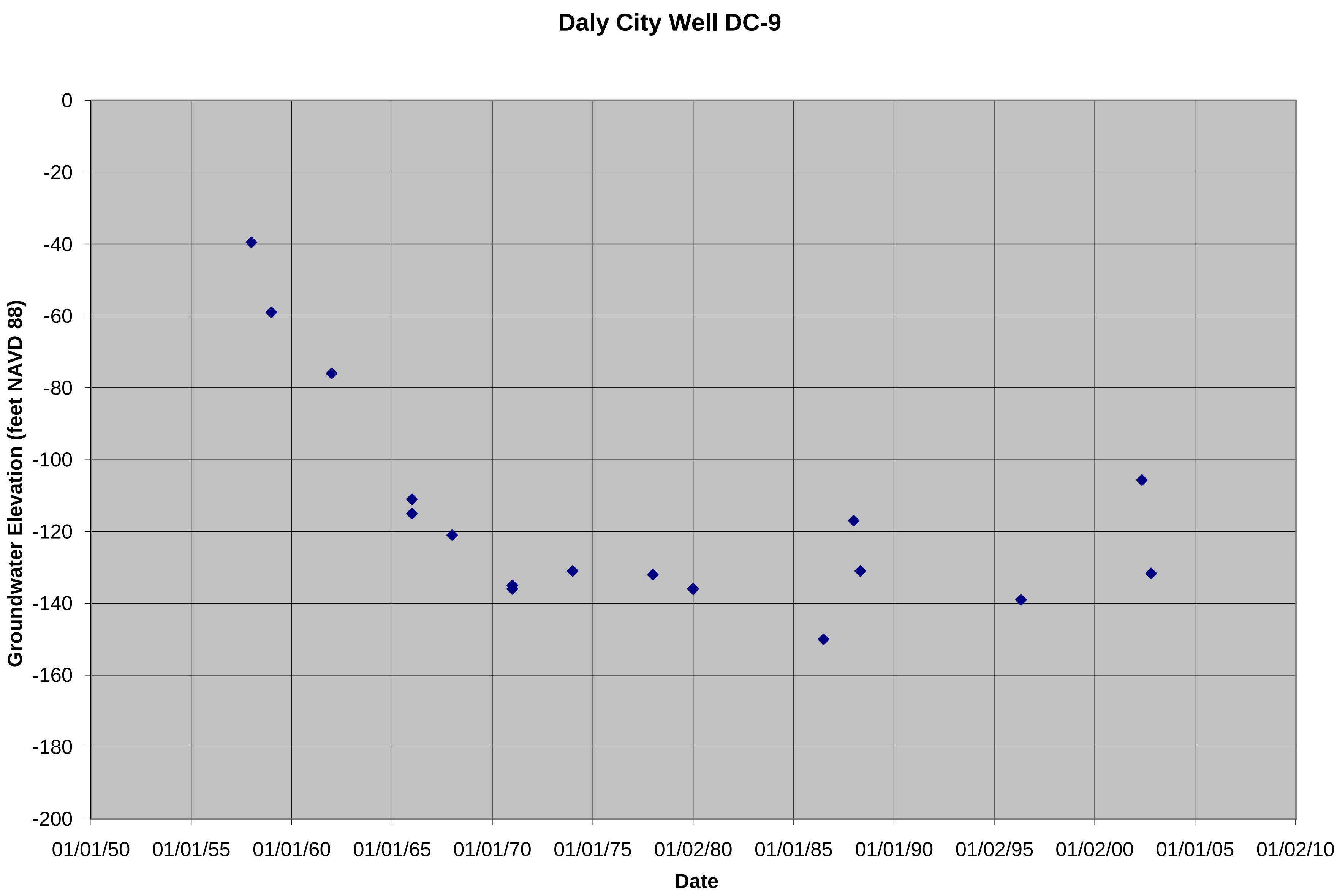
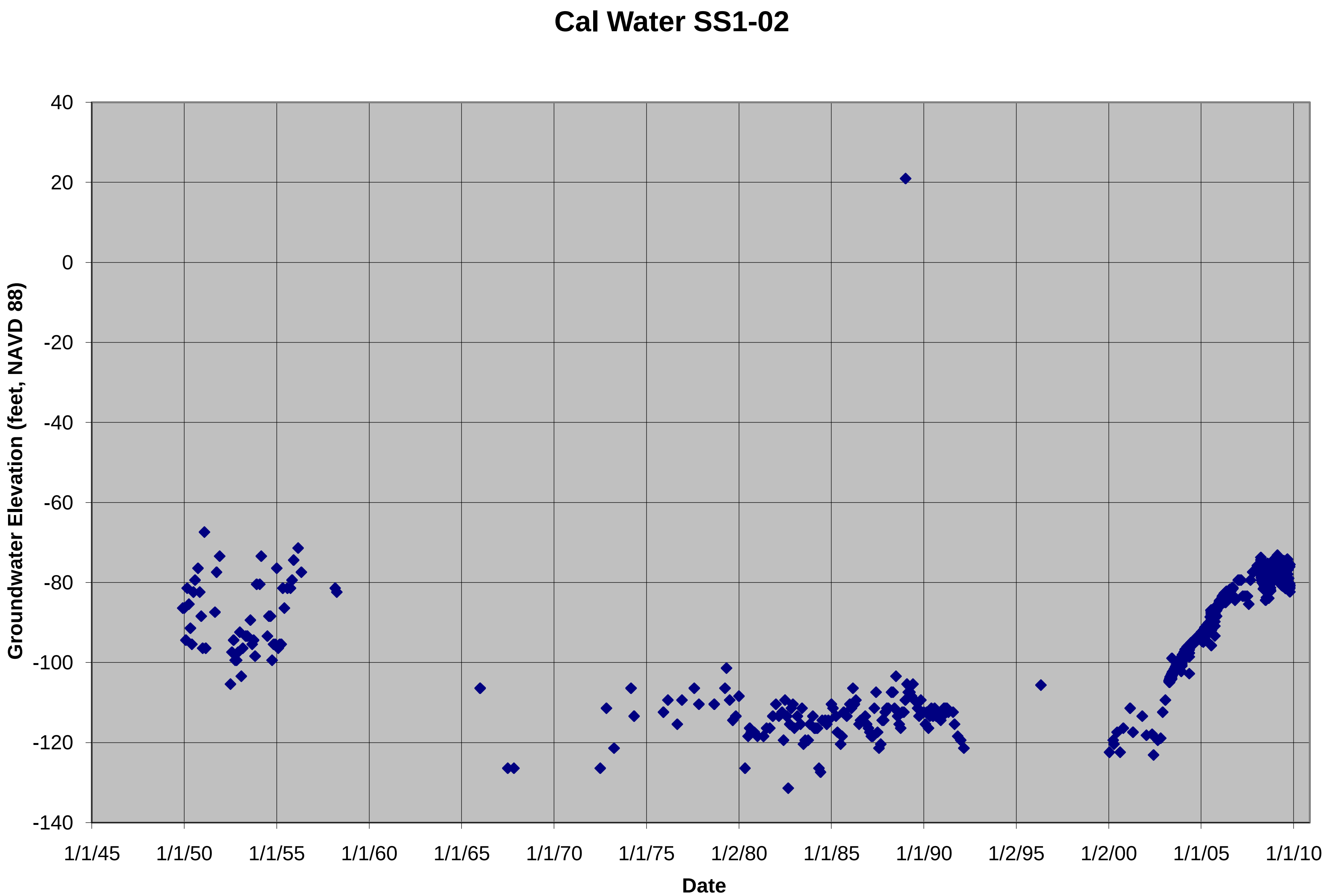

APPENDIX C



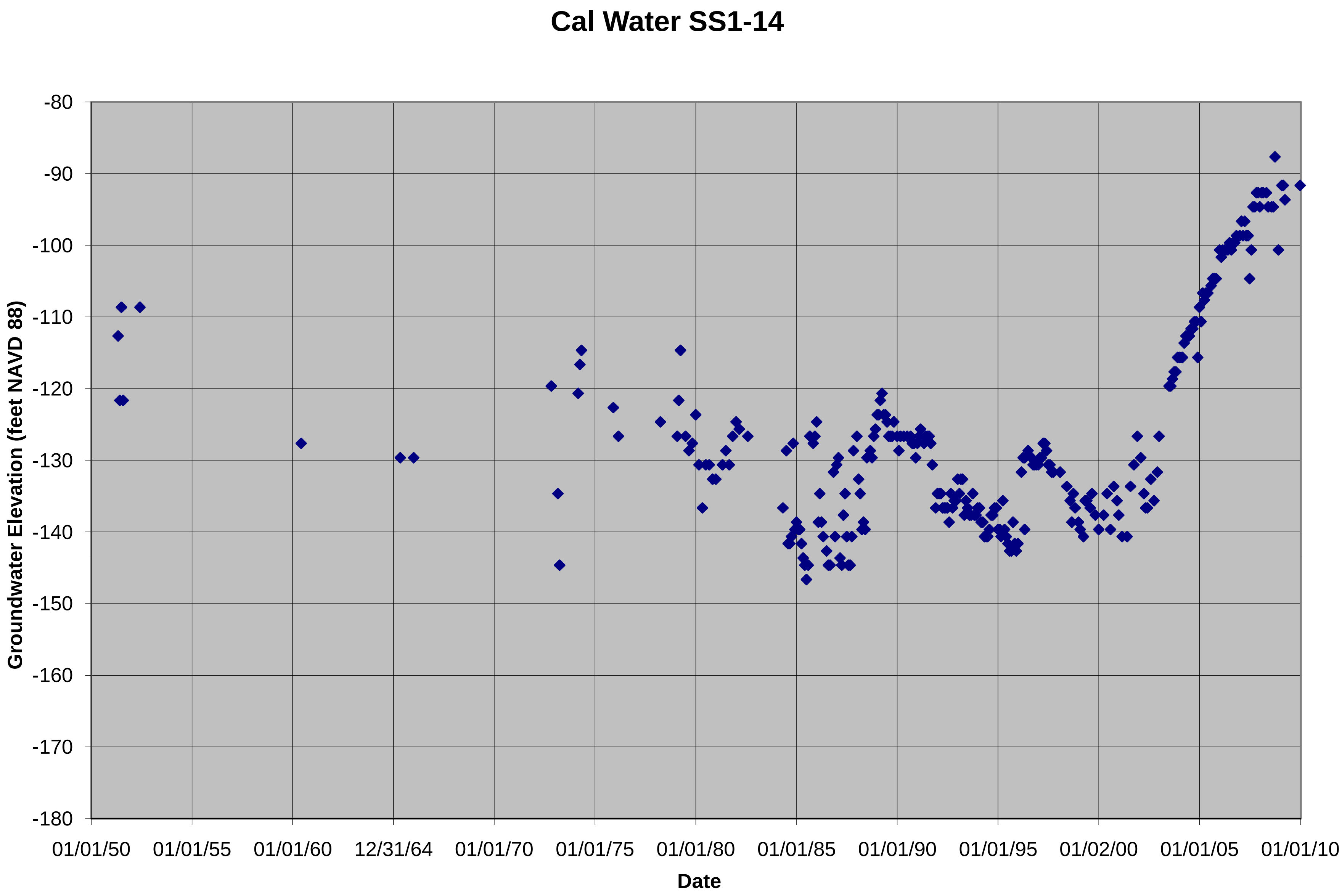
Daly City Well DC-1
Groundwater Elevation (feet NAVD 88)
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
01/01/50
01/01/55
01/01/60
01/01/65
01/01/70
01/01/75
01/02/80
01/01/85
01/01/90
01/02/95
01/02/00
01/01/05
01/02/10
Date


Daly City Well DC-8
Groundwater Elevation (feet NAVD 88)
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
01/01/50
01/01/55
01/01/60
01/01/65
01/01/70
01/01/75
01/02/80
01/01/85
01/01/90
01/02/95
01/02/00
01/01/05
01/02/10
Date

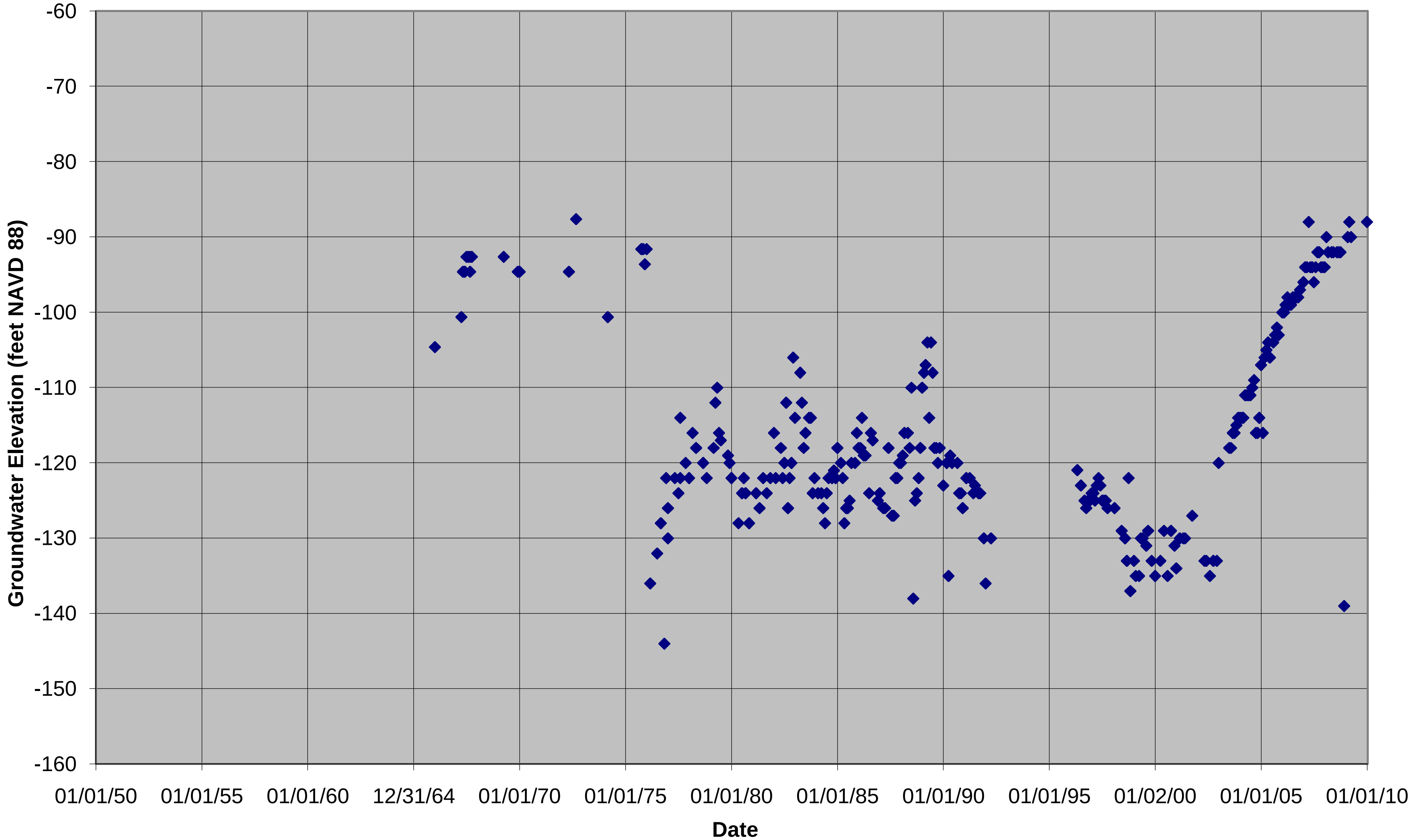

Daly City Well DC-9
Groundwater Elevation (feet NAVD 88)
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
01/01/50
01/01/55
01/01/60
01/01/65
01/01/70
01/01/75
01/02/80
01/01/85
01/01/90
01/02/95
01/02/00
01/01/05
01/02/10
Date

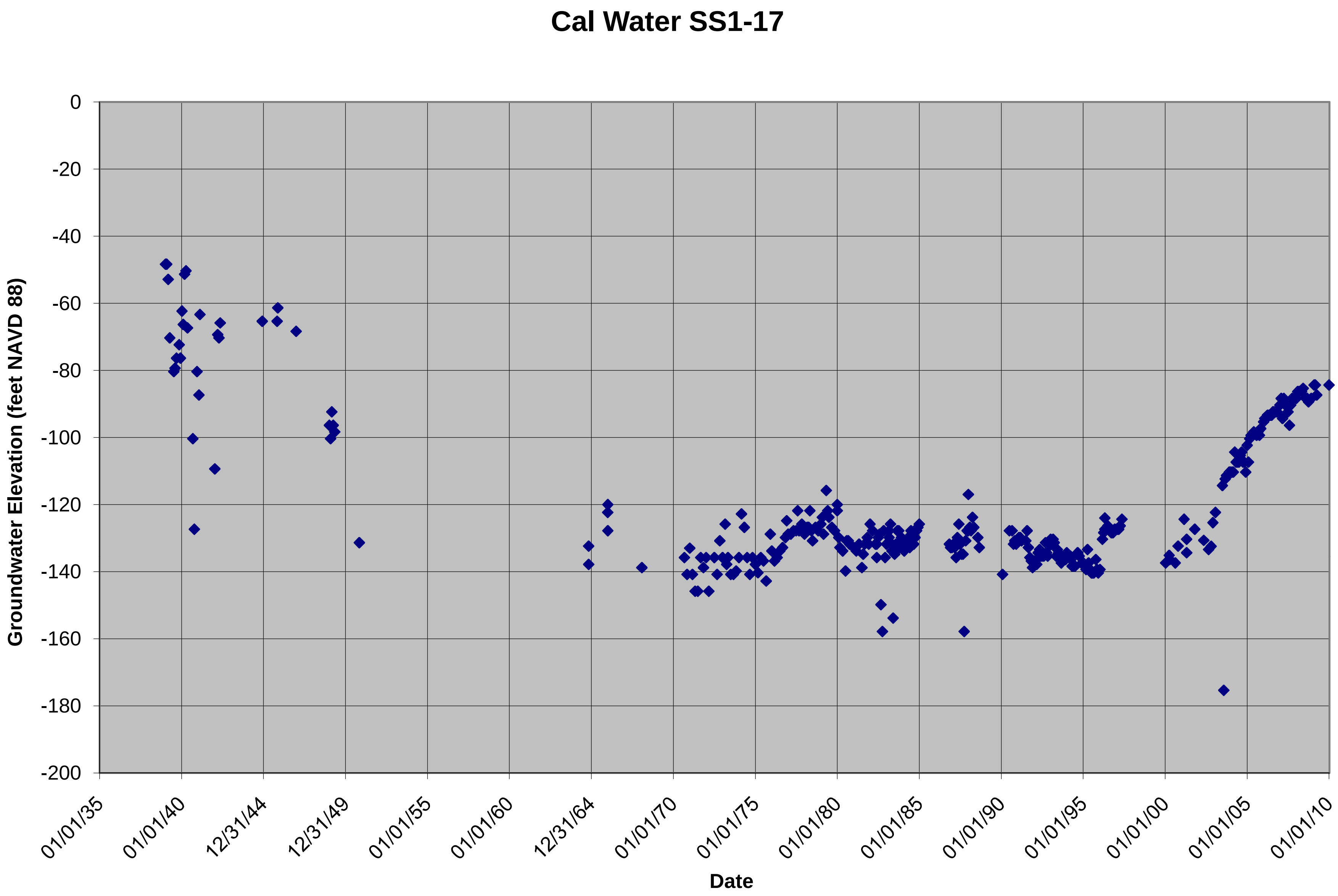


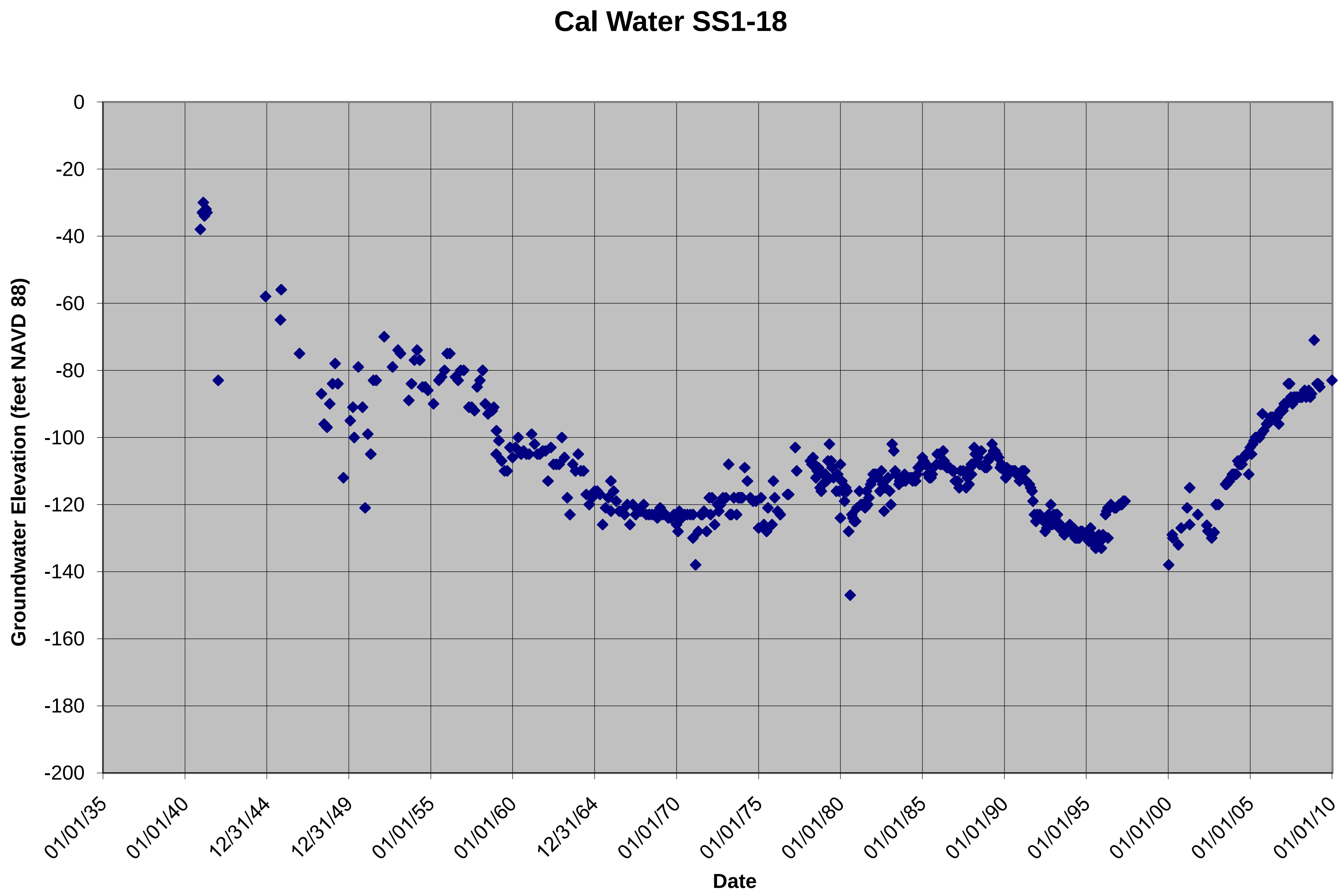
Cal Water SS1-02
Groundwater Elevation (feet, NAVD 88)
40
20
0
-20
-40
-60
-80
-100
-120
-140
1/1/45
1/1/50
1/1/55
1/1/60
1/1/65
1/1/70
1/1/75
1/2/80
1/1/85
1/1/90
1/2/95
1/2/00
1/1/05
1/1/10
Date


Cal Water SS1-14
Groundwater Elevation (feet NAVD 88)
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
01/01/50
01/01/55
01/01/60
12/31/64
01/01/70
01/01/75
01/01/80
01/01/85
01/01/90
01/01/95
01/02/00
01/01/05
01/01/10
Date

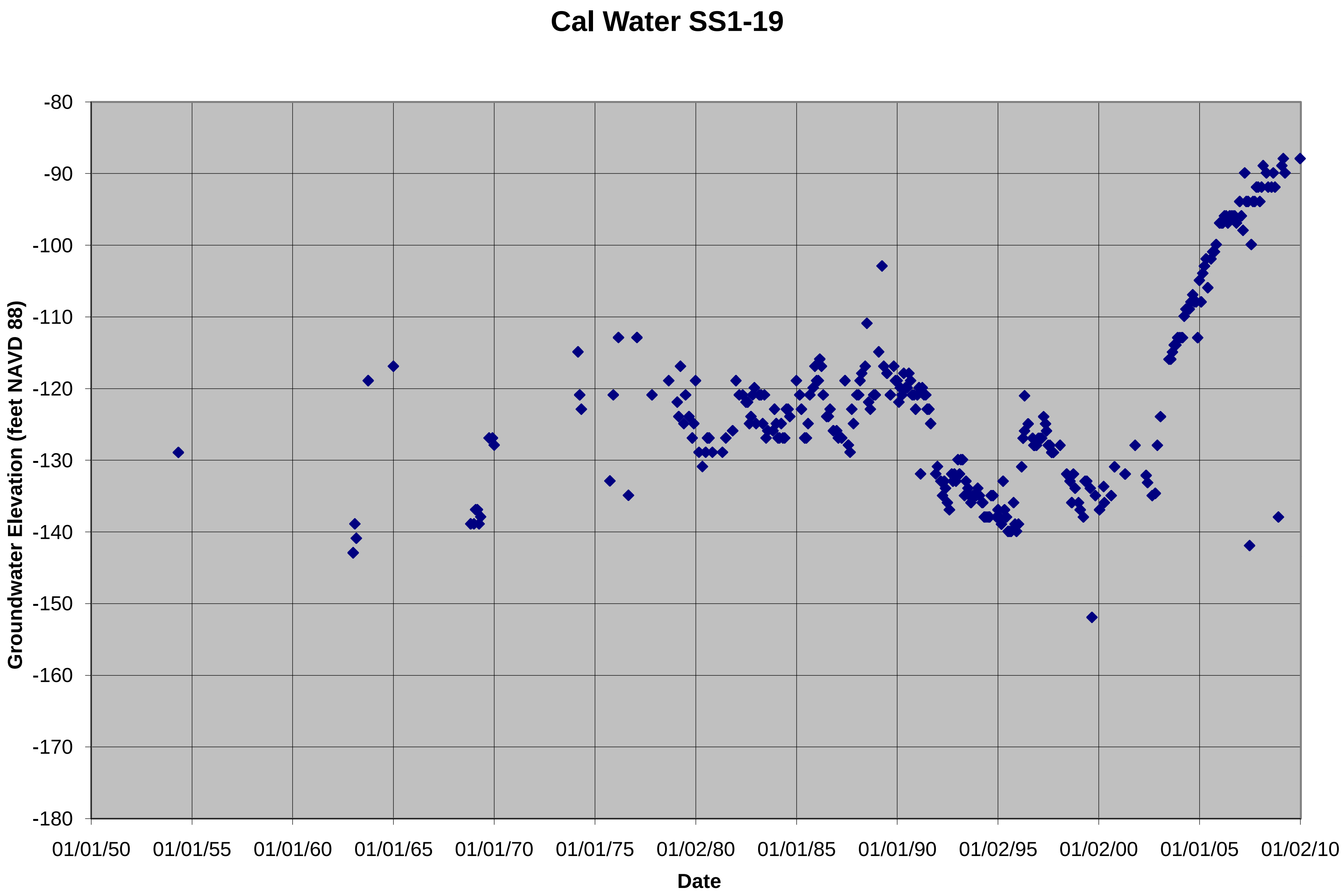
Cal Water SS1-15




Cal Water SS1-17
Groundwater Elevation (feet NAVD 88)
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
01/01/35
01/01/40
12/31/44
12/31/49
01/01/55
01/01/60
12/31/64
01/01/70
01/01/75
01/01/80
01/01/85
01/01/90
01/01/95
01/01/00
01/01/05
01/01/10
Date

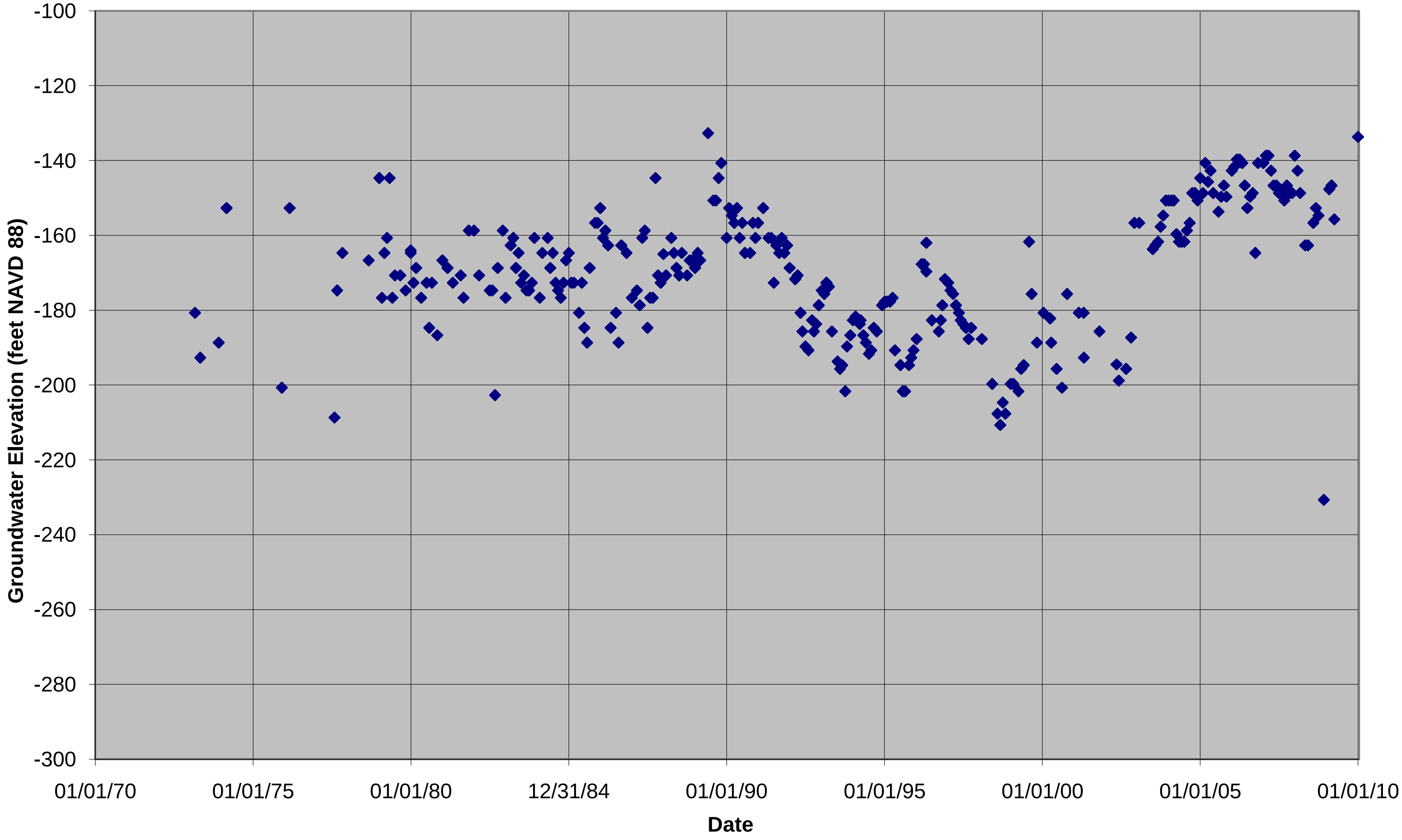


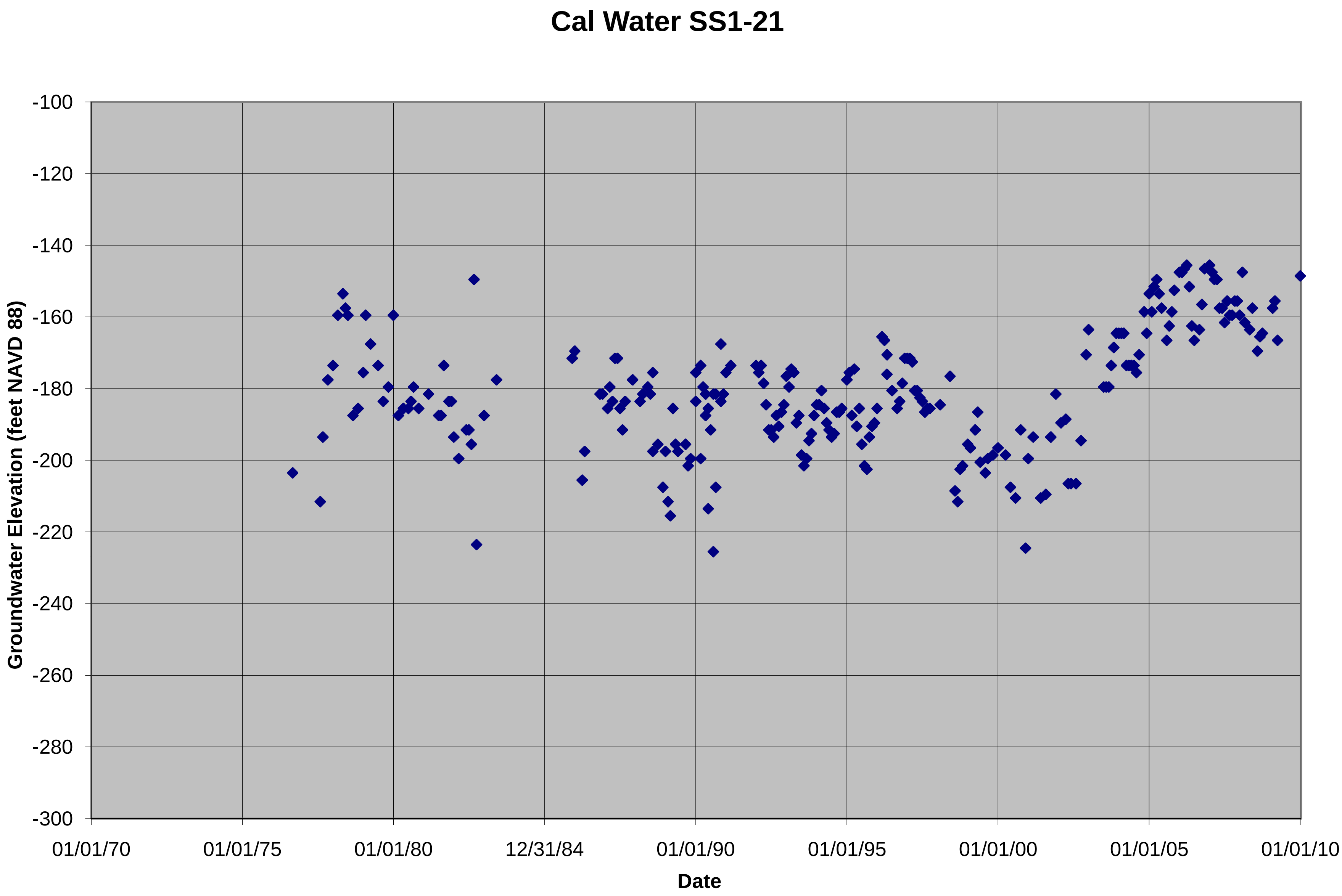
Cal Water SS1-18
Groundwater Elevation (feet NAVD 88)
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
01/01/35
01/01/40
12/31/44
12/31/49
01/01/55
01/01/60
12/31/64
01/01/70
01/01/75
01/01/80
01/01/85
01/01/90
01/01/95
01/01/00
01/01/05
01/01/10
Date



Cal Water SS1-19
Groundwater Elevation (feet NAVD 88)
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
01/01/50
01/01/55
01/01/60
01/01/65
01/01/70
01/01/75
01/02/80
01/01/85
01/01/90
01/02/95
01/02/00
01/01/05
01/02/10
Date

Cal Water SS1-20





Cal Water SS1-21
Groundwater Elevation (feet NAVD 88)
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
01/01/70
01/01/75
01/01/80
12/31/84
01/01/90
01/01/95
01/01/00
01/01/05
01/01/10
Date

APPENDIX D

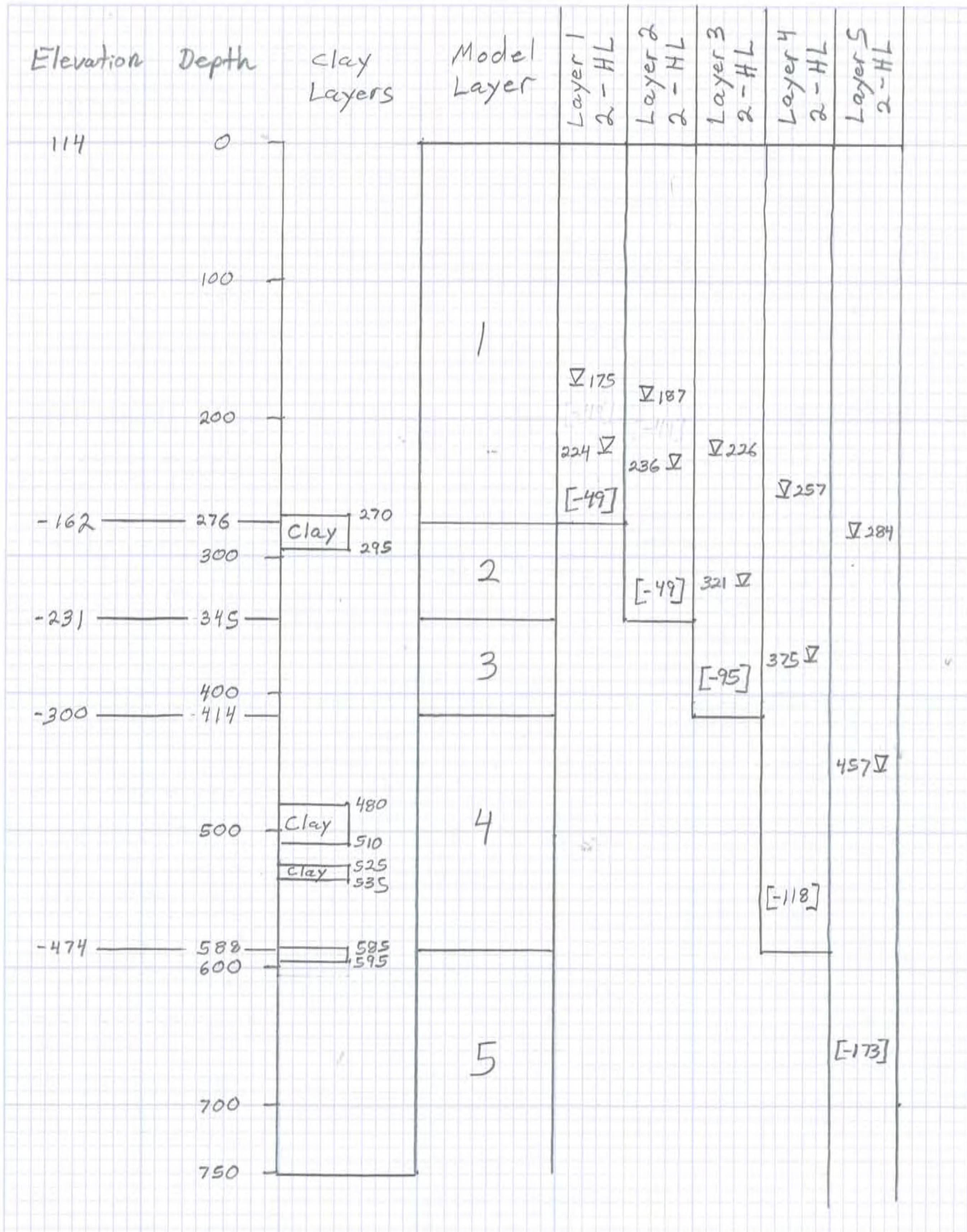
Form: Vta.(comp 11/93)
COMPUTATIONS

Job No.: ______ By: PML Date: 4/6/12

Checked By: ______ Date: ______ Sheet No. 1 of 4

Subject: CUP-19 Scenario 2 compared to Historic Lows

FUGRO



Form: Vta.(comp 11/93)

COMPUTATIONS

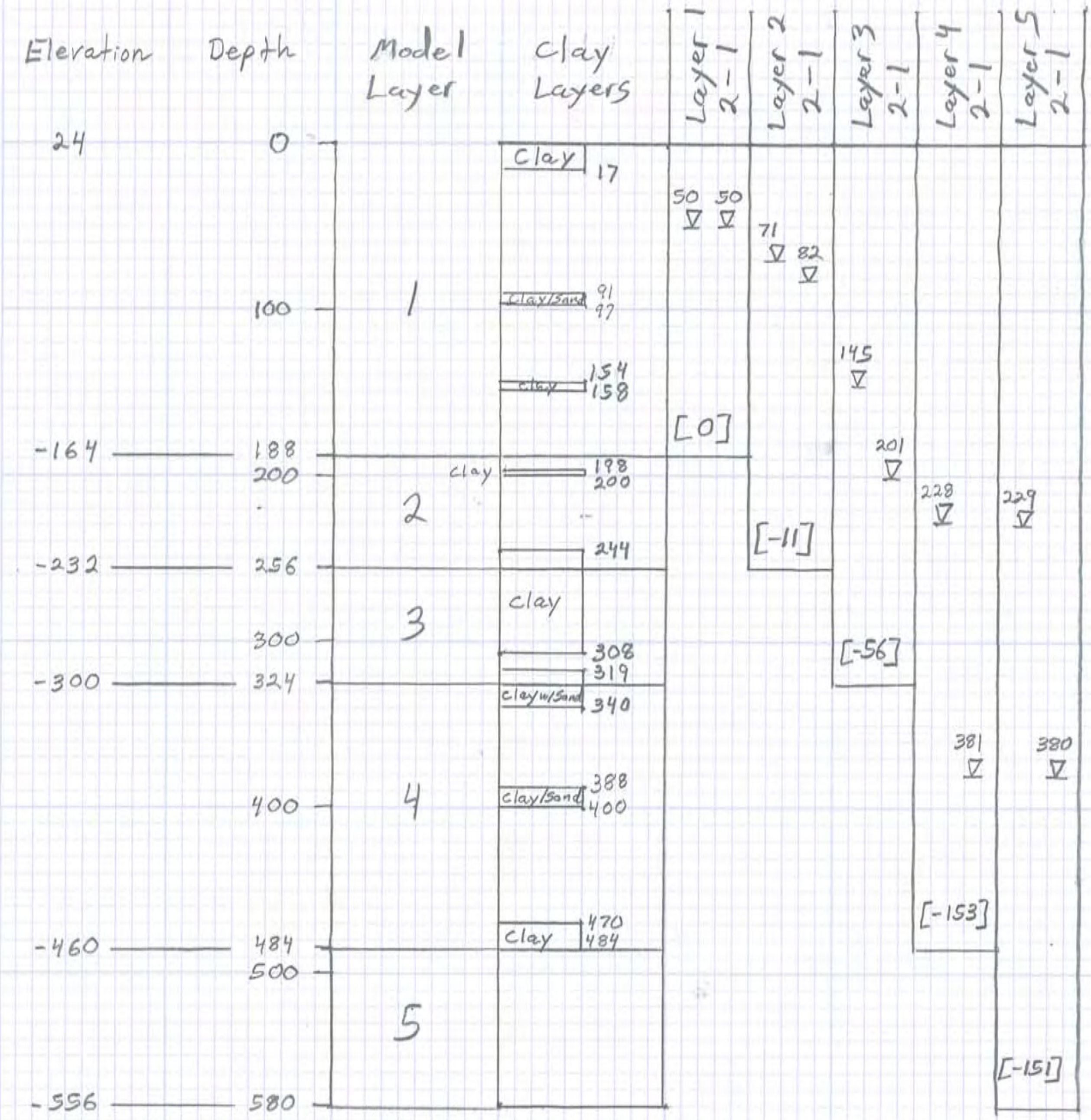
Job No.: ______ By: PML Date: 4/6/12

Checked By: ______ Date: ______ Sheet No. ____ of ____

Subject: CUP-41-4 Scenario 2

Compared to Scenario 1

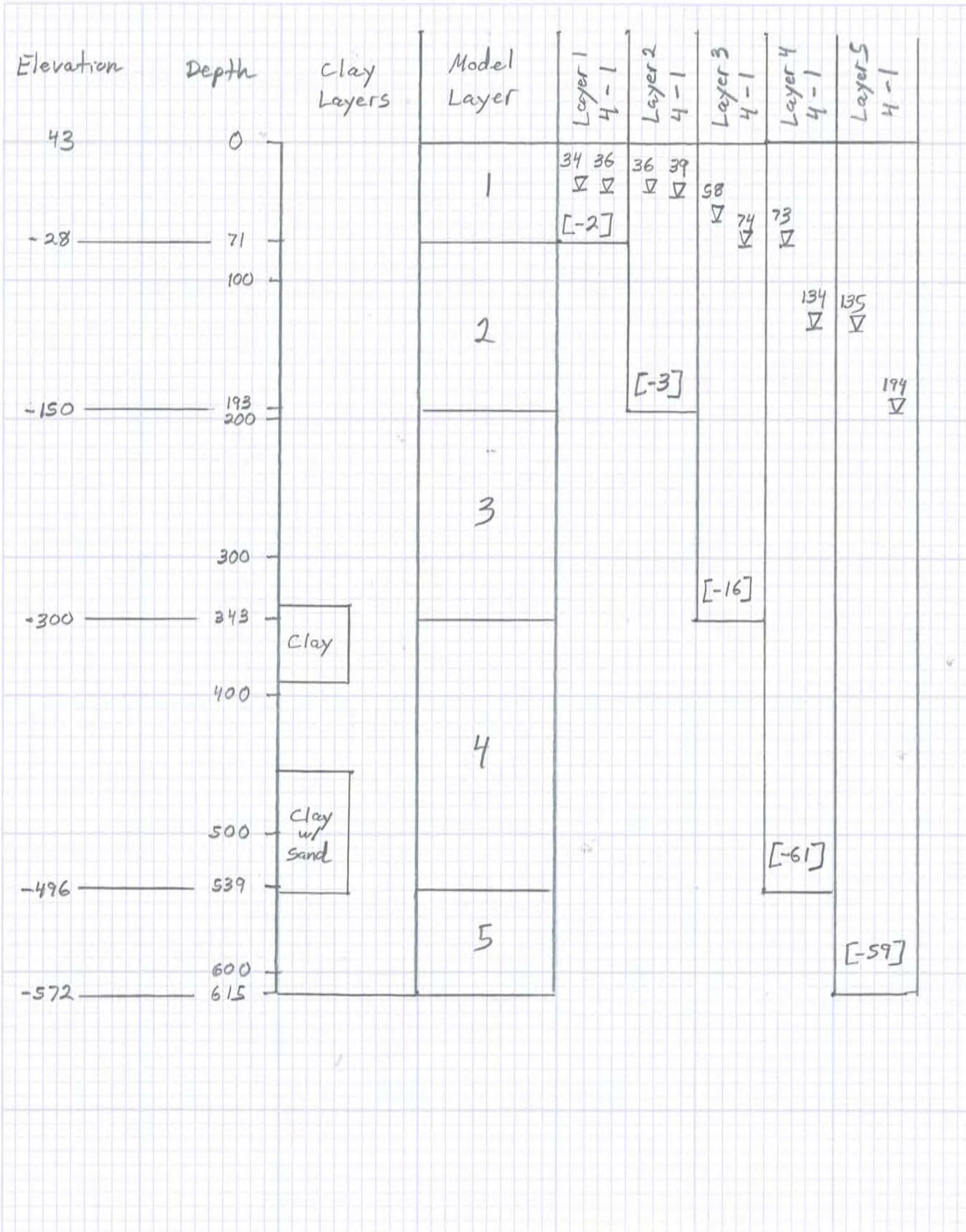
FUGRO



Form: Vta.(comp 11/93)
COMPUTATIONS

Job No.: ______ By: PML Date: 4/6/12
Checked By: ______ Date: ______ Sheet No. 3 of 4
Subject: LMPS Scenario 4

Compared to 1



Form: Vta.(comp 11/93)

COMPUTATIONS

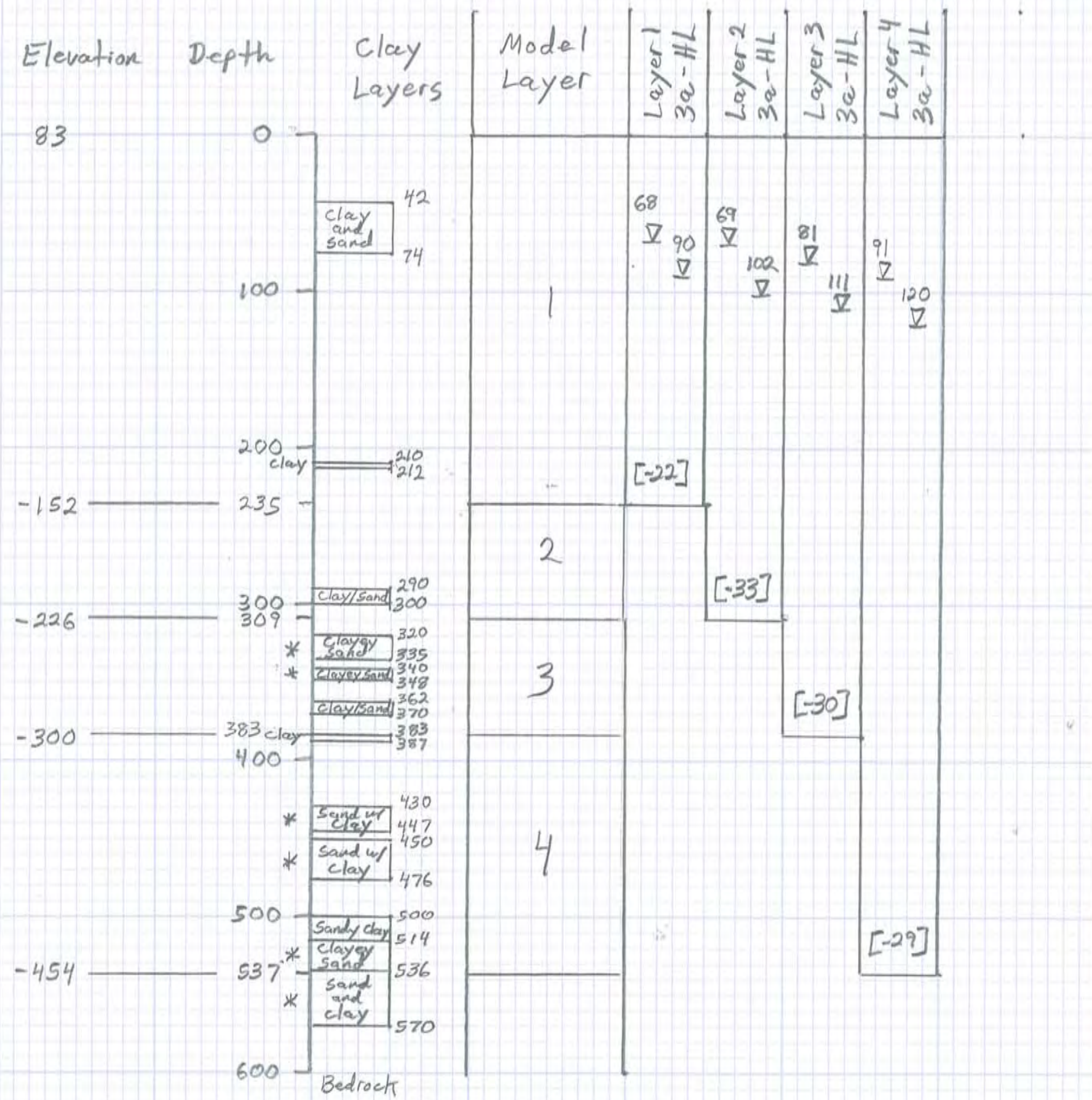
Job No.: ______ By: PML Date: 4/6/12

Checked By: ______ Date: ______ Sheet No. 4 of 4

Subject: South Sunset Scenario 3a

Compared to Historic Lows

FUGRO



APPENDIX E

Date	4/5/2012
Job No.	103.128
Boring ID	CUP-19
Scenario	2 to HL
Elevation	114 feet AMSL
Depth to Compressible	270 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec
1	175	224	0.005	0.01	0.03	0.18
2	187	236	0.005	0.01	0.03	0.18
3	226	321	0.005	0.01	0.03	0.18
4	257	375	0.005	0.01	0.03	0.18
5	284	457	0.005	0.01	0.03	0.18

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	50	25	114	64	89	50	123	175	224	3,075	6,149	3,075	0	0	3,075	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	Sand	50	100	75	64	14	39	50	124	175	224	9,242	12,334	9,242	0	0	9,242	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	3	Sand	100	150	125	14	-36	-11	50	124	175	224	15,436	18,537	15,436	0	0	15,436	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	4	Sand	150	200	175	-36	-86	-61	50	124	175	224	21,648	24,759	21,648	0	0	21,648	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	5	Sand	200	250	225	-86	-136	-111	50	125	175	224	27,879	30,999	27,879	0	0	27,879	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	6	Sand	250	270	260	-136	-156	-146	20	125	175	224	32,251	33,502	32,251	0	0	32,251	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	7	Clay	270	276	273	-156	-162	-159	6	125	175	224	33,878	34,253	27,763	98	6,115	30,820	49	3,058	3,058	1.11	0.030	0.00	0.10	0.10
2	8	Clay	276	295	285.5	-162	-181	-171.5	19	126	187	236	35,446	36,639	29,300	99	6,146	32,357	50	3,089	3,058	1.10	0.030	0.00	0.29	0.29
2	9	Sand	295	320	307.5	-181	-206	-193.5	25	126	187	236	38,213	39,787	30,694	121	7,519	33,752	72	4,462	3,058	1.10	0.005	0.06	0.00	0.06
2	10	Sand	320	345	332.5	-206	-231	-218.5	25	126	187	236	41,362	42,936	32,282	146	9,079	35,340	97	6,022	3,058	1.09	0.005	0.06	0.00	0.06
3	11	Sand	345	370	357.5	-231	-256	-243.5	25	126	226	321	44,515	46,094	36,310	132	8,206	42,238	37	2,278	5,928	1.16	0.005	0.10	0.00	0.10
3	12	Sand	370	400	385	-256	-286	-271	30	126	226	321	47,989	49,884	38,068	159	9,922	43,996	64	3,994	5,928	1.16	0.005	0.11	0.00	0.11
3	13	Sand	400	414	407	-286	-300	-293	14	127	226	321	50,771	51,658	39,477	181	11,294	45,405	86	5,366	5,928	1.15	0.005	0.05	0.00	0.05
4	14	Sand	414	440	427	-300	-326	-313	26	127	257	375	53,311	54,964	42,703	170	10,608	50,066	52	3,245	7,363	1.17	0.005	0.11	0.00	0.11
4	15	Sand	440	480	460	-326	-366	-346	40	127	257	375	57,506	60,049	44,839	203	12,667	52,202	85	5,304	7,363	1.16	0.005	0.16	0.00	0.16
4	16	Clay	480	495	487.5	-366	-381	-373.5	15	128	257	375	61,005	61,962	46,622	231	14,383	53,985	113	7,020	7,363	1.16	0.030	0.00	0.34	0.34
4	17	Clay	495	510	502.5	-381	-396	-388.5	15	128	257	375	62,918	63,875	47,599	246	15,319	54,962	128	7,956	7,363	1.15	0.030	0.00	0.34	0.34
4	18	Sand	510	525	517.5	-396	-411	-403.5	15	128	257	375	64,831	65,787	48,576	261	16,255	55,939	143	8,892	7,363	1.15	0.005	0.06	0.00	0.06
4	19	Clay	525	535	530	-411	-421	-416	10	128	257	375	66,425	67,063	49,390	273	17,035	56,753	155	9,672	7,363	1.15	0.030	0.00	0.22	0.22
4	20	Sand	535	560	547.5	-421	-446	-433.5	25	128	257	375	68,657	70,251	50,530	291	18,127	57,893	173	10,764	7,363	1.15	0.005	0.09	0.00	0.09
4	21	Sand	560	585	572.5	-446	-471	-458.5	25	128	257	375	71,850	73,450	52,163	316	19,687	59,526	198	12,324	7,363	1.14	0.005	0.09	0.00	0.09
4	22	Clay	585	588	586.5	-471	-474	-472.5	3	128	257	375	73,641	73,833	53,081	330	20,561	60,444	212	13,198	7,363	1.14	0.030	0.00	0.06	0.06
5	23	Clay	588	595	591.5	-474	-481	-477.5	7	128	284	457	74,281	74,729	55,093	308	19,188	65,888	135	8,393	10,795	1.20	0.030	0.00	0.20	0.20
5	24	Sand	595	600	597.5	-481	-486	-483.5	5	128	284	457	75,050	75,371	55,487	314	19,562	66,283	141	8,767	10,795	1.19	0.005	0.02	0.00	0.02
5	25	Sand	600	650	625	-486	-536	-511	50	128	284	457	78,580	81,788	57,301	341	21,278	68,096	168	10,483	10,795	1.19	0.005	0.22	0.00	0.22
5	26	Sand	650	700	675	-536	-586	-561	50	128	284	457	84,997	88,206	60,599	391	24,398	71,394	218	13,603	10,795	1.18	0.005	0.21	0.00	0.21
5	27	Sand	700	750	725	-586	-636	-611	50	128	284	457	91,415	94,624	63,897	441	27,518	74,692	268	16,723	10,795	1.17	0.005	0.20	0.00	0.20
																							Total Settlement (in) =	1.54	1.55	3.09
																							Total Layer Thickness (feet) =	405	75	480

Date	4/5/2012
Job No.	103.128
Boring ID	CUP-19
Scenario	4 to HL
Elevation	114 feet AMSL
Depth to Compressible	270 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec
1	175	221	0.005	0.01	0.03	0.18
2	187	232	0.005	0.01	0.03	0.18
3	226	314	0.005	0.01	0.03	0.18
4	257	369	0.005	0.01	0.03	0.18
5	284	452	0.005	0.01	0.03	0.18

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	50	25	114	64	89	50	123	175	221	3,075	6,149	3,075	0	0	3,075	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	Sand	50	100	75	64	14	39	50	124	175	221	9,242	12,334	9,242	0	0	9,242	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	3	Sand	100	150	125	14	-36	-11	50	124	175	221	15,436	18,537	15,436	0	0	15,436	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	4	Sand	150	200	175	-36	-86	-61	50	124	175	221	21,648	24,759	21,648	0	0	21,648	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	5	Sand	200	250	225	-86	-136	-111	50	125	175	221	27,879	30,999	27,879	0	0	27,879	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	6	Sand	250	270	260	-136	-156	-146	20	125	175	221	32,251	33,502	32,251	0	0	32,251	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	7	Clay	270	276	273	-156	-162	-159	6	125	175	221	33,878	34,253	27,763	98	6,115	30,633	52	3,245	2,870	1.10	0.030	0.00	0.09	0.09
2	8	Clay	276	295	285.5	-162	-181	-171.5	19	126	187	232	35,446	36,639	29,300	99	6,146	32,108	54	3,338	2,808	1.10	0.030	0.00	0.27	0.27
2	9	Sand	295	320	307.5	-181	-206	-193.5	25	126	187	232	38,213	39,787	30,694	121	7,519	33,502	76	4,711	2,808	1.09	0.005	0.06	0.00	0.06
2	10	Sand	320	345	332.5	-206	-231	-218.5	25	126	187	232	41,362	42,936	32,282	146	9,079	35,090	101	6,271	2,808	1.09	0.005	0.05	0.00	0.05
3	11	Sand	345	370	357.5	-231	-256	-243.5	25	126	226	314	44,515	46,094	36,310	132	8,206	41,801	44	2,714	5,491	1.15	0.005	0.09	0.00	0.09
3	12	Sand	370	400	385	-256	-286	-271	30	126	226	314	47,989	49,884	38,068	159	9,922	43,559	71	4,430	5,491	1.14	0.005	0.11	0.00	0.11
3	13	Sand	400	414	407	-286	-300	-293	14	127	226	314	50,771	51,658	39,477	181	11,294	44,968	93	5,803	5,491	1.14	0.005	0.05	0.00	0.05
4	14	Sand	414	440	427	-300	-326	-313	26	127	257	369	53,311	54,964	42,703	170	10,608	49,692	58	3,619	6,989	1.16	0.005	0.10	0.00	0.10
4	15	Sand	440	480	460	-326	-366	-346	40	127	257	369	57,506	60,049	44,839	203	12,667	51,828	91	5,678	6,989	1.16	0.005	0.15	0.00	0.15
4	16	Clay	480	495	487.5	-366	-381	-373.5	15	128	257	369	61,005	61,962	46,622	231	14,383	53,611	119	7,394	6,989	1.15	0.030	0.00	0.33	0.33
4	17	Clay	495	510	502.5	-381	-396	-388.5	15	128	257	369	62,918	63,875	47,599	246	15,319	54,588	134	8,330	6,989	1.15	0.030	0.00	0.32	0.32
4	18	Sand	510	525	517.5	-396	-411	-403.5	15	128	257	369	64,831	65,787	48,576	261	16,255	55,565	149	9,266	6,989	1.14	0.005	0.05	0.00	0.05
4	19	Clay	525	535	530	-411	-421	-416	10	128	257	369	66,425	67,063	49,390	273	17,035	56,379	161	10,046	6,989	1.14	0.030	0.00	0.21	0.21
4	20	Sand	535	560	547.5	-421	-446	-433.5	25	128	257	369	68,657	70,251	50,530	291	18,127	57,519	179	11,138	6,989	1.14	0.005	0.08	0.00	0.08
4	21	Sand	560	585	572.5	-446	-471	-458.5	25	128	257	369	71,850	73,450	52,163	316	19,687	59,152	204	12,698	6,989	1.13	0.005	0.08	0.00	0.08
4	22	Clay	585	588	586.5	-471	-474	-472.5	3	128	257	369	73,641	73,833	53,081	330	20,561	60,069	218	13,572	6,989	1.13	0.030	0.00	0.06	0.06
5	23	Clay	588	595	591.5	-474	-481	-477.5	7	128	284	452	74,281	74,729	55,093	308	19,188	65,576	140	8,705	10,483	1.19	0.030	0.00	0.19	0.19
5	24	Sand	595	600	597.5	-481	-486	-483.5	5	128	284	452	75,050	75,371	55,487	314	19,562	65,971	146	9,079	10,483	1.19	0.005	0.02	0.00	0.02
5	25	Sand	600	650	625	-486	-536	-511	50	128	284	452	78,580	81,788	57,301	341	21,278	67,784	173	10,795	10,483	1.18	0.005	0.22	0.00	0.22
5	26	Sand	650	700	675	-536	-586	-561	50	128	284	452	84,997	88,206	60,599	391	24,398	71,082	223	13,915	10,483	1.17	0.005	0.21	0.00	0.21
5	27	Sand	700	750	725	-586	-636	-611	50	128	284	452	91,415	94,624	63,897	441	27,518	74,380	273	17,035	10,483	1.16	0.005	0.20	0.00	0.20
																							Total Settlement (in) =	1.48	1.47	2.94
																							Total Layer Thickness (feet) =	405	75	480

Date 4/5/2012
Job No. 103.128

Boring ID CUP-19
Scenario 2 to 1
Elevation 114 feet AMSL
Depth to Compressible 270 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec
1	193	224	0.005	0.01	0.03	0.18
2	201	236	0.005	0.01	0.03	0.18
3	229	321	0.005	0.01	0.03	0.18
4	250	375	0.005	0.01	0.03	0.18
5	308	457	0.005	0.01	0.03	0.18

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	50	25	114	64	89	50	123	193	224	3,075	6,149	3,075	0	0	3,075	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	Sand	50	100	75	64	14	39	50	124	193	224	9,242	12,334	9,242	0	0	9,242	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	3	Sand	100	150	125	14	-36	-11	50	124	193	224	15,436	18,537	15,436	0	0	15,436	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	4	Sand	150	200	175	-36	-86	-61	50	124	193	224	21,648	24,759	21,648	0	0	21,648	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	5	Sand	200	250	225	-86	-136	-111	50	125	193	224	27,879	30,999	27,879	0	0	27,879	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	6	Sand	250	270	260	-136	-156	-146	20	125	193	224	32,251	33,502	32,251	0	0	32,251	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	7	Clay	270	276	273	-156	-162	-159	6	125	193	224	33,878	34,253	28,886	80	4,992	30,820	49	3,058	1,934	1.07	0.030	0.00	0.06	0.06
2	8	Clay	276	295	285.5	-162	-181	-171.5	19	126	201	236	35,446	36,639	30,173	85	5,273	32,357	50	3,089	2,184	1.07	0.030	0.00	0.21	0.21
2	9	Sand	295	320	307.5	-181	-206	-193.5	25	126	201	236	38,213	39,787	31,568	107	6,646	33,752	72	4,462	2,184	1.07	0.005	0.04	0.00	0.04
2	10	Sand	320	345	332.5	-206	-231	-218.5	25	126	201	236	41,362	42,936	33,156	132	8,206	35,340	97	6,022	2,184	1.07	0.005	0.04	0.00	0.04
3	11	Sand	345	370	357.5	-231	-256	-243.5	25	126	229	321	44,515	46,094	36,497	129	8,018	42,238	37	2,278	5,741	1.16	0.005	0.10	0.00	0.10
3	12	Sand	370	400	385	-256	-286	-271	30	126	229	321	47,989	49,884	38,255	156	9,734	43,996	64	3,994	5,741	1.15	0.005	0.11	0.00	0.11
3	13	Sand	400	414	407	-286	-300	-293	14	127	229	321	50,771	51,658	39,664	178	11,107	45,405	86	5,366	5,741	1.14	0.005	0.05	0.00	0.05
4	14	Sand	414	440	427	-300	-326	-313	26	127	250	375	53,311	54,964	42,266	177	11,045	50,066	52	3,245	7,800	1.18	0.005	0.11	0.00	0.11
4	15	Sand	440	480	460	-326	-366	-346	40	127	250	375	57,506	60,049	44,402	210	13,104	52,202	85	5,304	7,800	1.18	0.005	0.17	0.00	0.17
4	16	Clay	480	495	487.5	-366	-381	-373.5	15	128	250	375	61,005	61,962	46,185	238	14,820	53,985	113	7,020	7,800	1.17	0.030	0.00	0.37	0.37
4	17	Clay	495	510	502.5	-381	-396	-388.5	15	128	250	375	62,918	63,875	47,162	253	15,756	54,962	128	7,956	7,800	1.17	0.030	0.00	0.36	0.36
4	18	Sand	510	525	517.5	-396	-411	-403.5	15	128	250	375	64,831	65,787	48,139	268	16,692	55,939	143	8,892	7,800	1.16	0.005	0.06	0.00	0.06
4	19	Clay	525	535	530	-411	-421	-416	10	128	250	375	66,425	67,063	48,953	280	17,472	56,753	155	9,672	7,800	1.16	0.030	0.00	0.23	0.23
4	20	Sand	535	560	547.5	-421	-446	-433.5	25	128	250	375	68,657	70,251	50,093	298	18,564	57,893	173	10,764	7,800	1.16	0.005	0.09	0.00	0.09
4	21	Sand	560	585	572.5	-446	-471	-458.5	25	128	250	375	71,850	73,450	51,726	323	20,124	59,526	198	12,324	7,800	1.15	0.005	0.09	0.00	0.09
4	22	Clay	585	588	586.5	-471	-474	-472.5	3	128	250	375	73,641	73,833	52,644	337	20,998	60,444	212	13,198	7,800	1.15	0.030	0.00	0.06	0.06
5	23	Clay	588	595	591.5	-474	-481	-477.5	7	128	308	457	74,281	74,729	56,591	284	17,690	65,888	135	8,393	9,298	1.16	0.030	0.00	0.17	0.17
5	24	Sand	595	600	597.5	-481	-486	-483.5	5	128	308	457	75,050	75,371	56,985	290	18,065	66,283	141	8,767	9,298	1.16	0.005	0.02	0.00	0.02
5	25	Sand	600	650	625	-486	-536	-511	50	128	308	457	78,580	81,788	58,799	317	19,781	68,096	168	10,483	9,298	1.16	0.005	0.19	0.00	0.19
5	26	Sand	650	700	675	-536	-586	-561	50	128	308	457	84,997	88,206	62,096	367	22,901	71,394	218	13,603	9,298	1.15	0.005	0.18	0.00	0.18
5	27	Sand	700	750	725	-586	-636	-611	50	128	308	457	91,415	94,624	65,394	417	26,021	74,692	268	16,723	9,298	1.14	0.005	0.17	0.00	0.17

	Sand	Clay	Total
Total Settlement (in) =	1.43	1.46	2.89
Total Layer Thickness (feet) =	405	75	480

Date 4/5/2012
Job No. 103.128

Boring ID CUP-19
Scenario 4 to 1
Elevation 114 feet AMSL
Depth to Compressible 270 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec
1	193	221	0.005	0.01	0.03	0.18
2	201	232	0.005	0.01	0.03	0.18
3	229	314	0.005	0.01	0.03	0.18
4	250	369	0.005	0.01	0.03	0.18
5	308	452	0.005	0.01	0.03	0.18

Model	Sub		Depth			Elevation					Total Head		Total Stress		Initial Stresses @ mid point			Final Stresses @ mid point			Delta	$\sigma'_{vf}/\sigma'_{vi}$	Comp	Settlement		
Layer	Layer	Material	Top (feet)	Bottom (feet)	Middle (feet)	Top (feet)	Bottom (feet)	Middle (feet)	Thickness (feet)	Unit wt (pcf)	Initial (feet)	Final (feet)	Mid point (psf)	Bottom (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Eff. Stress (psf)		Index	Sand (inches)	Clay (inches)	Total (inches)
1	1	Sand	0	50	25	114	64	89	50	123	193	221	3,075	6,149	3,075	0	0	3,075	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	Sand	50	100	75	64	14	39	50	124	193	221	9,242	12,334	9,242	0	0	9,242	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	3	Sand	100	150	125	14	-36	-11	50	124	193	221	15,436	18,537	15,436	0	0	15,436	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	4	Sand	150	200	175	-36	-86	-61	50	124	193	221	21,648	24,759	21,648	0	0	21,648	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	5	Sand	200	250	225	-86	-136	-111	50	125	193	221	27,879	30,999	27,879	0	0	27,879	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	6	Sand	250	270	260	-136	-156	-146	20	125	193	221	32,251	33,502	32,251	0	0	32,251	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	7	Clay	270	276	273	-156	-162	-159	6	125	193	221	33,878	34,253	28,886	80	4,992	30,633	52	3,245	1,747	1.06	0.030	0.00	0.06	0.06
2	8	Clay	276	295	285.5	-162	-181	-171.5	19	126	201	232	35,446	36,639	30,173	85	5,273	32,108	54	3,338	1,934	1.06	0.030	0.00	0.18	0.18
2	9	Sand	295	320	307.5	-181	-206	-193.5	25	126	201	232	38,213	39,787	31,568	107	6,646	33,502	76	4,711	1,934	1.06	0.005	0.04	0.00	0.04
2	10	Sand	320	345	332.5	-206	-231	-218.5	25	126	201	232	41,362	42,936	33,156	132	8,206	35,090	101	6,271	1,934	1.06	0.005	0.04	0.00	0.04
3	11	Sand	345	370	357.5	-231	-256	-243.5	25	126	229	314	44,515	46,094	36,497	129	8,018	41,801	44	2,714	5,304	1.15	0.005	0.09	0.00	0.09
3	12	Sand	370	400	385	-256	-286	-271	30	126	229	314	47,989	49,884	38,255	156	9,734	43,559	71	4,430	5,304	1.14	0.005	0.10	0.00	0.10
3	13	Sand	400	414	407	-286	-300	-293	14	127	229	314	50,771	51,658	39,664	178	11,107	44,968	93	5,803	5,304	1.13	0.005	0.05	0.00	0.05
4	14	Sand	414	440	427	-300	-326	-313	26	127	250	369	53,311	54,964	42,266	177	11,045	49,692	58	3,619	7,426	1.18	0.005	0.11	0.00	0.11
4	15	Sand	440	480	460	-326	-366	-346	40	127	250	369	57,506	60,049	44,402	210	13,104	51,828	91	5,678	7,426	1.17	0.005	0.16	0.00	0.16
4	16	Clay	480	495	487.5	-366	-381	-373.5	15	128	250	369	61,005	61,962	46,185	238	14,820	53,611	119	7,394	7,426	1.16	0.030	0.00	0.35	0.35
4	17	Clay	495	510	502.5	-381	-396	-388.5	15	128	250	369	62,918	63,875	47,162	253	15,756	54,588	134	8,330	7,426	1.16	0.030	0.00	0.34	0.34
4	18	Sand	510	525	517.5	-396	-411	-403.5	15	128	250	369	64,831	65,787	48,139	268	16,692	55,565	149	9,266	7,426	1.15	0.005	0.06	0.00	0.06
4	19	Clay	525	535	530	-411	-421	-416	10	128	250	369	66,425	67,063	48,953	280	17,472	56,379	161	10,046	7,426	1.15	0.030	0.00	0.22	0.22
4	20	Sand	535	560	547.5	-421	-446	-433.5	25	128	250	369	68,657	70,251	50,093	298	18,564	57,519	179	11,138	7,426	1.15	0.005	0.09	0.00	0.09
4	21	Sand	560	585	572.5	-446	-471	-458.5	25	128	250	369	71,850	73,450	51,726	323	20,124	59,152	204	12,698	7,426	1.14	0.005	0.09	0.00	0.09
4	22	Clay	585	588	586.5	-471	-474	-472.5	3	128	250	369	73,641	73,833	52,644	337	20,998	60,069	218	13,572	7,426	1.14	0.030	0.00	0.06	0.06
5	23	Clay	588	595	591.5	-474	-481	-477.5	7	128	308	452	74,281	74,729	56,591	284	17,690	65,576	140	8,705	8,986	1.16	0.030	0.00	0.16	0.16
5	24	Sand	595	600	597.5	-481	-486	-483.5	5	128	308	452	75,050	75,371	56,985	290	18,065	65,971	146	9,079	8,986	1.16	0.005	0.02	0.00	0.02
5	25	Sand	600	650	625	-486	-536	-511	50	128	308	452	78,580	81,788	58,799	317	19,781	67,784	173	10,795	8,986	1.15	0.005	0.19	0.00	0.19
5	26	Sand	650	700	675	-536	-586	-561	50	128	308	452	84,997	88,206	62,096	367	22,901	71,082	223	13,915	8,986	1.14	0.005	0.18	0.00	0.18
5	27	Sand	700	750	725	-586	-636	-611	50	128	308	452	91,415	94,624	65,394	417	26,021	74,380	273	17,035	8,986	1.14	0.005	0.17	0.00	0.17
																							Total Settlement (in) =	1.36	1.38	2.74
																							Total Layer Thickness (feet) =	405	75	480

Date	5/7/2012
Job No.	103.128
Boring ID	CUP-41-4
Scenario	2 To HL
Elevation	24 feet AMSL
Depth to Compressible	158 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	104	50	0.005	0.01	0.03	0.18	0.025	0.15
2	124	82	0.005	0.01	0.03	0.18	0.025	0.15
3	151	201	0.005	0.01	0.03	0.18	0.025	0.15
4	218	381	0.005	0.01	0.03	0.18	0.025	0.15
5	207	380	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth			Elevation					Total Head		Total Stress		Initial Stresses @ mid point			Final Stresses @ mid point			Delta	$\sigma'_{vf}/\sigma'_{vi}$	Comp	Settlement		
			Top (feet)	Bottom (feet)	Middle (feet)	Top (feet)	Bottom (feet)	Middle (feet)	Thickness (feet)	Unit wt (pcf)	Initial (feet)	Final (feet)	Mid point (psf)	Bottom (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Eff. Stress (psf)		Index	Sand (inches)	Clay (inches)	Total (inches)
1	1	Clay	0	17	8.5	24	7	15.5	17	123	104	50	1,045	2,091	1,045	0	0	1,045	0	0	0	1.00	0.030	Incomp.	Incomp.	0.00
1	2	Sand	17	50	33.5	7	-26	-9.5	33	124	104	50	4,132	6,173	4,132	0	0	4,132	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	3	Sand	50	91	70.5	-26	-67	-46.5	41	124	104	50	8,716	11,259	8,716	0	0	8,716	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	4	CLS	91	97	94	-67	-73	-70	6	124	104	50	11,633	12,006	11,633	0	0	11,633	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	5	Sand	97	154	125.5	-73	-130	-101.5	57	125	104	50	15,563	19,120	15,563	0	0	15,563	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	6	Clay	154	158	156	-130	-134	-132	4	125	104	50	19,370	19,620	19,370	0	0	19,370	0	0	0	1.00	0.030	Incomp.	Incomp.	0.00
1	7	Sand	158	188	173	-134	-164	-149	30	125	104	50	21,498	23,375	17,192	69	4,306	13,823	123	7,675	-3,370	0.80	0.005	-0.17	0.00	-0.17
2	8	Sand	188	198	193	-164	-174	-169	10	126	124	82	24,003	24,631	19,698	69	4,306	17,077	111	6,926	-2,621	0.87	0.005	-0.04	0.00	-0.04
2	9	Clay	198	200	199	-174	-176	-175	2	126	124	82	24,757	24,883	20,077	75	4,680	17,456	117	7,301	-2,621	0.87	0.030	0.00	-0.04	-0.04
2	10	Sand	200	244	222	-176	-220	-198	44	126	124	82	27,654	30,424	21,538	98	6,115	18,918	140	8,736	-2,621	0.88	0.005	-0.15	0.00	-0.15
2	11	Clay	244	256	250	-220	-232	-226	12	126	124	82	31,182	31,940	23,320	126	7,862	20,699	168	10,483	-2,621	0.89	0.030	0.00	-0.22	-0.22
3	12	Clay	256	282	269	-232	-258	-245	26	126	151	201	33,583	35,225	26,219	118	7,363	29,339	68	4,243	3,120	1.12	0.030	0.00	0.46	0.46
3	13	Clay	282	308	295	-258	-284	-271	26	127	151	201	36,872	38,520	27,887	144	8,986	31,007	94	5,866	3,120	1.11	0.030	0.00	0.43	0.43
3	14	Sand	308	319	313.5	-284	-295	-289.5	11	127	151	201	39,219	39,918	29,079	163	10,140	32,199	113	7,020	3,120	1.11	0.005	0.03	0.00	0.03
3	15	CLS	319	324	321.5	-295	-300	-297.5	5	127	151	201	40,236	40,554	29,597	171	10,639	32,717	121	7,519	3,120	1.11	0.025	0.00	0.07	0.07
4	16	CLS	324	340	332	-300	-316	-308	16	128	218	381	41,574	42,594	34,460	114	7,114	41,574	0	0	7,114	1.21	0.025	0.00	0.39	0.39
4	17	Sand	340	388	364	-316	-364	-340	48	128	218	381	45,655	48,716	36,545	146	9,110	45,655	0	0	9,110	1.25	0.005	0.28	0.00	0.28
4	18	CLS	388	400	394	-364	-376	-370	12	128	218	381	49,481	50,246	38,499	176	10,982	48,670	13	811	10,171	1.26	0.025	0.00	0.37	0.37
4	19	Sand	400	470	435	-376	-446	-411	70	128	218	381	54,710	59,173	41,169	217	13,541	51,340	54	3,370	10,171	1.25	0.005	0.40	0.00	0.40
4	20	Clay	470	484	477	-446	-460	-453	14	128	218	381	60,066	60,959	43,904	259	16,162	54,076	96	5,990	10,171	1.23	0.030	0.00	0.46	0.46
5	21	Sand	484	520	502	-460	-496	-478	36	128	207	380	63,262	65,564	44,854	295	18,408	55,649	122	7,613	10,795	1.24	0.005	0.20	0.00	0.20
5	22	Sand	520	580	550	-496	-556	-526	60	128	207	380	69,403	73,241	47,999	343	21,403	58,795	170	10,608	10,795	1.22	0.005	0.32	0.00	0.32
																							Total Settlement (in) =	0.87	1.90	2.77
																							Total Layer Thickness (feet) =	309	113	422

Date	5/7/2012
Job No.	103.128
Boring ID	CUP-41-4
Scenario	4 To HL
Elevation	24 feet AMSL
Depth to Compressible	158 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	104	50	0.005	0.01	0.03	0.18	0.025	0.15
2	124	82	0.005	0.01	0.03	0.18	0.025	0.15
3	151	201	0.005	0.01	0.03	0.18	0.025	0.15
4	218	382	0.005	0.01	0.03	0.18	0.025	0.15
5	207	382	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Clay	0	17	8.5	24	7	15.5	17	123	104	50	1,045	2,091	1,045	0	0	1,045	0	0	0	1.00	0.030	Incomp.	Incomp.	0.00
1	2	Sand	17	50	33.5	7	-26	-9.5	33	124	104	50	4,132	6,173	4,132	0	0	4,132	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	3	Sand	50	91	70.5	-26	-67	-46.5	41	124	104	50	8,716	11,259	8,716	0	0	8,716	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	4	CLS	91	97	94	-67	-73	-70	6	124	104	50	11,633	12,006	11,633	0	0	11,633	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	5	Sand	97	154	125.5	-73	-130	-101.5	57	125	104	50	15,563	19,120	15,563	0	0	15,563	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	6	Clay	154	158	156	-130	-134	-132	4	125	104	50	19,370	19,620	19,370	0	0	19,370	0	0	0	1.00	0.030	Incomp.	Incomp.	0.00
1	7	Sand	158	188	173	-134	-164	-149	30	125	104	50	21,498	23,375	17,192	69	4,306	13,823	123	7,675	-3,370	0.80	0.005	-0.17	0.00	-0.17
2	8	Sand	188	198	193	-164	-174	-169	10	126	124	82	24,003	24,631	19,698	69	4,306	17,077	111	6,926	-2,621	0.87	0.005	-0.04	0.00	-0.04
2	9	Clay	198	200	199	-174	-176	-175	2	126	124	82	24,757	24,883	20,077	75	4,680	17,456	117	7,301	-2,621	0.87	0.030	0.00	-0.04	-0.04
2	10	Sand	200	244	222	-176	-220	-198	44	126	124	82	27,654	30,424	21,538	98	6,115	18,918	140	8,736	-2,621	0.88	0.005	-0.15	0.00	-0.15
2	11	Clay	244	256	250	-220	-232	-226	12	126	124	82	31,182	31,940	23,320	126	7,862	20,699	168	10,483	-2,621	0.89	0.030	0.00	-0.22	-0.22
3	12	Clay	256	282	269	-232	-258	-245	26	126	151	201	33,583	35,225	26,219	118	7,363	29,339	68	4,243	3,120	1.12	0.030	0.00	0.46	0.46
3	13	Clay	282	308	295	-258	-284	-271	26	127	151	201	36,872	38,520	27,887	144	8,986	31,007	94	5,866	3,120	1.11	0.030	0.00	0.43	0.43
3	14	Sand	308	319	313.5	-284	-295	-289.5	11	127	151	201	39,219	39,918	29,079	163	10,140	32,199	113	7,020	3,120	1.11	0.005	0.03	0.00	0.03
3	15	CLS	319	324	321.5	-295	-300	-297.5	5	127	151	201	40,236	40,554	29,597	171	10,639	32,717	121	7,519	3,120	1.11	0.025	0.00	0.07	0.07
4	16	CLS	324	340	332	-300	-316	-308	16	128	218	382	41,574	42,594	34,460	114	7,114	41,574	0	0	7,114	1.21	0.025	0.00	0.39	0.39
4	17	Sand	340	388	364	-316	-364	-340	48	128	218	382	45,655	48,716	36,545	146	9,110	45,655	0	0	9,110	1.25	0.005	0.28	0.00	0.28
4	18	CLS	388	400	394	-364	-376	-370	12	128	218	382	49,481	50,246	38,499	176	10,982	48,732	12	749	10,234	1.27	0.025	0.00	0.37	0.37
4	19	Sand	400	470	435	-376	-446	-411	70	128	218	382	54,710	59,173	41,169	217	13,541	51,402	53	3,307	10,234	1.25	0.005	0.40	0.00	0.40
4	20	Clay	470	484	477	-446	-460	-453	14	128	218	382	60,066	60,959	43,904	259	16,162	54,138	95	5,928	10,234	1.23	0.030	0.00	0.46	0.46
5	21	Sand	484	520	502	-460	-496	-478	36	128	207	382	63,262	65,564	44,854	295	18,408	55,774	120	7,488	10,920	1.24	0.005	0.20	0.00	0.20
5	22	Sand	520	580	550	-496	-556	-526	60	128	207	382	69,403	73,241	47,999	343	21,403	58,919	168	10,483	10,920	1.23	0.005	0.32	0.00	0.32
																							Total Settlement (in) =	0.88	1.90	2.79
																							Total Layer Thickness (feet) =	309	113	422

Date	5/7/2012
Job No.	103.128
Boring ID	CUP-41-4
Scenario	2 To 1
Elevation	24 feet AMSL
Depth to Compressible	158 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	50	50	0.005	0.01	0.03	0.18	0.025	0.15
2	71	82	0.005	0.01	0.03	0.18	0.025	0.15
3	145	201	0.005	0.01	0.03	0.18	0.025	0.15
4	228	381	0.005	0.01	0.03	0.18	0.025	0.15
5	229	380	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Clay	0	17	8.5	24	7	15.5	17	123	50	50	1,045	2,091	1,045	0	0	1,045	0	0	0	1.00	0.030	Incomp.	Incomp.	0.00
1	2	Sand	17	50	33.5	7	-26	-9.5	33	124	50	50	4,132	6,173	4,132	0	0	4,132	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	3	Sand	50	91	70.5	-26	-67	-46.5	41	124	50	50	8,716	11,259	8,716	0	0	8,716	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	4	CLS	91	97	94	-67	-73	-70	6	124	50	50	11,633	12,006	11,633	0	0	11,633	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	5	Sand	97	154	125.5	-73	-130	-101.5	57	125	50	50	15,563	19,120	15,563	0	0	15,563	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	6	Clay	154	158	156	-130	-134	-132	4	125	50	50	19,370	19,620	19,370	0	0	19,370	0	0	0	1.00	0.030	Incomp.	Incomp.	0.00
1	7	Sand	158	188	173	-134	-164	-149	30	125	50	50	21,498	23,375	13,823	123	7,675	13,823	123	7,675	0	1.00	0.005	0.00	0.00	0.00
2	8	Sand	188	198	193	-164	-174	-169	10	126	71	82	24,003	24,631	16,390	122	7,613	17,077	111	6,926	686	1.04	0.005	0.01	0.00	0.01
2	9	Clay	198	200	199	-174	-176	-175	2	126	71	82	24,757	24,883	16,770	128	7,987	17,456	117	7,301	686	1.04	0.030	0.00	0.01	0.01
2	10	Sand	200	244	222	-176	-220	-198	44	126	71	82	27,654	30,424	18,231	151	9,422	18,918	140	8,736	686	1.04	0.005	0.04	0.00	0.04
2	11	Clay	244	256	250	-220	-232	-226	12	126	71	82	31,182	31,940	20,013	179	11,170	20,699	168	10,483	686	1.03	0.030	0.00	0.06	0.06
3	12	Clay	256	282	269	-232	-258	-245	26	126	145	201	33,583	35,225	25,845	124	7,738	29,339	68	4,243	3,494	1.14	0.030	0.00	0.52	0.52
3	13	Clay	282	308	295	-258	-284	-271	26	127	145	201	36,872	38,520	27,512	150	9,360	31,007	94	5,866	3,494	1.13	0.030	0.00	0.49	0.49
3	14	Sand	308	319	313.5	-284	-295	-289.5	11	127	145	201	39,219	39,918	28,705	169	10,514	32,199	113	7,020	3,494	1.12	0.005	0.03	0.00	0.03
3	15	CLS	319	324	321.5	-295	-300	-297.5	5	127	145	201	40,236	40,554	29,222	177	11,014	32,717	121	7,519	3,494	1.12	0.025	0.00	0.07	0.07
4	16	CLS	324	340	332	-300	-316	-308	16	128	228	381	41,574	42,594	35,084	104	6,490	41,574	0	0	6,490	1.18	0.025	0.00	0.35	0.35
4	17	Sand	340	388	364	-316	-364	-340	48	128	228	381	45,655	48,716	37,169	136	8,486	45,655	0	0	8,486	1.23	0.005	0.26	0.00	0.26
4	18	CLS	388	400	394	-364	-376	-370	12	128	228	381	49,481	50,246	39,123	166	10,358	48,670	13	811	9,547	1.24	0.025	0.00	0.34	0.34
4	19	Sand	400	470	435	-376	-446	-411	70	128	228	381	54,710	59,173	41,793	207	12,917	51,340	54	3,370	9,547	1.23	0.005	0.38	0.00	0.38
4	20	Clay	470	484	477	-446	-460	-453	14	128	228	381	60,066	60,959	44,528	249	15,538	54,076	96	5,990	9,547	1.21	0.030	0.00	0.43	0.43
5	21	Sand	484	520	502	-460	-496	-478	36	128	229	380	63,262	65,564	46,226	273	17,035	55,649	122	7,613	9,422	1.20	0.005	0.17	0.00	0.17
5	22	Sand	520	580	550	-496	-556	-526	60	128	229	380	69,403	73,241	49,372	321	20,030	58,795	170	10,608	9,422	1.19	0.005	0.27	0.00	0.27
																							Total Settlement (in) =	1.17	2.27	3.44
																							Total Layer Thickness (feet) =	309	113	422

Date	5/7/2012	
Job No.	103.128	
Boring ID	CUP-41-4	
Scenario	4 To 1	
Elevation	24	feet AMSL
Depth to Compressible	158	feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	50	50	0.005	0.01	0.03	0.18	0.025	0.15
2	71	82	0.005	0.01	0.03	0.18	0.025	0.15
3	145	201	0.005	0.01	0.03	0.18	0.025	0.15
4	228	382	0.005	0.01	0.03	0.18	0.025	0.15
5	229	382	0.005	0.01	0.03	0.18	0.025	0.15

Model	Sub		Depth			Elevation					Total Head		Total Stress		Initial Stresses @ mid point			Final Stresses @ mid point			Delta	$\sigma'_{vf}/\sigma'_{vi}$	Comp	Settlement		
Layer	Layer	Material	Top (feet)	Bottom (feet)	Middle (feet)	Top (feet)	Bottom (feet)	Middle (feet)	Thickness (feet)	Unit wt (pcf)	Initial (feet)	Final (feet)	Mid point (psf)	Bottom (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Eff. Stress (psf)		Index	Sand (inches)	Clay (inches)	Total (inches)
1	1	Clay	0	17	8.5	24	7	15.5	17	123	50	50	1,045	2,091	1,045	0	0	1,045	0	0	0	1.00	0.030	Incomp.	Incomp.	0.00
1	2	Sand	17	50	33.5	7	-26	-9.5	33	124	50	50	4,132	6,173	4,132	0	0	4,132	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	3	Sand	50	91	70.5	-26	-67	-46.5	41	124	50	50	8,716	11,259	8,716	0	0	8,716	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	4	CLS	91	97	94	-67	-73	-70	6	124	50	50	11,633	12,006	11,633	0	0	11,633	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	5	Sand	97	154	125.5	-73	-130	-101.5	57	125	50	50	15,563	19,120	15,563	0	0	15,563	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	6	Clay	154	158	156	-130	-134	-132	4	125	50	50	19,370	19,620	19,370	0	0	19,370	0	0	0	1.00	0.030	Incomp.	Incomp.	0.00
1	7	Sand	158	188	173	-134	-164	-149	30	125	50	50	21,498	23,375	13,823	123	7,675	13,823	123	7,675	0	1.00	0.005	0.00	0.00	0.00
2	8	Sand	188	198	193	-164	-174	-169	10	126	71	82	24,003	24,631	16,390	122	7,613	17,077	111	6,926	686	1.04	0.005	0.01	0.00	0.01
2	9	Clay	198	200	199	-174	-176	-175	2	126	71	82	24,757	24,883	16,770	128	7,987	17,456	117	7,301	686	1.04	0.030	0.00	0.01	0.01
2	10	Sand	200	244	222	-176	-220	-198	44	126	71	82	27,654	30,424	18,231	151	9,422	18,918	140	8,736	686	1.04	0.005	0.04	0.00	0.04
2	11	Clay	244	256	250	-220	-232	-226	12	126	71	82	31,182	31,940	20,013	179	11,170	20,699	168	10,483	686	1.03	0.030	0.00	0.06	0.06
3	12	Clay	256	282	269	-232	-258	-245	26	126	145	201	33,583	35,225	25,845	124	7,738	29,339	68	4,243	3,494	1.14	0.030	0.00	0.52	0.52
3	13	Clay	282	308	295	-258	-284	-271	26	127	145	201	36,872	38,520	27,512	150	9,360	31,007	94	5,866	3,494	1.13	0.030	0.00	0.49	0.49
3	14	Sand	308	319	313.5	-284	-295	-289.5	11	127	145	201	39,219	39,918	28,705	169	10,514	32,199	113	7,020	3,494	1.12	0.005	0.03	0.00	0.03
3	15	CLS	319	324	321.5	-295	-300	-297.5	5	127	145	201	40,236	40,554	29,222	177	11,014	32,717	121	7,519	3,494	1.12	0.025	0.00	0.07	0.07
4	16	CLS	324	340	332	-300	-316	-308	16	128	228	382	41,574	42,594	35,084	104	6,490	41,574	0	0	6,490	1.18	0.025	0.00	0.35	0.35
4	17	Sand	340	388	364	-316	-364	-340	48	128	228	382	45,655	48,716	37,169	136	8,486	45,655	0	0	8,486	1.23	0.005	0.26	0.00	0.26
4	18	CLS	388	400	394	-364	-376	-370	12	128	228	382	49,481	50,246	39,123	166	10,358	48,732	12	749	9,610	1.25	0.025	0.00	0.34	0.34
4	19	Sand	400	470	435	-376	-446	-411	70	128	228	382	54,710	59,173	41,793	207	12,917	51,402	53	3,307	9,610	1.23	0.005	0.38	0.00	0.38
4	20	Clay	470	484	477	-446	-460	-453	14	128	228	382	60,066	60,959	44,528	249	15,538	54,138	95	5,928	9,610	1.22	0.030	0.00	0.43	0.43
5	21	Sand	484	520	502	-460	-496	-478	36	128	229	382	63,262	65,564	46,226	273	17,035	55,774	120	7,488	9,547	1.21	0.005	0.18	0.00	0.18
5	22	Sand	520	580	550	-496	-556	-526	60	128	229	382	69,403	73,241	49,372	321	20,030	58,919	168	10,483	9,547	1.19	0.005	0.28	0.00	0.28

	Sand	Clay	Total
Total Settlement (in) =	1.17	2.28	3.45
Total Layer Thickness (feet) =	309	113	422

Date 4/5/2012
Job No. 103.128

Boring ID LMPS
Scenario 2 to HL
Elevation 43 feet AMSL
Depth to Compressible 71 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	32	34	0.005	0.01	0.03	0.18	0.025	0.15
2	33	37	0.005	0.01	0.03	0.18	0.025	0.15
3	50	68	0.005	0.01	0.03	0.18	0.025	0.15
4	65	88	0.005	0.01	0.03	0.18	0.025	0.15
5	113	198	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	71	35.5	43	-28	7.5	71	123	32	34	4,367	8,733	4,367	0	0	4,367	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
2	2	Sand	71	100	85.5	-28	-57	-42.5	29	124	33	37	10,531	12,329	7,255	53	3,276	7,505	49	3,026	250	1.03	0.005	0.03	0.00	0.03
2	3	Sand	100	143	121.5	-57	-100	-78.5	43	124	33	37	14,995	17,661	9,473	89	5,522	9,722	85	5,273	250	1.03	0.005	0.03	0.00	0.03
2	4	Sand	143	193	168	-100	-150	-125	50	124	33	37	20,761	23,861	12,337	135	8,424	12,587	131	8,174	250	1.02	0.005	0.03	0.00	0.03
3	5	Sand	193	233	213	-150	-190	-170	40	125	50	68	26,361	28,861	16,190	163	10,171	17,313	145	9,048	1,123	1.07	0.005	0.07	0.00	0.07
3	6	Sand	233	283	258	-190	-240	-215	50	125	50	68	31,986	35,111	19,007	208	12,979	20,130	190	11,856	1,123	1.06	0.005	0.07	0.00	0.07
3	7	Sand	283	333	308	-240	-290	-265	50	125	50	68	38,236	41,361	22,137	258	16,099	23,260	240	14,976	1,123	1.05	0.005	0.06	0.00	0.06
3	8	Clay	333	343	338	-290	-300	-295	10	126	50	68	41,991	42,621	24,020	288	17,971	25,143	270	16,848	1,123	1.05	0.030	0.00	0.07	0.07
4	9	Clay	343	360	351.5	-300	-317	-308.5	17	126	65	88	43,692	44,763	25,814	287	17,878	27,250	264	16,442	1,435	1.06	0.030	0.00	0.14	0.14
4	10	Clay	360	375	367.5	-317	-332	-324.5	15	126	65	88	45,708	46,653	26,832	303	18,876	28,267	280	17,441	1,435	1.05	0.030	0.00	0.12	0.12
4	11	Clay	375	390	382.5	-332	-347	-339.5	15	126	65	88	47,598	48,543	27,786	318	19,812	29,221	295	18,377	1,435	1.05	0.030	0.00	0.12	0.12
4	12	Sand	390	420	405	-347	-377	-362	30	126	65	88	50,433	52,323	29,217	340	21,216	30,652	317	19,781	1,435	1.05	0.005	0.04	0.00	0.04
4	13	Sand	420	454	437	-377	-411	-394	34	127	65	88	54,482	56,641	31,269	372	23,213	32,704	349	21,778	1,435	1.05	0.005	0.04	0.00	0.04
4	14	CLS	454	474	464	-411	-431	-421	20	127	65	88	57,911	59,181	33,013	399	24,898	34,449	376	23,462	1,435	1.04	0.025	0.00	0.11	0.11
4	15	CLS	474	494	484	-431	-451	-441	20	127	65	88	60,451	61,721	34,305	419	26,146	35,741	396	24,710	1,435	1.04	0.025	0.00	0.11	0.11
4	16	CLS	494	514	504	-451	-471	-461	20	128	65	88	63,001	64,281	35,607	439	27,394	37,043	416	25,958	1,435	1.04	0.025	0.00	0.10	0.10
4	17	CLS	514	539	526.5	-471	-496	-483.5	25	128	65	88	65,881	67,481	37,083	462	28,798	38,519	439	27,362	1,435	1.04	0.025	0.00	0.12	0.12
5	18	CLS	539	542	540.5	-496	-499	-497.5	3	128	113	198	67,673	67,865	40,997	428	26,676	46,301	343	21,372	5,304	1.13	0.025	0.00	0.05	0.05
5	19	Sand	542	555	548.5	-499	-512	-505.5	13	128	113	198	68,697	69,529	41,522	436	27,175	46,826	351	21,871	5,304	1.13	0.005	0.04	0.00	0.04
5	20	Sand	555	575	565	-512	-532	-522	20	128	113	198	70,809	72,089	42,604	452	28,205	47,908	367	22,901	5,304	1.12	0.005	0.06	0.00	0.06
5	21	Sand	575	595	585	-532	-552	-542	20	128	113	198	73,369	74,649	43,916	472	29,453	49,220	387	24,149	5,304	1.12	0.005	0.06	0.00	0.06
5	22	Sand	595	615	605	-552	-572	-562	20	128	113	198	75,929	77,209	45,228	492	30,701	50,532	407	25,397	5,304	1.12	0.005	0.06	0.00	0.06
																							Total Settlement (in) =	0.59	0.95	1.53
																							Total Layer Thickness (feet) =	399	145	544

Date	4/5/2012	
Job No.	103.128	
Boring ID	LMPS	
Scenario	3a to HL	
Elevation	43	feet AMSL
Depth to Compressible	71	feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	32	48	0.005	0.01	0.03	0.18	0.025	0.15
2	33	51	0.005	0.01	0.03	0.18	0.025	0.15
3	50	79	0.005	0.01	0.03	0.18	0.025	0.15
4	65	135	0.005	0.01	0.03	0.18	0.025	0.15
5	113	145	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	71	35.5	43	-28	7.5	71	123	32	48	4,367	8,733	4,367	0	0	4,367	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
2	2	Sand	71	100	85.5	-28	-57	-42.5	29	124	33	51	10,531	12,329	7,255	53	3,276	8,378	35	2,153	1,123	1.15	0.005	0.11	0.00	0.11
2	3	Sand	100	143	121.5	-57	-100	-78.5	43	124	33	51	14,995	17,661	9,473	89	5,522	10,596	71	4,399	1,123	1.12	0.005	0.13	0.00	0.13
2	4	Sand	143	193	168	-100	-150	-125	50	124	33	51	20,761	23,861	12,337	135	8,424	13,460	117	7,301	1,123	1.09	0.005	0.11	0.00	0.11
3	5	Sand	193	233	213	-150	-190	-170	40	125	50	79	26,361	28,861	16,190	163	10,171	17,999	134	8,362	1,810	1.11	0.005	0.11	0.00	0.11
3	6	Sand	233	283	258	-190	-240	-215	50	125	50	79	31,986	35,111	19,007	208	12,979	20,816	179	11,170	1,810	1.10	0.005	0.12	0.00	0.12
3	7	Sand	283	333	308	-240	-290	-265	50	125	50	79	38,236	41,361	22,137	258	16,099	23,946	229	14,290	1,810	1.08	0.005	0.10	0.00	0.10
3	8	Clay	333	343	338	-290	-300	-295	10	126	50	79	41,991	42,621	24,020	288	17,971	25,829	259	16,162	1,810	1.08	0.030	0.00	0.11	0.11
4	9	Clay	343	360	351.5	-300	-317	-308.5	17	126	65	135	43,692	44,763	25,814	287	17,878	30,182	217	13,510	4,368	1.17	0.030	0.00	0.42	0.42
4	10	Clay	360	375	367.5	-317	-332	-324.5	15	126	65	135	45,708	46,653	26,832	303	18,876	31,200	233	14,508	4,368	1.16	0.030	0.00	0.35	0.35
4	11	Clay	375	390	382.5	-332	-347	-339.5	15	126	65	135	47,598	48,543	27,786	318	19,812	32,154	248	15,444	4,368	1.16	0.030	0.00	0.34	0.34
4	12	Sand	390	420	405	-347	-377	-362	30	126	65	135	50,433	52,323	29,217	340	21,216	33,585	270	16,848	4,368	1.15	0.005	0.11	0.00	0.11
4	13	Sand	420	454	437	-377	-411	-394	34	127	65	135	54,482	56,641	31,269	372	23,213	35,637	302	18,845	4,368	1.14	0.005	0.12	0.00	0.12
4	14	CLS	454	474	464	-411	-431	-421	20	127	65	135	57,911	59,181	33,013	399	24,898	37,381	329	20,530	4,368	1.13	0.025	0.00	0.32	0.32
4	15	CLS	474	494	484	-431	-451	-441	20	127	65	135	60,451	61,721	34,305	419	26,146	38,673	349	21,778	4,368	1.13	0.025	0.00	0.31	0.31
4	16	CLS	494	514	504	-451	-471	-461	20	128	65	135	63,001	64,281	35,607	439	27,394	39,975	369	23,026	4,368	1.12	0.025	0.00	0.30	0.30
4	17	CLS	514	539	526.5	-471	-496	-483.5	25	128	65	135	65,881	67,481	37,083	462	28,798	41,451	392	24,430	4,368	1.12	0.025	0.00	0.36	0.36
5	18	CLS	539	542	540.5	-496	-499	-497.5	3	128	113	145	67,673	67,865	40,997	428	26,676	42,994	396	24,679	1,997	1.05	0.025	0.00	0.02	0.02
5	19	Sand	542	555	548.5	-499	-512	-505.5	13	128	113	145	68,697	69,529	41,522	436	27,175	43,519	404	25,178	1,997	1.05	0.005	0.02	0.00	0.02
5	20	Sand	555	575	565	-512	-532	-522	20	128	113	145	70,809	72,089	42,604	452	28,205	44,601	420	26,208	1,997	1.05	0.005	0.02	0.00	0.02
5	21	Sand	575	595	585	-532	-552	-542	20	128	113	145	73,369	74,649	43,916	472	29,453	45,913	440	27,456	1,997	1.05	0.005	0.02	0.00	0.02
5	22	Sand	595	615	605	-552	-572	-562	20	128	113	145	75,929	77,209	45,228	492	30,701	47,225	460	28,704	1,997	1.04	0.005	0.02	0.00	0.02
																							Total Settlement (in) =	0.99	2.54	3.53
																							Total Layer Thickness (feet) =	399	145	544

Date	4/5/2012
Job No.	103.128
Boring ID	LMPS
Scenario	3b to HL
Elevation	43 feet AMSL
Depth to Compressible	71 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	32	48	0.005	0.01	0.03	0.18	0.025	0.15
2	33	51	0.005	0.01	0.03	0.18	0.025	0.15
3	50	78	0.005	0.01	0.03	0.18	0.025	0.15
4	65	135	0.005	0.01	0.03	0.18	0.025	0.15
5	113	145	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	71	35.5	43	-28	7.5	71	123	32	48	4,367	8,733	4,367	0	0	4,367	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
2	2	Sand	71	100	85.5	-28	-57	-42.5	29	124	33	51	10,531	12,329	7,255	53	3,276	8,378	35	2,153	1,123	1.15	0.005	0.11	0.00	0.11
2	3	Sand	100	143	121.5	-57	-100	-78.5	43	124	33	51	14,995	17,661	9,473	89	5,522	10,596	71	4,399	1,123	1.12	0.005	0.13	0.00	0.13
2	4	Sand	143	193	168	-100	-150	-125	50	124	33	51	20,761	23,861	12,337	135	8,424	13,460	117	7,301	1,123	1.09	0.005	0.11	0.00	0.11
3	5	Sand	193	233	213	-150	-190	-170	40	125	50	78	26,361	28,861	16,190	163	10,171	17,937	135	8,424	1,747	1.11	0.005	0.11	0.00	0.11
3	6	Sand	233	283	258	-190	-240	-215	50	125	50	78	31,986	35,111	19,007	208	12,979	20,754	180	11,232	1,747	1.09	0.005	0.11	0.00	0.11
3	7	Sand	283	333	308	-240	-290	-265	50	125	50	78	38,236	41,361	22,137	258	16,099	23,884	230	14,352	1,747	1.08	0.005	0.10	0.00	0.10
3	8	Clay	333	343	338	-290	-300	-295	10	126	50	78	41,991	42,621	24,020	288	17,971	25,767	260	16,224	1,747	1.07	0.030	0.00	0.11	0.11
4	9	Clay	343	360	351.5	-300	-317	-308.5	17	126	65	135	43,692	44,763	25,814	287	17,878	30,182	217	13,510	4,368	1.17	0.030	0.00	0.42	0.42
4	10	Clay	360	375	367.5	-317	-332	-324.5	15	126	65	135	45,708	46,653	26,832	303	18,876	31,200	233	14,508	4,368	1.16	0.030	0.00	0.35	0.35
4	11	Clay	375	390	382.5	-332	-347	-339.5	15	126	65	135	47,598	48,543	27,786	318	19,812	32,154	248	15,444	4,368	1.16	0.030	0.00	0.34	0.34
4	12	Sand	390	420	405	-347	-377	-362	30	126	65	135	50,433	52,323	29,217	340	21,216	33,585	270	16,848	4,368	1.15	0.005	0.11	0.00	0.11
4	13	Sand	420	454	437	-377	-411	-394	34	127	65	135	54,482	56,641	31,269	372	23,213	35,637	302	18,845	4,368	1.14	0.005	0.12	0.00	0.12
4	14	CLS	454	474	464	-411	-431	-421	20	127	65	135	57,911	59,181	33,013	399	24,898	37,381	329	20,530	4,368	1.13	0.025	0.00	0.32	0.32
4	15	CLS	474	494	484	-431	-451	-441	20	127	65	135	60,451	61,721	34,305	419	26,146	38,673	349	21,778	4,368	1.13	0.025	0.00	0.31	0.31
4	16	CLS	494	514	504	-451	-471	-461	20	128	65	135	63,001	64,281	35,607	439	27,394	39,975	369	23,026	4,368	1.12	0.025	0.00	0.30	0.30
4	17	CLS	514	539	526.5	-471	-496	-483.5	25	128	65	135	65,881	67,481	37,083	462	28,798	41,451	392	24,430	4,368	1.12	0.025	0.00	0.36	0.36
5	18	CLS	539	542	540.5	-496	-499	-497.5	3	128	113	145	67,673	67,865	40,997	428	26,676	42,994	396	24,679	1,997	1.05	0.025	0.00	0.02	0.02
5	19	Sand	542	555	548.5	-499	-512	-505.5	13	128	113	145	68,697	69,529	41,522	436	27,175	43,519	404	25,178	1,997	1.05	0.005	0.02	0.00	0.02
5	20	Sand	555	575	565	-512	-532	-522	20	128	113	145	70,809	72,089	42,604	452	28,205	44,601	420	26,208	1,997	1.05	0.005	0.02	0.00	0.02
5	21	Sand	575	595	585	-532	-552	-542	20	128	113	145	73,369	74,649	43,916	472	29,453	45,913	440	27,456	1,997	1.05	0.005	0.02	0.00	0.02
5	22	Sand	595	615	605	-552	-572	-562	20	128	113	145	75,929	77,209	45,228	492	30,701	47,225	460	28,704	1,997	1.04	0.005	0.02	0.00	0.02
																							Total Settlement (in) =	0.98	2.54	3.52
																							Total Layer Thickness (feet) =	399	145	544

Date 4/5/2012
Job No. 103.128

Boring ID	LMPS	
Scenario	4 to HL	
Elevation	43	feet AMSL
Depth to Compressible	71	feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	32	36	0.005	0.01	0.03	0.18	0.025	0.15
2	33	39	0.005	0.01	0.03	0.18	0.025	0.15
3	50	74	0.005	0.01	0.03	0.18	0.025	0.15
4	65	134	0.005	0.01	0.03	0.18	0.025	0.15
5	113	194	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	71	35.5	43	-28	7.5	71	123	32	36	4,367	8,733	4,367	0	0	4,367	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
2	2	Sand	71	100	85.5	-28	-57	-42.5	29	124	33	39	10,531	12,329	7,255	53	3,276	7,629	47	2,902	374	1.05	0.005	0.04	0.00	0.04
2	3	Sand	100	143	121.5	-57	-100	-78.5	43	124	33	39	14,995	17,661	9,473	89	5,522	9,847	83	5,148	374	1.04	0.005	0.04	0.00	0.04
2	4	Sand	143	193	168	-100	-150	-125	50	124	33	39	20,761	23,861	12,337	135	8,424	12,711	129	8,050	374	1.03	0.005	0.04	0.00	0.04
3	5	Sand	193	233	213	-150	-190	-170	40	125	50	74	26,361	28,861	16,190	163	10,171	17,687	139	8,674	1,498	1.09	0.005	0.09	0.00	0.09
3	6	Sand	233	283	258	-190	-240	-215	50	125	50	74	31,986	35,111	19,007	208	12,979	20,504	184	11,482	1,498	1.08	0.005	0.10	0.00	0.10
3	7	Sand	283	333	308	-240	-290	-265	50	125	50	74	38,236	41,361	22,137	258	16,099	23,634	234	14,602	1,498	1.07	0.005	0.09	0.00	0.09
3	8	Clay	333	343	338	-290	-300	-295	10	126	50	74	41,991	42,621	24,020	288	17,971	25,517	264	16,474	1,498	1.06	0.030	0.00	0.09	0.09
4	9	Clay	343	360	351.5	-300	-317	-308.5	17	126	65	134	43,692	44,763	25,814	287	17,878	30,120	218	13,572	4,306	1.17	0.030	0.00	0.41	0.41
4	10	Clay	360	375	367.5	-317	-332	-324.5	15	126	65	134	45,708	46,653	26,832	303	18,876	31,138	234	14,570	4,306	1.16	0.030	0.00	0.35	0.35
4	11	Clay	375	390	382.5	-332	-347	-339.5	15	126	65	134	47,598	48,543	27,786	318	19,812	32,092	249	15,506	4,306	1.15	0.030	0.00	0.34	0.34
4	12	Sand	390	420	405	-347	-377	-362	30	126	65	134	50,433	52,323	29,217	340	21,216	33,523	271	16,910	4,306	1.15	0.005	0.11	0.00	0.11
4	13	Sand	420	454	437	-377	-411	-394	34	127	65	134	54,482	56,641	31,269	372	23,213	35,575	303	18,907	4,306	1.14	0.005	0.11	0.00	0.11
4	14	CLS	454	474	464	-411	-431	-421	20	127	65	134	57,911	59,181	33,013	399	24,898	37,319	330	20,592	4,306	1.13	0.025	0.00	0.32	0.32
4	15	CLS	474	494	484	-431	-451	-441	20	127	65	134	60,451	61,721	34,305	419	26,146	38,611	350	21,840	4,306	1.13	0.025	0.00	0.31	0.31
4	16	CLS	494	514	504	-451	-471	-461	20	128	65	134	63,001	64,281	35,607	439	27,394	39,913	370	23,088	4,306	1.12	0.025	0.00	0.30	0.30
4	17	CLS	514	539	526.5	-471	-496	-483.5	25	128	65	134	65,881	67,481	37,083	462	28,798	41,389	393	24,492	4,306	1.12	0.025	0.00	0.36	0.36
5	18	CLS	539	542	540.5	-496	-499	-497.5	3	128	113	194	67,673	67,865	40,997	428	26,676	46,051	347	21,622	5,054	1.12	0.025	0.00	0.05	0.05
5	19	Sand	542	555	548.5	-499	-512	-505.5	13	128	113	194	68,697	69,529	41,522	436	27,175	46,576	355	22,121	5,054	1.12	0.005	0.04	0.00	0.04
5	20	Sand	555	575	565	-512	-532	-522	20	128	113	194	70,809	72,089	42,604	452	28,205	47,659	371	23,150	5,054	1.12	0.005	0.06	0.00	0.06
5	21	Sand	575	595	585	-532	-552	-542	20	128	113	194	73,369	74,649	43,916	472	29,453	48,971	391	24,398	5,054	1.12	0.005	0.06	0.00	0.06
5	22	Sand	595	615	605	-552	-572	-562	20	128	113	194	75,929	77,209	45,228	492	30,701	50,283	411	25,646	5,054	1.11	0.005	0.06	0.00	0.06
																							Total Settlement (in) =	0.83	2.52	3.35
																							Total Layer Thickness (feet) =	399	145	544

Date 4/5/2012
Job No. 103.128

Boring ID LMPS
Scenario 2 to 1
Elevation 43 feet AMSL
Depth to Compressible 71 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	34	34	0.005	0.01	0.03	0.18	0.025	0.15
2	36	37	0.005	0.01	0.03	0.18	0.025	0.15
3	58	68	0.005	0.01	0.03	0.18	0.025	0.15
4	73	88	0.005	0.01	0.03	0.18	0.025	0.15
5	135	198	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	71	35.5	43	-28	7.5	71	123	34	34	4,367	8,733	4,367	0	0	4,367	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
2	2	Sand	71	100	85.5	-28	-57	-42.5	29	124	36	37	10,531	12,329	7,442	50	3,089	7,505	49	3,026	62	1.01	0.005	0.01	0.00	0.01
2	3	Sand	100	143	121.5	-57	-100	-78.5	43	124	36	37	14,995	17,661	9,660	86	5,335	9,722	85	5,273	62	1.01	0.005	0.01	0.00	0.01
2	4	Sand	143	193	168	-100	-150	-125	50	124	36	37	20,761	23,861	12,524	132	8,237	12,587	131	8,174	62	1.00	0.005	0.01	0.00	0.01
3	5	Sand	193	233	213	-150	-190	-170	40	125	58	68	26,361	28,861	16,689	155	9,672	17,313	145	9,048	624	1.04	0.005	0.04	0.00	0.04
3	6	Sand	233	283	258	-190	-240	-215	50	125	58	68	31,986	35,111	19,506	200	12,480	20,130	190	11,856	624	1.03	0.005	0.04	0.00	0.04
3	7	Sand	283	333	308	-240	-290	-265	50	125	58	68	38,236	41,361	22,636	250	15,600	23,260	240	14,976	624	1.03	0.005	0.04	0.00	0.04
3	8	Clay	333	343	338	-290	-300	-295	10	126	58	68	41,991	42,621	24,519	280	17,472	25,143	270	16,848	624	1.03	0.030	0.00	0.04	0.04
4	9	Clay	343	360	351.5	-300	-317	-308.5	17	126	73	88	43,692	44,763	26,314	279	17,378	27,250	264	16,442	936	1.04	0.030	0.00	0.09	0.09
4	10	Clay	360	375	367.5	-317	-332	-324.5	15	126	73	88	45,708	46,653	27,331	295	18,377	28,267	280	17,441	936	1.03	0.030	0.00	0.08	0.08
4	11	Clay	375	390	382.5	-332	-347	-339.5	15	126	73	88	47,598	48,543	28,285	310	19,313	29,221	295	18,377	936	1.03	0.030	0.00	0.08	0.08
4	12	Sand	390	420	405	-347	-377	-362	30	126	73	88	50,433	52,323	29,716	332	20,717	30,652	317	19,781	936	1.03	0.005	0.02	0.00	0.02
4	13	Sand	420	454	437	-377	-411	-394	34	127	73	88	54,482	56,641	31,768	364	22,714	32,704	349	21,778	936	1.03	0.005	0.03	0.00	0.03
4	14	CLS	454	474	464	-411	-431	-421	20	127	73	88	57,911	59,181	33,513	391	24,398	34,449	376	23,462	936	1.03	0.025	0.00	0.07	0.07
4	15	CLS	474	494	484	-431	-451	-441	20	127	73	88	60,451	61,721	34,805	411	25,646	35,741	396	24,710	936	1.03	0.025	0.00	0.07	0.07
4	16	CLS	494	514	504	-451	-471	-461	20	128	73	88	63,001	64,281	36,107	431	26,894	37,043	416	25,958	936	1.03	0.025	0.00	0.07	0.07
4	17	CLS	514	539	526.5	-471	-496	-483.5	25	128	73	88	65,881	67,481	37,583	454	28,298	38,519	439	27,362	936	1.02	0.025	0.00	0.08	0.08
5	18	CLS	539	542	540.5	-496	-499	-497.5	3	128	135	198	67,673	67,865	42,370	406	25,303	46,301	343	21,372	3,931	1.09	0.025	0.00	0.03	0.03
5	19	Sand	542	555	548.5	-499	-512	-505.5	13	128	135	198	68,697	69,529	42,895	414	25,802	46,826	351	21,871	3,931	1.09	0.005	0.03	0.00	0.03
5	20	Sand	555	575	565	-512	-532	-522	20	128	135	198	70,809	72,089	43,977	430	26,832	47,908	367	22,901	3,931	1.09	0.005	0.04	0.00	0.04
5	21	Sand	575	595	585	-532	-552	-542	20	128	135	198	73,369	74,649	45,289	450	28,080	49,220	387	24,149	3,931	1.09	0.005	0.04	0.00	0.04
5	22	Sand	595	615	605	-552	-572	-562	20	128	135	198	75,929	77,209	46,601	470	29,328	50,532	407	25,397	3,931	1.08	0.005	0.04	0.00	0.04
																							Total Settlement (in) =	0.34	0.61	0.95
																							Total Layer Thickness (feet) =	399	145	544

Date 4/5/2012
Job No. 103.128

Boring ID LMPS
Scenario 3a to 1
Elevation 43 feet AMSL
Depth to Compressible 71 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	34	48	0.005	0.01	0.03	0.18	0.025	0.15
2	36	51	0.005	0.01	0.03	0.18	0.025	0.15
3	58	79	0.005	0.01	0.03	0.18	0.025	0.15
4	73	135	0.005	0.01	0.03	0.18	0.025	0.15
5	135	145	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	71	35.5	43	-28	7.5	71	123	34	48	4,367	8,733	4,367	0	0	4,367	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
2	2	Sand	71	100	85.5	-28	-57	-42.5	29	124	36	51	10,531	12,329	7,442	50	3,089	8,378	35	2,153	936	1.13	0.005	0.09	0.00	0.09
2	3	Sand	100	143	121.5	-57	-100	-78.5	43	124	36	51	14,995	17,661	9,660	86	5,335	10,596	71	4,399	936	1.10	0.005	0.10	0.00	0.10
2	4	Sand	143	193	168	-100	-150	-125	50	124	36	51	20,761	23,861	12,524	132	8,237	13,460	117	7,301	936	1.07	0.005	0.09	0.00	0.09
3	5	Sand	193	233	213	-150	-190	-170	40	125	58	79	26,361	28,861	16,689	155	9,672	17,999	134	8,362	1,310	1.08	0.005	0.08	0.00	0.08
3	6	Sand	233	283	258	-190	-240	-215	50	125	58	79	31,986	35,111	19,506	200	12,480	20,816	179	11,170	1,310	1.07	0.005	0.08	0.00	0.08
3	7	Sand	283	333	308	-240	-290	-265	50	125	58	79	38,236	41,361	22,636	250	15,600	23,946	229	14,290	1,310	1.06	0.005	0.07	0.00	0.07
3	8	Clay	333	343	338	-290	-300	-295	10	126	58	79	41,991	42,621	24,519	280	17,472	25,829	259	16,162	1,310	1.05	0.030	0.00	0.08	0.08
4	9	Clay	343	360	351.5	-300	-317	-308.5	17	126	73	135	43,692	44,763	26,314	279	17,378	30,182	217	13,510	3,869	1.15	0.030	0.00	0.36	0.36
4	10	Clay	360	375	367.5	-317	-332	-324.5	15	126	73	135	45,708	46,653	27,331	295	18,377	31,200	233	14,508	3,869	1.14	0.030	0.00	0.31	0.31
4	11	Clay	375	390	382.5	-332	-347	-339.5	15	126	73	135	47,598	48,543	28,285	310	19,313	32,154	248	15,444	3,869	1.14	0.030	0.00	0.30	0.30
4	12	Sand	390	420	405	-347	-377	-362	30	126	73	135	50,433	52,323	29,716	332	20,717	33,585	270	16,848	3,869	1.13	0.005	0.10	0.00	0.10
4	13	Sand	420	454	437	-377	-411	-394	34	127	73	135	54,482	56,641	31,768	364	22,714	35,637	302	18,845	3,869	1.12	0.005	0.10	0.00	0.10
4	14	CLS	454	474	464	-411	-431	-421	20	127	73	135	57,911	59,181	33,513	391	24,398	37,381	329	20,530	3,869	1.12	0.025	0.00	0.28	0.28
4	15	CLS	474	494	484	-431	-451	-441	20	127	73	135	60,451	61,721	34,805	411	25,646	38,673	349	21,778	3,869	1.11	0.025	0.00	0.27	0.27
4	16	CLS	494	514	504	-451	-471	-461	20	128	73	135	63,001	64,281	36,107	431	26,894	39,975	369	23,026	3,869	1.11	0.025	0.00	0.27	0.27
4	17	CLS	514	539	526.5	-471	-496	-483.5	25	128	73	135	65,881	67,481	37,583	454	28,298	41,451	392	24,430	3,869	1.10	0.025	0.00	0.32	0.32
5	18	CLS	539	542	540.5	-496	-499	-497.5	3	128	135	145	67,673	67,865	42,370	406	25,303	42,994	396	24,679	624	1.01	0.025	0.00	0.01	0.01
5	19	Sand	542	555	548.5	-499	-512	-505.5	13	128	135	145	68,697	69,529	42,895	414	25,802	43,519	404	25,178	624	1.01	0.005	0.00	0.00	0.00
5	20	Sand	555	575	565	-512	-532	-522	20	128	135	145	70,809	72,089	43,977	430	26,832	44,601	420	26,208	624	1.01	0.005	0.01	0.00	0.01
5	21	Sand	575	595	585	-532	-552	-542	20	128	135	145	73,369	74,649	45,289	450	28,080	45,913	440	27,456	624	1.01	0.005	0.01	0.00	0.01
5	22	Sand	595	615	605	-552	-572	-562	20	128	135	145	75,929	77,209	46,601	470	29,328	47,225	460	28,704	624	1.01	0.005	0.01	0.00	0.01
																							Total Settlement (in) =	0.75	2.21	2.95
																							Total Layer Thickness (feet) =	399	145	544

Date 4/5/2012
Job No. 103.128

Boring ID LMPS
Scenario 3b to 1
Elevation 43 feet AMSL
Depth to Compressible 71 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	34	48	0.005	0.01	0.03	0.18	0.025	0.15
2	36	51	0.005	0.01	0.03	0.18	0.025	0.15
3	58	78	0.005	0.01	0.03	0.18	0.025	0.15
4	73	135	0.005	0.01	0.03	0.18	0.025	0.15
5	135	145	0.005	0.01	0.03	0.18	0.025	0.15

Model Layer	Sub Layer	Material	Depth			Elevation					Total Head		Total Stress		Initial Stresses @ mid point			Final Stresses @ mid point			Delta	$\sigma'_{vf}/\sigma'_{vi}$	Comp	Settlement		
			Top (feet)	Bottom (feet)	Middle (feet)	Top (feet)	Bottom (feet)	Middle (feet)	Thickness (feet)	Unit wt (pcf)	Initial (feet)	Final (feet)	Mid point (psf)	Bottom (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Eff. Stress (psf)		Index	Sand (inches)	Clay (inches)	Total (inches)
1	1	Sand	0	71	35.5	43	-28	7.5	71	123	34	48	4,367	8,733	4,367	0	0	4,367	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
2	2	Sand	71	100	85.5	-28	-57	-42.5	29	124	36	51	10,531	12,329	7,442	50	3,089	8,378	35	2,153	936	1.13	0.005	0.09	0.00	0.09
2	3	Sand	100	143	121.5	-57	-100	-78.5	43	124	36	51	14,995	17,661	9,660	86	5,335	10,596	71	4,399	936	1.10	0.005	0.10	0.00	0.10
2	4	Sand	143	193	168	-100	-150	-125	50	124	36	51	20,761	23,861	12,524	132	8,237	13,460	117	7,301	936	1.07	0.005	0.09	0.00	0.09
3	5	Sand	193	233	213	-150	-190	-170	40	125	58	78	26,361	28,861	16,689	155	9,672	17,937	135	8,424	1,248	1.07	0.005	0.08	0.00	0.08
3	6	Sand	233	283	258	-190	-240	-215	50	125	58	78	31,986	35,111	19,506	200	12,480	20,754	180	11,232	1,248	1.06	0.005	0.08	0.00	0.08
3	7	Sand	283	333	308	-240	-290	-265	50	125	58	78	38,236	41,361	22,636	250	15,600	23,884	230	14,352	1,248	1.06	0.005	0.07	0.00	0.07
3	8	Clay	333	343	338	-290	-300	-295	10	126	58	78	41,991	42,621	24,519	280	17,472	25,767	260	16,224	1,248	1.05	0.030	0.00	0.08	0.08
4	9	Clay	343	360	351.5	-300	-317	-308.5	17	126	73	135	43,692	44,763	26,314	279	17,378	30,182	217	13,510	3,869	1.15	0.030	0.00	0.36	0.36
4	10	Clay	360	375	367.5	-317	-332	-324.5	15	126	73	135	45,708	46,653	27,331	295	18,377	31,200	233	14,508	3,869	1.14	0.030	0.00	0.31	0.31
4	11	Clay	375	390	382.5	-332	-347	-339.5	15	126	73	135	47,598	48,543	28,285	310	19,313	32,154	248	15,444	3,869	1.14	0.030	0.00	0.30	0.30
4	12	Sand	390	420	405	-347	-377	-362	30	126	73	135	50,433	52,323	29,716	332	20,717	33,585	270	16,848	3,869	1.13	0.005	0.10	0.00	0.10
4	13	Sand	420	454	437	-377	-411	-394	34	127	73	135	54,482	56,641	31,768	364	22,714	35,637	302	18,845	3,869	1.12	0.005	0.10	0.00	0.10
4	14	CLS	454	474	464	-411	-431	-421	20	127	73	135	57,911	59,181	33,513	391	24,398	37,381	329	20,530	3,869	1.12	0.025	0.00	0.28	0.28
4	15	CLS	474	494	484	-431	-451	-441	20	127	73	135	60,451	61,721	34,805	411	25,646	38,673	349	21,778	3,869	1.11	0.025	0.00	0.27	0.27
4	16	CLS	494	514	504	-451	-471	-461	20	128	73	135	63,001	64,281	36,107	431	26,894	39,975	369	23,026	3,869	1.11	0.025	0.00	0.27	0.27
4	17	CLS	514	539	526.5	-471	-496	-483.5	25	128	73	135	65,881	67,481	37,583	454	28,298	41,451	392	24,430	3,869	1.10	0.025	0.00	0.32	0.32
5	18	CLS	539	542	540.5	-496	-499	-497.5	3	128	135	145	67,673	67,865	42,370	406	25,303	42,994	396	24,679	624	1.01	0.025	0.00	0.01	0.01
5	19	Sand	542	555	548.5	-499	-512	-505.5	13	128	135	145	68,697	69,529	42,895	414	25,802	43,519	404	25,178	624	1.01	0.005	0.00	0.00	0.00
5	20	Sand	555	575	565	-512	-532	-522	20	128	135	145	70,809	72,089	43,977	430	26,832	44,601	420	26,208	624	1.01	0.005	0.01	0.00	0.01
5	21	Sand	575	595	585	-532	-552	-542	20	128	135	145	73,369	74,649	45,289	450	28,080	45,913	440	27,456	624	1.01	0.005	0.01	0.00	0.01
5	22	Sand	595	615	605	-552	-572	-562	20	128	135	145	75,929	77,209	46,601	470	29,328	47,225	460	28,704	624	1.01	0.005	0.01	0.00	0.01
																							Total Settlement (in) =	0.74	2.20	2.94
																							Total Layer Thickness (feet) =	399	145	544

Date	4/5/2012										
Job No.	103.128										
			Model	Initial Head	Final Head	Sand		Clay		Sandy Clay	
Boring ID	LMPS		Layer	(feet)	(feet)	Cer	Cec	Cer	Cec	Cer	Cec
Scenario	4 to 1		1	34	36	0.005	0.01	0.03	0.18	0.025	0.15
Elevation	43	feet AMSL	2	36	39	0.005	0.01	0.03	0.18	0.025	0.15
Depth to Compressible	71	feet	3	58	74	0.005	0.01	0.03	0.18	0.025	0.15
			4	73	134	0.005	0.01	0.03	0.18	0.025	0.15
			5	135	194	0.005	0.01	0.03	0.18	0.025	0.15

Model	Sub		Depth			Elevation					Total Head		Total Stress		Initial Stresses @ mid point			Final Stresses @ mid point			Delta	$\sigma'_{vf}/\sigma'_{vi}$	Comp	Settlement		
Layer	Layer	Material	Top (feet)	Bottom (feet)	Middle (feet)	Top (feet)	Bottom (feet)	Middle (feet)	Thickness (feet)	Unit wt (pcf)	Initial (feet)	Final (feet)	Mid point (psf)	Bottom (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Effective (psf)	Pore Water (feet)	Pore Water (psf)	Eff. Stress (psf)		Index	Sand (inches)	Clay (inches)	Total (inches)
1	1	Sand	0	71	35.5	43	-28	7.5	71	123	34	36	4,367	8,733	4,367	0	0	4,367	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
2	2	Sand	71	100	85.5	-28	-57	-42.5	29	124	36	39	10,531	12,329	7,442	50	3,089	7,629	47	2,902	187	1.03	0.005	0.02	0.00	0.02
2	3	Sand	100	143	121.5	-57	-100	-78.5	43	124	36	39	14,995	17,661	9,660	86	5,335	9,847	83	5,148	187	1.02	0.005	0.02	0.00	0.02
2	4	Sand	143	193	168	-100	-150	-125	50	124	36	39	20,761	23,861	12,524	132	8,237	12,711	129	8,050	187	1.01	0.005	0.02	0.00	0.02
3	5	Sand	193	233	213	-150	-190	-170	40	125	58	74	26,361	28,861	16,689	155	9,672	17,687	139	8,674	998	1.06	0.005	0.06	0.00	0.06
3	6	Sand	233	283	258	-190	-240	-215	50	125	58	74	31,986	35,111	19,506	200	12,480	20,504	184	11,482	998	1.05	0.005	0.07	0.00	0.07
3	7	Sand	283	333	308	-240	-290	-265	50	125	58	74	38,236	41,361	22,636	250	15,600	23,634	234	14,602	998	1.04	0.005	0.06	0.00	0.06
3	8	Clay	333	343	338	-290	-300	-295	10	126	58	74	41,991	42,621	24,519	280	17,472	25,517	264	16,474	998	1.04	0.030	0.00	0.06	0.06
4	9	Clay	343	360	351.5	-300	-317	-308.5	17	126	73	134	43,692	44,763	26,314	279	17,378	30,120	218	13,572	3,806	1.14	0.030	0.00	0.36	0.36
4	10	Clay	360	375	367.5	-317	-332	-324.5	15	126	73	134	45,708	46,653	27,331	295	18,377	31,138	234	14,570	3,806	1.14	0.030	0.00	0.31	0.31
4	11	Clay	375	390	382.5	-332	-347	-339.5	15	126	73	134	47,598	48,543	28,285	310	19,313	32,092	249	15,506	3,806	1.13	0.030	0.00	0.30	0.30
4	12	Sand	390	420	405	-347	-377	-362	30	126	73	134	50,433	52,323	29,716	332	20,717	33,523	271	16,910	3,806	1.13	0.005	0.09	0.00	0.09
4	13	Sand	420	454	437	-377	-411	-394	34	127	73	134	54,482	56,641	31,768	364	22,714	35,575	303	18,907	3,806	1.12	0.005	0.10	0.00	0.10
4	14	CLS	454	474	464	-411	-431	-421	20	127	73	134	57,911	59,181	33,513	391	24,398	37,319	330	20,592	3,806	1.11	0.025	0.00	0.28	0.28
4	15	CLS	474	494	484	-431	-451	-441	20	127	73	134	60,451	61,721	34,805	411	25,646	38,611	350	21,840	3,806	1.11	0.025	0.00	0.27	0.27
4	16	CLS	494	514	504	-451	-471	-461	20	128	73	134	63,001	64,281	36,107	431	26,894	39,913	370	23,088	3,806	1.11	0.025	0.00	0.26	0.26
4	17	CLS	514	539	526.5	-471	-496	-483.5	25	128	73	134	65,881	67,481	37,583	454	28,298	41,389	393	24,492	3,806	1.10	0.025	0.00	0.31	0.31
5	18	CLS	539	542	540.5	-496	-499	-497.5	3	128	135	194	67,673	67,865	42,370	406	25,303	46,051	347	21,622	3,682	1.09	0.025	0.00	0.03	0.03
5	19	Sand	542	555	548.5	-499	-512	-505.5	13	128	135	194	68,697	69,529	42,895	414	25,802	46,576	355	22,121	3,682	1.09	0.005	0.03	0.00	0.03
5	20	Sand	555	575	565	-512	-532	-522	20	128	135	194	70,809	72,089	43,977	430	26,832	47,659	371	23,150	3,682	1.08	0.005	0.04	0.00	0.04
5	21	Sand	575	595	585	-532	-552	-542	20	128	135	194	73,369	74,649	45,289	450	28,080	48,971	391	24,398	3,682	1.08	0.005	0.04	0.00	0.04
5	22	Sand	595	615	605	-552	-572	-562	20	128	135	194	75,929	77,209	46,601	470	29,328	50,283	411	25,646	3,682	1.08	0.005	0.04	0.00	0.04
																							Total Settlement (in) =	0.59	2.18	2.77
																							Total Layer Thickness (feet) =	399	145	544

Date 5/7/2012
Job No. 103.128

Boring ID So. Sunset Well
Scenario 3a to HL
Elevation 83 feet AMSL
Depth to Compressible 74 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	68	90	0.005	0.01	0.03	0.18	0.025	0.15
2	69	102	0.005	0.01	0.03	0.18	0.025	0.15
3	81	111	0.005	0.01	0.03	0.18	0.025	0.15
4	91	120	0.005	0.01	0.03	0.18	0.025	0.15
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Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	42	21	83	41	62	42	123	68	90	2,583	5,166	2,583	0	0	2,583	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	CLS	42	57	49.5	41	26	33.5	15	124	68	90	6,096	7,026	6,096	0	0	6,096	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	3	CLS	57	74	65.5	26	9	17.5	17	124	68	90	8,080	9,134	8,080	0	0	8,080	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	4	Sand	74	100	87	9	-17	-4	26	124	68	90	10,746	12,358	9,560	19	1,186	10,746	0	0	1,186	1.12	0.005	0.08	0.00	0.08
1	5	Sand	100	150	125	-17	-67	-42	50	125	68	90	15,483	18,608	11,926	57	3,557	13,299	35	2,184	1,373	1.12	0.005	0.14	0.00	0.14
1	6	Sand	150	210	180	-67	-127	-97	60	125	68	90	22,358	26,108	15,369	112	6,989	16,742	90	5,616	1,373	1.09	0.005	0.13	0.00	0.13
1	7	Clay	210	212	211	-127	-129	-128	2	125	68	90	26,233	26,358	17,310	143	8,923	18,683	121	7,550	1,373	1.08	0.030	0.00	0.02	0.02
1	8	Sand	212	235	223.5	-129	-152	-140.5	23	126	68	90	27,807	29,256	18,104	156	9,703	19,477	134	8,330	1,373	1.08	0.005	0.04	0.00	0.04
2	9	Sand	235	265	250	-152	-182	-167	30	126	69	102	31,146	33,036	19,852	181	11,294	21,911	148	9,235	2,059	1.10	0.005	0.08	0.00	0.08
2	10	Sand	265	290	277.5	-182	-207	-194.5	25	126	69	102	34,611	36,186	21,601	209	13,010	23,660	176	10,951	2,059	1.10	0.005	0.06	0.00	0.06
2	11	CLS	290	300	295	-207	-217	-212	10	126	69	102	36,816	37,446	22,714	226	14,102	24,773	193	12,043	2,059	1.09	0.025	0.00	0.11	0.11
2	12	Sand	300	309	304.5	-217	-226	-221.5	9	126	69	102	38,013	38,580	23,318	236	14,695	25,377	203	12,636	2,059	1.09	0.005	0.02	0.00	0.02
3	13	Sand	309	320	314.5	-226	-237	-231.5	11	127	81	111	39,279	39,977	24,708	234	14,570	26,580	204	12,698	1,872	1.08	0.005	0.02	0.00	0.02
3	14	Clay	320	335	327.5	-237	-252	-244.5	15	127	81	111	40,930	41,882	25,548	247	15,382	27,420	217	13,510	1,872	1.07	0.030	0.00	0.17	0.17
3	15	Sand	335	340	337.5	-252	-257	-254.5	5	127	81	111	42,200	42,517	26,194	257	16,006	28,066	227	14,134	1,872	1.07	0.005	0.01	0.00	0.01
3	16	Clay	340	348	344	-257	-265	-261	8	127	81	111	43,025	43,533	26,614	263	16,411	28,486	233	14,539	1,872	1.07	0.030	0.00	0.09	0.09
3	17	Sand	348	362	355	-265	-279	-272	14	127	81	111	44,422	45,311	27,324	274	17,098	29,196	244	15,226	1,872	1.07	0.005	0.02	0.00	0.02
3	18	CLS	362	370	366	-279	-287	-283	8	127	81	111	45,819	46,327	28,035	285	17,784	29,907	255	15,912	1,872	1.07	0.025	0.00	0.07	0.07
3	19	Sand	370	383	376.5	-287	-300	-293.5	13	127	81	111	47,153	47,978	28,713	296	18,439	30,585	266	16,567	1,872	1.07	0.005	0.02	0.00	0.02
4	20	Clay	383	387	385	-300	-304	-302	4	127	91	120	48,232	48,486	29,886	294	18,346	31,696	265	16,536	1,810	1.06	0.030	0.00	0.04	0.04
4	21	Sand	387	417	402	-304	-334	-319	30	127	91	120	50,391	52,296	30,985	311	19,406	32,794	282	17,597	1,810	1.06	0.005	0.04	0.00	0.04
4	22	Sand	417	430	423.5	-334	-347	-340.5	13	127	91	120	53,122	53,947	32,374	333	20,748	34,183	304	18,938	1,810	1.06	0.005	0.02	0.00	0.02
4	23	CLS	430	447	438.5	-347	-364	-355.5	17	127	91	120	55,027	56,106	33,343	348	21,684	35,152	319	19,874	1,810	1.05	0.025	0.00	0.12	0.12
4	24	Clay	447	450	448.5	-364	-367	-365.5	3	127	91	120	56,297	56,487	33,989	358	22,308	35,798	329	20,498	1,810	1.05	0.030	0.00	0.02	0.02
4	25	CLS	450	476	463	-367	-393	-380	26	127	91	120	58,138	59,789	34,925	372	23,213	36,735	343	21,403	1,810	1.05	0.025	0.00	0.17	0.17
4	26	Sand	476	500	488	-393	-417	-405	24	127	91	120	61,313	62,837	36,540	397	24,773	38,350	368	22,963	1,810	1.05	0.005	0.03	0.00	0.03
4	27	Clay	500	514	507	-417	-431	-424	14	127	91	120	63,726	64,615	37,768	416	25,958	39,577	387	24,149	1,810	1.05	0.030	0.00	0.10	0.10
4	28	CLS	514	536	525	-431	-453	-442	22	127	91	120	66,012	67,409	38,930	434	27,082	40,740	405	25,272	1,810	1.05	0.025	0.00	0.13	0.13
4	29	CLS	536	570	553	-453	-487	-470	34	127	91	120	69,568	71,727	40,739	462	28,829	42,549	433	27,019	1,810	1.04	0.025	0.00	0.19	0.19
4	30	Sand	570	600	585	-487	-517	-502	30	127	91	120	73,632	75,537	42,806	494	30,826	44,616	465	29,016	1,810	1.04	0.005	0.03	0.00	0.03
																							Total Settlement (in) =	0.76	1.23	1.99
																							Total Layer Thickness (feet) =	363	163	526

Date 5/7/2012
Job No. 103.128

Boring ID So. Sunset Well
Scenario 3b to HL
Elevation 83 feet AMSL
Depth to Compressible 74 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	68	89	0.005	0.01	0.03	0.18	0.025	0.15
2	69	100	0.005	0.01	0.03	0.18	0.025	0.15
3	81	110	0.005	0.01	0.03	0.18	0.025	0.15
4	91	119	0.005	0.01	0.03	0.18	0.025	0.15
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Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	42	21	83	41	62	42	123	68	89	2,583	5,166	2,583	0	0	2,583	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	CLS	42	57	49.5	41	26	33.5	15	124	68	89	6,096	7,026	6,096	0	0	6,096	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	3	CLS	57	74	65.5	26	9	17.5	17	124	68	89	8,080	9,134	8,080	0	0	8,080	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	4	Sand	74	100	87	9	-17	-4	26	124	68	89	10,746	12,358	9,560	19	1,186	10,746	0	0	1,186	1.12	0.005	0.08	0.00	0.08
1	5	Sand	100	150	125	-17	-67	-42	50	125	68	89	15,483	18,608	11,926	57	3,557	13,237	36	2,246	1,310	1.11	0.005	0.14	0.00	0.14
1	6	Sand	150	210	180	-67	-127	-97	60	125	68	89	22,358	26,108	15,369	112	6,989	16,680	91	5,678	1,310	1.09	0.005	0.13	0.00	0.13
1	7	Clay	210	212	211	-127	-129	-128	2	125	68	89	26,233	26,358	17,310	143	8,923	18,620	122	7,613	1,310	1.08	0.030	0.00	0.02	0.02
1	8	Sand	212	235	223.5	-129	-152	-140.5	23	126	68	89	27,807	29,256	18,104	156	9,703	19,414	135	8,393	1,310	1.07	0.005	0.04	0.00	0.04
2	9	Sand	235	265	250	-152	-182	-167	30	126	69	100	31,146	33,036	19,852	181	11,294	21,786	150	9,360	1,934	1.10	0.005	0.07	0.00	0.07
2	10	Sand	265	290	277.5	-182	-207	-194.5	25	126	69	100	34,611	36,186	21,601	209	13,010	23,535	178	11,076	1,934	1.09	0.005	0.06	0.00	0.06
2	11	CLS	290	300	295	-207	-217	-212	10	126	69	100	36,816	37,446	22,714	226	14,102	24,648	195	12,168	1,934	1.09	0.025	0.00	0.11	0.11
2	12	Sand	300	309	304.5	-217	-226	-221.5	9	126	69	100	38,013	38,580	23,318	236	14,695	25,252	205	12,761	1,934	1.08	0.005	0.02	0.00	0.02
3	13	Sand	309	320	314.5	-226	-237	-231.5	11	127	81	110	39,279	39,977	24,708	234	14,570	26,518	205	12,761	1,810	1.07	0.005	0.02	0.00	0.02
3	14	Clay	320	335	327.5	-237	-252	-244.5	15	127	81	110	40,930	41,882	25,548	247	15,382	27,358	218	13,572	1,810	1.07	0.030	0.00	0.16	0.16
3	15	Sand	335	340	337.5	-252	-257	-254.5	5	127	81	110	42,200	42,517	26,194	257	16,006	28,004	228	14,196	1,810	1.07	0.005	0.01	0.00	0.01
3	16	Clay	340	348	344	-257	-265	-261	8	127	81	110	43,025	43,533	26,614	263	16,411	28,423	234	14,602	1,810	1.07	0.030	0.00	0.08	0.08
3	17	Sand	348	362	355	-265	-279	-272	14	127	81	110	44,422	45,311	27,324	274	17,098	29,134	245	15,288	1,810	1.07	0.005	0.02	0.00	0.02
3	18	CLS	362	370	366	-279	-287	-283	8	127	81	110	45,819	46,327	28,035	285	17,784	29,845	256	15,974	1,810	1.06	0.025	0.00	0.07	0.07
3	19	Sand	370	383	376.5	-287	-300	-293.5	13	127	81	110	47,153	47,978	28,713	296	18,439	30,523	267	16,630	1,810	1.06	0.005	0.02	0.00	0.02
4	20	Clay	383	387	385	-300	-304	-302	4	127	91	119	48,232	48,486	29,886	294	18,346	31,634	266	16,598	1,747	1.06	0.030	0.00	0.04	0.04
4	21	Sand	387	417	402	-304	-334	-319	30	127	91	119	50,391	52,296	30,985	311	19,406	32,732	283	17,659	1,747	1.06	0.005	0.04	0.00	0.04
4	22	Sand	417	430	423.5	-334	-347	-340.5	13	127	91	119	53,122	53,947	32,374	333	20,748	34,121	305	19,001	1,747	1.05	0.005	0.02	0.00	0.02
4	23	CLS	430	447	438.5	-347	-364	-355.5	17	127	91	119	55,027	56,106	33,343	348	21,684	35,090	320	19,937	1,747	1.05	0.025	0.00	0.11	0.11
4	24	Clay	447	450	448.5	-364	-367	-365.5	3	127	91	119	56,297	56,487	33,989	358	22,308	35,736	330	20,561	1,747	1.05	0.030	0.00	0.02	0.02
4	25	CLS	450	476	463	-367	-393	-380	26	127	91	119	58,138	59,789	34,925	372	23,213	36,672	344	21,466	1,747	1.05	0.025	0.00	0.17	0.17
4	26	Sand	476	500	488	-393	-417	-405	24	127	91	119	61,313	62,837	36,540	397	24,773	38,287	369	23,026	1,747	1.05	0.005	0.03	0.00	0.03
4	27	Clay	500	514	507	-417	-431	-424	14	127	91	119	63,726	64,615	37,768	416	25,958	39,515	388	24,211	1,747	1.05	0.030	0.00	0.10	0.10
4	28	CLS	514	536	525	-431	-453	-442	22	127	91	119	66,012	67,409	38,930	434	27,082	40,678	406	25,334	1,747	1.04	0.025	0.00	0.13	0.13
4	29	CLS	536	570	553	-453	-487	-470	34	127	91	119	69,568	71,727	40,739	462	28,829	42,486	434	27,082	1,747	1.04	0.025	0.00	0.19	0.19
4	30	Sand	570	600	585	-487	-517	-502	30	127	91	119	73,632	75,537	42,806	494	30,826	44,554	466	29,078	1,747	1.04	0.005	0.03	0.00	0.03
																							Total Settlement (in) =	0.73	1.19	1.91
																							Total Layer Thickness (feet) =	363	163	526

Date 5/7/2012
Job No. 103.128

Boring ID So. Sunset Well
Scenario 4 to HL
Elevation 83 feet AMSL
Depth to Compressible 74 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	68	84	0.005	0.01	0.03	0.18	0.025	0.15
2	69	95	0.005	0.01	0.03	0.18	0.025	0.15
3	81	106	0.005	0.01	0.03	0.18	0.025	0.15
4	91	117	0.005	0.01	0.03	0.18	0.025	0.15
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Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	42	21	83	41	62	42	123	68	84	2,583	5,166	2,583	0	0	2,583	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	CLS	42	57	49.5	41	26	33.5	15	124	68	84	6,096	7,026	6,096	0	0	6,096	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	3	CLS	57	74	65.5	26	9	17.5	17	124	68	84	8,080	9,134	8,080	0	0	8,080	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	4	Sand	74	100	87	9	-17	-4	26	124	68	84	10,746	12,358	9,560	19	1,186	10,559	3	187	998	1.10	0.005	0.07	0.00	0.07
1	5	Sand	100	150	125	-17	-67	-42	50	125	68	84	15,483	18,608	11,926	57	3,557	12,925	41	2,558	998	1.08	0.005	0.10	0.00	0.10
1	6	Sand	150	210	180	-67	-127	-97	60	125	68	84	22,358	26,108	15,369	112	6,989	16,368	96	5,990	998	1.06	0.005	0.10	0.00	0.10
1	7	Clay	210	212	211	-127	-129	-128	2	125	68	84	26,233	26,358	17,310	143	8,923	18,308	127	7,925	998	1.06	0.030	0.00	0.02	0.02
1	8	Sand	212	235	223.5	-129	-152	-140.5	23	126	68	84	27,807	29,256	18,104	156	9,703	19,102	140	8,705	998	1.06	0.005	0.03	0.00	0.03
2	9	Sand	235	265	250	-152	-182	-167	30	126	69	95	31,146	33,036	19,852	181	11,294	21,474	155	9,672	1,622	1.08	0.005	0.06	0.00	0.06
2	10	Sand	265	290	277.5	-182	-207	-194.5	25	126	69	95	34,611	36,186	21,601	209	13,010	23,223	183	11,388	1,622	1.08	0.005	0.05	0.00	0.05
2	11	CLS	290	300	295	-207	-217	-212	10	126	69	95	36,816	37,446	22,714	226	14,102	24,336	200	12,480	1,622	1.07	0.025	0.00	0.09	0.09
2	12	Sand	300	309	304.5	-217	-226	-221.5	9	126	69	95	38,013	38,580	23,318	236	14,695	24,940	210	13,073	1,622	1.07	0.005	0.02	0.00	0.02
3	13	Sand	309	320	314.5	-226	-237	-231.5	11	127	81	106	39,279	39,977	24,708	234	14,570	26,268	209	13,010	1,560	1.06	0.005	0.02	0.00	0.02
3	14	Clay	320	335	327.5	-237	-252	-244.5	15	127	81	106	40,930	41,882	25,548	247	15,382	27,108	222	13,822	1,560	1.06	0.030	0.00	0.14	0.14
3	15	Sand	335	340	337.5	-252	-257	-254.5	5	127	81	106	42,200	42,517	26,194	257	16,006	27,754	232	14,446	1,560	1.06	0.005	0.01	0.00	0.01
3	16	Clay	340	348	344	-257	-265	-261	8	127	81	106	43,025	43,533	26,614	263	16,411	28,174	238	14,851	1,560	1.06	0.030	0.00	0.07	0.07
3	17	Sand	348	362	355	-265	-279	-272	14	127	81	106	44,422	45,311	27,324	274	17,098	28,884	249	15,538	1,560	1.06	0.005	0.02	0.00	0.02
3	18	CLS	362	370	366	-279	-287	-283	8	127	81	106	45,819	46,327	28,035	285	17,784	29,595	260	16,224	1,560	1.06	0.025	0.00	0.06	0.06
3	19	Sand	370	383	376.5	-287	-300	-293.5	13	127	81	106	47,153	47,978	28,713	296	18,439	30,273	271	16,879	1,560	1.05	0.005	0.02	0.00	0.02
4	20	Clay	383	387	385	-300	-304	-302	4	127	91	117	48,232	48,486	29,886	294	18,346	31,509	268	16,723	1,622	1.05	0.030	0.00	0.03	0.03
4	21	Sand	387	417	402	-304	-334	-319	30	127	91	117	50,391	52,296	30,985	311	19,406	32,607	285	17,784	1,622	1.05	0.005	0.04	0.00	0.04
4	22	Sand	417	430	423.5	-334	-347	-340.5	13	127	91	117	53,122	53,947	32,374	333	20,748	33,996	307	19,126	1,622	1.05	0.005	0.02	0.00	0.02
4	23	CLS	430	447	438.5	-347	-364	-355.5	17	127	91	117	55,027	56,106	33,343	348	21,684	34,965	322	20,062	1,622	1.05	0.025	0.00	0.11	0.11
4	24	Clay	447	450	448.5	-364	-367	-365.5	3	127	91	117	56,297	56,487	33,989	358	22,308	35,611	332	20,686	1,622	1.05	0.030	0.00	0.02	0.02
4	25	CLS	450	476	463	-367	-393	-380	26	127	91	117	58,138	59,789	34,925	372	23,213	36,548	346	21,590	1,622	1.05	0.025	0.00	0.15	0.15
4	26	Sand	476	500	488	-393	-417	-405	24	127	91	117	61,313	62,837	36,540	397	24,773	38,163	371	23,150	1,622	1.04	0.005	0.03	0.00	0.03
4	27	Clay	500	514	507	-417	-431	-424	14	127	91	117	63,726	64,615	37,768	416	25,958	39,390	390	24,336	1,622	1.04	0.030	0.00	0.09	0.09
4	28	CLS	514	536	525	-431	-453	-442	22	127	91	117	66,012	67,409	38,930	434	27,082	40,553	408	25,459	1,622	1.04	0.025	0.00	0.12	0.12
4	29	CLS	536	570	553	-453	-487	-470	34	127	91	117	69,568	71,727	40,739	462	28,829	42,362	436	27,206	1,622	1.04	0.025	0.00	0.17	0.17
4	30	Sand	570	600	585	-487	-517	-502	30	127	91	117	73,632	75,537	42,806	494	30,826	44,429	468	29,203	1,622	1.04	0.005	0.03	0.00	0.03

	Sand	Clay	Total
Total Settlement (in) =	0.60	1.07	1.67
Total Layer Thickness (feet) =	363	163	526

Date	5/7/2012
Job No.	103.128
Boring ID	So. Sunset Well
Scenario	3a to 1
Elevation	83 feet AMSL
Depth to Compressible	74 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	69	90	0.005	0.01	0.03	0.18	0.025	0.15
2	70	102	0.005	0.01	0.03	0.18	0.025	0.15
3	83	111	0.005	0.01	0.03	0.18	0.025	0.15
4	93	120	0.005	0.01	0.03	0.18	0.025	0.15
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Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	42	21	83	41	62	42	123	69	90	2,583	5,166	2,583	0	0	2,583	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	CLS	42	57	49.5	41	26	33.5	15	124	69	90	6,096	7,026	6,096	0	0	6,096	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	3	CLS	57	74	65.5	26	9	17.5	17	124	69	90	8,080	9,134	8,080	0	0	8,080	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	4	Sand	74	100	87	9	-17	-4	26	124	69	90	10,746	12,358	9,623	18	1,123	10,746	0	0	1,123	1.12	0.005	0.07	0.00	0.07
1	5	Sand	100	150	125	-17	-67	-42	50	125	69	90	15,483	18,608	11,989	56	3,494	13,299	35	2,184	1,310	1.11	0.005	0.14	0.00	0.14
1	6	Sand	150	210	180	-67	-127	-97	60	125	69	90	22,358	26,108	15,432	111	6,926	16,742	90	5,616	1,310	1.08	0.005	0.13	0.00	0.13
1	7	Clay	210	212	211	-127	-129	-128	2	125	69	90	26,233	26,358	17,372	142	8,861	18,683	121	7,550	1,310	1.08	0.030	0.00	0.02	0.02
1	8	Sand	212	235	223.5	-129	-152	-140.5	23	126	69	90	27,807	29,256	18,166	155	9,641	19,477	134	8,330	1,310	1.07	0.005	0.04	0.00	0.04
2	9	Sand	235	265	250	-152	-182	-167	30	126	70	102	31,146	33,036	19,914	180	11,232	21,911	148	9,235	1,997	1.10	0.005	0.07	0.00	0.07
2	10	Sand	265	290	277.5	-182	-207	-194.5	25	126	70	102	34,611	36,186	21,663	208	12,948	23,660	176	10,951	1,997	1.09	0.005	0.06	0.00	0.06
2	11	CLS	290	300	295	-207	-217	-212	10	126	70	102	36,816	37,446	22,776	225	14,040	24,773	193	12,043	1,997	1.09	0.025	0.00	0.11	0.11
2	12	Sand	300	309	304.5	-217	-226	-221.5	9	126	70	102	38,013	38,580	23,380	235	14,633	25,377	203	12,636	1,997	1.09	0.005	0.02	0.00	0.02
3	13	Sand	309	320	314.5	-226	-237	-231.5	11	127	83	111	39,279	39,977	24,833	232	14,446	26,580	204	12,698	1,747	1.07	0.005	0.02	0.00	0.02
3	14	Clay	320	335	327.5	-237	-252	-244.5	15	127	83	111	40,930	41,882	25,673	245	15,257	27,420	217	13,510	1,747	1.07	0.030	0.00	0.15	0.15
3	15	Sand	335	340	337.5	-252	-257	-254.5	5	127	83	111	42,200	42,517	26,319	255	15,881	28,066	227	14,134	1,747	1.07	0.005	0.01	0.00	0.01
3	16	Clay	340	348	344	-257	-265	-261	8	127	83	111	43,025	43,533	26,739	261	16,286	28,486	233	14,539	1,747	1.07	0.030	0.00	0.08	0.08
3	17	Sand	348	362	355	-265	-279	-272	14	127	83	111	44,422	45,311	27,449	272	16,973	29,196	244	15,226	1,747	1.06	0.005	0.02	0.00	0.02
3	18	CLS	362	370	366	-279	-287	-283	8	127	83	111	45,819	46,327	28,160	283	17,659	29,907	255	15,912	1,747	1.06	0.025	0.00	0.06	0.06
3	19	Sand	370	383	376.5	-287	-300	-293.5	13	127	83	111	47,153	47,978	28,838	294	18,314	30,585	266	16,567	1,747	1.06	0.005	0.02	0.00	0.02
4	20	Clay	383	387	385	-300	-304	-302	4	127	93	120	48,232	48,486	30,011	292	18,221	31,696	265	16,536	1,685	1.06	0.030	0.00	0.03	0.03
4	21	Sand	387	417	402	-304	-334	-319	30	127	93	120	50,391	52,296	31,109	309	19,282	32,794	282	17,597	1,685	1.05	0.005	0.04	0.00	0.04
4	22	Sand	417	430	423.5	-334	-347	-340.5	13	127	93	120	53,122	53,947	32,498	331	20,623	34,183	304	18,938	1,685	1.05	0.005	0.02	0.00	0.02
4	23	CLS	430	447	438.5	-347	-364	-355.5	17	127	93	120	55,027	56,106	33,467	346	21,559	35,152	319	19,874	1,685	1.05	0.025	0.00	0.11	0.11
4	24	Clay	447	450	448.5	-364	-367	-365.5	3	127	93	120	56,297	56,487	34,113	356	22,183	35,798	329	20,498	1,685	1.05	0.030	0.00	0.02	0.02
4	25	CLS	450	476	463	-367	-393	-380	26	127	93	120	58,138	59,789	35,050	370	23,088	36,735	343	21,403	1,685	1.05	0.025	0.00	0.16	0.16
4	26	Sand	476	500	488	-393	-417	-405	24	127	93	120	61,313	62,837	36,665	395	24,648	38,350	368	22,963	1,685	1.05	0.005	0.03	0.00	0.03
4	27	Clay	500	514	507	-417	-431	-424	14	127	93	120	63,726	64,615	37,892	414	25,834	39,577	387	24,149	1,685	1.04	0.030	0.00	0.10	0.10
4	28	CLS	514	536	525	-431	-453	-442	22	127	93	120	66,012	67,409	39,055	432	26,957	40,740	405	25,272	1,685	1.04	0.025	0.00	0.12	0.12
4	29	CLS	536	570	553	-453	-487	-470	34	127	93	120	69,568	71,727	40,864	460	28,704	42,549	433	27,019	1,685	1.04	0.025	0.00	0.18	0.18
4	30	Sand	570	600	585	-487	-517	-502	30	127	93	120	73,632	75,537	42,931	492	30,701	44,616	465	29,016	1,685	1.04	0.005	0.03	0.00	0.03
																						Total Settlement (in) =		0.72	1.15	1.87
																						Total Layer Thickness (feet) =		363	163	526

Date	5/7/2012
Job No.	103.128
Boring ID	So. Sunset Well
Scenario	3b to 1
Elevation	83 feet AMSL
Depth to Compressible	74 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	69	89	0.005	0.01	0.03	0.18	0.025	0.15
2	70	100	0.005	0.01	0.03	0.18	0.025	0.15
3	83	110	0.005	0.01	0.03	0.18	0.025	0.15
4	93	119	0.005	0.01	0.03	0.18	0.025	0.15
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Model Layer	Sub Layer	Material	Depth			Elevation			Thickness	Unit wt	Total Head		Total Stress		Initial Stresses @ mid point			Final Stresses @ mid point			Delta	$\sigma'_{vf}/\sigma'_{vi}$	Comp	Settlement		
			Top	Bottom	Middle	Top	Bottom	Middle			Initial	Final	Mid point	Bottom	Effective	Pore Water		Effective	Pore Water		Eff. Stress		Index	Sand	Clay	Total
			(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(feet)	(pcf)	(feet)	(feet)	(psf)	(psf)	(psf)	(feet)	(psf)	(psf)	(feet)	(psf)	(psf)			(inches)	(inches)	(inches)
1	1	Sand	0	42	21	83	41	62	42	123	69	89	2,583	5,166	2,583	0	0	2,583	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	CLS	42	57	49.5	41	26	33.5	15	124	69	89	6,096	7,026	6,096	0	0	6,096	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	3	CLS	57	74	65.5	26	9	17.5	17	124	69	89	8,080	9,134	8,080	0	0	8,080	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	4	Sand	74	100	87	9	-17	-4	26	124	69	89	10,746	12,358	9,623	18	1,123	10,746	0	0	1,123	1.12	0.005	0.07	0.00	0.07
1	5	Sand	100	150	125	-17	-67	-42	50	125	69	89	15,483	18,608	11,989	56	3,494	13,237	36	2,246	1,248	1.10	0.005	0.13	0.00	0.13
1	6	Sand	150	210	180	-67	-127	-97	60	125	69	89	22,358	26,108	15,432	111	6,926	16,680	91	5,678	1,248	1.08	0.005	0.12	0.00	0.12
1	7	Clay	210	212	211	-127	-129	-128	2	125	69	89	26,233	26,358	17,372	142	8,861	18,620	122	7,613	1,248	1.07	0.030	0.00	0.02	0.02
1	8	Sand	212	235	223.5	-129	-152	-140.5	23	126	69	89	27,807	29,256	18,166	155	9,641	19,414	135	8,393	1,248	1.07	0.005	0.04	0.00	0.04
2	9	Sand	235	265	250	-152	-182	-167	30	126	70	100	31,146	33,036	19,914	180	11,232	21,786	150	9,360	1,872	1.09	0.005	0.07	0.00	0.07
2	10	Sand	265	290	277.5	-182	-207	-194.5	25	126	70	100	34,611	36,186	21,663	208	12,948	23,535	178	11,076	1,872	1.09	0.005	0.05	0.00	0.05
2	11	CLS	290	300	295	-207	-217	-212	10	126	70	100	36,816	37,446	22,776	225	14,040	24,648	195	12,168	1,872	1.08	0.025	0.00	0.10	0.10
2	12	Sand	300	309	304.5	-217	-226	-221.5	9	126	70	100	38,013	38,580	23,380	235	14,633	25,252	205	12,761	1,872	1.08	0.005	0.02	0.00	0.02
3	13	Sand	309	320	314.5	-226	-237	-231.5	11	127	83	110	39,279	39,977	24,833	232	14,446	26,518	205	12,761	1,685	1.07	0.005	0.02	0.00	0.02
3	14	Clay	320	335	327.5	-237	-252	-244.5	15	127	83	110	40,930	41,882	25,673	245	15,257	27,358	218	13,572	1,685	1.07	0.030	0.00	0.15	0.15
3	15	Sand	335	340	337.5	-252	-257	-254.5	5	127	83	110	42,200	42,517	26,319	255	15,881	28,004	228	14,196	1,685	1.06	0.005	0.01	0.00	0.01
3	16	Clay	340	348	344	-257	-265	-261	8	127	83	110	43,025	43,533	26,739	261	16,286	28,423	234	14,602	1,685	1.06	0.030	0.00	0.08	0.08
3	17	Sand	348	362	355	-265	-279	-272	14	127	83	110	44,422	45,311	27,449	272	16,973	29,134	245	15,288	1,685	1.06	0.005	0.02	0.00	0.02
3	18	CLS	362	370	366	-279	-287	-283	8	127	83	110	45,819	46,327	28,160	283	17,659	29,845	256	15,974	1,685	1.06	0.025	0.00	0.06	0.06
3	19	Sand	370	383	376.5	-287	-300	-293.5	13	127	83	110	47,153	47,978	28,838	294	18,314	30,523	267	16,630	1,685	1.06	0.005	0.02	0.00	0.02
4	20	Clay	383	387	385	-300	-304	-302	4	127	93	119	48,232	48,486	30,011	292	18,221	31,634	266	16,598	1,622	1.05	0.030	0.00	0.03	0.03
4	21	Sand	387	417	402	-304	-334	-319	30	127	93	119	50,391	52,296	31,109	309	19,282	32,732	283	17,659	1,622	1.05	0.005	0.04	0.00	0.04
4	22	Sand	417	430	423.5	-334	-347	-340.5	13	127	93	119	53,122	53,947	32,498	331	20,623	34,121	305	19,001	1,622	1.05	0.005	0.02	0.00	0.02
4	23	CLS	430	447	438.5	-347	-364	-355.5	17	127	93	119	55,027	56,106	33,467	346	21,559	35,090	320	19,937	1,622	1.05	0.025	0.00	0.10	0.10
4	24	Clay	447	450	448.5	-364	-367	-365.5	3	127	93	119	56,297	56,487	34,113	356	22,183	35,736	330	20,561	1,622	1.05	0.030	0.00	0.02	0.02
4	25	CLS	450	476	463	-367	-393	-380	26	127	93	119	58,138	59,789	35,050	370	23,088	36,672	344	21,466	1,622	1.05	0.025	0.00	0.15	0.15
4	26	Sand	476	500	488	-393	-417	-405	24	127	93	119	61,313	62,837	36,665	395	24,648	38,287	369	23,026	1,622	1.04	0.005	0.03	0.00	0.03
4	27	Clay	500	514	507	-417	-431	-424	14	127	93	119	63,726	64,615	37,892	414	25,834	39,515	388	24,211	1,622	1.04	0.030	0.00	0.09	0.09
4	28	CLS	514	536	525	-431	-453	-442	22	127	93	119	66,012	67,409	39,055	432	26,957	40,678	406	25,334	1,622	1.04	0.025	0.00	0.12	0.12
4	29	CLS	536	570	553	-453	-487	-470	34	127	93	119	69,568	71,727	40,864	460	28,704	42,486	434	27,082	1,622	1.04	0.025	0.00	0.17	0.17
4	30	Sand	570	600	585	-487	-517	-502	30	127	93	119	73,632	75,537	42,931	492	30,701	44,554	466	29,078	1,622	1.04	0.005	0.03	0.00	0.03
																							Total Settlement (in) =	0.69	1.10	1.79
																							Total Layer Thickness (feet) =	363	163	526

Date	5/7/2012
Job No.	103.128
Boring ID	So. Sunset Well
Scenario	4 to 1
Elevation	83 feet AMSL
Depth to Compressible	74 feet

Model Layer	Initial Head (feet)	Final Head (feet)	Sand Cer	Sand Cec	Clay Cer	Clay Cec	Sandy Clay Cer	Sandy Clay Cec
1	69	84	0.005	0.01	0.03	0.18	0.025	0.15
2	70	95	0.005	0.01	0.03	0.18	0.025	0.15
3	83	106	0.005	0.01	0.03	0.18	0.025	0.15
4	93	117	0.005	0.01	0.03	0.18	0.025	0.15
5	----	----	----	----	----	----	----	----

Model Layer	Sub Layer	Material	Depth Top (feet)	Depth Bottom (feet)	Depth Middle (feet)	Elevation Top (feet)	Elevation Bottom (feet)	Elevation Middle (feet)	Thickness (feet)	Unit wt (pcf)	Total Head Initial (feet)	Total Head Final (feet)	Total Stress Mid point (psf)	Total Stress Bottom (psf)	Initial Stresses @ mid point Effective (psf)	Initial Pore Water (feet)	Initial Pore Water (psf)	Final Stresses @ mid point Effective (psf)	Final Pore Water (feet)	Final Pore Water (psf)	Delta Eff. Stress (psf)	$\sigma'_{vf}/\sigma'_{vi}$	Comp Index	Settlement Sand (inches)	Settlement Clay (inches)	Settlement Total (inches)
1	1	Sand	0	42	21	83	41	62	42	123	69	84	2,583	5,166	2,583	0	0	2,583	0	0	0	1.00	0.005	Incomp.	Incomp.	0.00
1	2	CLS	42	57	49.5	41	26	33.5	15	124	69	84	6,096	7,026	6,096	0	0	6,096	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	3	CLS	57	74	65.5	26	9	17.5	17	124	69	84	8,080	9,134	8,080	0	0	8,080	0	0	0	1.00	0.025	Incomp.	Incomp.	0.00
1	4	Sand	74	100	87	9	-17	-4	26	124	69	84	10,746	12,358	9,623	18	1,123	10,559	3	187	936	1.10	0.005	0.06	0.00	0.06
1	5	Sand	100	150	125	-17	-67	-42	50	125	69	84	15,483	18,608	11,989	56	3,494	12,925	41	2,558	936	1.08	0.005	0.10	0.00	0.10
1	6	Sand	150	210	180	-67	-127	-97	60	125	69	84	22,358	26,108	15,432	111	6,926	16,368	96	5,990	936	1.06	0.005	0.09	0.00	0.09
1	7	Clay	210	212	211	-127	-129	-128	2	125	69	84	26,233	26,358	17,372	142	8,861	18,308	127	7,925	936	1.05	0.030	0.00	0.02	0.02
1	8	Sand	212	235	223.5	-129	-152	-140.5	23	126	69	84	27,807	29,256	18,166	155	9,641	19,102	140	8,705	936	1.05	0.005	0.03	0.00	0.03
2	9	Sand	235	265	250	-152	-182	-167	30	126	70	95	31,146	33,036	19,914	180	11,232	21,474	155	9,672	1,560	1.08	0.005	0.06	0.00	0.06
2	10	Sand	265	290	277.5	-182	-207	-194.5	25	126	70	95	34,611	36,186	21,663	208	12,948	23,223	183	11,388	1,560	1.07	0.005	0.05	0.00	0.05
2	11	CLS	290	300	295	-207	-217	-212	10	126	70	95	36,816	37,446	22,776	225	14,040	24,336	200	12,480	1,560	1.07	0.025	0.00	0.09	0.09
2	12	Sand	300	309	304.5	-217	-226	-221.5	9	126	70	95	38,013	38,580	23,380	235	14,633	24,940	210	13,073	1,560	1.07	0.005	0.02	0.00	0.02
3	13	Sand	309	320	314.5	-226	-237	-231.5	11	127	83	106	39,279	39,977	24,833	232	14,446	26,268	209	13,010	1,435	1.06	0.005	0.02	0.00	0.02
3	14	Clay	320	335	327.5	-237	-252	-244.5	15	127	83	106	40,930	41,882	25,673	245	15,257	27,108	222	13,822	1,435	1.06	0.030	0.00	0.13	0.13
3	15	Sand	335	340	337.5	-252	-257	-254.5	5	127	83	106	42,200	42,517	26,319	255	15,881	27,754	232	14,446	1,435	1.05	0.005	0.01	0.00	0.01
3	16	Clay	340	348	344	-257	-265	-261	8	127	83	106	43,025	43,533	26,739	261	16,286	28,174	238	14,851	1,435	1.05	0.030	0.00	0.07	0.07
3	17	Sand	348	362	355	-265	-279	-272	14	127	83	106	44,422	45,311	27,449	272	16,973	28,884	249	15,538	1,435	1.05	0.005	0.02	0.00	0.02
3	18	CLS	362	370	366	-279	-287	-283	8	127	83	106	45,819	46,327	28,160	283	17,659	29,595	260	16,224	1,435	1.05	0.025	0.00	0.05	0.05
3	19	Sand	370	383	376.5	-287	-300	-293.5	13	127	83	106	47,153	47,978	28,838	294	18,314	30,273	271	16,879	1,435	1.05	0.005	0.02	0.00	0.02
4	20	Clay	383	387	385	-300	-304	-302	4	127	93	117	48,232	48,486	30,011	292	18,221	31,509	268	16,723	1,498	1.05	0.030	0.00	0.03	0.03
4	21	Sand	387	417	402	-304	-334	-319	30	127	93	117	50,391	52,296	31,109	309	19,282	32,607	285	17,784	1,498	1.05	0.005	0.04	0.00	0.04
4	22	Sand	417	430	423.5	-334	-347	-340.5	13	127	93	117	53,122	53,947	32,498	331	20,623	33,996	307	19,126	1,498	1.05	0.005	0.02	0.00	0.02
4	23	CLS	430	447	438.5	-347	-364	-355.5	17	127	93	117	55,027	56,106	33,467	346	21,559	34,965	322	20,062	1,498	1.04	0.025	0.00	0.10	0.10
4	24	Clay	447	450	448.5	-364	-367	-365.5	3	127	93	117	56,297	56,487	34,113	356	22,183	35,611	332	20,686	1,498	1.04	0.030	0.00	0.02	0.02
4	25	CLS	450	476	463	-367	-393	-380	26	127	93	117	58,138	59,789	35,050	370	23,088	36,548	346	21,590	1,498	1.04	0.025	0.00	0.14	0.14
4	26	Sand	476	500	488	-393	-417	-405	24	127	93	117	61,313	62,837	36,665	395	24,648	38,163	371	23,150	1,498	1.04	0.005	0.03	0.00	0.03
4	27	Clay	500	514	507	-417	-431	-424	14	127	93	117	63,726	64,615	37,892	414	25,834	39,390	390	24,336	1,498	1.04	0.030	0.00	0.08	0.08
4	28	CLS	514	536	525	-431	-453	-442	22	127	93	117	66,012	67,409	39,055	432	26,957	40,553	408	25,459	1,498	1.04	0.025	0.00	0.11	0.11
4	29	CLS	536	570	553	-453	-487	-470	34	127	93	117	69,568	71,727	40,864	460	28,704	42,362	436	27,206	1,498	1.04	0.025	0.00	0.16	0.16
4	30	Sand	570	600	585	-487	-517	-502	30	127	93	117	73,632	75,537	42,931	492	30,701	44,429	468	29,203	1,498	1.03	0.005	0.03	0.00	0.03
																							Total Settlement (in) =	0.56	0.99	1.55
																							Total Layer Thickness (feet) =	363	163	526

Kennedy/Jenks Consultants

303 Second Street, Suite 300 South
San Francisco, California 94107
415-243-2150
FAX: 415-896-0999

Technical Memorandum 10.6

Assessment of Groundwater Quality

for the Regional Groundwater Storage and Recovery Project

3 May 2012

Prepared for

San Francisco Public Utilities Commission
525 Golden Gate Avenue, 10th Floor
San Francisco, CA 94102

K/J Project No. 0864001

Supplemental Explanation for Hydrographs - TM10.6

This supplemental explanation is prepared to address discrepancies on several graphs presented in TM 10.6.

First, the x-axis on several graphs showing model results was shifted. The x-axis is named Scenario Year which should correspond to a water year[1]. However, the graph template was plotted using a calendar year, so the intervals on the x-axis represent the period from January to December. The result is that the graph is shifted 3-months later relative to Scenario Year.

Second, the shaded area representing the Design Drought was added manually and because of this process, it was not presented consistently on the graphs. By definition per the PEIR, the 8.5-year Design Drought includes one Hold year before the 7.5-year Take period. In addition, the Design Drought needs to be shifted 3-months later for the x-axis issue to be consistent with the model output. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.

The following is a list of figures in TM 10.6 where the Design Drought shaded area is shown slightly different and does not match the correct display of the Design Drought. The figures should be viewed based on the correct representation of the Design Drought as explained above.

- Figure 10.6-6 has the shifted x-axis. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.
- Attachment 10.6-A graphs with model simulated groundwater levels have the shifted x-axis. The Design Drought should be shown as Scenario Years 35.5 to 44.0 on the shifted x-axis.

[1] A water year is October 1 of the previous year to September 30 of the current (named) year.

3 May 2012

Task 10.6 Technical Memorandum

San Francisco Public Utilities Commission

Assessment of Groundwater Quality for the Regional Groundwater Storage and Recovery Project

Prepared For: Greg Bartow, SFPUC

Prepared by: Sevim Onsoy, Les Chau, and Michael Maley, Kennedy/Jenks Consultants

1. Introduction

This Technical Memorandum (TM) was prepared to document work performed by Kennedy/Jenks Consultants (Kennedy/Jenks) pursuant to Task Order (TO) CUW30103-TO-1.14 authorized by the San Francisco Public Utilities Commission (SFPUC) under the Proposed Regional Groundwater Storage and Recovery (GSR) Project. This investigation is performed under the amended TO Pre-Design Investigation Task 10.6 Follow-up Engineering and Hydrogeological Support of the Environmental Phase. This project is funded by the SFPUC's Water System Improvement Program (WSIP).

1.1. Objective

Implementation of the GSR Project will influence groundwater levels within portions of the Westside Groundwater Basin (Westside Basin or Basin). Depending on the magnitude of the potential changes to groundwater levels, groundwater quality conditions may be influenced during the GSR Project operations. Evaluation of the potential groundwater quality effects is a management issue for the long-term sustainability of the groundwater resources in the Westside Basin. The GSR Project has installed numerous monitoring wells to collect data since 2009 for baseline conditions prerequisite of the construction of the proposed production wells. Groundwater samples are being tested for complete Title 22 parameters to ensure highest drinking water quality and results have shown no impact from any man-made activities (e.g., commercial or industrial processes).

This TM was prepared specifically to support the Environmental Impact Report (EIR) that is being prepared for the GSR Project. Associated with the EIR are several significance criteria related to groundwater and surface water conditions within the southern Westside Basin (referred to as South Westside Basin). The specific criterion to be considered by this TM for the assessment of water quality for the GSR Project is stated as follows:

> The GSR Project could potentially and "substantially" affect existing water quality conditions in the South Westside Basin.

> The GSR Project “effect” in the context of this analysis is defined as “mobilization of contaminants in groundwater as a result of pumping or increase in groundwater levels in the South Westside Basin.”

Discussion of groundwater quality in this TM includes the evaluation of contaminants that are (1) currently in the groundwater flow system and are pre-existing to the GSR Project and (2) currently in soils that may be mobilized into groundwater from changes to groundwater levels and flow directions caused by the GSR Project operations. A 70 feet below ground surface (bgs) threshold depth was determined for this water quality assessment by canvassing the reported depths of contaminants in lists of active regulated sites from several state and local data sources (Section 5.1). The reported depths of contaminants were shallower than 50 feet bgs in nearly all the active and inactive regulated sites. An additional 20 feet was added as conservative buffer depth. The 70 feet bgs threshold depth can be compared to the model simulated depths to groundwater represented in the groundwater model as the uppermost layer (defined as Model Layer 1). In this water quality assessment, the groundwater model simulated depth to water was used to identify areas that might be within the 70-foot depth threshold from the ground surface and therefore might be most susceptible to groundwater quality effects (see Sections 4.3.3 and 5.2.1). More specifically, if groundwater levels rise to 70 feet bgs or shallower, then there is a potential for mobilization of existing contamination in the soil and/or shallow groundwater systems.

The overall purpose of this TM is to evaluate the potential groundwater quality issues that might result from the future operation of the GSR Project. These issues include the possible mobilization of contaminants or changes in shallow aquifer conditions due to increases in groundwater levels and storage in the South Westside Basin as a result of the GSR Project.

The specific objectives of this TM are as follows:

- To provide background information on the past and current physical setting of the GSR Project area with respect to groundwater flow and quality;
- To describe the controlling mechanisms for groundwater levels and flow conditions that could cause substantial degradation of water quality in the GSR Project area;
- To discuss groundwater flow model scenario results involving the GSR Project and the potential for water levels to rise to within 70 feet of the ground surface;
- To discuss the monitoring network currently in place with regard to the monitoring of groundwater quality; and
- To document the results of other analyses performed to assess the potential GSR Project effects on groundwater quality.

Assessment of groundwater quality effects from the GSR Project is limited to the geographic area of the GSR Project in the South Westside Basin (Figure 10.6-1) and the assessment therefore does not include any possible groundwater quality issues associated with the proposed San Francisco Groundwater Supply (SFGW) Project. Seawater intrusion is also excluded from this TM but is discussed in detail in a separate TM[1].

1.2. General Approach

The general approach used for evaluating the potential effects on groundwater quality resulting from the GSR Project operations is based on a multi-pronged approach that consists of the following three methods:

- Conceptual understanding
- Groundwater flow model analysis
- Empirical analysis

Each of these three methods was developed and performed to provide an inspection-level (i.e., qualitative) analysis for identifying areas of potential concern with respect to changes in groundwater levels and quality caused by the GSR Project. Individually, each method addresses specific issues using relevant data associated with that specific issue. The three methods collectively support each other for the basin-wide (regional) assessment of potential project effects on groundwater quality conditions.

A detailed discussion of the three methods is presented in Section 2 (for the conceptual understanding), Section 4 (for the groundwater flow modeling analysis), and Section 5 (for the empirical analysis supported by the groundwater setting in Section 3).

This TM is part of a series of technical memoranda that address various aspects of the GSR Project. Two technical memoranda with relevant data and analyses that are used in this TM include:

- Task 8B Technical Memorandum No.1 - Hydrologic Setting of the Westside Basin (also referred to as TM#1) (LSCE, 2010); and
- Task 10.1 Technical Memorandum - Groundwater Modeling Analysis for the Regional Groundwater Storage and Recovery Project and San Francisco Groundwater Supply Project (also referred to as TM 10.1) (Kennedy/Jenks, 2012b).

1.3. GSR Project Overview

The GSR Project is a conjunctive use project that would allow for increased groundwater supplies in the South Westside Basin during periods of drought when SFPUC surface water supplies become limited (MWH, 2008). The GSR Project is sponsored by SFPUC in coordination with its Partner Agencies (PAs): the California Water Service Company (Cal

[1] Kennedy/Jenks, 2012c, Task 10.3 Technical Memorandum - Assessment of Potential Seawater Intrusion for the Regional Groundwater Storage and Recovery Project and the San Francisco Groundwater Supply Project, prepared for the San Francisco Public Utilities Commissions, April 2012.

Water), the City of Daly City (Daly City), and the City of San Bruno (San Bruno). Figure 10.6-2 shows the GSR Project area, locations of the PA wells, and the proposed GSR Project wells. The GSR project will be designed to provide up to 60,500 acre-feet (af) of stored water to meet SFPUC system demands during the last 7.5 years of SFPUC's Design Drought. The GSR Project plans to install 16 new production wells to pump stored groundwater during a drought.

Under the Draft GSR Operating Agreement, the SFPUC would "store" water in the South Westside Basin through the mechanism of in-lieu recharge by providing surface water as a substitute for groundwater pumping by the PAs. As a result of the in-lieu deliveries, up to 60,500 af of groundwater storage or "put" credits could accrue to the SFPUC Storage Account (SFPUC, 2007). During shortages of SFPUC system water due to drought, emergencies or scheduled maintenance, or if the SFPUC Storage Account is at its full capacity of 60,500 af, the PAs would return to pumping from their existing wells. In addition, the SFPUC and the PAs would extract groundwater from the SFPUC Storage Account using the new wells installed by the SFPUC. The SFPUC will not direct pumping during these "take" periods unless a positive balance exists in the SFPUC Storage Account and there is a drought.

The GSR Project modeling scenario (Scenario 2) and cumulative modeling scenario (Scenario 4, which includes the GSR Project) both require a "put/take/hold" sequence to simulate in-lieu groundwater recharge during wet years and groundwater extraction during dry years. Figure 10.6-3 illustrates conceptualization of changing water levels during put and take periods of the GSR Project operations. The upper graph represents the filling of the storage space with groundwater through the mechanism of in-lieu recharge during put periods where SFPUC would provide surface water as a substitute for groundwater pumping by the PAs. The lower graph represents the decline in storage during take periods where the SFPUC and the PAs would extract groundwater from the SFPUC Storage Account. This conceptualization of the GSR Project is illustrated in the context of water quality assessment and depicts the 70 feet bgs threshold depth that can be compared to the simulated depths to groundwater represented in the groundwater model uppermost layer (i.e., Model Layer 1).

The model assumptions for the GSR Project and the Cumulative Scenario are presented in TM 10.1 (Kennedy/Jenks, 2012b). Table 10.6-1 presents a summary of the model scenario pumping assumptions for five model scenarios, including the assumptions for the existing irrigation pumping. In the context of this TM, only Scenarios 1, 2, and 4 are evaluated. A detailed explanation of the model scenario pumping assumptions and the proposed put/take/hold sequence is presented in TM 10.1 (Kennedy/Jenks, 2012b).

2. Conceptual Understanding

The conceptual understanding provides the basic framework for delineating the potential mechanisms that are anticipated to affect groundwater quality as a result of possible changes in groundwater levels and flow directions during the GSR Project operations. This section also presents an overview of monitoring procedures undertaken to manage the possible GSR Project effects. Also included in this section are general descriptions of the major aquifers in the Westside Basin and the hydrogeologic processes and mechanisms that control the occurrence of groundwater flow and water quality conditions.

2.1. Aquifers in the Westside Basin

Groundwater development in the Westside Basin has occurred in various aquifer units in the Colma and Merced Formations from the Golden Gate Park area, through Daly City and South San Francisco, to San Bruno. The Merced Formation contains the primary water-producing aquifer in the Basin (LSCE, 2006). Within the two major water bearing zones in the Westside Basin, there are multiple smaller aquifer zones that are delineated vertically by different sand and clay layers within the Merced and Colma formations. The thickness and extent of these interbedded sand and clay layers vary spatially throughout the Westside Basin.

The aquifer units in the Westside Basin are informally designated as the Shallow Aquifer, the Primary Production Aquifer, and the Deep Aquifer. The Shallow Aquifer is in the northern part of the Basin, in the vicinity of Lake Merced and the southern portion of the Sunset-Richmond district of San Francisco. In the North Westside Basin, aquifer units are separated by two distinctive fine-grained units, known as the -100-foot clay and the W-clay (LSCE, 2004). The base of the Shallow Aquifer is defined to be the top of the “-100 foot clay”. The Primary Production Aquifer is present throughout the Basin, overlying the “W-clay” where it is present. Where the “W-clay” is not present in locations to the south, in the South San Francisco area, the Primary Production Aquifer is divided into shallow and deep units separated by a clay unit at approximately -300 feet mean sea level (msl). The Primary Production Aquifer in the San Bruno area is located 200 feet bgs, and it underlies a thick, surficial fine-grained unit comprised predominantly of clay and sandy clay (LSCE, 2006). The Deep Aquifer underlies the “W-clay”, and thus its extent is limited to the generally-known extent of that clay unit (LSCE, 2010).

Based on the recent water level measurements in November 2008 and January 2009 from the GSR Project monitoring wells located in Colma and South San Francisco areas (MW-CUP-19-180 in Colma and MW-CUP-22A-140 in South San Francisco), the upper portion of the Primary Production Aquifer at these locations is currently under dewatered conditions (Kennedy/Jenks, 2010). However, as discussed in Section 2.3.1, the GSR Project proposes to extract water from the deeper portion of the Primary Production Aquifer (at depths 300 feet or more below the land surface).

2.2. Potential Mechanisms Affecting Groundwater Quality Conditions

Pre-existing contamination at some existing regulated sites may have the potential to generate groundwater contaminant plumes, and ongoing activities at those sites may have the potential to further contaminate the subsurface. In the context of the operation of the GSR Project, there may potentially be the changes to water quality listed below.

For purpose of discussions throughout this TM, the phrase “water table” in these analyses generally refers to the upper surface of groundwater or the top of the saturated zone and the phrase “piezometric surface” generally denotes hydraulic heads in the deeper, confined production aquifer.

- During put periods of the GSR Project operations, groundwater levels will rise in the Primary Production Aquifer. It is possible that the water table may also rise in the unconfined Shallow Aquifer during these periods. Such water table rises could potentially mobilize contaminants trapped in the unsaturated zone, which could cause the movement and spreading of possible pre-existing contaminant plumes or exacerbate future contaminant releases.

- During extended GSR Project recovery or take periods, changes in groundwater flow directions are anticipated to occur in the Primary Production Aquifer. If the response to deeper pumping propagates to the unconfined Shallow Aquifer, this may result in changes to flow directions in the Shallow Aquifer. In turn, this could have an effect on existing groundwater remediation projects. Conceptually, pump-and-treat systems in existing remediation sites could be less effective because lowered water levels and changes in flow directions, resulting in decreased flow/mass removal and reduced groundwater plume capture, prolonging time of cleanup, and in the extreme case, causing them to go dry.

2.3. Potential Areas of Concern during GSR Project Operations

The following is a description of potential areas of concern in the context of the groundwater setting.

2.3.1. Pumping Areas

Areas containing the PA municipal wells, GSR Project wells, and other existing irrigation wells are primary areas of concerns for the groundwater quality assessment described herein. Figure 10.6-3 shows the GSR Project area, locations of the PA wells and the proposed GSR Project wells. The groundwater model scenarios analyzed in this TM account for the existing irrigation pumping, as shown in Table 10.6-1.

During put periods, the effect of rising groundwater levels and possible induced changes in flow directions in the Primary Production Aquifer would likely occur in the vicinity of the PA wells. This is because of reduced PA pumping with the associated increased use of surface water.

During take periods, both the PA and the SFPUC GSR Project wells would extract water. Thus, declining groundwater levels and induced changes in flow directions can occur around both the PA wells and the GSR Project wells.

It is important to note that the GSR Project would extract water from the Primary Production Aquifer, which is approximately 300 feet or more below the land surface. Therefore, changes in the Basin from in-lieu recharge during put periods and from pumping during take periods are likely and primarily to affect the Primary Production Aquifer.

Given the proposed well screen intervals, the GSR Project wells would extract water from 340 feet to 700 feet bgs, except for CUP-M-1 where the proposed screen is from 240 feet to 410 feet bgs. Cal Water production wells as part of the PA wells have screens from 370 feet to 580 feet bgs; San Bruno production wells have screens from 260 feet to 600 feet bgs; and Daly City production wells have screens from 260 feet to 825 feet bgs.

2.3.2. Mechanisms of Transport

Potential effects of the GSR Project on existing subsurface contamination, other anthropogenic effects, and existing remedial systems (e.g., pump-and-treat) depend greatly on the degree of *physical separation* between the occurrences of perched water bearing zones, unconfined Shallow Aquifer, and the deeper pumping zone in the Primary Production Aquifer. The two mechanisms of transport are explained below. The nature of perched groundwater is further explained in Section 2.6.2.

First, aquifer materials between perched water bearing zones and shallow groundwater can be comprised of thin and discontinuous fine-grain impermeable to low permeable materials. Aquifer materials between the shallow unconfined and deeper production aquifers can be comprised of (1) thick aquifer materials of interstitial clay in sedimentary sands and (2) thick sequences of intervening clay lenses that are considered to be aquitards (i.e., confining units) in some portions of the South Westside Basin. The effect of this hydrostratigraphic arrangement of aquifers and aquitards is that shallow groundwater is shielded from the pumping effects in the deeper production aquifers by thick sequences of fine grained materials at varying depths, which minimizes the movement of downward groundwater flow in the shallow groundwater (including perched water bearing zones) during take periods and dampens the effects of rising water levels during put periods.

Second, and less specific to the GSR Project, the interstitial clays and contiguous confining units between the shallow and deep groundwater zones could retard the transport of highly mobile as well as less-mobile contaminants. Specifically, travel time between the shallow and deep groundwater zones is very long. Furthermore, natural attenuation of dissolved constituents generally occurs due to dispersion and dilution. Hence, the effect of the clay-rich materials is equivalent to a physical barrier that isolates shallow contaminant point sources from the GSR Project effects that occur in the deeper production aquifers. This mechanism is only relevant during take periods, when the drawdown due to the GSR Project wells may induce increased downward gradients and changes in local horizontal gradients and flow directions that might have otherwise resulted in migration of contaminants in shallow groundwater. This secondary mechanism may limit the impact of the cause (i.e., deep aquifer pumping) and effect of reactivating shallow groundwater contamination sources.

In addition to water quality issues in shallow groundwater, the primary nonpoint source constituent of interest is isolated pre-existing nitrate occurrence in the Shallow Aquifer and the upper portion of the Primary Production Aquifer, as described in Section 3.2.2.

2.4. Potential Effects on Groundwater Quality

This section briefly describes the most common issues that are encountered with respect to groundwater quality as a result of variable pumping conditions. The intent of this section is to conceptually introduce the most common issues in broad terms, not with respect to the specific GSR Project operations. Water quality issues that could result from the GSR Project operations are further discussed and evaluated in Sections 4 and 5.

In general, the magnitude of effects would vary depending on pumping implementation (pumping amount, location, frequency, duration, and pumping depth) and the hydrogeologic setting. In many instances, depending on the magnitude of resulting changes in groundwater levels and flow directions, existing and planned beneficial uses of groundwater (for drinking water and/or agricultural use) could be affected. For example, in areas with a shallow water table, the most common effects from reduced pumping (or in the context of this analysis "in-lieu" recharge during put periods of the GSR Project operations) may include a rise in the water table or fluctuations that could potentially reactivate contaminants residing in the unsaturated zone and perched water bearing zones or result in remobilization and potential movement and spread of possible contaminating plumes and activities. This situation is of particular interest in areas with existing active regulated sites with possible contaminant plumes and release activities and in areas where pesticides and fertilizers have been applied on the ground.

In the case of increased pumping (or in the context of this analysis pumping during take periods of the GSR Project operations), conceptually lowered water levels are anticipated within cones of drawdown in the vicinities of the pumping areas (i.e., GSR Project and the PA municipal pumping wells). It is noted that conceptually pump-and-treat systems in areas with a shallow water table could be less effective because lowered water levels would result in decreased yields in remediation wells and, in the extreme case, could cause them to go dry, decreased flow/mass removal, and prolonging time of cleanup. Conversely, pump-and-treat systems could be less effective because of reduced groundwater plume capture as a remediation well's capture zone is narrowed due to higher groundwater levels and flow.

2.5. Typical Monitoring Procedures

Routine monitoring of groundwater levels and quality at a network of groundwater monitoring wells is essential for planning and implementing strategies to reduce the risk of groundwater quality effects caused by variable pumping conditions. Analysis of data collected from routine monitoring can help investigators to understand the response of the groundwater basin to variable pumping conditions and to identify short-term or long-term potential effects from reduced or increased pumping. Monitoring data can help identify where and when groundwater quality issues may arise. Therefore, it is helpful to implement adequate contingency plans and to streamline decision-making in response to crisis situations.

Depth-discrete multilevel monitoring systems are particularly important to characterize hydraulic head and water quality variations with depth. Groundwater elevation data from multi-level completion wells and aquifer pumping tests can provide evidence for the extent of the hydraulic connection among various aquifer depths. Analysis of measured data can help identify the relative direction of vertical flow between different aquifer units under reduced and increased pumping conditions. Data can be used to assess the horizontal zones of influence of pumping and the vertical effect of deep aquifer pumping on the water table.

Environmental isotopes, such as tritium, deuterium, and oxygen-18, have proven useful in various types of hydrogeologic settings to (1) track the movement of water between different groundwater systems, (2) estimate travel times, (3) determine potential contamination processes, and (4) estimate aquifer vulnerability to groundwater contamination. Groundwater systems that are not in communication with each other often have distinctly different geochemical signatures. On the other hand, groundwater systems that are in hydraulic connection have similar chemical signatures or show a mixing trend. Similar geochemical signatures of groundwater can help characterize the extent of penetration of the same origin water into various groundwater zones.

2.6. Physical Processes Affecting Groundwater Quality

For the purpose of this analysis, potential groundwater quality effects from the GSR Project operations were evaluated conceptually and qualitatively with respect to general hydrogeological conditions and physical processes that can control groundwater flow and quality. The general hydrogeological conditions listed below, and described briefly in the following subsections, may influence the GSR Project’s effects on water quality.

- Recharge mechanisms and shallow groundwater contaminants;
- Vadose zone, perched groundwater, and aquifer hydraulic connections; and
- Aquifer types and hydrologic conditions;
- Aquifer hydraulic connections; and
- The occurrence and nature of subsurface contaminants.

2.6.1. Recharge Mechanisms and Shallow Groundwater Contaminants

Groundwater recharge is considered one of the most important factors influencing groundwater vulnerability to contaminating activities on the ground or shallow subsurface because recharge is the primary vehicle by which a contaminant is transported from the ground surface to groundwater. In general, groundwater recharge to an unconfined aquifer is a result of deep percolation into groundwater derived from precipitation and runoff. Recharge to a confined aquifer is complex and dependent on the proximity of the aquifer to the recharge zone, adjacent groundwater zones, confining layers, vertical gradients, and groundwater pumping effects.

From the GSR Project perspective, the predominant inflow component for the Westside Basin (and the South Westside Basin) is from percolating rain and irrigation water, which are the primary recharge mechanisms. Much of the GSR Project area supports commercial and residential land uses and hence surfaces are paved. Direct recharge of precipitation to the ground surface and the shallow unconfined aquifer can be a secondary contributor to the groundwater in the aquifers in developed areas; hence, primary recharging ground waters beneath the GSR Project area flow horizontally from aquifer zones peripheral to the GSR Project area. Due to frequently occurring fine-grained materials separating the upper Shallow Aquifer system from the Primary Production Aquifer (Section 2.3), contaminants in shallow groundwater zones are not likely to affect water quality in the Primary Production and Deep Aquifers. Based on the historical data, there is no evidence for the occurrence of shallow contaminants (i.e., volatile organic compounds, or VOCs) in the drinking water supply aquifers (Primary Production and the Deep Aquifers). If the migration of VOCs were to occur in the future, under natural recharge conditions, it would require a very long time (on the order of decades) for shallow contaminants to migrate if at all down to the Primary Production and the Deep Aquifer at very low concentrations given sufficient time for natural attenuation.

As mentioned above, the GSR Project involves the storage of groundwater through in-lieu recharge into the semi-confined and confined aquifers at depths greater than 300 feet bgs (Section 2.3), which could indirectly lead to higher water levels in the Shallow Aquifer. During put periods, water levels in the Primary Production Aquifer (under confined to semi-confined conditions) would be expected to experience larger fluctuations than would those in the shallow unconfined aquifers. Since groundwater would be recovered from the same Primary Production Aquifer during dry years (take periods), the deeper aquifer system would readily experience declining water levels as a result of pumping by the PA municipal wells and SFPUC GSR Project wells, and the Shallow Aquifer would likely experience negligible water level changes due to their unconfined condition (as suggested by the model results for Model Layer 1 in Section 4). Moreover, the underlying fine grained aquifer materials would minimize the effects of in-lieu recharge on shallow water levels.

2.6.2. Vadose Zone and Perched Groundwater

The lithology of the unsaturated zone and the presence of perched water bearing zones under the land surface are important with respect to groundwater vulnerability to shallow releases of contaminants and plumes. The thickness and soil types in the vadose zone control the degree to which a contaminant can be attenuated prior to reaching groundwater. In general, subsurface media comprised of fine-grained materials (silts, clays) would create lower susceptibility to groundwater contamination while coarse-grained materials (sands and gravels) would create higher susceptibility. The type of soil media in the vadose zone (e.g., clay versus sand) affects the rate at which a contaminant can travel within the vadose zone and from the surface, where most contaminants reside, to groundwater.

The presence of perched groundwater can also control the movement of constituents released into the vadose zone and their continued downward path of migration into groundwater aquifer. By definition, a perched water bearing zone is an unconfined groundwater body supported or underlain by impermeable or slowly permeable materials. The existence of a low-permeability clay layer in a high-permeability sand formation can lead to the formation of a discontinuous saturated lense, with unsaturated conditions existing both above and below (Freeze and Cherry, 1979). The majority of the contaminant release activities canvassed in this evaluation have constituents detected in groundwater in the perched water bearing zones. The depths to perched water bearing zones are on the order of 30 feet to 50 feet bgs beneath which groundwater can be classified as the Shallow Aquifer. The perched water bearing zones and the Shallow Aquifer are separated by low permeability fine-grained materials.

2.6.3. Aquifer Types and Hydrologic Conditions

Aquifer types and conditions play a significant role controlling groundwater occurrence and the effects on the subsurface from potential contaminating activities. It is necessary to understand conceptually the circumstances under which the GSR Project operations would lead to rising or declining water levels and changing groundwater flow directions in the Shallow Aquifer, and how these changes could affect contamination in the unsaturated zone and the Shallow Aquifer.

By definition, unconfined aquifers are directly beneath the unsaturated zone and the water table forms the upper boundary of unconfined aquifers (Freeze and Cherry, 1979). The mechanism that causes rising water levels in unconfined aquifers is the filling of soil porosity with water. In an unconfined aquifer, water released from storage during pumping is derived from the dewatering of these pore spaces. Pumping from an unconfined aquifer lowers the water table (i.e., the hydraulic head) around the wells and produces a water table in the shape of a downward-pointing, curved cone, called the cone of depression or drawdown cone. Drawdown locally alters the general groundwater flow rate and direction, and a contaminant plume in the vicinity of the pumping well can be drawn towards the well. These physical factors make the unconfined aquifer more vulnerable to human activities on the land surface, as water levels in the unconfined aquifer may experience localized fluctuations over a short period of time due to rapid changes in recharge and pumping. Thus, direct recharge to the water table, such as percolating rain during storm events or irrigation, would tend to have direct influence on contaminant plumes.

In confined and semi-confined aquifers, on the other hand, the mechanism of rising groundwater levels during in-lieu recharge (put periods) is different than in the unconfined aquifer. Pressure in the production zone would rebound toward pre-pumping conditions in response to reduced pumping, contrasting with a physical rise in the water table surface in unconfined aquifers. Confined aquifers, by definition, remain saturated during pumping. A volume of water removed from the confined aquifer by a well is released in response to a water-pressure drop that causes aquifer compaction and pore-water expansion, not a dewatering of pore spaces as in the unconfined aquifer.

The aquifer units in the Westside Basin are informally designated as the Shallow Aquifer, the Primary Production Aquifer, and the Deep Aquifer, as described in Section 2.1. In the GSR Project area, both the GSR Project wells and the PA wells would pump from the Merced Formation under confined/semi-confined conditions. Currently, groundwater elevations in the Primary Production Aquifer in the South Westside Basin are substantially lower than water levels in the overlying Shallow Aquifer Colma Formation, suggesting a general downward vertical gradient. The downward gradient is of general interest, as constituents in the upper zone could migrate into the lower production zone. The multilevel monitoring well clusters in the GSR Project area can be used to observe inter-aquifer changes in water quality conditions. However, in regard to the GSR Project, the lack of a downward vertical gradient is also of interest because that could increase the likelihood of a rise in water levels during in-lieu recharge or put periods.

Even though in-lieu recharge is anticipated to increase water levels (pressure heads) in the Primary Production Aquifer, the likelihood of the apparent downward gradient reversing upwards due to the GSR Project operations is uncertain given the anticipated future municipal pumping in the production zone. However, a reduction in vertical gradient by in-lieu recharge would reduce the downward flow of groundwater. With the same argument, reduction of the vertical gradient could potentially cause a rise in the shallow groundwater table.

2.6.4. Aquifer Hydraulic Connections

The degree of hydraulic connection between different aquifer systems (perched, shallow, and deep) is important with respect to groundwater vulnerability to contaminating activities because it controls whether the effects of pumping in the “deep” Primary Production Aquifer can propagate to shallow aquifer systems and cause changes in flow conditions in a manner that would induce groundwater quality effects. The hydraulic connection also defines the possible flow paths a contaminant could travel and the potential for attenuation once it reaches the aquifer.

In the context of hydraulic connections in the subsurface, the presence of fine-grained aquifer materials in the subsurface above pumping zones is critical as these confining materials exert controls on the occurrence and flow of groundwater between the upper and lower aquifer systems. The aggregate occurrences of aquitards and intervening fine grained units could restrict vertical migration of contaminants from the shallow to the deep groundwater zones, and isolate the pumping effects in the deep production aquifer.

The generalized regional cross-sections in the Westside Basin were updated in 2010 based on the new subsurface lithological data obtained from recently installed monitoring wells for the

GSR Project (LSCE, 2010). Based on interpretation of the subsurface, the regional cross-section that extends from north (Golden Gate Park) to south (San Francisco International Airport) and several regional cross-sections that stretch from west to east along the Daly City, South San Francisco, and San Bruno areas provide insight on the presence of fine-grained layers overlying the Primary Production Aquifer and the potential for confined to semi-confined conditions in the Primary Production Aquifer.

Local stratigraphy and recently obtained groundwater level data suggest that in the Daly City, South San Francisco, and San Bruno areas, the Primary Production Aquifer is under semi-confined to confined conditions. In the North Westside Basin area away from Daly City, the presence of the -100 foot clay clearly separates the Primary Production Aquifer from the overlying Shallow Aquifer.

It is noted that the -100 foot clay is no longer present beneath the Daly City area and thus the split between the Shallow Aquifer and deeper Primary Production Aquifer is not formally defined in this portion of the Basin. However, cross-section F-F’ in TM# 1 (LSCE, 2010) oriented north-south through the Basin indicates that from Daly City south to South San Francisco, the Primary Production Aquifer is isolated from shallow groundwater by 50 feet to 100 feet aggregate thickness of intervening clay and sand deposits. The aggregate thicknesses of these materials make up discontinuous low permeability zones that reduce the possibility for vertical migration of contaminants. These relatively low-permeability shallow sediments in the Daly City to South San Francisco area are markedly different than the higher-permeability shallow sands found in the North Westside Basin. South of Daly City, from South San Francisco to San Bruno, the presence of thick surficial Bay Mud deposits of even lower relative permeability likely provides an even greater degree of isolation to the Primary Production Aquifer in that area.

Additional evidence for isolation of the Primary Production Aquifer beneath the cities of Colma and Millbrae is apparent from relative groundwater elevations measured in multilevel GSR Project monitoring well clusters installed in 2008 and 2009. At each monitoring well location, there are three or four separate wells installed at discrete depths. The completion depths for these wells generally correspond to the Primary Production Aquifer and the Deep Aquifer, and an apparent equivalent to the Shallow Aquifer in the North Westside Basin is identified, although it is not formally recognized in this area.

Differences in groundwater levels measured in the GSR Project monitoring wells suggest likely hydraulic separations of these three aquifers in the central and southern portions of the South Westside Basin. For instance, at the monitoring well cluster MW-CUP-18-490 and MW-CUP-18-660 installed in Colma, groundwater levels in the Primary Production Aquifer well (490 feet deep) are typically 31 feet higher than levels in the next deeper well (660 feet deep), installed in the Deep Aquifer. An even greater difference exists in groundwater levels between the 250-foot deep well and the next deepest well, at 500-foot depth, at the monitoring well site CUP-10A. Similar differences in groundwater levels exist for the Shallow Aquifer and Primary Production Aquifer well completions for the other GSR Project monitoring well groupings between Daly City and San Bruno. At the monitoring well MW-CUP-44-1 in northern San Bruno, groundwater levels in the shallowest well completion (190 feet deep) are typically about 10 to 15 feet higher than levels in the intermediate-depth well (300 feet deep). As with conditions in the North Westside Basin, these relative groundwater level differences in the South Westside Basin suggest a similar degree of isolation of the Primary Production Aquifer.

2.6.5. Occurrence and Nature of Contaminants in the Subsurface

For the purpose of this analysis, and consistent with the California Department of Public Health (CDPH) definition, possible contaminating activities (PCAs) are activities, industries, or land uses considered to be potential origins of contamination of the hydrologic environment. These activities may include transporting, storing, manufacturing, producing, using, or disposing of industrial chemical, agricultural chemicals or other potential contaminants. PCAs may include petroleum releases, land disposal of solid wastes, and land-applied chemicals from agricultural practices that may pose a threat to the drinking water supply, by causing the release of contaminants. The locations, status, and groundwater conditions of PCAs were evaluated as part of the water quality assessment to determine potential effects from the GSR Project operations. The inventory of the existing PCAs and their effects on the GSR Project operations are discussed in Section 5.

With respect to the GSR Project operations, potential effects on nitrate conditions may occur, including mobility such as redistribution of nitrate mass in the lower portion of the Shallow Aquifer mainly due to potential changes in flow directions, resulting from the GSR Project pumping conditions.

Nitrate (as NO_3) concentrations historically exceed the drinking water standard primary maximum contaminant level (MCL) of 45 milligrams per liter (mg/l) in some locations (LSCE, 2010), as discussed in Section 3.2.2. Nitrogen, in the form of nitrate, commonly affects water quality beneath agricultural lands (Harter et al., 2012). The extent of nitrate detected in groundwater is mainly attributed to past fertilizer applications and possible confined animal facilities that are not related to the GSR Project conditions. Whether or not the GSR Project is implemented, the occurrence of nitrate in native groundwater is considered a pre-existing condition due to past land use practices. The effect of the GSR Project on nitrate concentrations in the vadose zone or native shallow groundwater depends greatly on the potential for the GSR Project to cause changes in shallow groundwater levels. As explained in Section 2.6.1, fluctuations of shallow groundwater levels due to GSR Project storage and recovery are likely negligible because of the Shallow Aquifer and its hydraulic isolation from the deep aquifers that the GSR Project would extract from.

The primary concern with respect to landfills and other land disposal of solid wastes is leaching by percolating water from rain. Since the GSR Project will use in-lieu recharge rather than surface spreading, it would not directly induce changes in the current conditions of land disposal sites.

In situations where leaks at underground storage tank (UST) sites move through the unsaturated zone, downward movement of hydrocarbons typically ceases when the seepage front reaches the water table. Except for small amounts of hydrocarbons that go into solution, petroleum hydrocarbons do not penetrate below the water table because they are less dense than water and immiscible in water. As a result of this characteristic, oil and gasoline from leaky tanks migrate almost exclusively in the capillary fringe, directly above the water table (Freeze and Cherry, 1979). Dense non-aqueous phase chemicals, on the other hand, can migrate great distances after reaching groundwater, given their densities, which are greater than that of water. However, the downward migration of chemicals denser than water is typically limited by the presence of confining layers.

3. Groundwater Setting

This section provides an overview of the regional geology and hydrogeology of the GSR Project area most relevant to the water quality analysis. The geology and hydrogeology of the Westside Basin have been described previously (LSCE, 2005; DWR, 2003; Yates et al., 1990), and will not be extensively described in this section.

For the assessment of groundwater quality changes from the GSR Project, the South Westside Basin is considered to be the general project area that would be subject to changes in groundwater levels and storage from the GSR Project operations. Contaminant plumes and release activities that are known to be located in the GSR Project area are briefly introduced in this section and further evaluated as part of the empirical analysis in Section 5.

3.1. Westside Groundwater Basin

The groundwater basin beneath the western part of San Francisco from the vicinity of Golden Gate Park and extending southeasterly into San Mateo County is identified in the California Department of Water Resources (DWR) Bulletin 118 as both the Merced Valley Basin and the Westside Basin (DWR, 2003). Since it is more commonly known as the Westside Basin, this designation is used in this TM. Figure 10.6-1 shows the boundary of the Westside Basin and the northern and southern portions of the Basin.

Relevant to this discussion, the Westside Basin has been divided into northern and southern portions at the San Francisco County-San Mateo County line. This subdivision is a political division, which is not representative of a physical boundary, and it is not meant to imply that there is any restriction of groundwater flow between the two areas. The portion of the Basin that lies within San Francisco County is referred to as the North Westside Basin and the portion of the Basin that lies within San Mateo County is referred to as the South Westside Basin. Figure 10.6-1 shows the boundary of the North and South Westside basins. The GSR Project would be located in the South Westside Basin, which has an area of about 25 square miles. The proposed SFGW Project would be located in the North Westside Basin, which has an area of about 15 square miles. Aquifers in the GSR Project area are described earlier in Section 2.1.

3.1.1. Groundwater Flow Conditions

Groundwater levels and general direction of flow vary in the Westside Basin. In the portion of the North Westside Basin north of Lake Merced, groundwater in the Shallow and Primary Production Aquifers tends to flow in a westerly direction towards the Pacific Ocean. Groundwater in this area, from near Lake Merced north to Stern Grove and Golden Gate Park, is encountered at relatively shallow depths, ranging from approximately 5 feet to 60 feet bgs (LSCE, 2006). The Shallow Aquifer beneath Lake Merced also has a generally westward groundwater flow direction.

Near Lake Merced and immediately southward, the groundwater direction in the Primary Production Aquifer is to the south and southeast towards Daly City (the Shallow Aquifer as defined previously is no longer present in the Daly City area). In these areas and further south the depth to piezometric head can exceed 300 feet bgs, due largely to the effects of long-term municipal pumping beneath the Colma and South San Francisco areas. The groundwater depressions caused by concentrated areas of long-term pumping induce flow locally towards those depressions.

In the portion of the Basin from Daly City northward, groundwater elevations have generally exhibited a flat (Shallow Aquifer) to decreasing (Primary Production Aquifer) trend over the past two to three years, as compared to an upward trend from 2002 to 2006. The slight downward trend in the Primary Production Aquifer appears to be caused by resumption of groundwater pumping by Daly City during this period (LSCE, 2010).

From South San Francisco southward to Burlingame in the vicinity of San Francisco Bay (Bay), groundwater within the shallow units overlying the Primary Production Aquifer generally flows east towards the Bay (Rogge, 2003; Yates, 2003). Throughout this portion of the Basin, groundwater flow in the Deep Aquifer is generally east towards the Bay. In the vicinity of San Bruno, groundwater extraction has created a local depression in the water table (City of San Bruno, 2007). A flow divide near the south end of the San Francisco Airport separates the area where groundwater flows toward the pumping depression in San Bruno from the area where groundwater flows toward the Bay (Yates, 2003). The divide trends southwest from near the Millbrae exit on Highway 101, and groundwater northwest of the divide is captured by the San Bruno wells (Yates, 2003).

Groundwater elevations in areas south of South San Francisco are highly variable, depending largely on proximity to pumping wells and depths in the aquifer where water levels are measured. In areas near South San Francisco and San Bruno, the groundwater in the Primary Production Aquifer is typically at elevations ranging from -100 to -200 feet msl (or 130 feet to 230 feet bgs). However, in areas closer to the Bay, groundwater elevations are in the range of approximately 10 to -30 feet msl, with the lower levels corresponding to measurements made in deeper monitoring wells.

3.1.2. Pumping in the Westside Groundwater Basin

Groundwater pumping in the Westside Basin consists primarily of pumping for municipal (potable) supply by Daly City, Cal Water (serving South San Francisco), and San Bruno. Groundwater is also used for irrigation and other non-potable uses, most notably on golf courses around Lake Merced, cemeteries in Colma, at the San Francisco Zoo, and at Golden Gate Park (LSCE, 2006). Groundwater is pumped primarily from deeper, semi-confined portions of the aquifers within the Basin (SFPUC, 2009a). Historical trends and current pumping conditions for municipal and irrigation pumping are described extensively in TM#1 (LSCE, 2010).

3.1.3. Existing Groundwater Quality Monitoring and Reporting Activities

Groundwater quality in the Westside Basin is monitored in a network of production and monitoring wells as part of the semi-annual monitoring program that was initiated throughout the Basin in 2000. Figure 10.6-4 shows the locations of wells monitored by SFPUC in the South Westside Basin. Results of the most recent groundwater quality monitoring were reported in the 2010 Annual Groundwater Monitoring Report Westside Basin, prepared by the SFPUC in coordination with the City of Daly City, San Bruno, and the Cal Water (SFPUC, 2011).

3.2. Groundwater Quality Conditions

This section summarizes general water quality conditions particularly in the South Westside Basin based on the review of available and relevant reports, documents, and data from the ongoing monitoring activities in the Basin, particularly those from sampling events in 2009 (Kennedy/Jenks, 2009 and 2010), and the review of water quality in 2011 (Kennedy/Jenks, 2012a). Since the GSR Project would be implemented in the Daly City, South San Francisco, and San Bruno areas, monitored water quality in these areas is expected to represent the nature of water quality that would be produced during the GSR Project operations. Therefore, water quality conditions are discussed with respect to these general pumping areas based on data at selected key monitoring locations.

Data sources were reviewed for all Title 22 water quality indicators, VOCs, and radiological to note general trends and to identify elevated concentrations and the localized areas where those concentrations exceed the drinking water standards. Data primarily come from four sources listed below:

- Hydrogeologic Conditions in the Westside Basin (LSCE, 2006)
- 2008 and 2010 SFPUC Annual Groundwater Monitoring Reports (SFPUC, 2009a, 2011)
- GSR Phase 1 and 2 Monitoring Well Installation Technical Memoranda (Kennedy/Jenks, 2009 and 2010)
- Review of Water Quality, Treatment, and Operations for Future SFPUC Groundwater Supply Final Draft, October 2011 (Kennedy/Jenks, 2012a).

In addition to these sources, groundwater quality conditions in the Westside Basin are also described as part of TM#1 (LSCE, 2010); thus, references were made to TM#1 as needed for detailed information on basin groundwater quality.

Based on evaluating groundwater quality conditions alone, groundwater quality generally meets the MCLs of the primary and secondary drinking water standards set by the CDPH and SFPUC water quality criteria, with the exception of nitrate in selected areas (see below), fluoride, and other select secondary constituents in selected areas (i.e., pH, color, hardness, turbidity, conductivity, total dissolved solids (TDS), sulfate, chloride, manganese, and iron). For most constituents, SFPUC water quality standards are more stringent than regulatory drinking water standards (i.e., MCLs). Blending analysis of groundwater-surface water was conducted for compliance with the primary and secondary drinking water standards and SFPUC criteria and to determine blending and treatment requirements that will address water quality issues (Kennedy/Jenks, 2012a). Based on the future blended groundwater and surface water supply that will be delivered to SFPUC drinking water customers, predicted blended water quality for the SFPUC GSR Project wells meets regulatory and SFPUC criteria for the constituents listed above, except for hardness, iron, manganese, turbidity, and fluoride (Kennedy/Jenks, 2012a). Turbidity levels are anticipated to be addressed by well operations. Exceedances for iron and manganese indicate that treatment will be required. Fluoride and hardness will be addressed by blending. While there are localized areas with naturally occurring manganese and iron concentrations that exceed the secondary drinking water standards, these issues will be addressed by treatments during the GSR Project implementation. It should also be noted that this TM primarily focuses on the potential effects the GSR Project on existing anthropogenic pollution, not water quality issues associated with naturally occurring conditions.

Other water quality parameters are not necessarily of concern, but are noted below based on long-term data available at key locations in the South Westside Basin. All water quality parameters vary by locations and depths of groundwater. The GSR Project proposes locations and aquifers that are expected to provide the best available water quality for groundwater production.

3.2.1. General Minerals

Data from recently installed monitoring wells by SFPUC as part of the GSR Project showed several sites with elevated levels for the following constituents: hardness, specific conductance (EC), TDS, turbidity, color, iron, manganese, sulfate, and aluminum. In addition, pH for groundwater is in the range of 7-8 units and will have to be raised to meet water quality standard through treatment and/or blending (Kennedy/Jenks 2012a). Concentrations of these constituents may need to be lowered to meet the primary and secondary MCLs, and/or water quality targets developed by SFPUC and the PAs. It is anticipated that potential blending/treatment may be necessary to reduce concentrations. In terms of the relevance of monitoring data collected from the monitoring wells, it is important to note that these results are informative but not fully representative of the raw water quality that would be pumped from the GSR Project production wells. As reported in the Phase 1 and 2 Monitoring Well Installation Technical Memoranda, recommendations were made for design and construction of the 16 GSR Project production wells with potential test well design parameters and noted water quality effects (Kennedy/Jenks, 2009 and 2010). Groundwater quality conditions with respect to general minerals are further described below by the general pumping areas in Daly City, South San Francisco, and San Bruno.

Daly City Area - Long-term historical data extending back to the mid-1970s (DC-2 Westlake) suggest an increase in mineral concentrations (EC, TDS, and chloride) as of 2000, but data are too sporadic to conclude that there are any current trends or changes. More recent data (since 2000) show that TDS has fluctuated, but EC and chloride concentrations are similar to 2000 conditions (Figure 21 in TM#1, LSCE, 2010).

South San Francisco Area - A Cal Water well (SS1-14) has the longest period of record in the Basin, dating back to the 1950s (Figure 22 in TM#1, LSCE, 2010). Chloride concentrations have remained around 120 mg/l to 130 mg/l for the entire period. Concentrations of EC and TDS fluctuated more than chloride and appeared to exhibit a generally upward trend since the 2000 monitoring event. During the 2008 sampling event, total and dissolved manganese concentrations exceeded the secondary MCL of 0.05 mg/l at the South San Francisco Linear Park wells (MW-120, 220, 220, 440, and 520). At this well cluster, detected concentrations ranged from 0.147 mg/l to 0.825 mg/l for total manganese.

San Bruno Area - Available data extending back to 2000 suggest fairly constant conditions and generally lower concentrations than elsewhere in the Basin. TDS concentrations have been around 300 mg/l, and chloride concentrations are consistently low at around 60 mg/l. The 2008 sampling results remained within historical ranges for EC, TDS, and chloride (Figure 23 in TM#1, LSCE, 2010). As part of the City of San Bruno's Bay monitoring program, the two well clusters installed in 2006 (Burlingame-S, M, D and SFO-S-D) show chloride concentrations less than 350 mg/l in the shallow well Burlingame-S, and less than 140 mg/l in both the medium (Burlingame-M) and deep well (Burlingame-D).

3.2.2. Nitrate

Among the general water quality parameters, trends in nitrate in the GSR Project area are discussed separately due to elevated concentrations that exceed drinking water standards in localized areas. Historical data are available at the selected key monitoring locations in the PA pumping areas, as summarized below (Figure 24 in TM#1, LSCE, 2010). In this analysis, observed nitrate is described in terms of nitrate as nitrate (NO_3) and all nitrate values are reported in terms of nitrate (as NO_3). Data are compared relative to the primary MCL of 45 mg/l for nitrate as NO_3 (the primary MCL for nitrate as nitrogen (N) is 10 mg/l).

Nitrate (as NO_3) concentrations reported in groundwater sampled in 2008 and 2009 are shown in Figure 10.6-5 based on observed data from the PA wells and the GSR Project monitoring wells. The following is a description of nitrate distribution by the general areas of Daly City, Colma, South San Francisco, Golden Gate National Cemetery, and San Bruno. In general, data indicate isolated occurrences of elevated nitrate levels above the primary MCL of 45 mg/l for nitrate in portions of Daly City and South San Francisco. Ongoing monitoring will continue to examine trends and help delineate whether the recent data are indicative of changing, temporary, or anomalous conditions with respect to nitrate in the Daly City and South San Francisco areas.

Daly City Area – During the spring 2008 sampling, detected nitrate concentrations in four wells sampled ranged from 10 mg/l in the Jefferson to 131 mg/l in inactive Daly City A Street well, which exceeds the primary MCL of 45 mg/l. Historical data available since 2000 from DC 2 and Vale wells show nitrate concentrations ranging mostly from 20 to 40 mg/l. Detected nitrate concentrations in three of the four wells sampled in 2008 decreased slightly compared to 2007, with the exception of the Jefferson well, which remained relatively the same (9.4 mg/l in 2007 and 10 mg/l in 2008).

Nitrate concentrations reported at the GSR Project monitoring well MW-10A in Daly City were elevated, ranging from about 36 mg/l from MW-10A-160 and MW-10A-250 to 49.5 mg/l from MW-10A-500. Nitrate from the 645-foot screen in MW-CUP-10A-710 was about 0.9 mg/l. The Park Plaza monitoring well had nitrate concentrations of 26.5 mg/l in the primary production zone depth (i.e., Primary Production Aquifer) and a much lower concentration of 0.6 mg/l in the deeper zone (i.e., Deep Aquifer).

City of Colma Area – The GSR Project monitoring well MW-CUP-18 located in Colma had nitrate concentrations ranging from 6.6 mg/l from MW-CUP-18-230 to 14.85 mg/l from MW-CUP-18-425 mg/l and a much lower concentration of 0.63 mg/l from MW-CUP-18-660 in the deeper zone. Nitrate was not detected from the GSR Project monitoring well MW-CUP-19 sampled at three different depths (475 feet, 600 feet, and 690 feet bgs).

South San Francisco Area – Detected nitrate concentrations in raw groundwater during the 2008 sampling were 47 mg/l in SS1-19, which is slightly above the primary MCL of 45 mg/l, and 35 mg/l in SS1-20 (Note that groundwater from these Cal Water wells is blended with SFPUC surface water prior to distribution and the resulting blend fully meets all drinking water standards). The inactive SS1-14 well, with historical data dating back to the late 1950s, was offline during the 2008 sampling; data show concentrations increased slightly from the 1950s to 1990s, while remaining below 40 mg/l. Nitrate concentrations from 2000 to 2007 in SS1-14 fluctuated considerably with the highest concentration of 120 mg/l measured in spring 2001. Recent measurements since 2004 have been approximately 80 mg/l. Since 2001, nitrate concentrations remained near 80 mg/l, based on the data reported in the SFPUC's 2010 Annual Groundwater Monitoring Reports (SFPUC, 2011). Detected nitrate concentration was 0.5 mg/l in the SSF Linear Park MW-220 and non-detect at other depths.

Data are also available from three multi-level monitoring wells installed by SFPUC in the South San Francisco as part of the GSR Project. Nitrate from the GSR Project monitoring well MW-CUP-22A-290 was about 43 mg/l, which is close to the primary MCL of 45 mg/l. At greater depths, nitrate concentrations at this location were much lower, about 1.1 mg/l from MW-CUP-22A-440 and 2.4 mg/l from MW-CUP-22A-545. Nitrate concentration of 64.9 mg/l was reported at the GSR Project monitoring well MW-CUP-23-230 in September 2009. Nitrate concentrations in MW-CUP-23 from deeper depths were lower and below the primary MCL: 29 mg/l in MW-CUP-23-600, 21.3 mg/l in MW-CUP-23-440, and non-detect in MW-CUP-23-515. MW-CUP-36 had nitrate concentration of about 32 mg/l at the shallowest depth (160 feet bgs) and much lower concentration of about 6.8 mg/l at the 270-foot screen and no nitrate detections from deeper depths.

Golden Gate National Cemetery – Nitrate concentrations reported at the GSR Project monitoring well MW-CUP-44-1-190 and MW-CUP-44-1-300 were 37 and 32.8 mg/l, respectively. Nitrate was not detected in MW-CUP-44-1-460 and MW-CUP-44-1-580.

San Bruno Area – Nitrate concentrations reported in 2008 were 5.5 mg/l in SB-17 and 1 mg/l in SB-20. Historical data available for SB-17 since 2000 show measured nitrate concentrations of 3.5 mg/l to 6 mg/l, which are well below the primary MCL of 45 mg/l. Similarly, data from SB-20 since 2004 showed very low nitrate concentrations, less than 2 mg/l, at this location. MW-CUP-M-1 located in Millbrae had relatively low nitrate at 12.1 mg/l.

3.2.3. Organic Compounds

A few trace organic compounds were detected in the monitoring wells for the GSR Project during sampling in 2008 and 2009, but these are not necessarily of concern because detected concentrations were near their respective reporting limits, which are well below the respective MCLs.

During the December 2008 and January 2009 sampling, acetone was detected in low concentrations in groundwater samples from the Phase 1 wells, including the existing SFPUC Park Plaza monitoring well cluster (MW135, MW195, MW460, and MW620). To assess the validity of acetone presence in the native groundwater, Phase 1 wells MW-CUP-18-230 and MW-CUP-18-490 were re-sampled in October 2009 and acetone was not detected. The previously detected acetone concentrations were not repeatable and are not considered to be representative of regional water quality conditions (Kennedy/Jenks, 2009 and 2010).

As found in numerous studies in the State and in particular the “California Aquifer Susceptibility” study by the Lawrence Livermore National Laboratory (Moran et al., 2004), the Westside Basin wells with deeper screens draw an older groundwater component, and are free of VOCs and other contaminants residence in the shallow groundwater zones. In this Basin, vulnerability of groundwater is largely controlled by depth, and wells that tap deeper aquifers are apparently protected from VOC contamination that may be present in shallow groundwater zones.

3.2.4. Groundwater Quality Near Cemeteries

Cemeteries in the GSR Project area were evaluated by SFPUC for potential groundwater quality concerns. Based on the recent groundwater sampling conducted by SFPUC from five monitoring wells (MW-CUP-18, MW-CUP-19, MW-CUP-22A, MW-CUP-44-1, and the Linear Park monitoring well) located in the vicinity of the cemeteries, there is no apparent groundwater contamination from cemeteries (Kennedy/Jenks, 2010, see also Section 5.4). The ongoing SFPUC monitoring at the monitoring wells for the GSR Project will continue to evaluate groundwater quality conditions in the vicinity of the cemeteries.

The initial samples were taken in September, October, and November 2009 at three different monitoring locations near the cemeteries. Samples were analyzed for aldehydes, including formaldehyde (a chemical used for embalming) and acetaldehyde (most likely a natural microbial degradation byproduct in the aquifer sediments and unrelated to cemeteries or embalming). Locations sampled included a multi-level monitoring well MW-CUP-44-1 (screened at five depths from 190 feet to 580 feet bgs and each depth sampled) located in the Golden Gate National Cemetery, MW-CUP-18 (two depths sampled at 230 feet and 490 feet bgs) located near Cypress Lawn Cemetery, and the Linear Park multi-level monitoring wells (screened at four depths from 120 feet to 530 feet bgs and each depth sampled). All samples had concentrations of non-detect below the reporting limit for formaldehyde (less than 5 micrograms per liter(μg/l)), with the exception of the reported concentration of 26 μg/l measured from the Linear Park monitoring well at 440 feet bgs (Kennedy/Jenks, 2009 and 2010). This detection is below the notification level of 100 μg/l for formaldehyde. It is important to note that this detection was flagged by the laboratory as being received past the holding time and not considered acceptable for regulatory compliance. The 2009 samples were also analyzed for acetaldehyde (most likely a natural microbial degradation byproduct). For acetaldehyde, only two samples were reported to be 1.0 and 2.0 μg/l, which are slightly above the reporting limit of 1.0 μg/l (no reported MCL or notification level for acetaldehyde). It is possible that the acetaldehyde detections are due to natural background or sample contamination.

SFPUC conducted a subsequent re-sampling for formaldehyde in 2010 at five monitoring well locations including the Linear Park well and re-sampling did not confirm the presence of formaldehyde where the samples were all below the detection limit (less than 5 μg/l). The subsequent sampling was conducted in May, October, and December 2010 and included the following well locations: MW-CUP-18 (three depths sampled at 230 feet, 425 feet, and 490 feet bgs) and MW-CUP-22A (two depths sampled at 290 feet and 545 feet bgs), MW-CUP-19 (sampled at 475 feet bgs) and the Linear Park monitoring well (re-sampled at four depths from 120 feet to 520 feet bgs).

3.3. Existing Regulated Sites

Possible groundwater contamination from human activities at the ground surface is an important aspect of groundwater quality assessment. The PCAs from existing regulated sites warrant special considerations because of their potential to pose notable risk to groundwater quality during the GSR Project operations. Records of known PCAs were compiled from the following sources. Locations of these sites were mapped and are further discussed in Section 5.2.4. The inventory of the existing PCAs was previously compiled and evaluated as part of the CDPH Drinking Water Source Assessment Program (DWSAP) documentation as discussed in Section 5.2.3.

- **State Water Resources Control Board (SWRCB) GeoTracker Database** – The GeoTracker database (compiled in March 2012 at http://geotracker.swrcb.ca.gov/), contains a total of 1,560 regulated sites within San Mateo County (SWRCB, 2012). Each of these sites is identified with a status of “closed” or “open”[2]. Among these, the majority of them (1,155) were closed under regulatory oversight. Among the 405 open sites, 49 were reported to be inactive and the remaining 356 sites are leaking underground storage tank (LUST) sites or other cleanup sites currently undergoing active investigation, monitoring, and/or soil/groundwater remediation. There is no military LUST site (closed or open) in the South Westside Basin. There is one Military cleanup site listed in San Mateo County located in Half Moon Bay, but the site was reported to be inactive.

- **California Solid Waste Information System (SWIS) Database** – This contains solid waste facilities, operations, and disposal sites (compiled in January 2010 at http://www.calrecycle.ca.gov/SWFacilities/). According to the SWIS database, among 33 land disposal sites/transfer stations in San Mateo County, 14 sites were located in the general GSR Project area (CalRecycle, 2010). Among the 14 sites, one (1) site is closed, one (1) site in the process of closing, and 12 sites were reported to be active.

- **San Francisco Bay Regional Water Quality Control (RWQCB) Board Spills, Leaks, Investigations, and Cleanup (SLIC) Database** – According to the SLIC database, there are 145 sites reported in the San Mateo County (compiled in May 2010 at http://www.waterboards.ca.gov/sanfranciscobay/publications_forms/avail_doc.shtml). Among these, 15 sites are reported in the general area of the GSR Project in the South Westside Basin (RWQCB, 2010).

- **California Department of Toxic Substances Control (DTSC) Database** – Facilities and sites that are regulated by the California Department of Toxic Substances Control (DTSC) were searched through the Envirostor database website (compiled in May 2010 at http://www.envirostor.dtsc.ca.gov/public/) that allows a search for properties where extensive investigation and/or cleanup actions are planned or have been completed at permitted facilities and clean-up sites (DTSC, 2010). In the compiled database, 15 sites were reported in the general area of the GSR Project in the South Westside Basin.

[2] Open sites include sites that are currently active with site assessments or remediation activities. These sites are likely to have verification monitoring requirements. Closed sites have a status of completed closed cases. A case closed site qualifies to receive a "no further action" (closure) letter once the owner or operator meets all appropriate corrective action requirements. After this occurs, a closure letter or other formal closure decision document is issued for the site to indicate no further work is required.

4. Groundwater Model Analysis

Groundwater models are useful tools that can help quantify the changes in groundwater conditions associated with future project activities. This section presents the current modeling analysis conducted to evaluate the GSR Project effects on groundwater quality using the latest Westside Basin Groundwater Flow Model (HydroFocus, 2011). Presented in this section is a summary of the modeling scenario results related specifically to the potential effects on groundwater quality from Scenario 2 for the GSR Project and Scenario 4 for the Cumulative Scenario.

4.1. MODFLOW Model

The existing Westside Basin Groundwater Flow Model was developed over a period of time from 2002 to 2011 by HydroFocus (HydroFocus, 2007, 2009, and 2011). The model development has been a collaborative effort sponsored by Daly City with review by SFPUC, Cal Water, San Bruno, and their respective consultants.

The existing Westside Basin Groundwater Flow Model was used to simulate future model scenarios to evaluate potential effects from the GSR Project. The model scenario development and assumptions, including modifications made to the existing model, are discussed in Task 10.1 TM (Kennedy/Jenks, 2012b).

For the assessment of groundwater quality effects from the GSR Project, the model results were used to demonstrate general trends as they pertain to changes in groundwater levels at the regional-scale. The assessment also identifies general areas with a shallow water table that might be susceptible to remobilization of existing contaminants and/or plumes as a result of fluctuation in the water levels in the shallow water bearing zones.

4.2. Model Scenario Summary

The numerical groundwater model discussed in the Task 10.1 TM was used as a predictive tool for simulating the basin conditions under various management scenarios associated with the GSR Project. A detailed description of the model setup and assumptions of these scenarios, including amounts and distribution of pumping, is provided in the Task 10.1 TM (Kennedy/Jenks, 2012b). Among the five modeling scenarios developed, the following three scenarios are applicable to analyzing the GSR Project effects on groundwater quality:

- **Scenario 1 – Existing Conditions** – Scenario 1 represents the Existing Conditions and does not include the SFPUC Projects. Groundwater pumping by the PAs and irrigation pumping are representative of the existing pumping conditions (as of June 2009).
- **Scenario 2 – GSR Project** – Scenario 2 represents the implementation of the GSR Project and the PA pumping rates as designated by the GSR Project operations. The PA

and GSR Project pumping occur according to the put/take/hold sequence described in TM 10.1. Irrigation pumping remains the same as in Scenario 1.

- **Scenario 4 – Cumulative Scenario** – Scenario 4 represents the implementation of both the GSR Project (Scenario 2) and the SFGW Project (Scenario 3b) along with other foreseeable projects, such as the Daly City Vista Grande Drainage Area Improvements Project (which increases stormwater diversions into Lake Merced). Irrigation pumping remains the same as Scenario 1, except with minor variations such as the planned build-out at Holy Cross cemetery.

4.3. Use of Model Results

The results of modeling scenarios are analyzed to determine general areas in the South Westside Basin where the GSR Project could affect groundwater quality. This analysis was conducted at the regional scale and was by necessity, fairly qualitative. The assessment focused on the Full SFPUC Storage Account and the Design Drought. This is because these aspects of the GSR Project may play an important role in the GSR Project's possible effects on groundwater levels and storage. All of the model scenarios start with the initial condition of June 2009 groundwater levels. The June 2009 SFPUC Storage Account value is approximately 20,000 af. In order to achieve a "Full" SFPUC Storage Account value of 60,500 af in both Scenarios 2 and 4, the first 6.5 years of the model simulation are put years. The 60,500 af that represents the Full SFPUC Storage Account is 40,500 af larger than the June 2009 initial condition of 20,000 af. It is therefore very likely that groundwater levels in the South Westside Basin are higher under the Full SFPUC Storage Account than under the Existing Conditions of Scenario 1.

For the GSR Project water quality assessment, the results of the modeling analysis are presented as model estimated basin-wide change in groundwater storage (Section 4.3.1 and Figure 10.6-6), water level hydrographs at selected locations (Section 4.3.2 and Attachment 10.6-A), estimated basin-wide depth to water contour maps (Section 4.3.3 and Figures 10.6-7 through 10.6-11), and groundwater flow directions in the shallow groundwater (Section 4.3.4 and Figures 10.6-12 through 10.6.17).

HydroFocus (2007) suggests the strongest predictive ability of the model is in relative changes over time rather than the absolute predictions of water levels. However, in this analysis, it is also important to assess the estimated absolute depths to water table. Therefore, the results are presented for Scenarios 1, 2 and 4 for both the absolute and relative differences from Scenario 1.

4.3.1. Change in Groundwater Basin Storage

Model estimated change in groundwater basin storage is presented in Figure 10.6-6 for each of the five scenarios separately over the simulation period. Unlike groundwater levels, the model-simulated groundwater storage values are not relied upon in this analysis. Instead, the results of the Full SFPUC Storage Account condition are assumed to represent the highest water levels and are used as a reference for the water quality assessment.

4.3.2. Water Levels

Model-simulated water levels for each of the five model scenarios and relative to the Existing Conditions are presented in Attachment 10.6-A. However, as described previously, only Scenarios 1, 2 and 4 are considered in this TM.

The existing groundwater model includes the capability of monitoring head at 125 different monitoring points. This section examines the results for 11 selected monitoring points (Figure 10.6-2). These well locations were selected within the general extent of the pumping areas in the South Westside Basin and within the vicinity of the GSR Project wells and the PA production wells. As discussed previously, historical groundwater pumping has been relatively intense and focused within the South Westside Basin. Furthermore, most GSR Project wells would be located in these general pumping areas, with one GSR Project well (CUP-M-1) planned to the south, in the City of Millbrae. Therefore, the model-simulated effects on groundwater levels would be most evident in the PA pumping areas and the GSR Project pumping areas.

As per TM 10.1, in this analysis, hydrograph representations for each of the monitoring points are presented for Model Layer 1 (which includes the shallow unconfined aquifer) and for Model Layer 4 (which represents the Primary Production Aquifer). TM 10.1 also presents groundwater model-simulated hydrographs for selected locations from all five model layers. The results for Model Layer 1 are of particular interest for assessing water quality effects associated with rising water levels (such as the potential mobilization of contaminants).

In each hydrograph in Attachment 10.6-A, the model-simulated water levels are expressed as feet of elevation (datum NGVD29) and the time axis is in scenario years. The total duration of each hydrograph corresponds to the total length of time for each model simulation (47.25 years).

4.3.3. Depth to Water

Depth to water contour maps were generated for Scenarios 1, 2, and 4 based on the model-simulated water levels in Model Layer 1 as a representation of the shallow aquifer conditions (Figures 10.6-7, 10.6-8, and 10.6-10). For the purpose of evaluating the GSR Project effects, the changes in depth to water for Scenarios 2 and 4 were also contoured relative to the Existing Conditions (Figures 10.6-9 and 10.6-11). On Figures 10.6-9 and 10.6-11, a positive sign indicates a rise in water table elevation relative to Scenario 1. In this analysis, the relative difference contour maps were used to identify general areas that would be most susceptible to rising water levels as a result of the GSR Project operations under Scenarios 2 and 4. The absolute depth-to-water contour maps were used to identify areas that might be within the 70-foot depth threshold (Section 1.1) from the ground surface under the Existing Conditions and therefore might be most susceptible to groundwater quality effects. This approach was taken because, generally speaking, areas with a shallow water table (less than 70 feet bgs) are considered most sensitive to changes in water quality. As discussed in Section 1.1, in this water quality assessment, the 70-foot depth threshold is considered conservative and was determined by canvassing the reported depths of contaminants in lists of active regulated sites from several State and local data sources. As a conservative approach, all depth to water table contours were prepared and evaluated at the time period that corresponds to the Full SFPUC Storage Account condition (or Scenario year 7).

4.3.4. Groundwater Flow Directions

During the GSR Project recharge and recovery periods, changes in groundwater flow directions would be anticipated to occur as a result of changes in the Production Aquifer zone pumping conditions. If the response to deeper pumping propagates to the unconfined Shallow Aquifer, this may result in changes in flow directions due to changes in the shallow aquifer hydraulic gradient.

Model estimated flow directions in Model Layer 1 were used to evaluate general basin-wide flow directions and to identify areas that may be subject to changes in flow directions due to the GSR Project operations. This is a qualitative comparison performed at the basin scale. Maps with arrows indicating flow directions (Figures 10.6-12 through 10.6-17) were prepared for Scenarios 1, 2 and 4 and the results of Scenarios 2 and 4 were compared to those of Scenario 1 visually in order to identify potential changes relative to the Existing Conditions.

For the purpose of comparative analysis, the model estimated flow directions were mapped at the simulation periods that would represent the most conservative conditions. In Scenarios 2 and 4, these conditions are associated with the Full SFPUC Storage Account (for the maximum rise in water levels) and at the end of the Design Drought (for the maximum drawdown).

4.4. Scenario 2 - GSR Project Analysis

The possible effects of the GSR Project upon groundwater levels and associated groundwater quality issues are considered in this section for Scenario 2.

4.4.1. Water Levels

In the South Westside Basin, the groundwater model results for water levels are evaluated for the following 11 locations: DC-A St, DC-3, DC-8, DC-2-Westlake, Cypress Lawn No. 02, SSF-2, SSF-18, SB-12, SB-13, SB-15, and SB-16. Hydrographs corresponding to these locations for Model Layer 1 and Model Layer 4 are presented in Attachment 10.6-A, both based on the absolute water levels and relative to the Existing Conditions (Scenario 1).

Scenario 2 typically produces groundwater levels higher than Scenario 1 in the South Westside Basin. The Full SFPUC Storage Account generally reflects the maximum rise in groundwater levels. The maximum drawdown in groundwater levels generally corresponds to the end of the

Design Drought. This is mainly due to the aggregate effects of pumping by the PAs, GSR Project and the background irrigation pumping.

For the water quality assessment, Model Layer 1 results are of particular interest as they represent changes in water table conditions in response to the GSR Project operations. Among the major pumping areas, the changes in groundwater level in Model Layer 1 associated with the GSR Project vary from the largest changes in the Daly City and Colma areas, to somewhat medium changes in South San Francisco, and minor changes in the San Bruno area. The largest changes in water table conditions (both declines and increases) in the Daly City area appear to coincide with areas with large depth to water table under the Existing Conditions. In the Daly City area, water levels in Model Layer 1 generally remain above Scenario 1 conditions, ranging from a net increase of 80 feet at the Full SFPUC Storage Account to a net decline of about 55 feet at the end of the Design Drought. In the South San Francisco area, the model-simulated water levels are higher in Scenario 2 relative to Scenario 1, except at the end of the simulation period, but the relative changes remain within 20 feet of Scenario 1. In the San Bruno area, the water levels in Scenario 2 are consistently higher than in Scenario 1 throughout the entire simulation period. However, the maximum increase is about 8 feet, which represents a smaller effect compared to the Daly City and Cal Water pumping areas.

Results from Model Layer 4 for Scenario 2 relative to the Existing Conditions are briefly discussed, as they represent conditions in the Primary Production Aquifer and are not directly related to the assessment of water quality in the Shallow Aquifer. In Model Layer 4, water levels show large fluctuations controlled mainly by the GSR Project put/take/hold sequence. These particular trends in predicted groundwater levels for Scenario 2 are clearly evident on all of the hydrographs. At the end of the Design Drought, groundwater levels under Scenario 2 are projected to decline, relative to Scenario 1 levels from approximately 60 feet to 120 feet in the Daly City and Colma pumping areas (DC-2-Westlake, DC-3, DC-8, DC-A-St, and Cypress Lawn No.2), about 130 feet in the Cal Water area (SSF-2 and SSF-18), and from about 80 feet to 100 feet in the San Bruno area (SB-12, SB-13, SB-15, and SB-16).

4.4.2. Depth to Water

Figures 10.6-7 and 10.6-8 show depth to water contour maps for Scenario 1 and 2, respectively, at the time period corresponding to the Full SFPUC Storage Account. Based on the Existing Conditions, the estimated depth to the water table is largest near Daly City and becomes shallow further south toward San Bruno and Millbrae. Overall, the depth to water table ranges from 200 feet to 300 feet bgs in the Daly City area, within 50 feet to 100 feet in the Cal Water area, and mostly within 50 feet in the San Bruno area (Figure 10.6-7). In general, both Scenario 1 and Scenario 2 show similar ranges of depth to water tables in these major pumping areas, but each scenario shows different spatial variations.

Figure 10.6-8 shows the difference in depth to water table conditions from Scenario 2 relative to Scenario 1. Consistent with the results from the water level hydrographs in Model Layer 1, the largest rise in water table resulting from the GSR Project is seen in the vicinity of the Daly City area, ranging from 40 feet to 80 feet (Figure 10.6-8). While the overall rise in water table is large, the resulting depth to water table from the GSR Project would be well below the 70-foot depth threshold, given the large depth to water table (200 feet to 300 feet bgs) without the GSR Project. At the Full SFPUC Storage Account, increase in water table would be around 5 feet in the South San Francisco area and less than 3 feet in the San Bruno area. In the San Bruno and South San Francisco areas, the maximum increase in depth to water table from the GSR Project is estimated to be less than 10 feet. While the existing depths to water table in these areas are shallower compared to Daly City, the overall rise in water table resulting from the GSR Project is relatively small.

4.4.3. Groundwater Flow Directions

Model estimated groundwater flow directions are presented for Scenarios 1, 2, and 4 in Figures 10.6-12 through 10.6-17. Groundwater flow directions are presented in Model Layer 1 at two selected time periods that correspond to the Full SFPUC Storage Account and the end of the Design Drought.

At the Full SFPUC Storage Account, flow directions in Scenario 2 tend to follow trends similar to Scenario 1, with the most notable changes apparent in the Daly City area (as shown by comparing Figures 10.6-12 and 10.6-14). Scenario 1 demonstrates flow directions in the Daly City area that are primarily towards the pumping center around the Daly City municipal wells; while Scenarios 2 shows continued flow to slightly further south of Day City towards the Colma area, as a result of the large rise in water table conditions from the GSR Project. San Bruno and Cal Water pumping areas show no appreciable changes in flow directions relative to Scenario 1, both at the Full SFPUC Storage Account and the end of the Design Drought.

In light of the large depth to water table conditions in the Daly City area, changes in flow conditions resulting from the GSR Project would occur well below the 70-foot depth threshold. Therefore, these changes are not anticipated to affect the conditions of contaminants and plumes residing in the soil above 70 feet bgs. See also discussion on nitrate in Section 5.6.5.

4.4.4. Evaluation

The groundwater model results show that at the regional scale, groundwater levels and storage at the Full SFPUC Storage Account represent the highest water levels. However, the increase in water levels and storage as a result of the Full SFPUC Storage Account relative to Scenario 1 does not appear to be sufficient to result in a substantial rise in the water table (or shallow aquifer water levels) above the 70-foot depth threshold associated with the potential mobilization of shallow contaminants.

In general, Model Layer 1 results show that the maximum rise in water table (40 feet to 80 feet rise) would occur primarily in the Daly City area, where large depths to the water table (200 feet to 300 feet bgs) exist before the GSR Project. Therefore, the rise in the water table of up to 80 feet from the GSR Project would not cause water levels to rise to within the 70 feet bgs threshold and would not be anticipated to cause mobilization of contaminants in soil or shallow aquifer conditions.

At the Full SFPUC Storage Account condition, the overall rise in water tables resulting from the GSR Project is less than 5 feet in the South San Francisco and San Bruno areas. However, as shown in Attachment 10.6-A, the maximum rise in water table could reach locally to about 20 feet in the South San Francisco area and 10 feet in the San Bruno area. These changes are smaller compared to those in the Daly City area and should be viewed in the context of the shallow depth to water table conditions (less than 100 feet bgs) and the locations of the PCAs, which are pre-existing conditions. As further discussed in Section 5, the maximum rise in water tables resulting from the GSR Project does not appear to affect areas with existing contaminants that are located in the soil and/or in the shallow depths of water. Therefore, this small increase in water levels from the GSR Project operations in these areas does not appear to be an issue with respect to the mobilization of contaminants.

Changes in flow directions in Model Layer 1 are apparent in response to the GSR Project. However, the effect of change in flow directions is not anticipated to affect the existing contaminants and plumes because of their geographic locations and/or depths (e.g., Model Layer 1 groundwater levels in the Daly City area are projected to remain well below 70 feet bgs threshold depth under Scenario 2) (Section 5).

4.5. Scenario 4 - Cumulative Scenario Analysis

Scenario 4 includes the proposed operation of both the GSR and SFGW Projects, projected pumping for the PAs and third party pumpers such as irrigation pumping, and other foreseeable projects. Reasonably foreseeable projects that are considered under the cumulative scenarios include Daly City’s Vista Grande Drainage Area Improvements Project and Holy Cross cemetery future build-out. A detailed description of the model assumptions used for Scenario 4 is presented in the Task 10.1 TM (Kennedy/Jenks, 2012b).

4.5.1. Water Levels

Hydrographs corresponding to the selected 11 locations for Model Layer 1 and Model Layer 4 are presented in Appendix 10.6-A. Results from Scenario 4 in the South Westside Basin are similar to those from Scenario 2. The combined effects of the two SFPUC Projects are most notable in the Daly City area due to the proximity to SFGW Project operations in the North Westside Basin. In the South San Francisco and San Bruno areas, there is no appreciable difference between Scenario 4 and Scenario 2 with the GSR Project. Therefore, the findings presented in Section 4.4 for Scenario 2 are applicable to Scenario 4.

Similar to Scenario 2, the lowest groundwater levels predicted in the South Westside Basin for Scenario 4 correspond to the Design Drought. Recovery of groundwater levels, relative to simulated Scenario 1 conditions, is expected to be similarly discrete during the GSR Project put periods, as shown in hydrographs in Attachment 10.6-A. During hold periods, the PAs would return to their designated pumping, which is essentially the same as the pumping under Scenario 1. The trends seen in groundwater levels during hold periods in Scenario 4 therefore tend to follow trends seen in Scenario 1.

4.5.2. Depth to Water

Figure 10.6-10 shows the depth to water contour map generated for Scenario 4 to represent conditions at the Full SFPUC Storage Account. Under Scenario 4, the combined effects of the GSR and the SFGW Projects in the northern portions of the South Westside Basin result in depth to water table conditions very similar to Scenario 2 at the Full SFPUC Storage Account condition (Scenario Year 7). However, there are slight spatial variations in the depth to water between Scenario 4 and Scenario 2. These can be attributed to the effects of the SFGW Project and very minor modifications in the PA pumping assumptions, primarily for the Daly City and Cal Water municipal wells. In general, the Scenario 2 results are more conservative than the Scenario 4 results with respect to rising water table conditions. This is because the SFGW Project is absent from Scenario 2. Under Scenario 4, only slightly higher depths to water table are experienced than in Scenario 2. These are located primarily in the Daly City area and occur as a result of shifting a portion of the Daly City pumping under the Existing Conditions to the proposed DC-A Replacement well under the Cumulative Scenario (which is located on the west side of Daly City, further away from the well locations under the Existing Conditions).

4.5.3. Groundwater Flow Directions

Model estimated groundwater flow directions in Model Layer 1 for Scenarios 1 and 4 are presented in Figures 10.6-12 and 10.6-16 for the Full SFPUC Storage Account and in Figures 10.6.13 and 10.6-17 at the end of the Design Drought. The effects of the Cumulative Scenario in the South Westside Basin are very similar to those of Scenario 2 for the GSR Project because the SFGW Project under the Cumulative Scenario is concentrated in the North Westside Basin.

At the end of the Design Drought, Scenarios 1 and 4 show strong flow directions towards the Daly City, Colma and South San Francisco areas of the Basin where the majority of pumping would occur (Figures 10.6-13 and 10.6-17). Similar to Scenario 2, the most notable difference for Scenario 4 compared to Scenario 1 is the increased pumping in the Daly City area. As a result of this change, the overall flow direction south of Daly City appears to be primarily towards Daly City.

At the Full SFPUC Storage Account, the flow directions in Scenario 4 tend to be similar to those of Scenario 1, but slight changes are apparent in the Daly City area where the flow direction changes from toward the pumping area under Scenario 1 to a more southwesterly flow direction under Scenario 4.

4.5.4. Evaluation

The effects of Scenario 4 in the South Westside Basin are similar to those of Scenario 2. Because the SFGW Project operates solely in the North Westside Basin, the majority of the SFGW Project effects are limited to the general extent of that area. Therefore, the general model findings for Scenario 2 are also applicable for the Cumulative Scenario with respect to water quality effects.

In summary, the model analysis results suggest that the Cumulative Scenario would not cause mobilization of contaminants in soil or shallow aquifer zones as a result of increases in groundwater levels and storage in the South Westside Basin. The model results show that at the regional scale, the groundwater levels and storage associated with the Full SFPUC Storage Account condition represent the highest levels. However, the increase in water levels and storage as a result of the Full SFPUC Storage Account under the Cumulative Scenario relative to Scenario 1 does not appear to result in a substantial rise in the water table (or the water levels in the shallow aquifer) (Figure 10.6-10). Therefore, increases in water levels and storage from the Cumulative Scenario do not appear to be an issue with respect to the mobilization of shallow contaminants and plumes. Changes in flow directions in Model Layer 1 are apparent under Scenario 4 and similar to those conditions anticipated for Scenario 2. Therefore, general findings presented in Section 4.4.4 for Scenario 2 would be applicable for the Cumulative Scenario with respect to the effects of changes in flow directions on water quality.

5. Empirical Analysis

This section describes the empirical analysis for evaluating the effects of potential changes in groundwater quality as a result of the possible changes in groundwater levels and storage associated with the GSR Project operations. The focus is on existing and open regulated cleanup sites, referred to as possible contaminating activities or PCAs. Records of known PCAs were compiled from the following sources and relevant sites were included in Preliminary DWSAPs submitted to the CDPH. These sites were mapped and are further discussed in Section 5.2.3 as part of the CDPH DWSAP documentation and analysis of groundwater protection zones.

The main criterion to be addressed with respect to groundwater quality is the potential mobilization of contaminants in groundwater and soil as a result of possible increases in shallow groundwater levels from the GSR Project operations. In addition, the potential change to the shallow groundwater flow direction is also considered as this may influence existing contaminant plumes. This assessment also evaluates groundwater quality effects based on historical land use such as localized nitrate distribution and assessment of potential contamination from cemeteries.

5.1. Data Sources

As noted in Section 3.3, data sources listed below were compiled and evaluated at the basin-wide scale and in the vicinity of the pumping areas for the GSR Project.

- Records of known contaminating activities from GeoTracker (SWRCB, 2012);
- Records of known historical land disposal sites (SWIS, 2010);
- Records of DTSC sites (California DTSC, 2010);
- Records of SLIC sites (San Francisco Bay RWQCB Spills, Leaks, Investigations, and Cleanup, 2010); and
- Recent 2008 nitrate measurements in the South Westside Basin.

The databases used for the analysis were mapped in a Geographic Information System (GIS). Data compiled for the existing regulated sites, including the GeoTracker, SWIS, DTSC, and SLIC databases, are available in electronic format and can be provided upon request.

5.2. Approach and Methodology

An inspection level assessment was conducted using a comprehensive mapping of listed PCAs in the GSR Project area. It was the main intent of this qualitative assessment to investigate basin-wide soil and groundwater contamination activities. The approach included a basin-wide compilation and review of known contaminant sites at the regional scale. First, a basin-wide screening was applied to identify known existing open regulated sites across the entire GSR Project area in the South Westside Basin. Figure 10.6-18 is an index figure to Figures 10.6-19 through 10.6-23 that show the open regulated site locations and recorded depths to groundwater (also in Plate B-1). Listings of open and closed sites are included in Table B-1 in Attachment 10.6-B. Table B-1 lists open and closed regulated sites within the 2,000 feet groundwater protection zones and the South Westside Basin boundary. The relevant databases were sorted based on salient themes such as the type of cleanup site, regulatory status (e.g., open or closed), and the potential media affected (e.g., soil, drinking water aquifer). GIS maps were created to show locations of the existing PCAs with respect to these themes over the entire South Westside Basin. These maps are represented as Figures 10.6-19 through 10.6-23 for the open regulated sites.

To assess the potential for water quality changes related to rising groundwater levels associated with the GSR Project, the areas that may be most susceptible to groundwater quality effects were identified. This identification was based on four key components that were evaluated jointly in order to determine the vulnerability of specific portions of the groundwater basin. The four key components are:

1. Depth to water in the perched water bearing zone or in the Shallow Aquifer;

2. Presence of confining layers in the subsurface;

3. Groundwater protection zones around the GSR Project pumping centers; and

4. Status and spatial distributions of PCAs in the GSR Project area.

5.2.1. Depth to Water

Depth to water is considered an important parameter with respect to groundwater vulnerability, because it represents the distance a contaminant must travel through the unsaturated zone before reaching the water table (or top of the Shallow Aquifer) and affecting quality of water supply. It is noted that perched water bearing zones occur and are considered to be overlying the Shallow Aquifer in the Basin. According to the GeoTracker database, contaminants from PCAs in the GSR Project area are mostly characterized as occurring in soil and in the perched zones above the primary or drinking water supply aquifers.

In general, shallow contaminants below ground are more likely to affect unsaturated and perched water bearing zones in areas with a shallow water table in the Shallow Aquifer. Hence, areas with shallow water levels have a higher risk of groundwater contamination, while areas with a deep water table would present a lower risk to groundwater quality. Thus, depth to water table was analyzed in conjunction with the locations and status of the existing PCAs.

Based on groundwater model results, the depth to water contour maps for Scenario 1 (Figure 10.6-7) and Scenarios 2 and 4 (Figures 10.6-8 and 10.6-10) are compared to evaluate the potential for higher water levels in the Shallow Aquifer (Model Layer 1) due to the GSR Project in-lieu recharge operations. For the GSR Project, the Full SFPUC Storage Account, which represents 60,500 af of in-lieu recharge, generally has the highest water levels in the South Westside Basin. Therefore, the depths to water contour maps for Scenarios 1, 2 and 4 were prepared at the time period that corresponds to the Full SFPUC Storage Account (Scenario Year 7).

Depths to the water table in Model Layer 1 in Scenarios 2 and 4 were compared relative to Scenario 1 to demonstrate the effect of GSR Project operations on water levels, as shown in Figure 10.6-9 for Scenario 2 and Figure 10.6-11 for Scenario 4. Results of the modeling analysis presented in Section 4 demonstrate that GSR Project operations in the production depths (Primary Production Aquifer) would result in about 80 feet of water level rise in Model Layer 1, which generally represents conditions in the Shallow Aquifer. The largest rise in water levels is naturally centered on the portion of the groundwater basin with the historically lowest water levels under pre-GSR Project conditions – i.e., beneath Daly City (Figures 10.6-9 and 10.6-11). Water depths in the Shallow Aquifer are further evaluated in Section 5.6.1.

5.2.2. Presence of Confining Layers In the Subsurface

The presence of confining layers comprised of fine grained sediments above the GSR Project pumping zones is critical for assessing potential groundwater quality changes from the GSR Project operations. Confining layers exert controls on the groundwater flow and direction. Confining strata of fine grained aquifer material, when encountered in the subsurface between the PCAs and the deep pumping aquifer, could restrict flow from the shallow zone to the production zone (Primary Production Aquifer) and isolate the pumping effects in the deep production aquifer. The following describes the main geographic areas of significance in the Westside Basin:

- In the North Westside Basin away from Daly City, the presence of the -100-foot clay clearly separates the Primary Production Aquifer from the overlying Shallow Aquifer.
- The -100-foot clay is not encountered beneath Golden Gate Park and differences in groundwater levels between the two aquifers indicate that the Shallow Aquifer is unconfined and the Primary Production Aquifer is semi-confined, with a downward component of groundwater flow.
- Local stratigraphy and recently-obtained groundwater level data suggest that in the Daly City, South San Francisco, and San Bruno areas, the Primary Production Aquifer is confined to semi-confined. The -100-foot clay is no longer present beginning in the Daly City area, and thus the Shallow Aquifer is also not formally defined for this area.

- Nonetheless, from South San Francisco to San Bruno, the presence of thick surficial Bay Mud deposits of even lower relative permeability likely provides an even greater degree of confinement to the Primary Production Aquifer in that area.

5.2.3. Groundwater Protection Zones

The concept of groundwater protection zones that was developed by the CDPH, formerly Department of Health Services, for the DWSAP was applied in this analysis as the basis for defining the anticipated area of influence around each pumping (existing or proposed) well. The overall objective of the DWSAP is to ensure the quality of drinking water sources is protected. Permitting of a new water supply well requires that a DWSAP assessment be completed as part of the permit process and submitted to CDPH. Compliance with the CDPH requirements is a key part of groundwater quality protection.

Groundwater protection zones as defined by the CDPH for DWSAP represent approximate areas from which groundwater may be withdrawn by the pumping well in two, five, and ten years of pumping. Groundwater protection zones associated with two, five, and ten years of travel time for groundwater are known as Zone A, Zone B5, and Zone B10, respectively. These zones also represent the area in which contaminants released to groundwater could migrate and potentially affect the groundwater extracted by wells located within the designated zones. The size of each zone is determined by the pumping rate of the well, interval of pumping, and local hydrogeologic conditions. The CDPH requires a minimum radius for each protection zone: 600 feet for Zone A, 1,000 feet for Zone B5, and 1,500 feet for Zone B10. If the calculated radii of the protection zones are less than the CDPH minimums, the minimum values are used instead. DWSAP includes the preparation of an inventory of PCAs that can show the release of contaminants within the protection zones, similar to the empirical analysis presented in this section.

For this analysis, 2,000-foot groundwater protection zones delineated by the DWSAP as illustrated in Figure 10.6-18 (also in Plate B-1) were considered as areas of influence around a pumping well(s) during take period pumping by the GSR Project and PAs. The 10-year time period, or Zone B10, was considered to represent a conservative groundwater protection zone around the pumping wells - given that the take period pumping during the Design Drought would occur over 7.5 years for Scenarios 2 and 4.

For the GSR Project, preliminary DWSAP groundwater protection zones were prepared for the 16 proposed production well sites (Figure 10.6-2). Estimated groundwater protection zone for the 10-year travel time for these well sites ranged from the minimum CDPH requirement of 1,500 feet to approximately 1,900 feet. For this analysis, a more conservative approach was taken, assigning a groundwater protection zone of 2,000 feet around each of the PA wells and the GSR Project wells. Consistent with DWSAP, the assigned groundwater protection zone serves as a search radius around the wells to identify PCAs that may be most affected by the GSR Project operations. Based on the above, contaminants released to groundwater could migrate downward and potentially affect groundwater extracted by the GSR Project wells. Additionally, contaminants within or in proximity to the GSR Project anticipated areas of influence can also be affected but may not be captured by groundwater extraction.

The inventory of PCAs was evaluated for all 16 proposed GSR Project well sites and included in the Preliminary DWSAPs. DWSAPs for seven of the 16 proposed wells were submitted to the CDPH in 2009. SFPUC received a letter from the CDPH for the approval of the seven well sites and CDPH did not place any restrictions or special conditions on well design or construction (CDPH, 2009). DWSAP documentation for the remaining nine well sites has not been submitted to CDPH since these wells will not be constructed until 2014.

5.2.4. Possible Contaminating Activities (PCAs) Analysis

For this study, PCAs are defined as human activities at the ground surface that are actual or possible sources of contamination for groundwater. PCAs include sources of chemical contaminants that could have adverse effects upon human health. Risk of groundwater contamination is directly related to specific land uses that entail handling of hazardous materials or waste (e.g., dry cleaners, solid waste facilities, gas stations and other facilities with underground tanks storing hazardous materials).

The objective of the PCA analysis is to compile a comprehensive database of PCAs in the GSR Project area and to develop a technically-sound and scientifically-defensible methodology to identify areas with PCAs that may be affected by the GSR Project due to rising water levels or change of flow directions. The PCA analysis was conducted at different scales, beginning from a regional scale to a more local scale in the vicinity of the PA municipal wells and GSR Project wells. A basin-wide map of the locations of known existing regulated sites was prepared to evaluate spatial distribution of all PCAs. PCAs were tabulated, grouped, and reviewed in appropriate categories (e.g., case status, case types, potential media affected) to characterize their status.

In the next level of inspection, the primary focus was on areas in the vicinity of the existing PA municipal wells and GSR Project wells. Locations of reported PCAs were mapped within the groundwater protection zones identified around the wells.

At the local scale, GIS maps were prepared to illustrate areas that would be most vulnerable with respect to groundwater quality because of the presence of PCAs within groundwater protection zones. This analysis focused only on open sites within the groundwater protection zones. PCA sites that are reported to be closed under regulatory oversight were screened out because the presence of closed sites is not anticipated to pose a groundwater quality risk. At this scale, PCAs were tabulated and grouped with their identification to further characterize the open PCAs with respect to their risk to groundwater quality. These sites were considered a risk to groundwater quality and their status was analyzed with respect to the potential affected media (soil, groundwater, or drinking water aquifer). Within each groundwater protection zone, pertinent information relating to the type of PCA record, type of land use activity, leaking underground storage tank information and other hazardous material information at the existing regulated site was noted and tabulated in summary tables. Sites with notable or possible contamination concerns were highlighted for further discussion in Sections 5.5.1 and 5.6.4.

5.3. Nitrate

As part of the groundwater quality assessment, the current condition of nitrate in the South Westside Basin was reviewed to identify general areas that may be affected by nitrate from historical land use applications. As discussed in Section 3, elevated nitrate concentrations, exceeding the drinking water standards, are known to exist in certain areas in the Basin such as Daly City. The nitrate measurements taken between April 2008 and September 2008 from the existing monitoring wells and the multiple nested monitoring wells installed by the SFPUC as part of the GSR Project (SFPUC, 2009a; Kennedy/Jenks, 2010) were compiled. Nitrate data are sampled in wells screened in the Shallow, Primary Production, and Deep Aquifers. Figure 10.6-5 presents data collected from groundwater wells at different aquifer depths and depicts the overall nitrate distribution in the Basin. To differentiate a nitrate-depth relationship and to identify localized areas with high nitrate levels, nitrate data measured at different depths were plotted together at the multi-level monitoring well locations.

5.4. Cemeteries

As discussed in Section 3.2.4, cemeteries in the GSR Project area were evaluated by SFPUC for potential groundwater quality concerns because cemeteries are in the vicinity of some of the GSR Project monitoring wells and the GSR Project production wells. Data were used to address potential regulatory issues and support the Preliminary DWSAP submittal to the CDPH.

Based on the recent groundwater sampling conducted in 2009 and 2010 by SFPUC, there is no apparent groundwater contamination from cemeteries (Kennedy/Jenks, 2010), supported by data from five monitoring wells (MW-CUP-18, MW-CUP-19, MW-CUP-22A, MW-CUP-44-1, and the Linear Park monitoring well) located in the vicinity of the cemeteries.

In a study of six cemetery sites in Ontario, Canada (Soo et al., 1992), the analysis of groundwater samples collected at wells located downgradient of the cemeteries indicated that the cemeteries are not a significant source of groundwater contamination. In the same study, the calculated loading estimates for formaldehyde and nitrates being released from cemeteries supports a low potential for groundwater contamination. For comparison to the existing PCAs, the CDPH considers cemeteries as a “medium” risk with respect to water quality concerns as compared to auto service stations, which are assigned a risk ranking of “very high”.

It is also important to note that the GSR Project wells will draw groundwater from the deep Primary Production Aquifer, typically below 350 feet to 600 feet bgs and are generally protected from shallow aquifer contaminants such as possible releases from cemeteries. The upper portion of the GSR Project wells will be sealed to a depth of at least 300 feet to prevent shallow surface pollution from entering the well. This exceeds the state well sealing requirement of 50 feet.

The GSR Project is not anticipated to mobilize related constituents in groundwater because of the depth of pumping. Because of the very shallow nature of constituents from the existing cemeteries, the rise in water levels in the lower portion of the Shallow Aquifer during GSR Project put periods is not likely to mobilize these shallow constituents in the soil. Moreover, groundwater quality effects from cemeteries are controlled by land use activities unrelated to GSR Project operations. In addition, the ongoing SFPUC monitoring at the monitoring wells for the GSR Project will continue to evaluate groundwater quality conditions in the vicinity of the cemeteries.

5.5. Results of Empirical Analysis

The complete PCA database that includes maps and PCA site inventory-listing is presented in Figures 10.6-19 through 10.6-23. Attachment 10.6-B shows the locations of the reported PCAs in the GeoTracker (Plate B-1), SWIS (Figure B-1), DTSC (Figure B-2), and SLIC (Figure B-3) databases. Plate B-1 shows locations of open regulated PCA sites based on the GeoTracker database. The inventory of the GeoTracker database for closed and open sites is listed in Table B-1 in Attachment 10.6-B.

5.5.1. GeoTracker Database

Regulated sites reported in the GeoTracker database were mapped based on case status, case type, and potential media affected, as shown on the GISs maps on Figures 10.6-19 through 10.6-23 and in Plate B-1 in Attachment 10.6-B. General findings based on the evaluation of the sites are as follows:

- Among the 1,560 sites reported in the GeoTracker database in San Mateo County, 514 sites are located in the GSR Project Area while the remaining are located outside of the GSR Project area (see the inventory list in Attachment 10.6-B, Table B-1).

- Out of the 514 sites identified in the GSR Project Area, 135 sites are identified with a status of open.

- A total of 153 sites closed and open are identified within the groundwater protection zones around the pumping wells. These are evaluated in Section 5.6.

- Out of the 153 sites located within the groundwater protection zones, 51 sites are reported to be open and the remaining 102 sites are reported closed under regulatory oversight.

An inventory is presented in Attachment 10.6-B with a listing of 514 closed and open sites located in the South Westside Basin. Figure 10.6-18 and Plate B-1 (Attachment 10.6-B) illustrate the locations of regulated sites classified as open and within the South Westside Basin and the vicinity. Figures 10.6-19 through 10.6-23 present small scale site maps with the locations of PCAs for the general pumping areas (e.g., Daly City, Colma, South San Francisco, San Bruno, and Millbrae) based on the reported potential media affected for each PCA. For clarity, PCA sites are posted with only their global ID numbers and recorded depths to water based on records from the GeoTracker. They can be cross referenced with site names listed in Table B-1.

Among the 51 sites identified within the groundwater protection zones in the GSR Project area (Figures 10.6-19 through 10.6-23), several PCA sites are reported to have affected soil with no groundwater contamination or plume. The majority of the remaining sites are LUST cleanup sites related to soil and shallow groundwater contamination.

Five sites in the GeoTracker database are identified in the groundwater protection zones and characterized in GeoTracker with the "*potential media affected as aquifer used for drinking water supply*", with the exception of one site (Olympic Service Station) that is not identified as affecting the drinking water, but included and briefly discussed below due to its proximity to the proposed GSR Project well CUP-M-1. Two of the five sites are recently listed as case closed. One of the five sites is located in the San Bruno area, three sites are located in the Daly City area, and one site is in the Millbrae area. Based on the review of the most recent information available at the GeoTracker database, general findings for these five sites are summarized as follows:

- **Arco #0465 (T0608100027)** – This is an active ARCO gasoline station with underlying soil and shallow/perched groundwater affected with petroleum hydrocarbons. This site is located on the southern corner of the intersection of Southgate Avenue and Lake Merced Boulevard in Daly City. The site is about 700 feet northeast of the Daly City Westlake production well and about 1,000 feet northwest of the GSR Project well cluster site (CUP-05, CUP-06, and CUP-07) (Figure 10.6-19). Based on the 2009 monitoring report available at GeoTracker website, on-site monitoring wells were screened from 39 feet to 70 feet bgs. Data available at the GeoTracker website indicate a shallow depth to water table at approximately 56 feet bgs (Figure 10.6-19), based on data measured in 2002, as reported by the GeoTracker records.

  A deep on-site monitoring well installed to a depth of 220 feet bgs (below an approximate 10-foot-thick clayey silt to silt clay zone) observes water levels at much lower depths at approximately 154 feet bgs, which may represent the intermediate regional drinking water aquifer. (i.e., Primary Production Aquifer). Groundwater sampling conducted in 2009 at the intermediate on-site monitoring well and off-site shallow monitoring well (screened from 39 feet to 49 feet bgs) detected no petroleum hydrocarbons. On-site shallow monitoring wells showed plume concentrations to be either stable or declining over time, with the contaminant plumes being contained on site.

- **Chevron 9-5584 (T0608179897)** – This was a former Chevron station. Currently, a strip mall and parking lot occupy the site. It is located on the northeastern corner of the intersection of El Camino Real and San Benito Avenue, about 1,700 feet south of the San Bruno production well No.17 (Figure 10.6-22). Site monitoring data indicate shallow depth to water, with water levels ranging from about 20 feet to 60 feet bgs. This is consistent with data available at the GeoTracker website indicating a shallow depth to water table at approximately 34 feet bgs (Figure 10.6-22), based on data measured in 2003, as reported by the GeoTracker records. The site has both soil vapor and groundwater extraction wells. The most recent monitoring event in March 2010 shows a benzene and TPH plume mostly contained on site.

- **Olympic Service Station (T0608121993)** – This is an existing service station located about 980 feet upgradient of the GSR Project proposed well CUP-M-1 (Figure 10.6-23). During the course of aquifer tests at monitoring well MW-CUP-M-1, the water level in a shallow monitoring well (Olympian MW-3, located at the Olympic Service Station) about 950 feet west of MW-CUP-M-1 was monitored. This was done to determine whether the pumping at MW-CUP-M-1 would affect any surrounding wells in the Shallow Aquifer. The pumping at M-1 resulted in no discernible effects on the water levels at the Olympic Service Station monitoring wells even after the removal of barometric pressure.

  Based on the review of the Pangea Environmental Services, Inc. 2008 Groundwater Monitoring Report (Pangea Environmental Services, Inc., 2008) (downloaded from the GeoTracker website), concentrations of total petroleum hydrocarbons as gasoline (TPHg) and benzene detected in on-site monitoring wells are on long-term declining trends, while total petroleum hydrocarbons as diesel (TPHd) have been generally stable. No MTBE was detected in the easternmost downgradient monitoring well (MW-3), which is the closest well, at a distance of 950 feet from CUP-M-1. Soil grab sampling indicates that MTBE attenuated to a concentration of ~0.88 parts per billion (ppb) with depth. An abstract of this conclusion is also included in the Categorical Exemption for the proposed GSR Project well CUP-M-1 (SFPUC, 2009b).

  The compounds detected at the Olympic Service Station release are isolated in the shallow groundwater zones, based on data from the well log CUP-M-1 and cross-section H-H' in the TM#1 (LSCE, 2010). This is also supported by depth to water data available at the GeoTracker website indicating shallow depth to water table conditions at approximately 17.5 feet bgs (Figure 10.6-23), based on data measured in 2003. The shallow water bearing zone is underlain by clay/Bay Deposits (Qbd) from about 100 feet to 170 feet bgs.

- **Gas and Wash Partners (T10000003031)** – This is a LUST cleanup site. Contamination at this site was discovered in February 2011, when the current property owner conducted sampling beneath three underground storage tanks that were proposed to be converted to use for storage of recycled water (TEC, 2011). Sampling indicated a historical release of gasoline, benzene, toluene and xylene from two of the three storage tanks and one of the fuel dispensers. Based on the particular contaminants encountered in the sampling, TEC (2011) speculated that the petroleum hydrocarbon release occurred before the introduction of oxygenated gasoline in the late 1970s to late 1980s; the fuel storage tanks were lined in early 1999. The investigation was limited to soil sampling, and did not sample deeper than just below the USTs; groundwater was not encountered or sampled. The detected concentrations of petroleum hydrocarbons were above the Environmental Screening Levels (ESLs) mandated for shallow soil at a commercial property over a potential drinking water source. TEC (2011) noted that a nearby LUST site (approximately 500 feet to the east) had groundwater depths no shallower than 160 feet below the ground surface. Based on the current information available from the site investigation report, there is no supporting data indicating this site has affected the drinking water supply aquifer.

  As of May 20, 2011, the Gas and Wash Partners site is listed as open-site assessment for the site characterization and investigation. The site is located east of well cluster CUP-05, CUP-06 and CUP-07, and north of Daly City Well No. 4 (Figure 10.6-19). This site is approximately 1,900 feet from CUP-07 and 470 feet from Daly City No.4.

- **Chevron 9-6982 (T0608100148) Classified as “Completed - Case Closed” 12/27/2011** – This is a Chevron service station with underlying soil and shallow/perched groundwater affected with gasoline. The site is located on the north side of John Daly Boulevard, about 2,000 feet north of the Daly City Westlake production well (Attachment 10.6-B, Table B-1). This site is just outside of the 2,000-foot search radius around the Daly City Westlake well, but due to its proximity, it was considered for evaluation.

  The site contains an underlying aquitard at a depth of approximately 30 feet bgs, as reported by the GeoTracker website and three different shallow water bearing zones to depths at 80 feet bgs. Based on the 2010 monitoring report available at the GeoTracker website, depth to the water table ranges from 26 feet to 35 feet bgs in the shallowest zone and at approximately 74 feet bgs in the deep zone. No total petroleum hydrocarbons as diesel (TPHd) were detected in soil samples collected during monitoring well installation to a depth of 35 feet bgs.

  Depth to water table at the site is relatively shallow, ranging from 63 feet to 74 feet bgs. The site is closed given that the extent of hydrocarbons in soil and groundwater are adequately defined, the sources of MTBE were removed in 1997, and the soil has residual hydrocarbon concentrations below the ESL.

5.5.2. SWIS Database

Locations of reported land disposal sites are shown in Attachment 10.6-B, Figure B-1 based on grouping by case type (i.e., closed, closing, and active) and facility type (i.e., disposal, composting, and transfer station). Fourteen (14) disposal/composting/transfer sites were identified in northern San Mateo County; of these, six sites are located in the South Westside Basin. However, as shown in Figure B-1, five sites out of the six are too far away from the GSR Project pumping areas and located near the Bay or the Pacific Ocean.

Based on the above analysis, there is only one land disposal site within the vicinity of the GSR Project wells. This site is the closed Junipero Serra Solid Waste Disposal Site, located in Colma about 1,700 feet southwest of CUP-18 and 2,500 feet west of CUP-19. This landfill was a solid waste disposal site that began operations in the year 1956 and accepted primarily commercial solid wastes. After site closure in 1983, the site was ultimately developed for commercial land uses, collectively known as the Metro Center. There are no current water quality issues reported on this closed landfill site.

5.5.3. DTSC Database

Locations of the sites reported by California DTSC are shown in Attachment 10.6-B, Figure B-2. Fifteen (15) sites were reported in the South Westside Basin and the majority of these sites are concentrated in South San Francisco, Daly City, and City of Brisbane away from the general pumping areas.

5.5.4. SLIC Database

Locations of the reported SLIC sites are shown in Attachment 10.6-B, Figure B-3 based on status type (i.e., inactive and active). Fifteen (15) sites were reported in the South Westside Basin. Similar to the findings with the DTSC database, the majority of these SLIC sites are located in South San Francisco away from the general pumping areas. The closest distance of existing SLIC site is approximately 1,100 feet to the proposed Cal Water municipal well SSF1-24 (shown as 41S0154 on Figure B-3) and 1,400 feet to the proposed GSR Project well CUP-41-4 (shown as 41S0048 on Figure B-3). As noted in TM 10.1, the Cal Water proposed well SSF1-24 is considered redundant and no pumping was assigned to this well in the groundwater modeling analysis.

5.6. Evaluation

The following evaluation is based on the approach introduced in Section 5.2 of combining the four key components of the GSR Project conditions and supporting data.

5.6.1. Depth to Water in the Shallow Aquifer

Based on the evaluation of the regulated PCAs reported in the GeoTracker database (Section 5.5.1), GSR Project operations under Scenarios 2 and 4 are not anticipated to influence sites with soil contamination located within the anticipated area of influence of the GSR Project. This is based on comparing the depth to water contours of Scenario 1 to Scenarios 2 and 4 (Figures 10.6-7, 10.6-8, and 10.6-10).

The intent of Figures 10.6-7, 10.6-8, and 10.6-10 is simply to show that shallow depths - of less than 70 feet - to groundwater as predicted in Model Layer 1 for the Shallow Aquifer primarily occur on the fringes of the GSR Project area, both with and without the GSR Project operations. It is noted that depths to water estimated by the groundwater model for Model Layer 1 do not distinguish multiple water bearing zones such as perched groundwater.

Scenarios 1, 2 and 4 show that the shallowest estimated occurrence of groundwater is beneath the City of Millbrae, San Francisco International Airport, and vicinity. The model results suggest that groundwater detected at and east of the GSR Project well CUP-M-1 could occur at depths of less than 50 feet (green and blue contours). However, the PCAs mapped for this particular area are all reported to have depths to water at less than 10 feet south of CUP-M-1 and depths of less than 17.3 feet between CUP-M-1 and north to SB No.16, as shown in Figures 10.6-22 and 10.6-23, which depict measured depth to water at the PCA sites based on the GeoTracker database. Therefore, rising water levels in Model Layer 1 during the GSR Project operations would not pose a risk of remobilizing existing contamination in the soil and/or shallow groundwater systems.

Other shallow depths to groundwater simulated by Scenarios 1 and 2 are beneath the east side of the City of South San Francisco. PCA sites mapped for this particular area have reported depths to water between 6 feet to 45 feet within the anticipated groundwater protection zones of CUP-36-1 and CUP-41-4 in this area (Figures 10.6-21). The PCAs located east the GSR Project well CUP-41-4 are all reported to have depths to water of less than 13 feet. Beneath the areas of Daly City and Colma, groundwater model estimated water levels are maintained low between 200 feet to 300 feet bgs. This can be generalized to the entire GSR Project area with water levels estimated to be at 200 feet to 400 feet bgs under the Full SFPUC Storage Account.

The lack of notable changes in water levels is apparent on the fringes of the GSR Project area (dark colored contours on Figures 10.6-7, 10.6-8, and 10.6-10). It is concluded that the shallow water levels encountered in these areas represent pre-project conditions and hence are not subject to further evaluation in regards to the GSR Project and its effect on existing shallow PCA releases.

<u>Relative Changes in Water Levels</u>

To further illustrate the model-simulated rise in water levels as related to PCA sites, the changes in shallow depth to water levels relative to Scenario 1 are quantified and illustrated as contours in Figure 10.6-9 for Scenario 2 with the GSR Project and Figure 10.6-11 for Scenario 4 with the combined GSR and SFGW Projects under the Cumulative Scenario. The greatest change in water levels is anticipated to be in the historically deepest ground waters in the South

Westside Basin – i.e., City of Daly City. However, the changes in water levels from the GSR Project operations under Scenarios 2 and 4 did not produce notable rise of water levels in the Shallow Aquifer that could influence the remobilization of shallow contaminants above the 70 feet bgs. This is shown by the relative changes in depth to water contours in Figure 10.6-9 for Scenario 2 and in Figure 10.6-11 for Scenario 4.

Changes in water level contours for Scenarios 2 and 4 are also shown in close-up views with PCA sites and their reported depths to water in Figures 10.6-19 to 10.6-23. These figures illustrate that the model simulated rise in water levels from Scenarios 2 and 4 relative to Scenario 1 are similar, with minor to no variations between the two model scenarios; thus, the findings for the effects of Scenarios 2 and 4 with respect to rise in water levels, and resulting effects on the existing PCA sites are essentially the same.

5.6.2. Presence of Confining Layers In the Subsurface

The aggregate occurrences of aquitards and intervening fine grained units between shallow contaminants and the groundwater production zones could restrict vertical migration of contaminants to the deep groundwater zones; hence, isolating the pumping effects in the Primary Production Aquifer.

As discussed in Section 2.6.4, additional evidence of the confinement of the Primary Production Aquifer beneath the cities of Colma and Millbrae is apparent from relative groundwater elevations measured in the multilevel GSR Project monitoring well clusters installed by SFPUC in 2008 and 2009 (Kennedy/Jenks, 2009 and 2010). At each monitoring well location, there are three or four separate wells installed at discrete depths. The completion depths for these wells generally correspond to the Primary Production Aquifer and the Deep Aquifer, and although it is not formally recognized in this area, an apparent equivalent to the Shallow Aquifer as defined in the North Westside Basin. Differences in groundwater levels measured in the GSR Project monitoring wells – or the lack of neutral vertical gradients – suggest likely hydraulic separations of these three aquifers in the central and south basin area.

5.6.3. Groundwater Protection Zones around GSR Project and PA Municipal Wells

The intent of this discussion is to characterize potential groundwater effects of the 51 PCA sites that are listed as open and that are located within the groundwater protection zones of the GSR Project and the PA municipal wells (See Section 5.2.3). The focus is to evaluate the likelihood of the GSR Project operations to draw down contaminants from PCA sites in the shallow zone into the Primary Production Aquifer and into the supply wells.

Contaminants as reported in PCA sites in soil, shallow or perched groundwater zones within the GSR Project area (Figures 10.6-19 to 10.6-23) are not anticipated to be mobilized due to the GSR Project operations. This conclusion is based on the reported shallow nature of these cleanup sites (Section 5.6.4) and intervening clay and other fine grained aquifer materials, suggesting varying degree of hydraulic separation between PCAs and the Primary Production Aquifer (Section 5.6.2).

5.6.4. PCA Status and Spatial Distribution of PCAs in the GSR Project Area

Out of the 51 PCAs identified in the GSR Project groundwater protection zones, four PCA sites (Arco #0465, Chevron 9-5584, Gas and Wash Partners, and Chevron 9-6982), were reported to have listed potential media affected as *"aquifer used for drinking water supply"* within the groundwater protection zone of 2,000 feet (see Figure 10.6-18 for the basin-wide view and Figures 10.6-19 through 10.6-23 for the small scale site maps). Only two open PCAs are within the GSR Project groundwater protection zones: Arco #0465 and Gas and Wash Partners are within the GSR Project well cluster CUP-5, 6, and 7 (Figure 10.6-19). Only one open PCA (Chevron 9-5584) is within the PA groundwater protection zones (Figure 10.6-23). The remaining PCA site Chevron 9-6982 is case closed (see Section 5.5.1 for details).

Given the current status of these sites with contained, stable, or declining concentrations over time, and the shallow nature of the contaminant plumes and the ongoing cleanup activities, the GSR Project is not anticipated to mobilize contaminants at the three open sites (Arco #0465, Chevron 9-5584, and Gas and Wash Partners). Therefore, the potential for the GSR Project to cause water quality effects at these PCA sites is low, further supported by the underlying fine grained deposits including the Bay-Mud.

5.6.5. Nitrate

Occurrence of elevated nitrate levels in the Basin is localized and present in the Shallow Aquifer and the upper part of the Primary Production Zone. Elevated nitrate concentrations in the Primary Production Aquifer are limited in extent to isolated areas of groundwater beneath Daly City, such as the inactive Daly City A Street production well and the nearby GSR Project monitoring well MW-CUP-10A-500 (Figure 10.6-5).

The GSR Project monitoring well MW-CUP-23-230 located in South San Francisco has a reported nitrate concentration of 64.9 mg/l. Also in South San Francisco where Cal Water pumping occurs, the detected nitrate concentration was 47 mg/l in SS1-19, which is slightly above the primary MCL of 45 mg/l, and 35 mg/l in SS1-20 (Note that groundwater from these Cal Water wells is blended with SFPUC surface water prior to distribution and the resulting blend fully meets all drinking water standards).

In light of findings from the modeling analysis, as suggested by the model results presented in Section 4, the GSR Project operations could have an effect on the current elevated nitrate conditions reported at depths in the Basin, mainly as a result of the potential rise in water levels in the lower portions of the South Westside Basin and changes in flow directions. The potential rise in water levels in the lower portions of the Shallow Aquifer could mobilize nitrate in groundwater. Conversely, it is likely that an increase in groundwater volume could result in a decrease in overall nitrate concentrations in the Primary Production Aquifer as a function of dilution – see Section 6.1 for more discussion.

5.6.6. Cemeteries

The recent groundwater sampling conducted by the SFPUC from five monitoring wells located in the vicinity of the cemeteries demonstrated no groundwater contamination from cemeteries. The GSR Project is not anticipated to mobilize related constituents in groundwater because of the depth of pumping. Because of the very shallow sources, the rise in water levels in the lower portion of the Shallow Aquifer during GSR put periods is not likely to mobilize these shallow constituents in the soil; moreover, groundwater quality effects from cemeteries are controlled by land use activities unrelated to the GRS Project operations.

6. Summary

This section summarizes the findings from the numerical groundwater model and empirical analyses.

6.1. Scenario 2 - GSR Project

The MODFLOW model results indicate that most of the changes relevant to the GSR Project are in the South Westside Basin. Changes in groundwater levels are most notable in the vicinity of the GSR Project wells (Figures 10.6-9 and 10.6-11), including the wells operated by the SFPUC and the PAs. This is because of in-lieu recharge during put periods and extraction of groundwater during take periods. More specifically for the GSR Project, the issues evaluated in this TM focused on the potential mobilization of contaminants in groundwater as a result of pumping or increase in groundwater levels and storage in the South Westside Basin. These higher water levels could occur under the Full SFPUC Storage Account of 60,500 af. This value represents an additional 40,500 af above the initial (June 2009) condition of 20,000 af.

The model results show that water levels are generally higher at the Full SFPUC Storage Account than at other times during the 47.25 years of simulation. In other words, at the basin-scale, the Full SFPUC Storage Account would be the most conservative with respect to higher groundwater levels that may occur due to the GSR Project operation. The modeling analysis further demonstrates that the GSR Project would generally produce higher groundwater levels in the South Westside Basin relative to Scenario 1 during the majority of the 47.25 year simulation period. Simulated water levels for the GSR Project tend to rise during the long put periods and decline during the long take periods (e.g., during the Design Drought) compared to Scenario 1. As shown by the model estimates, the water levels during the hold periods tend to follow the trends seen in Scenario 1. This occurs because during the hold periods both Scenarios 1 and 2 have similar pumping for the PA municipal wells (6.84 million gallons per day (mgd) under Scenario 1 and 6.9 mgd under Scenario 2). Trends vary by locations and show negligible to moderate declining water levels in response to the continued PA pumping during the hold periods.

However, the simulated depth to water (represented by water levels in Model Layer 1) in Scenario 2 during the Full SFPUC Storage Account condition shows deep water levels in most portions of the Basin. This suggests that the response of Model Layer 1 to changes in pumping conditions in deeper layers (e.g., Model Layer 4) is small, especially relative to the substantial depth to water in the Shallow Aquifer in the center of the Basin (Figures 10.6-7, 10.6-8, and 10.6-10). Therefore, rising water levels in Model Layer 1 during the GSR Project operations are expected to stay between 200 feet to 300 feet deep and are not anticipated to rise near the 70-foot threshold depth that is the indicator for risk of remobilization of existing contamination in the soil and/or shallow groundwater systems.

Based on the location and status of regulated existing cleanup sites in the GSR Project area, it is anticipated that the reported sites with contaminated soil and/or shallow unconfined/perched water bearing zones within the anticipated area of influence of the GSR Project would not be affected by the GSR Project pumping operations. Furthermore, the GSR Project is not expected to have an effect on existing groundwater remediation projects. This conclusion is based on the shallow nature of these reported cleanup sites and the aggregate thicknesses of intervening clay and sand layers between the shallow aquifer and deep pumping aquifer, from which the GSR Project would pump.

In light of the findings from the modeling analysis, as suggested by the model results presented in Section 4, the GSR Project operations could have an effect on the current isolated nitrate conditions reported at depths in the Basin, mainly as a result of the potential rise in water table in the lower portions of the Shallow Aquifer and changes in flow directions. It is likely that an increase in groundwater volume could result in the decrease in overall isolated nitrate concentrations in the Primary Production Aquifer as a function of dilution. While the occurrence and extent of nitrate in groundwater are mainly due to historical land use and natural recharge processes that are not related to the GSR Project operations, the effect of the GSR Project on nitrate distribution (lateral or vertical extents by spreading of nitrate in groundwater) is uncertain and the location of reported nitrate detections may change as more extraction wells come online. Therefore, the GSR Project effect on pre-Project nitrate conditions will require continued water quality monitoring to assess changes in nitrate distribution and concentration trends when the GSR Project production wells are commissioned.

With respect to water quality concerns near the cemeteries, the recent groundwater sampling conducted by the SFPUC from five monitoring wells located in the vicinity of the cemeteries demonstrates no existing groundwater contamination from cemeteries.

6.2. Scenario 4 - Cumulative Scenario

The Cumulative Scenario assumes the combined operations of the GSR Project and SFGW Project and other future projects that can operate concurrently. The MODFLOW simulation results under Scenario 4 show that groundwater levels in the South Westside Basin are similar to Scenario 2. Because the SFGW Project is focused in the North Westside Basin, the overall effect of the SFGW Project on the South Westside Basin is minimal. Model-simulated groundwater levels for the combined GSR and SFGW Projects south of Lake Merced and near Daly City primarily show the effects of the GSR Project, but show slightly lower water levels than the GSR Project due to the combined pumping effects of the two projects. This difference is attributed to the SFGW Project extracting and intercepting groundwater that would otherwise flow from the North Westside Basin south into the Daly City area. Groundwater levels from the Cumulative Scenario mimic the trends seen in the GSR Project in the remainder of the South Westside Basin. Near South San Francisco and San Bruno, the effects of the SFGW Project are minimal; the groundwater levels reflect conditions similar to the GSR Project Scenario.

Overall, with respect to changes in groundwater levels, depths to water, and groundwater storage, the effects of the Cumulative Scenario on the South Westside Basin are similar to Scenario 2. Therefore, the general findings discussed above for the GSR Project Scenario are essentially the same for the Cumulative Scenario.

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Figure List

Table List

Attachment List

Figures

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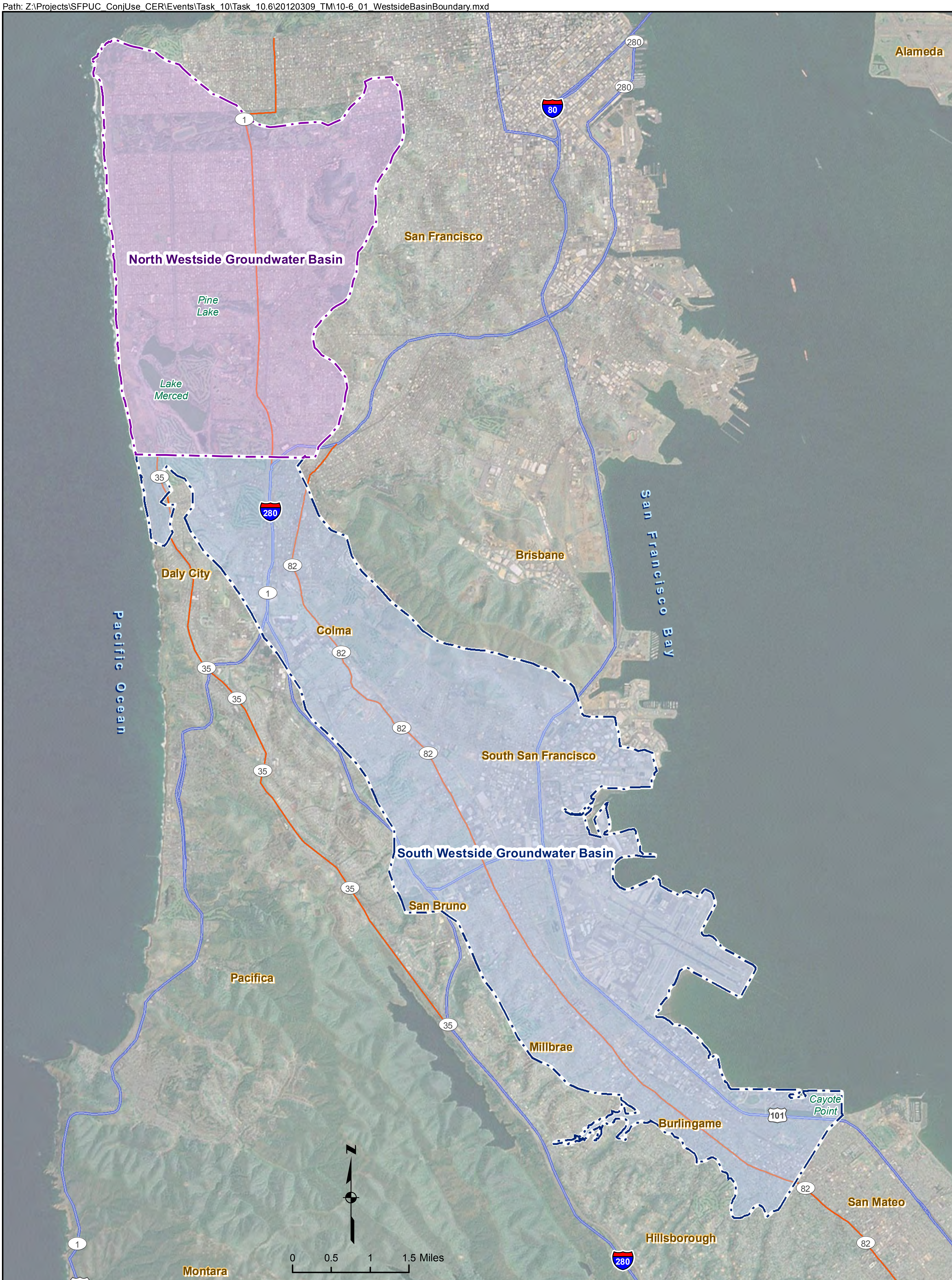

Aerial Photo Source: World Imagery from ESRI. Copyright:© 2009 ESRI, AND, TANA, UNEP-WCMC

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WESTSIDE GROUNDWATER BASIN BOUNDARY NORTH AND SOUTH WESTSIDE BASINS

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Regional Groundwater Storage and Recovery Project

Figure 10.6-1

Date April 2012

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Aerial Photo Source: World Imagery from ESRI. Copyright:© 2009 ESRI, AND, TANA, UNEP-WCMC

Legend

- GSR Project Proposed Municipal Wells
- Cal Water Municipal Wells
- Daly City Municipal Wells
- San Bruno Municipal Wells
- Selected Monitoring Wells with Model Results
- South Westside Groundwater Basin
- North Westside Groundwater Basin

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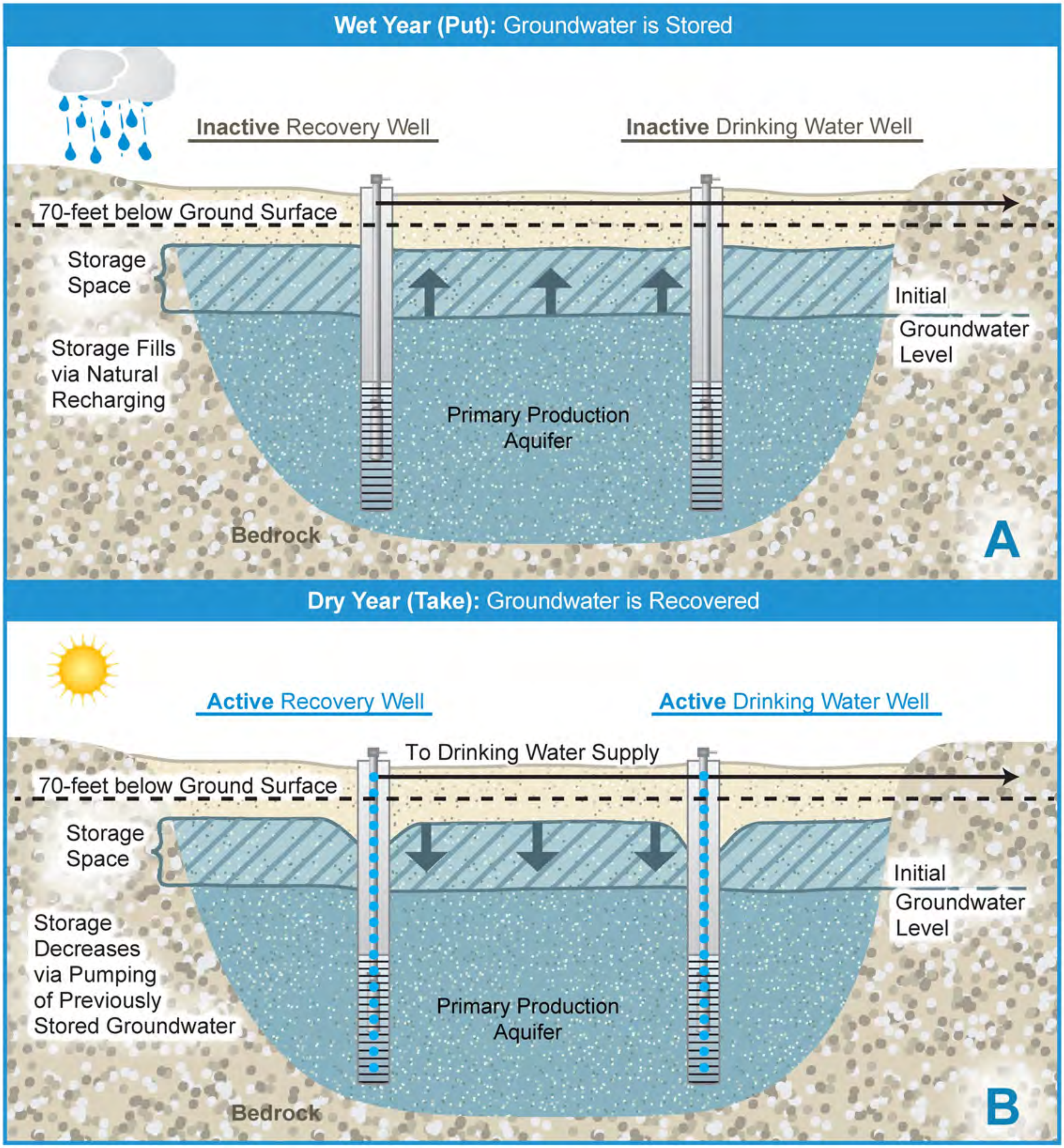
LOCATIONS OF PARTNER AGENCY WELLS, PROPOSED GSR PROJECT WELLS, AND SELECTED REPRESENTATIVE MONITORING WELLS

Kennedy/Jenks Consultants 303 Second Street, Suite 300 South San Francisco, CA 94107	Figure **10.6-2**
Regional Groundwater Storage and Recovery Project	Date April 2012



Note:

In illustration (A), the upward arrows represent the filling of the storage space with groundwater during wet years; while in illustration (B) the downward arrows represent the decline in stored water during dry years.

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Regional Groundwater Storage and Recovery Project

San Francisco Public Utilities Commission
Engineering Management Bureau

Conceptualization of Changing Water Levels GSR Project Operations

K/J 0864001
April 2012
Figure 10.6-3

Source:
Hetch Hetchy Regional Water System - Services of the San Francisco Public Utilities Commission
Regional Groundwater Storage and Recovery Project
Water System Improvement Program, Winter 2012

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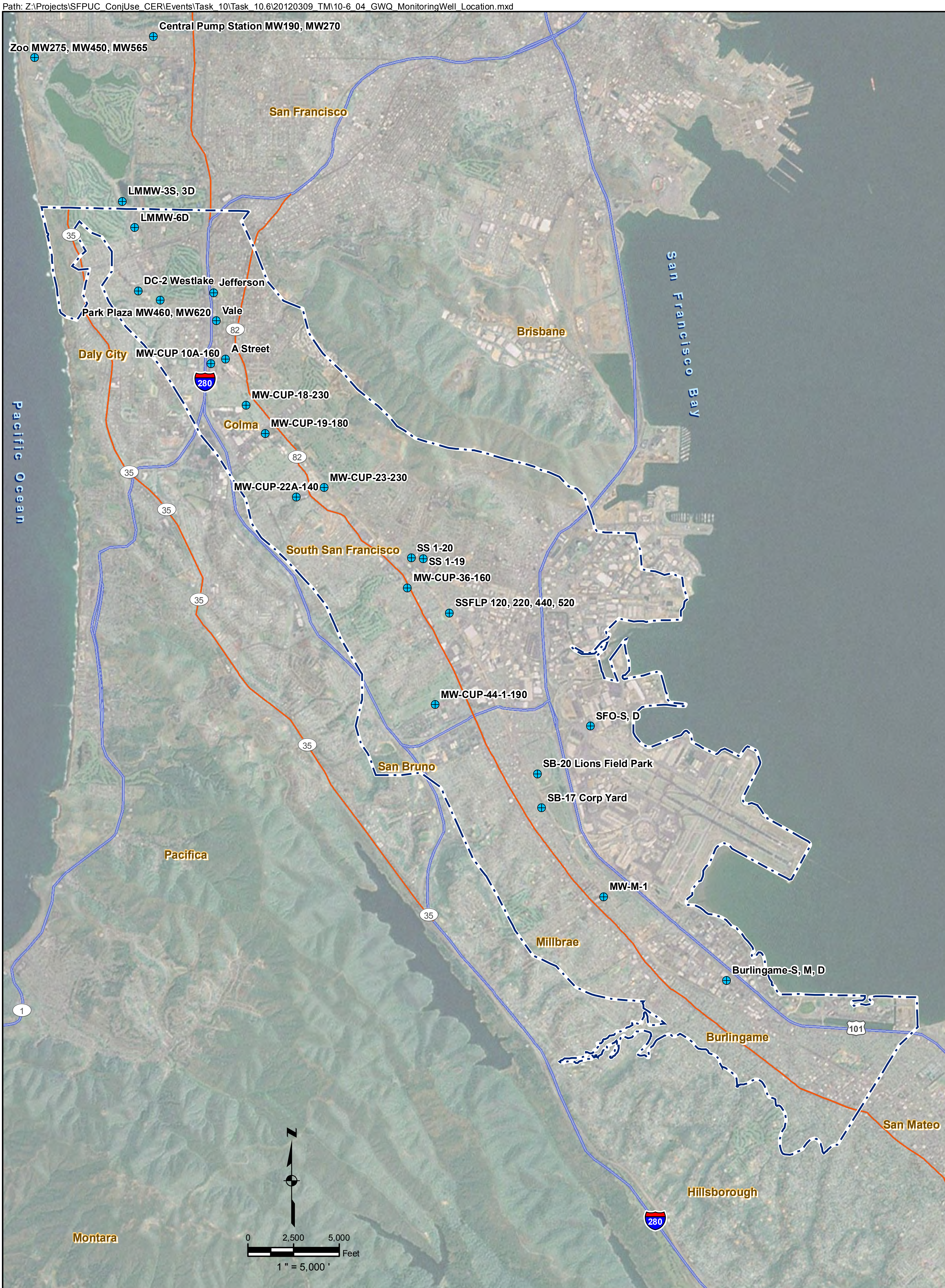

Legend

Ground Water Quality Monitoring Well

South Westside Groundwater Basin

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GROUNDWATER QUALITY MONITORING WELL NETWORK

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Regional Groundwater Storage and Recovery Project

Figure **10.6-4**

Date April 2012

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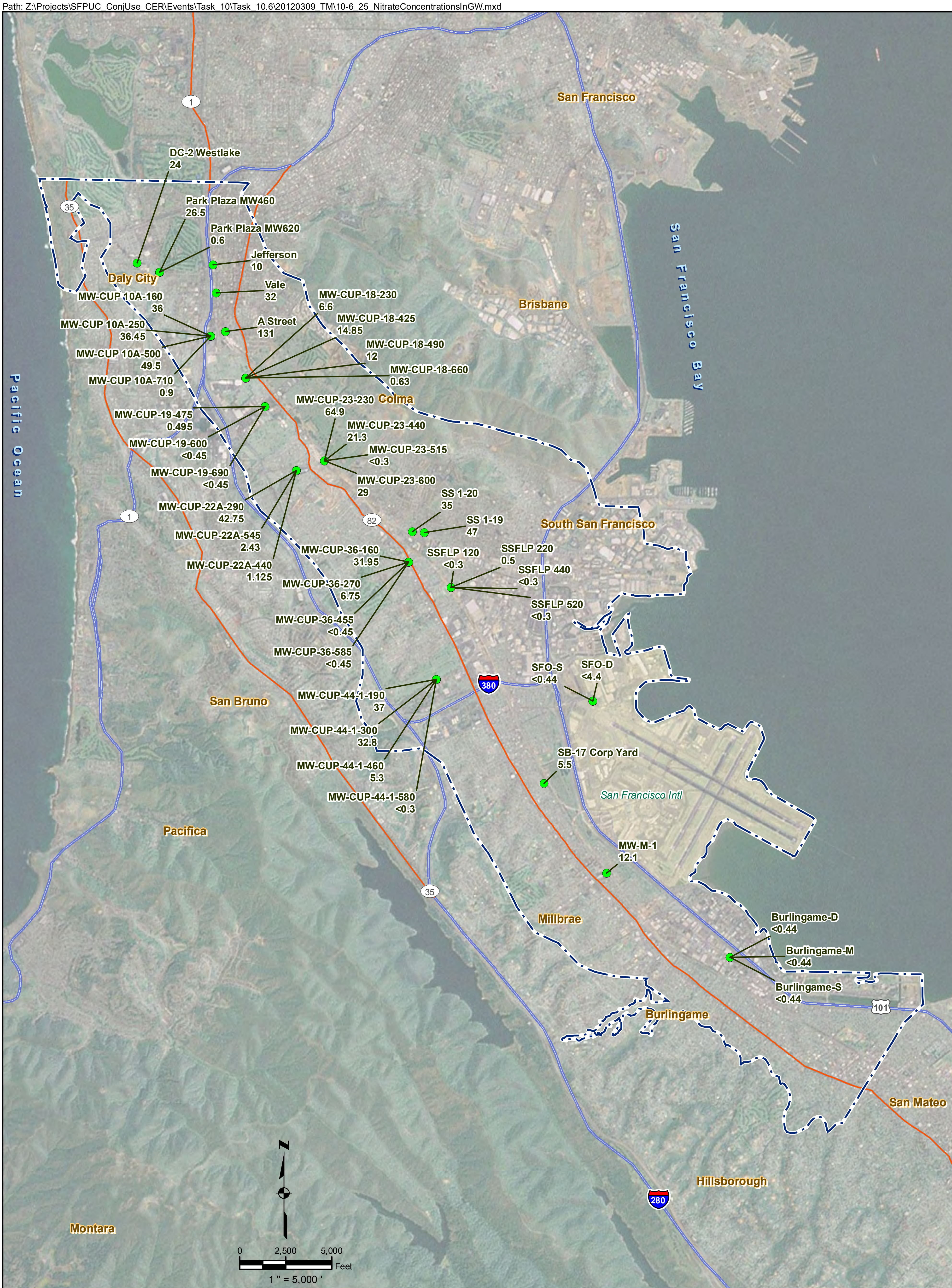

Legend

DC-2 Westlake = Monitoring Well Name
24: = Nitrate as NO3 (mg/l)

South Westside Groundwater Basin

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Nitrate Concentrations in Groundwater (as NO3, mg/l)

April 2008 and September 2009

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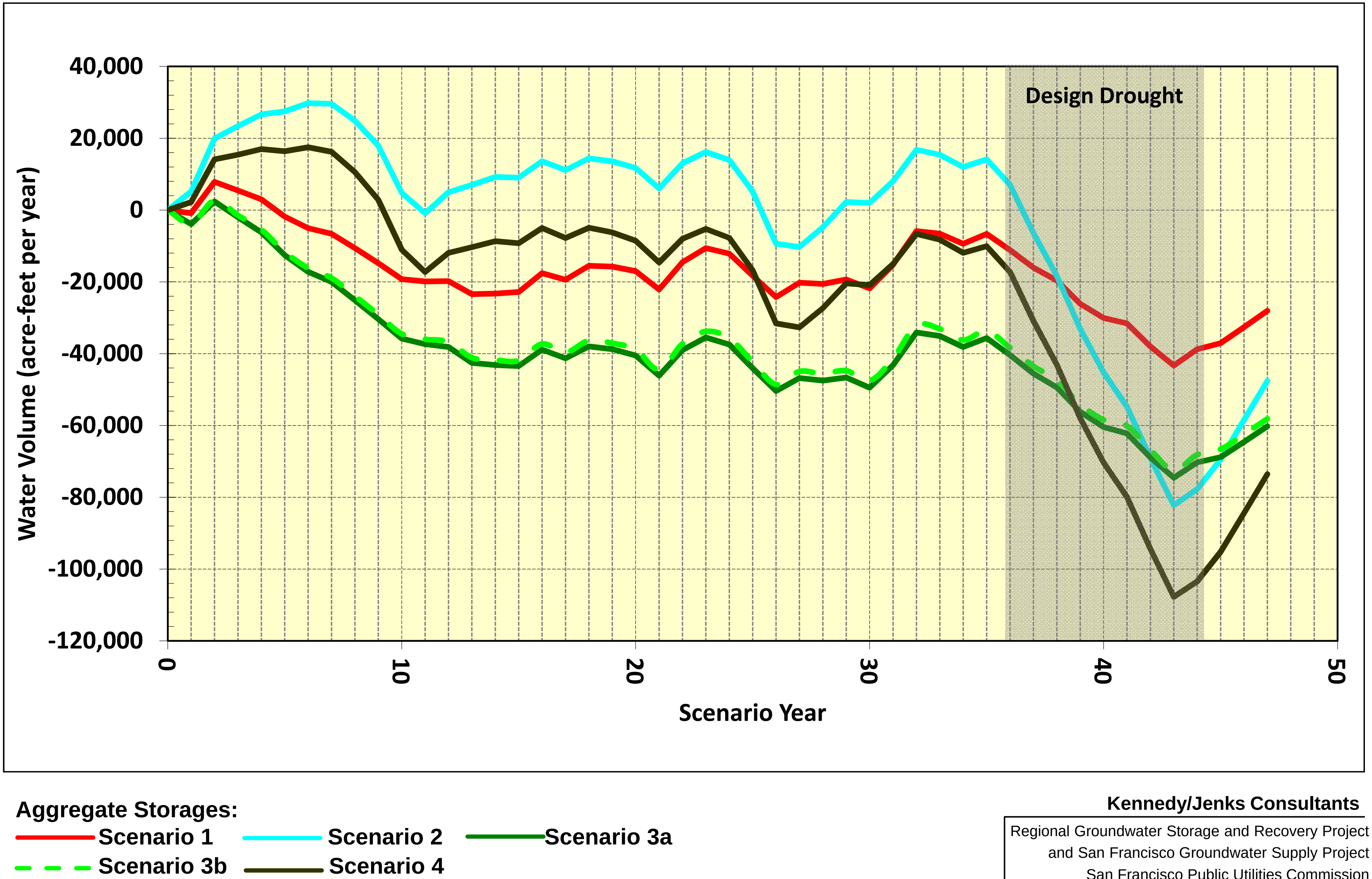
Figure **10.6-5**

Regional Groundwater Storage and Recovery Project

Date April 2012



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Regional Groundwater Storage and Recovery Project
and San Francisco Groundwater Supply Project
San Francisco Public Utilities Commission

Groundwater Model-Simulated Aggregate Change in Groundwater Storage

K/J 0864001
April 2012

Figure 10.6-6

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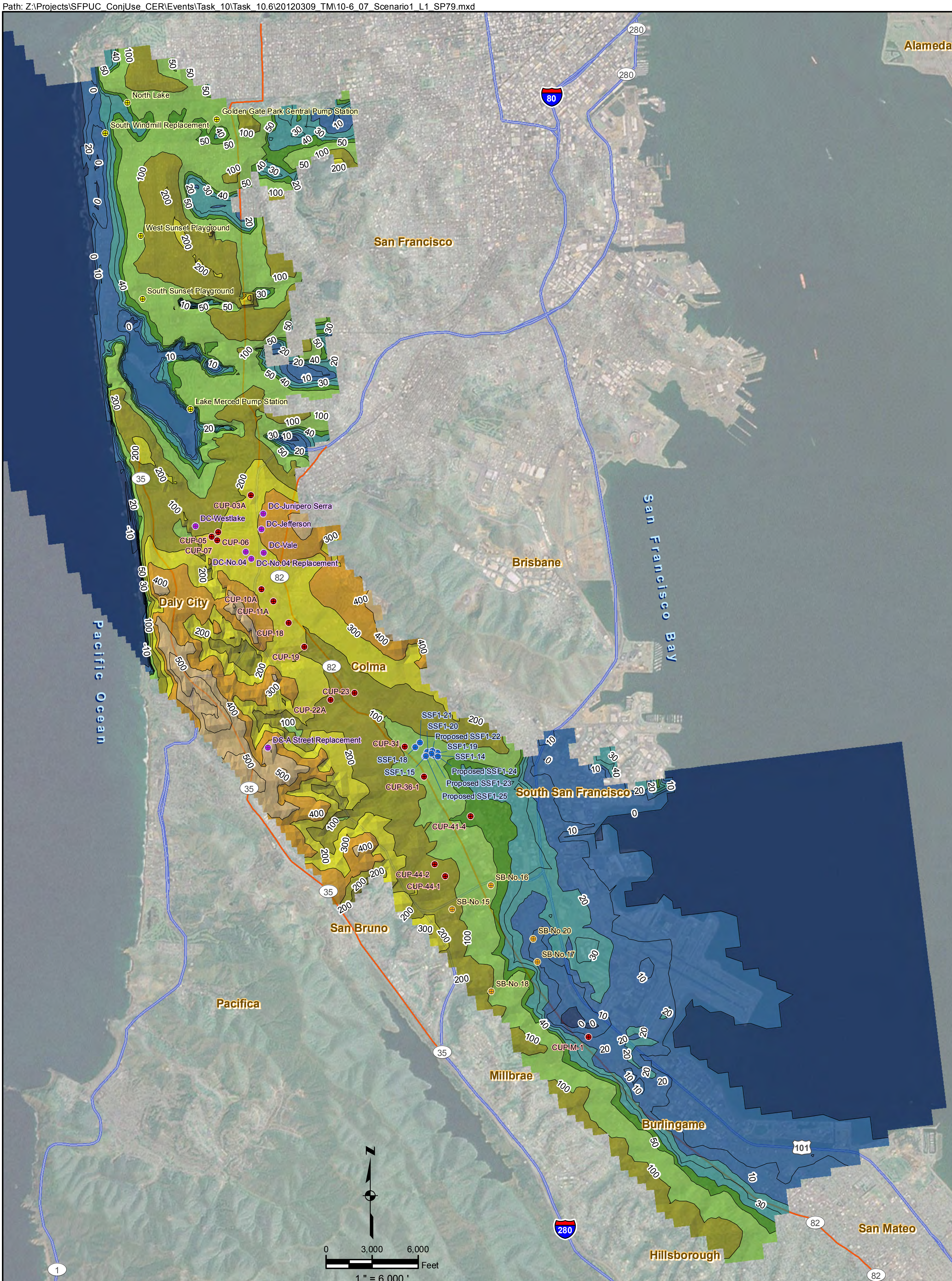

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Depth To Water (feet)

Model Simulated Depth To Water (feet)

- 400 - 594
- 300 - 400
- 200 - 300
- 100 - 200
- 50 - 100
- 40 - 50
- 20 - 40
- 0 - 20
- -22 - 0

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SCENARIO 1, LAYER 1
Model Simulated Depth to Water Contour Map

(Model Scenario Year 7)

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Figure **10.6-7**

Regional Groundwater Storage and Recovery Project

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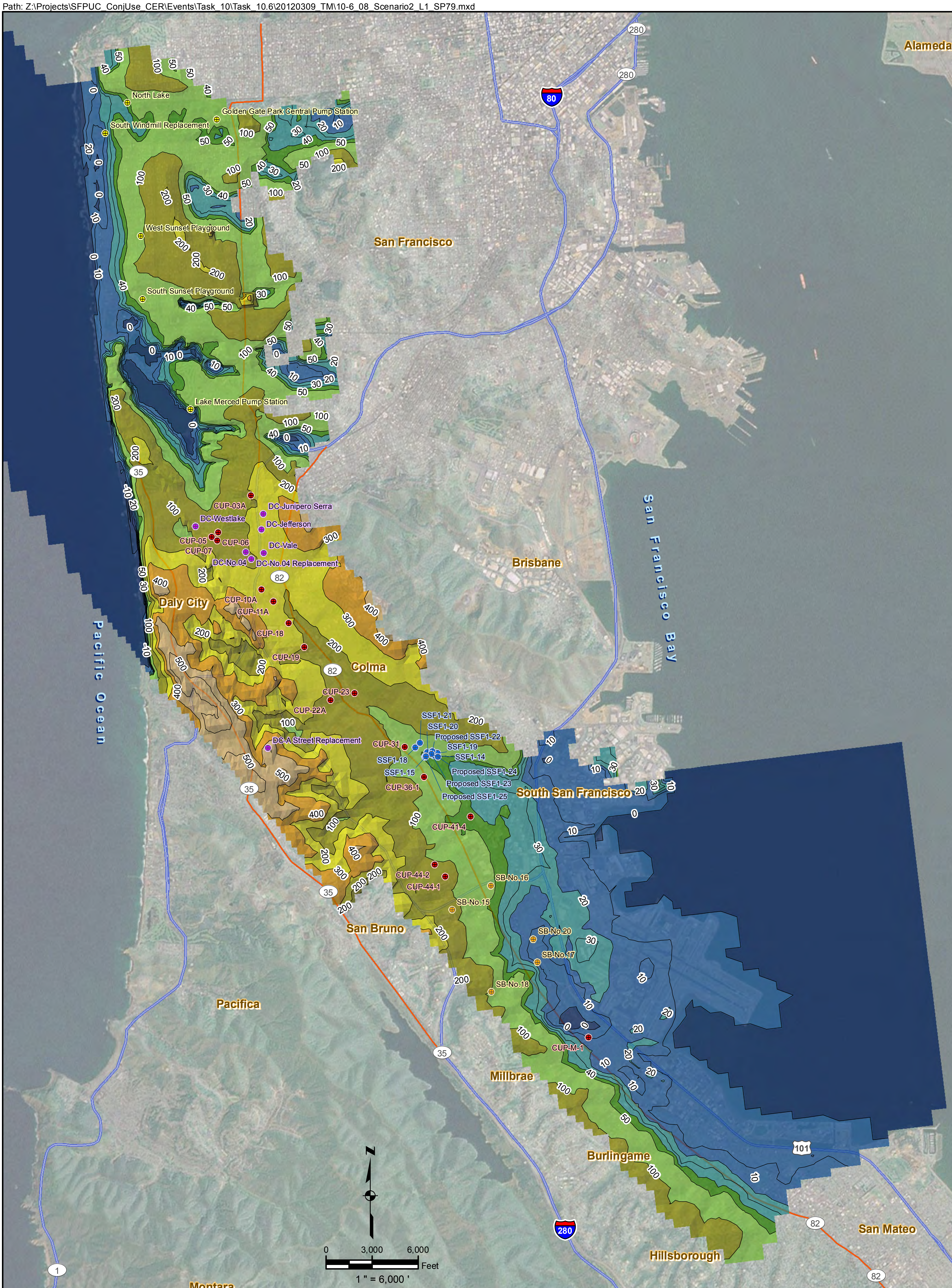

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Depth To Water (feet)

Model Simulated Depth To Water (feet)

- 400 - 651
- 300 - 400
- 200 - 300
- 100 - 200
- 50 - 100
- 40 - 50
- 20 - 40
- 0 - 20
- -22 - 0

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SCENARIO 2, LAYER 1
Model Simulated Depth to Water Contour Map
Full SFPUC Storage Account

(Model Scenario Year 7)

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Figure **10.6-8**

Regional Groundwater Storage and Recovery Project

Date April 2012

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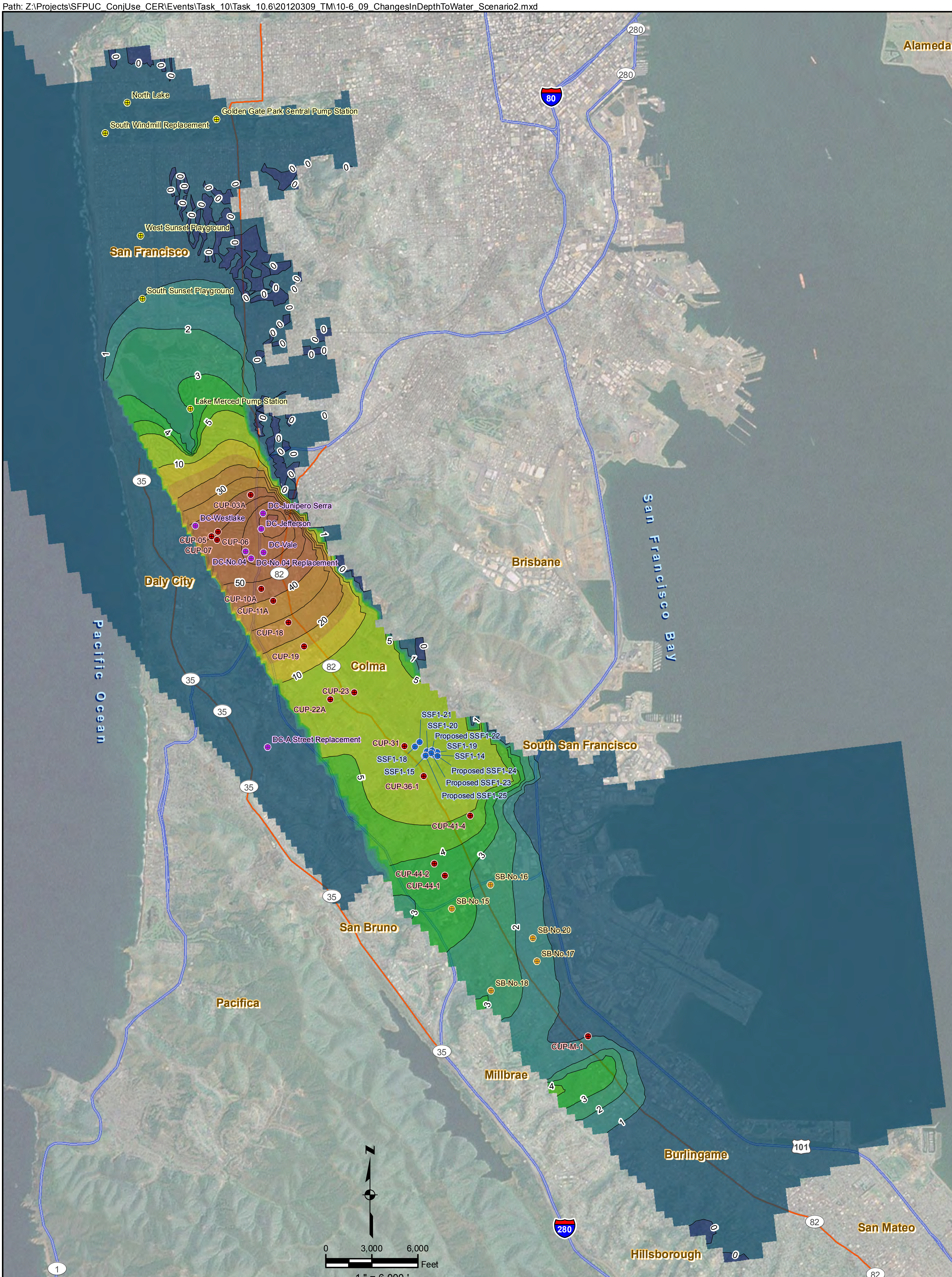

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Changes in Depth to Water (feet)

Model Simulated Depth To Water (Feet)

- 0 - -0.5
- 1 - 0
- 2 - 1
- 3 - 2
- 4 - 3
- 5 - 4
- 10 - 5
- 15 - 10
- 20 - 15
- 40 - 20
- 80 - 40
- 84 - 80

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SCENARIO 2, LAYER 1
Model Simulated Changes in Depth to Water Relative to Scenario 1 Full SFPUC Storage Account

(Model Scenario Year 7)

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Regional Groundwater Storage and Recovery Project

Figure **10.6-9**

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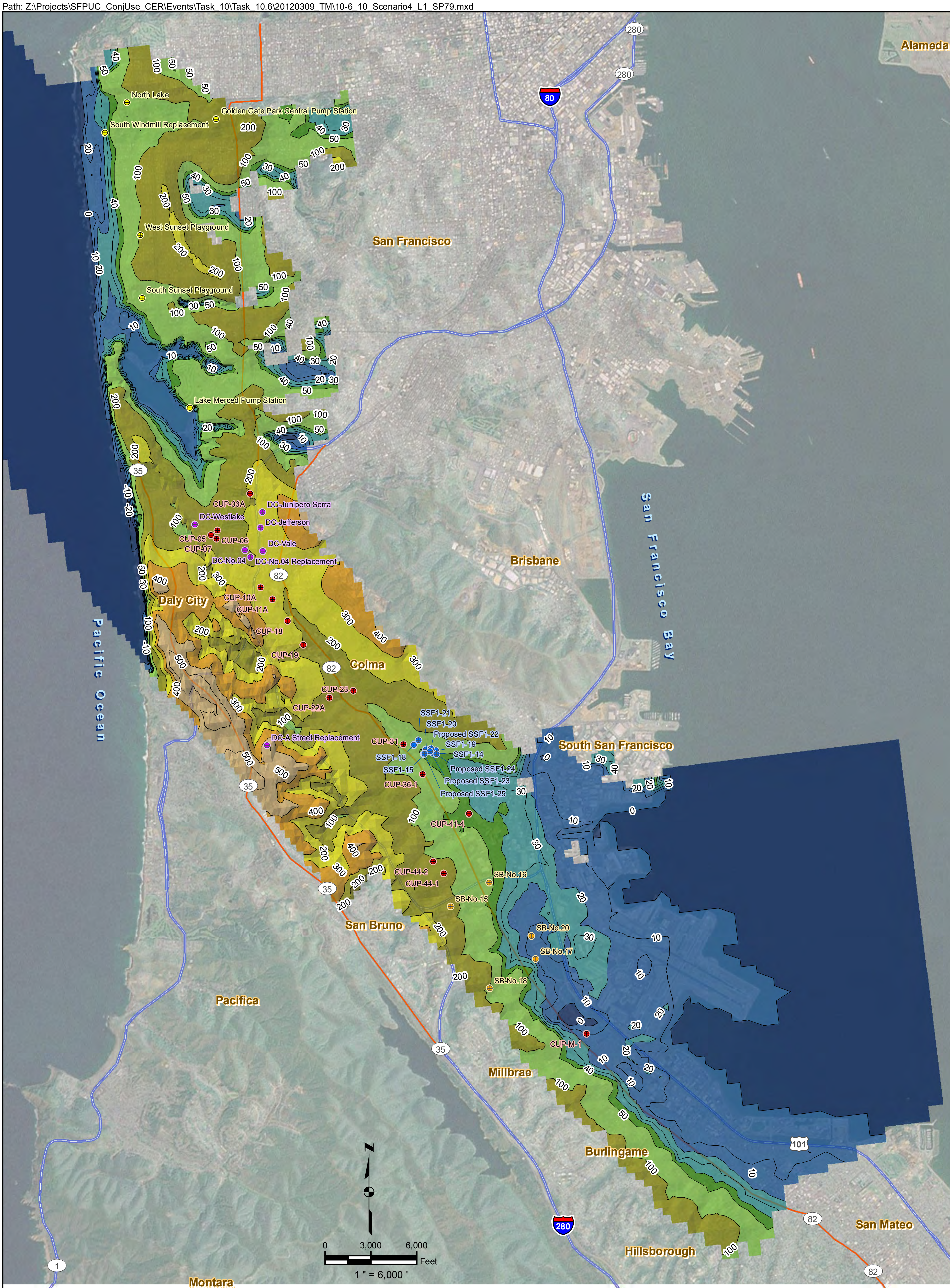

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Depth To Water (feet)

Model Simulated Depth To Water (feet)

- 400 - 594
- 300 - 400
- 200 - 300
- 100 - 200
- 50 - 100
- 40 - 50
- 20 - 40
- 0 - 20
- -22 - 0

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SCENARIO 4, LAYER 1
Model Simulated Depth
to Water Contour Map
Full SFPUC Storage Account

(Model Scenario Year 7)

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Regional Groundwater Storage and Recovery Project

Figure **10.6-10**

Date April 2012

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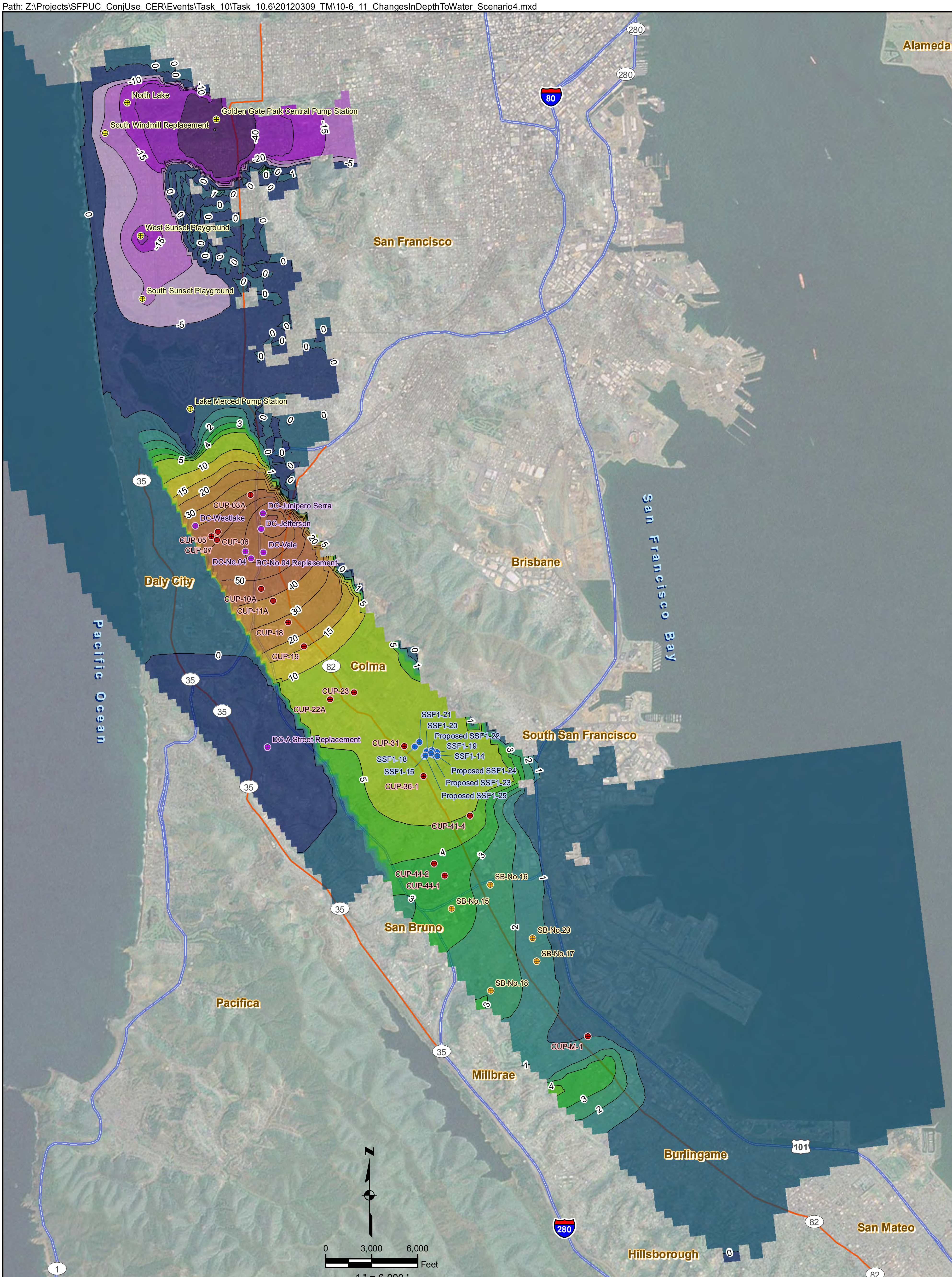

Legend

Symbol	Description
●	GSR Project Proposed Municipal Wells
⊕	SFGW Project Proposed Municipal Wells
⊕	San Bruno Municipal Wells
●	Daly City Municipal Wells
●	Cal Water Municipal Wells
～	Changes in Depth to Water (feet)

Model Simulated Depth To Water (Feet)

-40 - -80	-5 - -10	4 - 3	40 - 20
-20 - -40	0 - -5	5 - 4	80 - 40
-15 - -20	1 - 0	10 - 5	84 - 80
-10 - -15	2 - 1	15 - 10	
	3 - 2	20 - 15	

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SCENARIO 4, LAYER 1
Model Simulated Changes in Depth to Water Relative to Scenario 1 Full SFPUC Storage Account

(Model Scenario Year 7)

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Regional Groundwater Storage and Recovery Project

Figure **10.6-11**

Date April 2012

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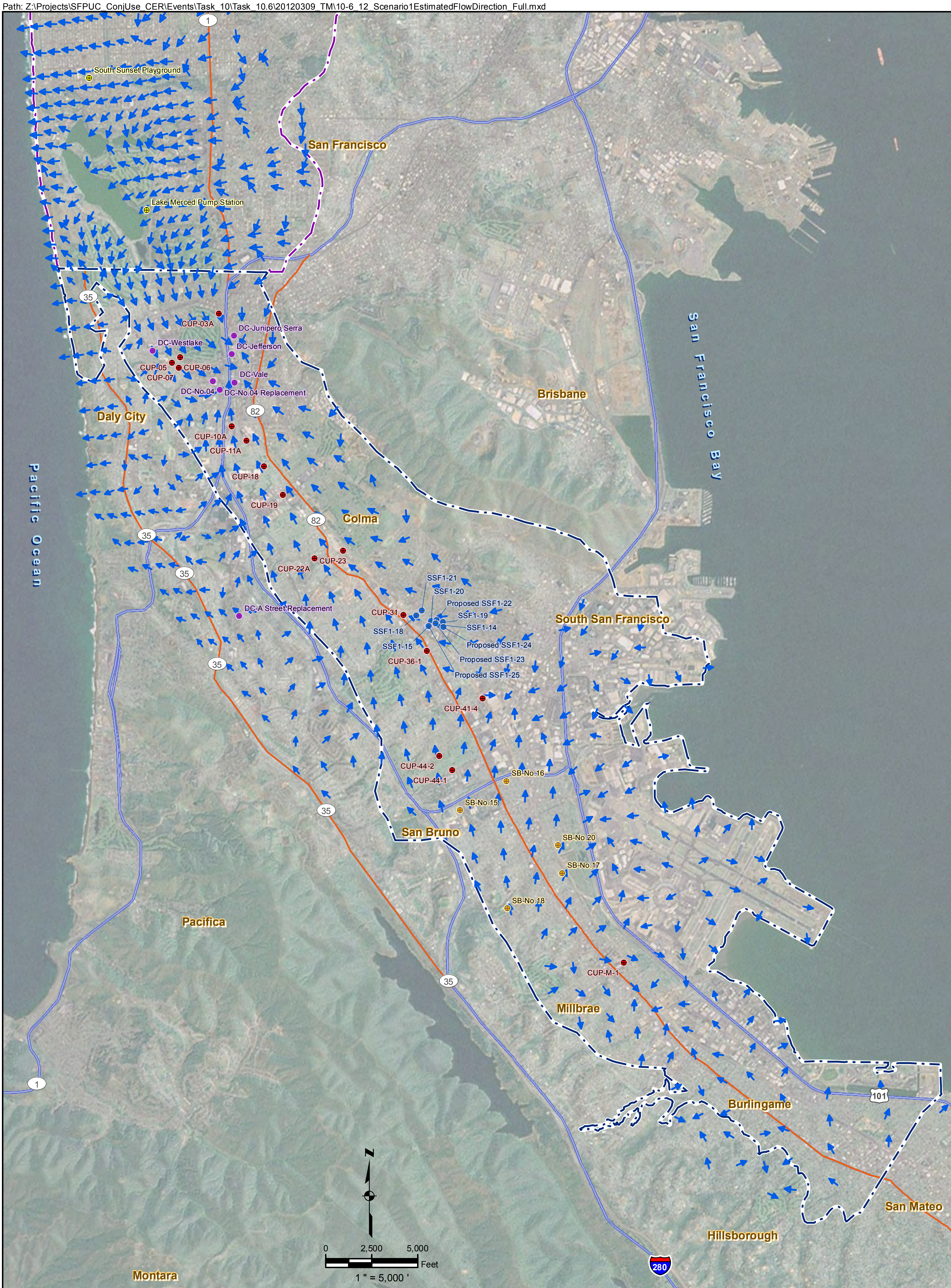

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Model Estimated Flow Direction
- South Westside Groundwater Basin
- North Westside Groundwater Basin

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SCENARIO 1, LAYER 1
Model Estimated Flow Directions
Full SFPUC Storage Account

(Model Scenario Year 7)

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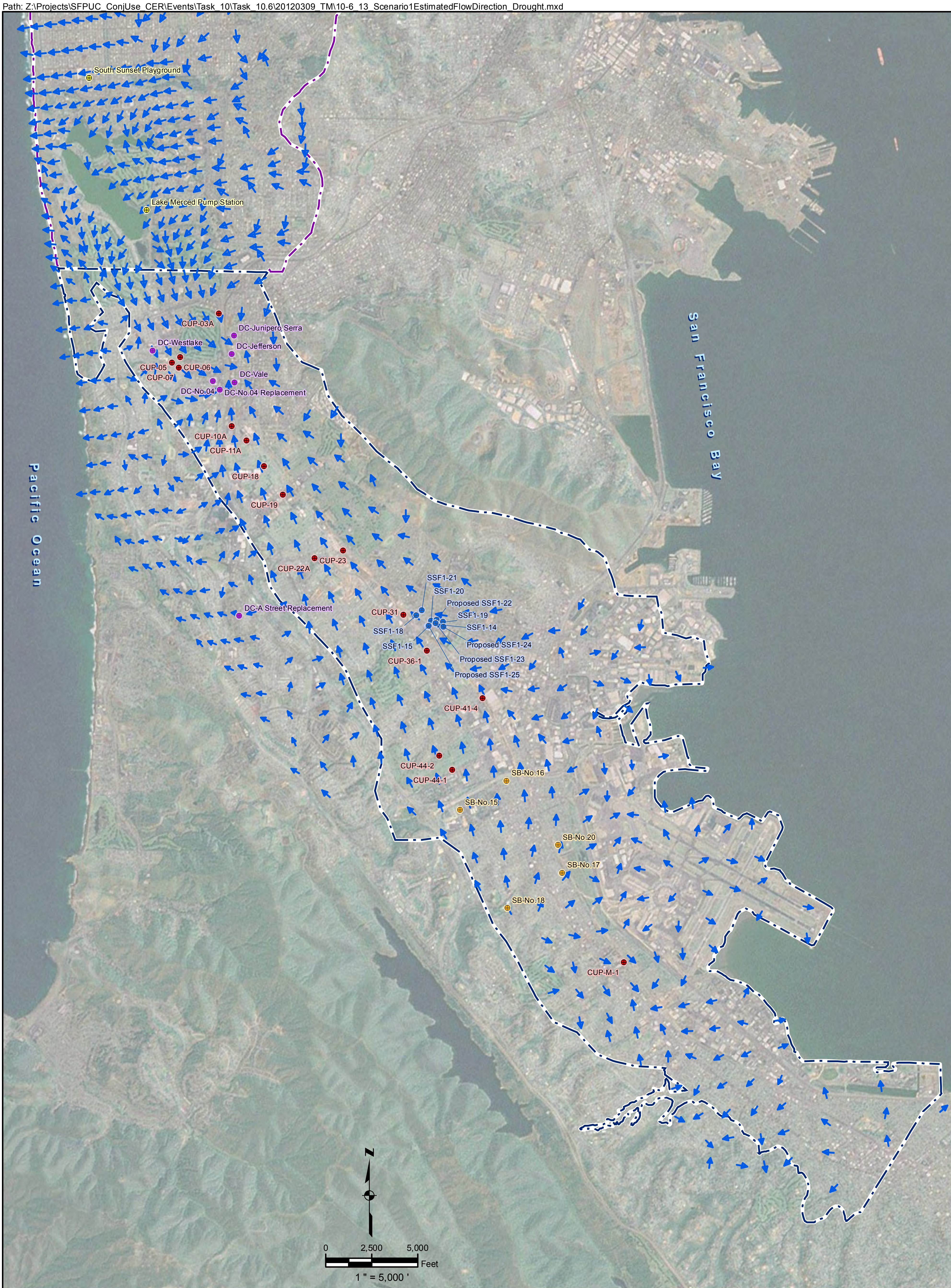
Figure
10.6-12

Regional Groundwater Storage
and Recovery Project

Date
April 2012

Path: Z:\Projects\SFPUC_ConjUse_CER\Events\Task_10\Task_10.6\20120309_TM\10-6_13_Scenario1EstimatedFlowDirection_Drought.mxd



Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Model Estimated Flow Direction
- South Westside Groundwater Basin
- North Westside Groundwater Basin

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SCENARIO 1, LAYER 1
Model Estimated Flow Directions
End of Design Drought

(Model Scenario Year 44)

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Regional Groundwater Storage and Recovery Project

Figure **10.6-13**

Date April 2012

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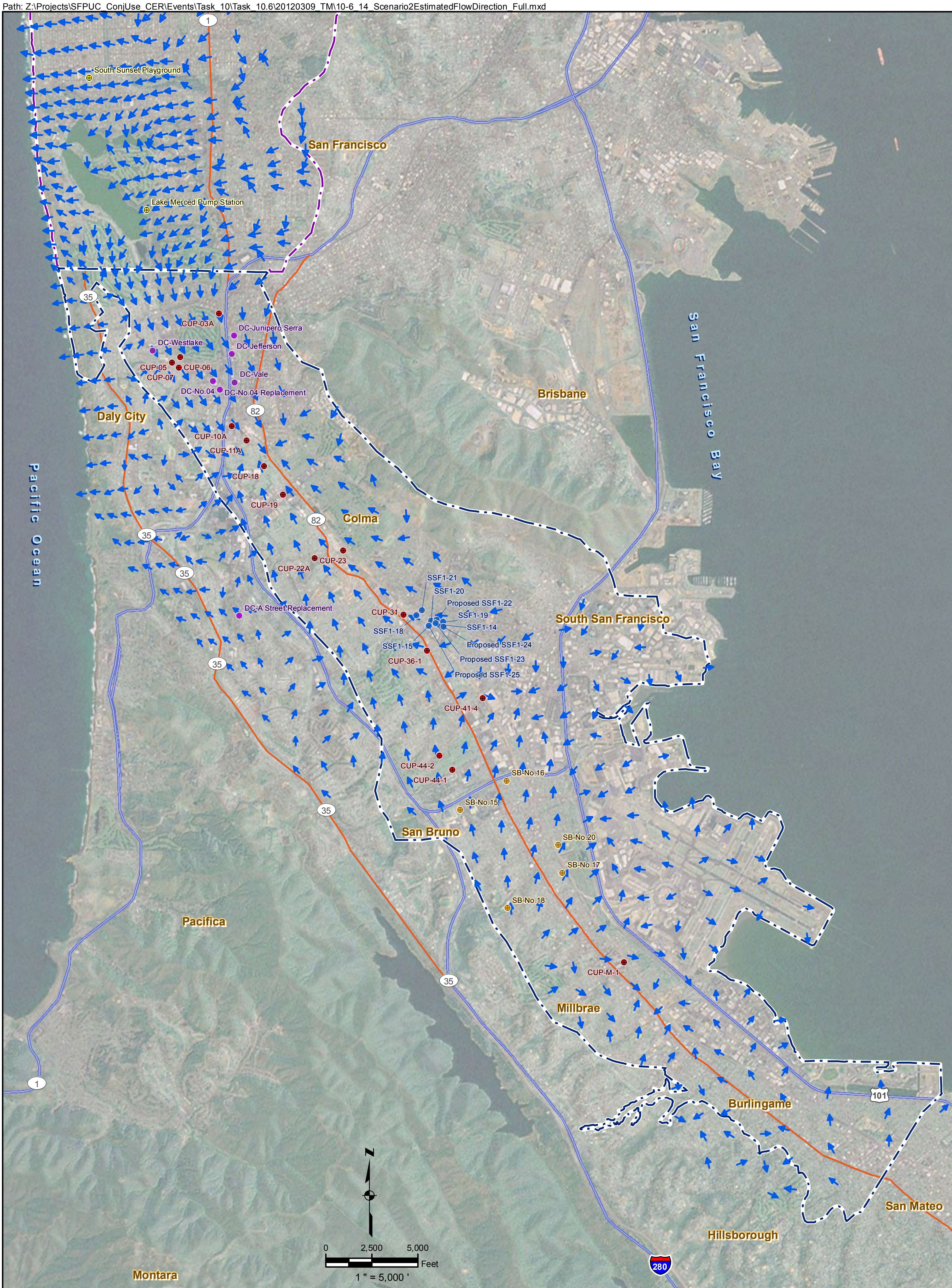

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Model Estimated Flow Direction
- South Westside Groundwater Basin
- North Westside Groundwater Basin

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SCENARIO 2, LAYER 1
Model Estimated Flow Directions
Full SFPUC Storage Account

(Model Scenario Year 7)

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Figure
10.6-14

Regional Groundwater Storage and Recovery Project

Date
April 2012

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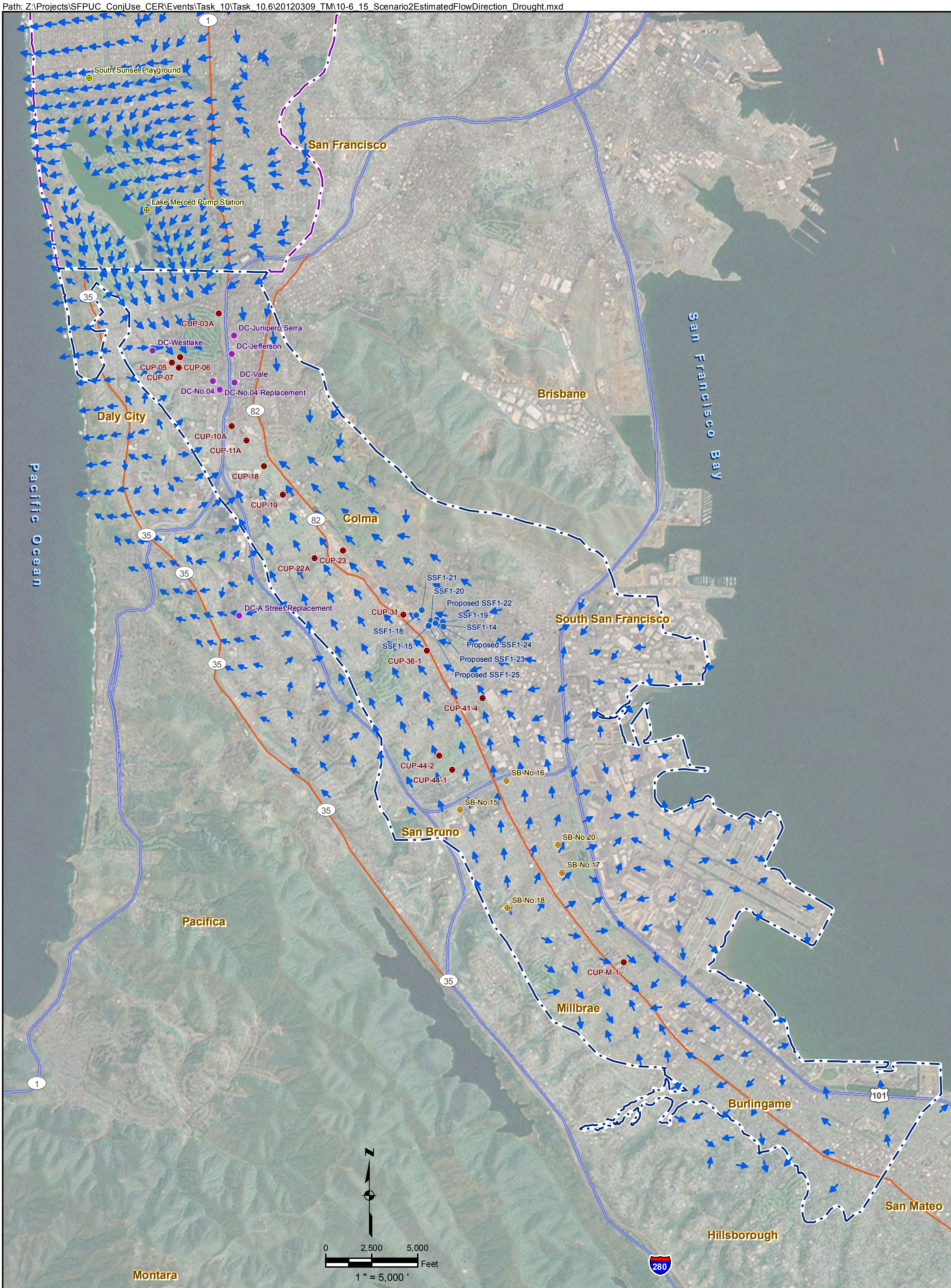

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Model Estimated Flow Direction
- South Westside Groundwater Basin
- North Westside Groundwater Basin

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SCENARIO 2, LAYER 1
Model Estimated Flow Directions
End of Design Drought

(Model Scenario Year 44)

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Figure
10.6-15

Regional Groundwater Storage and Recovery Project

Date
April 2012

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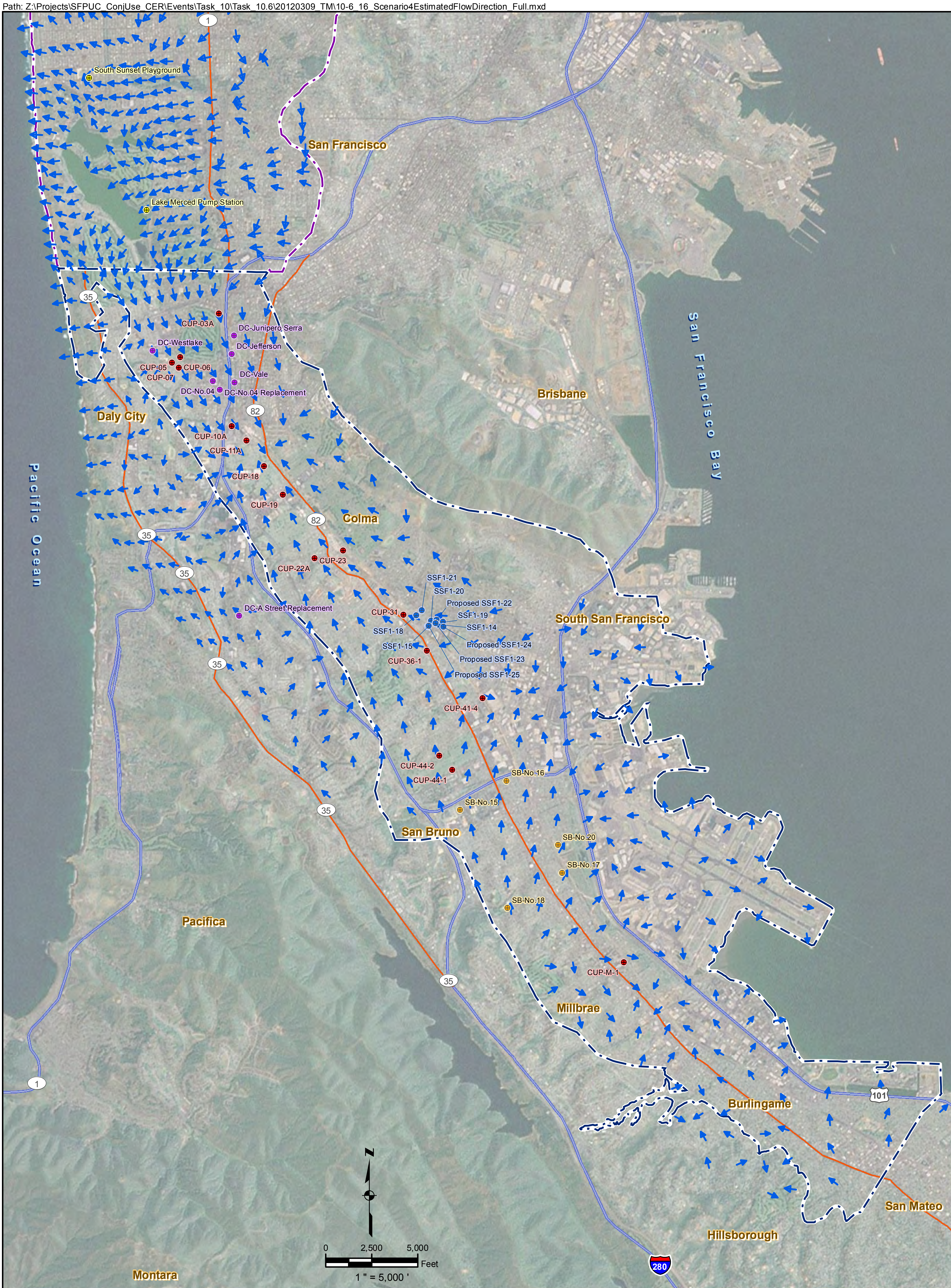

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Model Estimated Flow Direction
- South Westside Groundwater Basin
- North Westside Groundwater Basin

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SCENARIO 4, LAYER 1
Model Estimated Flow Directions
Full SFPUC Storage Account

(Model Scenario Year 7)

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Figure
10.6-16

Regional Groundwater Storage and Recovery Project

Date
April 2012

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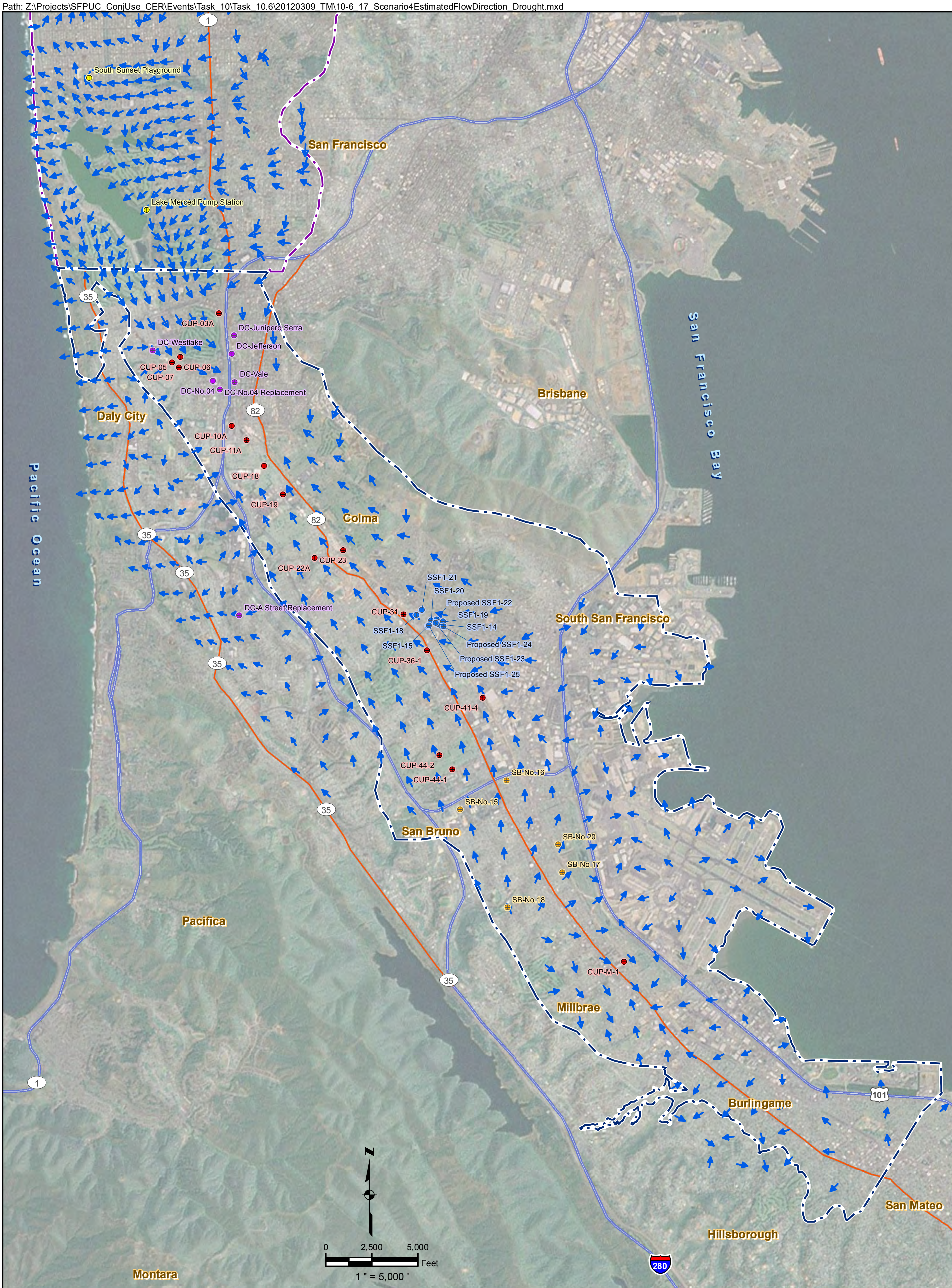

Legend

- GSR Project Proposed Municipal Wells
- SFGW Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Model Estimated Flow Direction
- South Westside Groundwater Basin
- North Westside Groundwater Basin

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SCENARIO 4, LAYER 1
Model Estimated Flow Directions
End of Design Drought

(Model Scenario Year 44)

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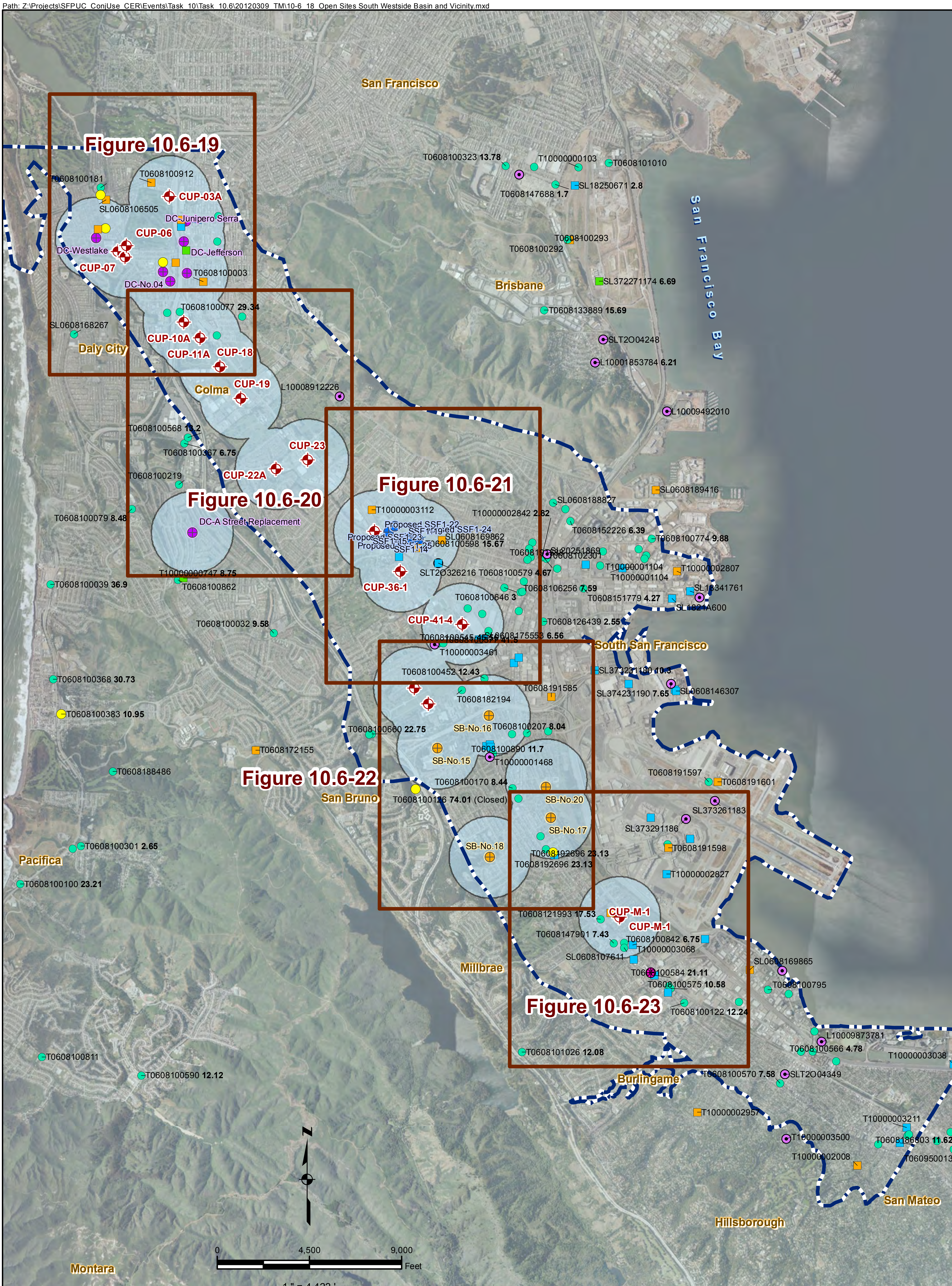
Figure
10.6-17

Regional Groundwater Storage and Recovery Project

Date
April 2012

Path: Z:\Projects\SFPUC_ConjUse_CER\Events\Task_10\Task_10.6\20120309_TM\10-6_18_Open Sites South Westside Basin and Vicinity.mxd



Legend

Potential Media Affected Near Project Area

- Other Groundwater (uses other than drinking water)
- Soil
- Soil/Other Groundwater (uses other than drinking water)
- Soil/Other Groundwater (uses other than drinking water)/Aquifer or Well used for drinking water supply
- Soil/Aquifer used for drinking water supply
- Well used for drinking water supply
- Aquifer used for drinking water supply
- Under Investigation
- Unknown

T0608194016 | 21.8
Global ID — Depth to Water (feet)

- GSR Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- South Westside Groundwater Basin
- 2000 feet Radius Buffer

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"OPEN" REGULATED SITES IN THE SOUTH WESTSIDE BASIN AND VICINITY WITH RECORDED DEPTHS TO WATER (See Also Plate B-1)

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Regional Groundwater Storage and Recovery Project

Figure **10.6-18**

Date April 2012

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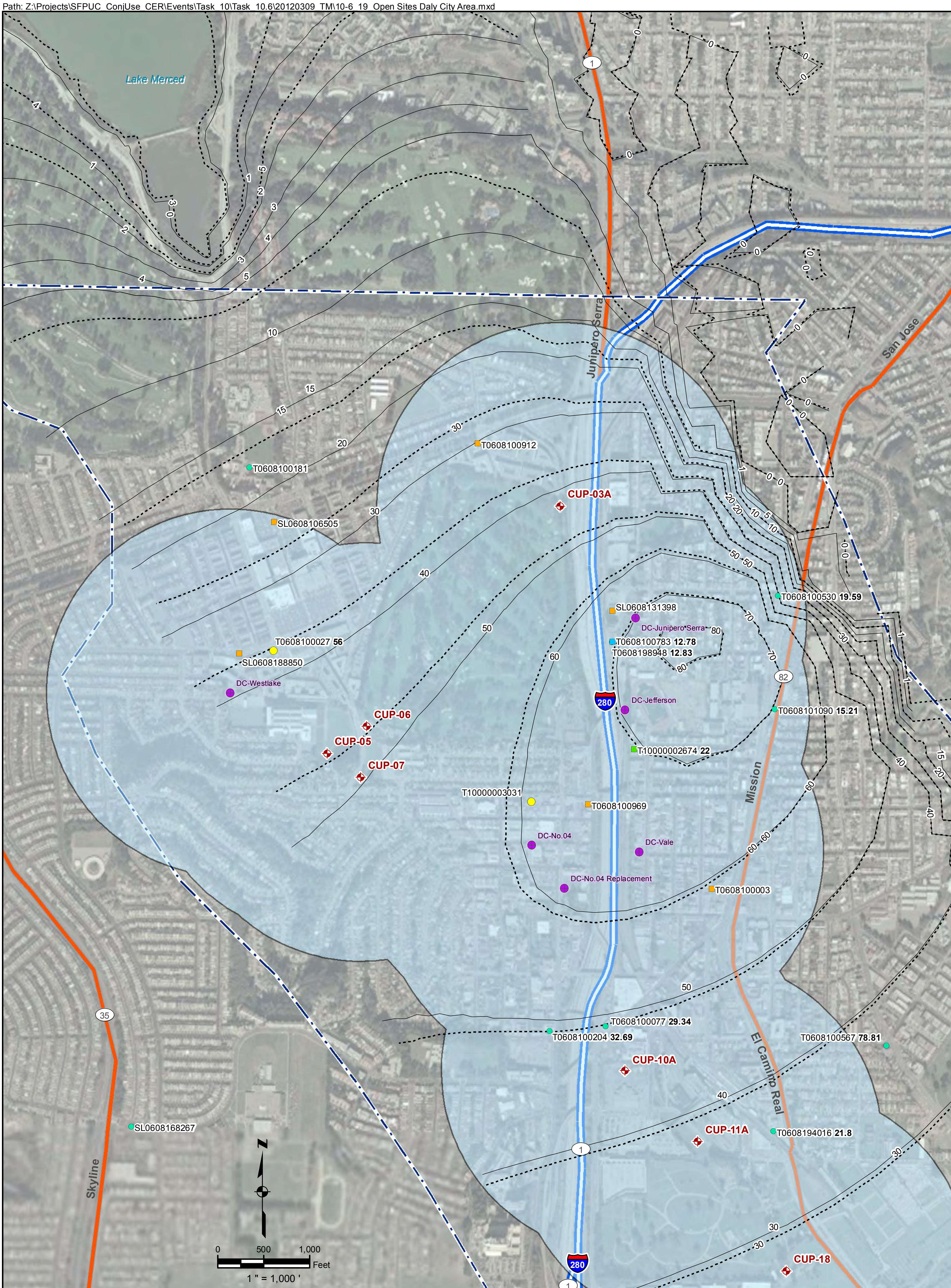

Legend

Potential Media Affected Near Project Area

- Other Groundwater (uses other than drinking water)
- Soil
- Soil/Other Groundwater (uses other than drinking water)
- Soil/Other Groundwater (uses other than drinking water)/Aquifer or Well used for drinking water supply
- Soil/Aquifer used for drinking water supply
- Aquifer used for drinking water supply
- Well used for drinking water supply
- Under Investigation
- Unknown

T0608194016 | 21.8

Global ID Depth to Water (feet)

- GSR Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Changes in Depth to Water (feet) Scenario 2
- Changes in Depth to Water (feet) Scenario 4
- 2000 feet Radius Buffer
- South Westside Groundwater Basin

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"OPEN" REGULATED SITES WITH RECORDED DEPTHS TO WATER NEAR PUMPING WELLS IN THE DALY CITY AREA

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Regional Groundwater Storage and Recovery Project

Figure **10.6-19**

Date April 2012

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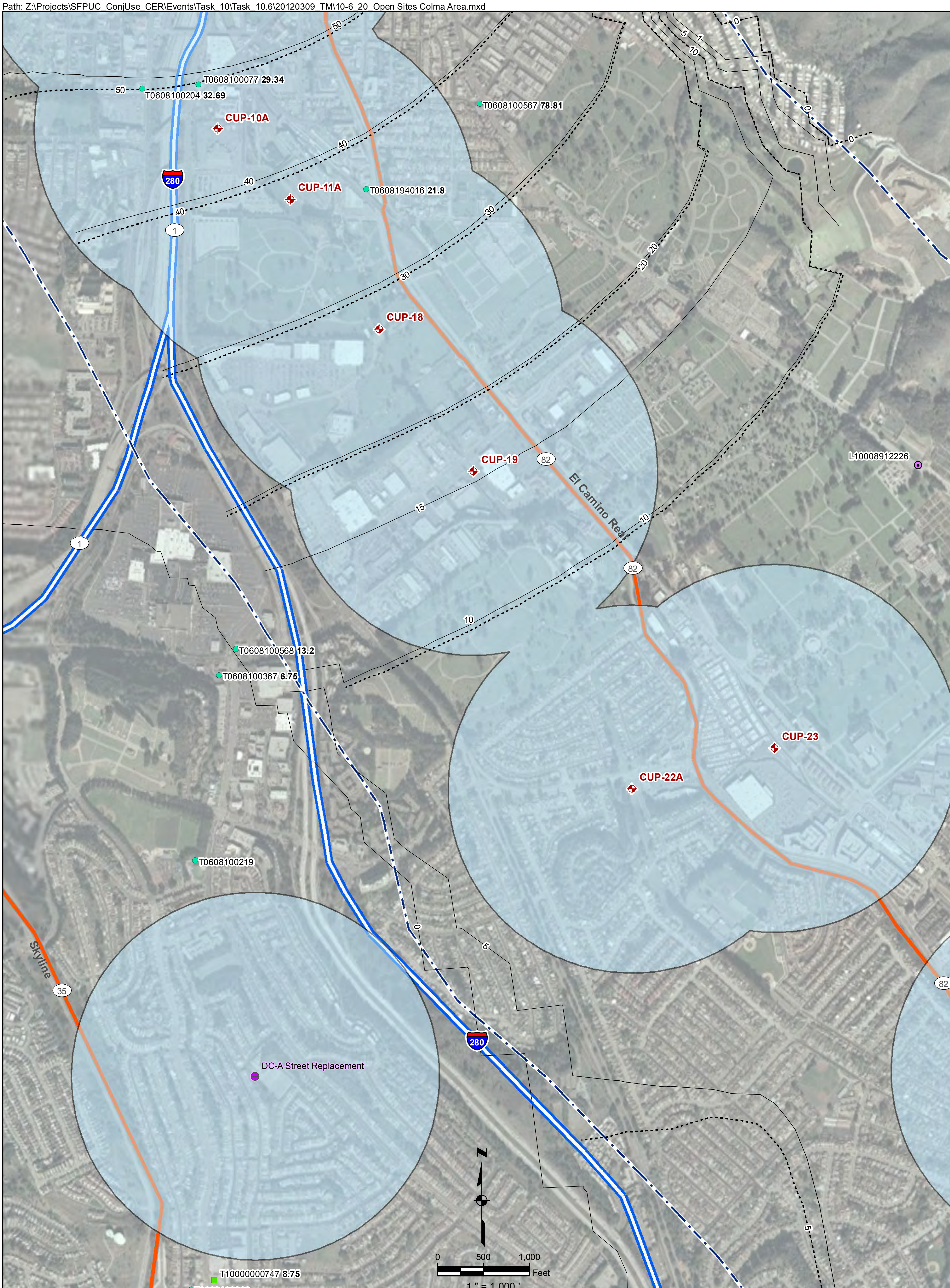

Legend

Potential Media Affected Near Project Area

- Other Groundwater (uses other than drinking water)
- Soil
- Soil/Other Groundwater (uses other than drinking water)
- Soil/Other Groundwater (uses other than drinking water)/Aquifer or Well used for drinking water supply
- Soil/Aquifer used for drinking water supply
- Aquifer used for drinking water supply
- Well used for drinking water supply
- Under Investigation
- Unknown

T0608194016 21.8
Global ID Depth to Water (feet)

- GSR Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Changes in Depth to Water (feet) Scenario 2
- Changes in Depth to Water (feet) Scenario 4
- 2000 feet Radius Buffer
- South Westside Groundwater Basin

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"OPEN" REGULATED SITES WITH RECORDED DEPTHS TO WATER NEAR PUMPING WELLS IN THE COLMA AREA

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Regional Groundwater Storage and Recovery Project

Figure **10.6-20**

Date April 2012

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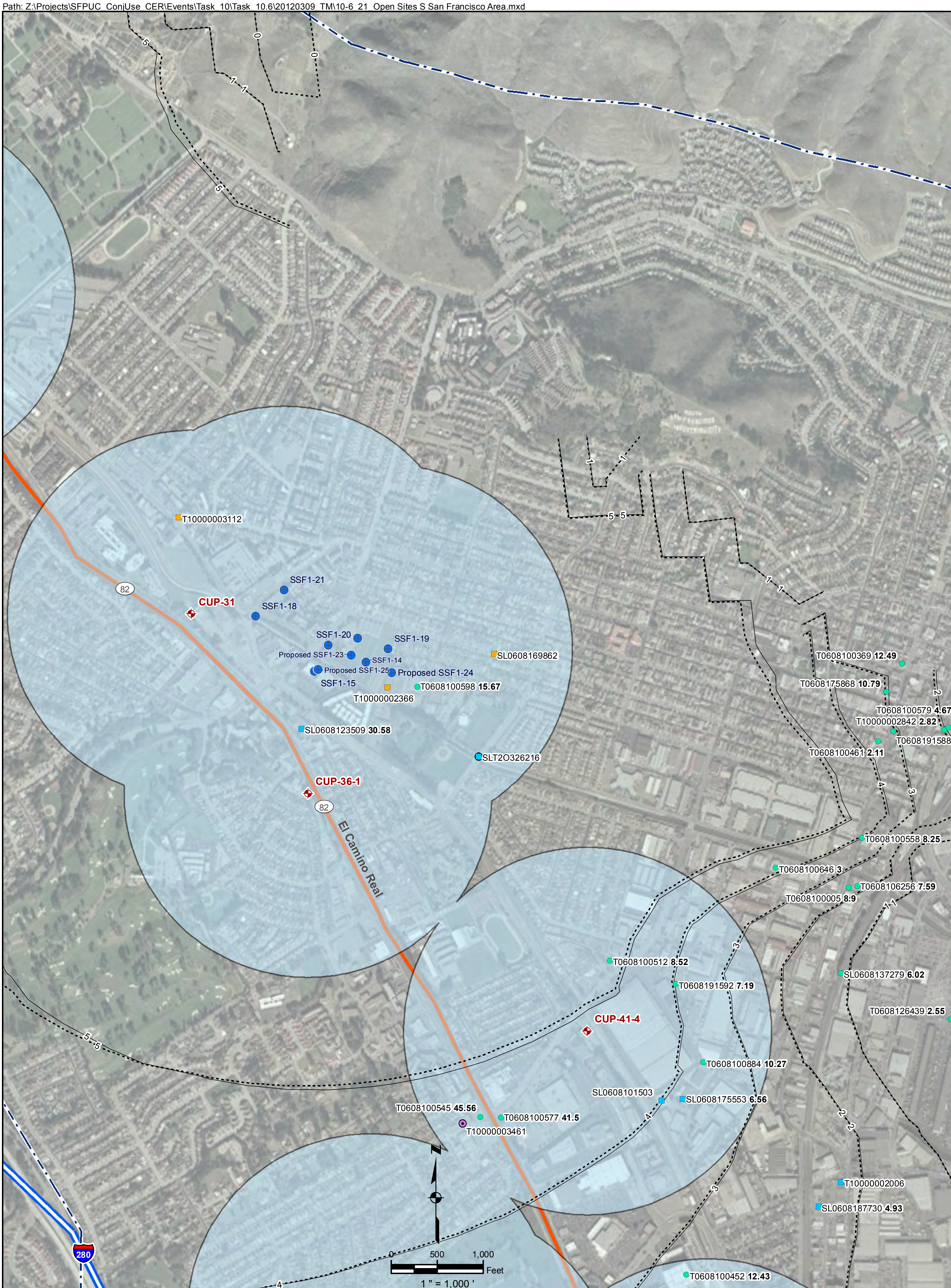

Legend

Potential Media Affected Near Project Area

- Other Groundwater (uses other than drinking water)
- Soil
- Soil/Other Groundwater (uses other than drinking water)
- Soil/Other Groundwater (uses other than drinking water)/Aquifer or Well used for drinking water supply
- Soil/Aquifer used for drinking water supply
- Aquifer used for drinking water supply
- Well used for drinking water supply
- Under Investigation
- Unknown

T0608194016 21.8
Global ID Depth to Water (feet)

- GSR Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Changes in Depth to Water (feet) Scenario 2
- Changes in Depth to Water (feet) Scenario 4
- 2000 feet Radius Buffer
- South Westside Groundwater Basin

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"OPEN" REGULATED SITES WITH RECORDED DEPTHS TO WATER NEAR PUMPING WELLS IN THE SOUTH SAN FRANCISCO AREA

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Regional Groundwater Storage and Recovery Project

Figure
10.6-21

Date
April 2012

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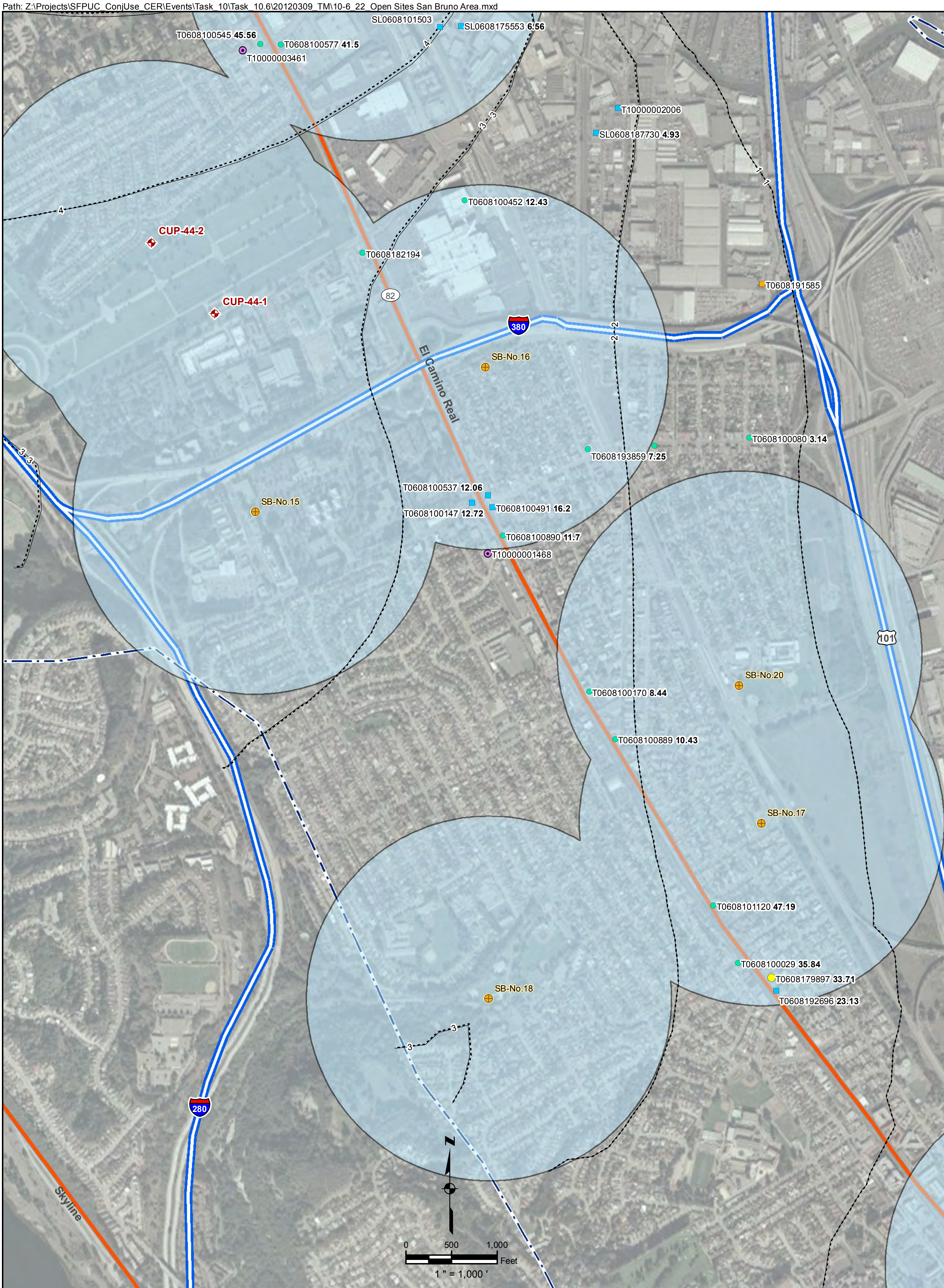

Legend

Potential Media Affected Near Project Area

- Other Groundwater (uses other than drinking water)
- Soil
- Soil/Other Groundwater (uses other than drinking water)
- Soil/Other Groundwater (uses other than drinking water)/Aquifer or Well used for drinking water supply
- Soil/Aquifer used for drinking water supply
- Aquifer used for drinking water supply
- Well used for drinking water supply
- Under Investigation
- Unknown

T0608194016 | 21.8
Global ID Depth to Water (feet)

- GSR Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Changes in Depth to Water (feet) Scenario 2
- Changes in Depth to Water (feet) Scenario 4
- 2000 feet Radius Buffer
- South Westside Groundwater Basin

CITY AND COUNTY OF SAN FRANCISCO
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"OPEN" REGULATED SITES WITH RECORDED DEPTHS TO WATER NEAR PUMPING WELLS IN THE SAN BRUNO AREA

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Regional Groundwater Storage and Recovery Project

Figure
10.6-22

Date
April 2012

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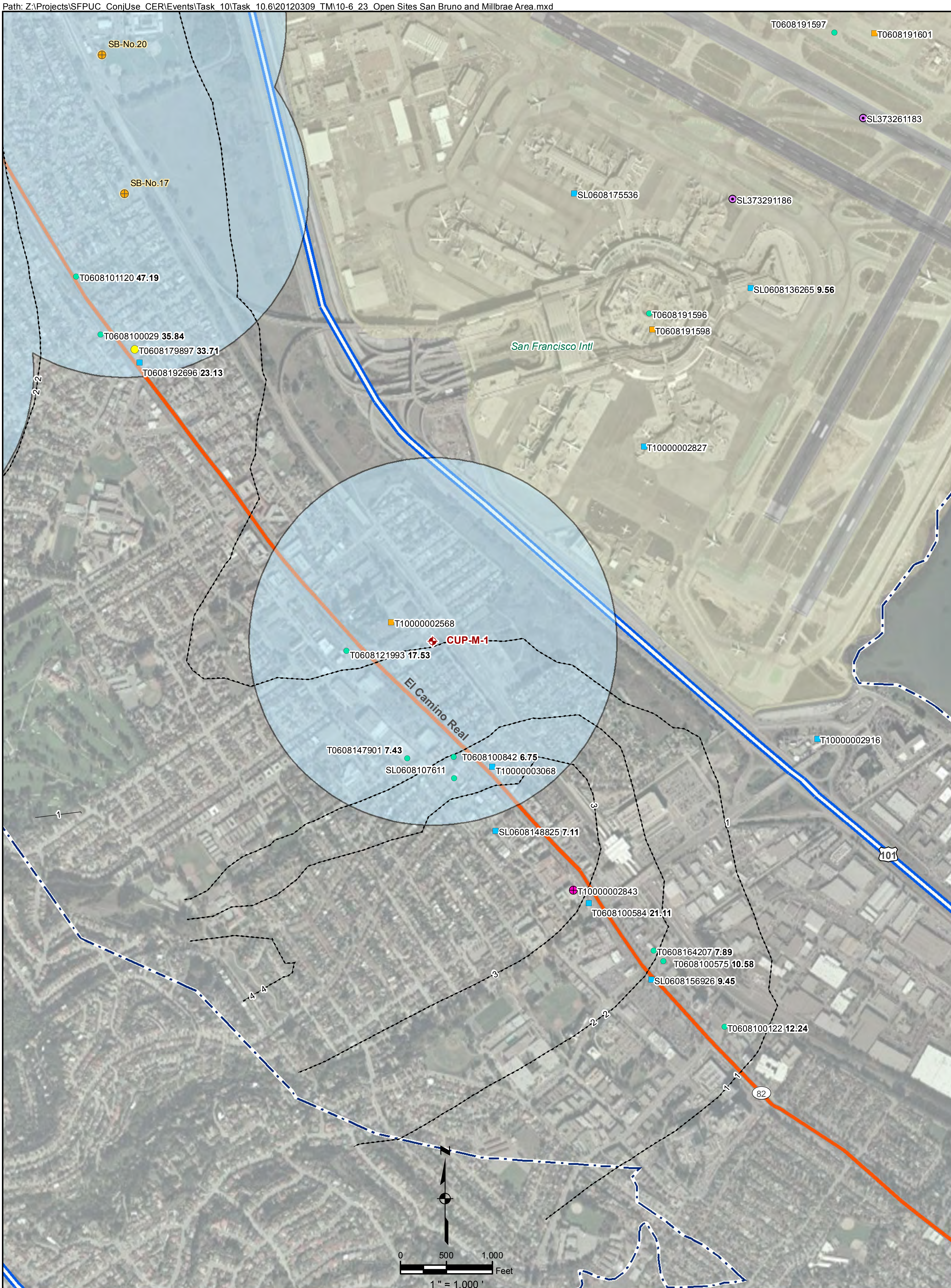

Legend

Potential Media Affected Near Project Area

- Other Groundwater (uses other than drinking water)
- Soil
- Soil/Other Groundwater (uses other than drinking water)
- Soil/Other Groundwater (uses other than drinking water)/Aquifer or Well used for drinking water supply
- Soil/Aquifer used for drinking water supply
- Aquifer used for drinking water supply
- Well used for drinking water supply
- Under Investigation
- Unknown

T0608194016 | 21.8
Global ID | Depth to Water (feet)

- GSR Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- Changes in Depth to Water (feet) Scenario 2
- Changes in Depth to Water (feet) Scenario 4
- 2000 feet Radius Buffer
- South Westside Groundwater Basin

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

"OPEN" REGULATED SITES WITH RECORDED DEPTHS TO WATER NEAR PUMPING WELLS IN THE SAN BRUNO/MILLBRAE AREA

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Regional Groundwater Storage and Recovery Project

Figure
10.6-23

Date
April 2012

Table

Table 10.6-1: Summary of Model Scenario Pumping Assumptions

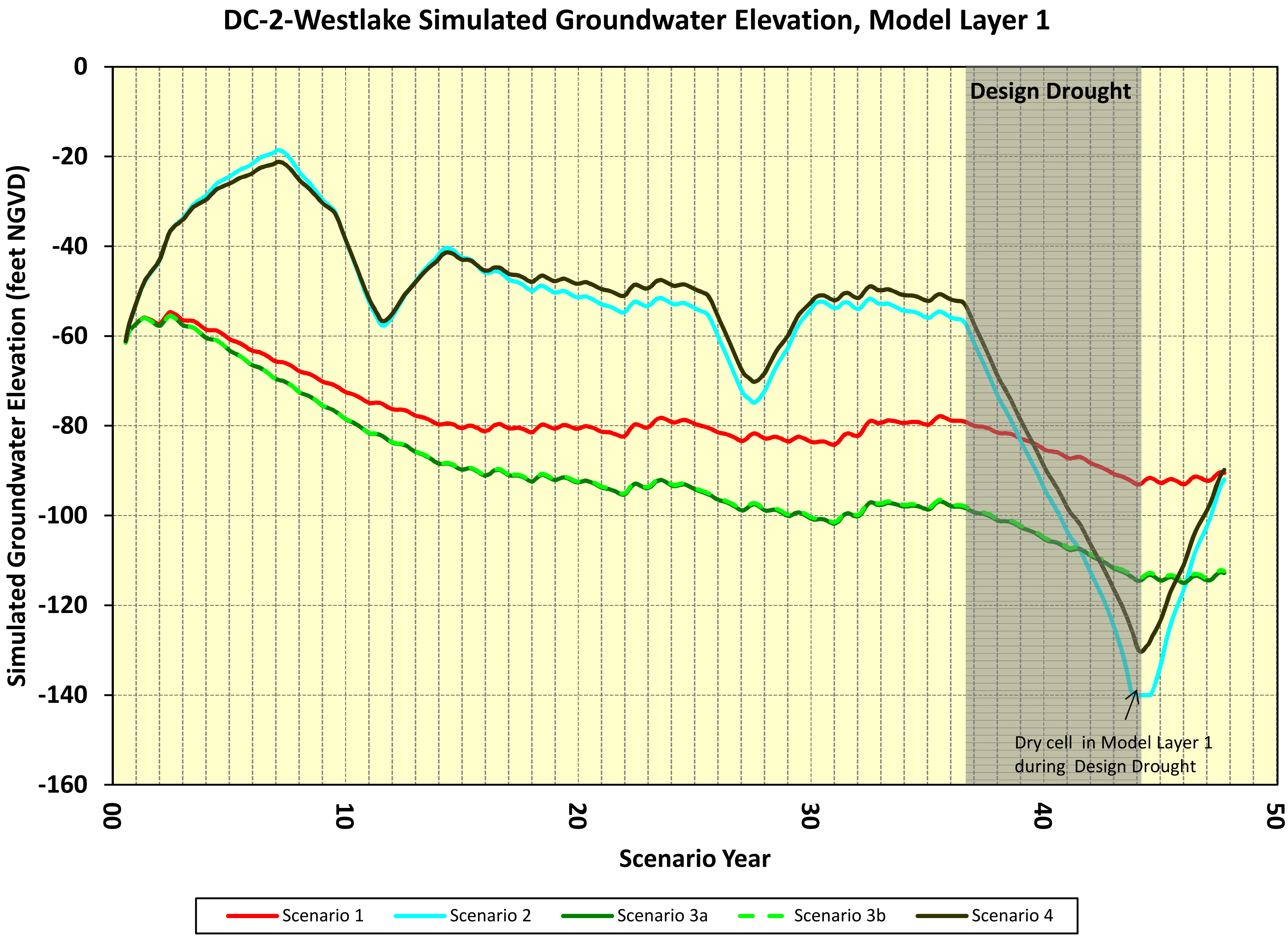
		Scenario 1	Scenario 2	Scenario 3a	Scenario 3b	Scenario 4
Model Scenarios		**Existing Conditions**	**GSR**	**SFGW**	**SFGW**	**Cumulative**
Establish Initial Conditions		Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence	Hydrologic Sequence
	June 2009 Condition	√	√	√	√	√
Model Scenario Simulation Period						
	47.25 years (including Design Drought) Hydrologic Sequence: July 1996 to September 2003 -> October 1958 to November 1992 -> December 1975 to June 1978 -> July 2003 - September 2006		√	√	√	√
Pumping Assumptions for Municipal Use						
PA Municipal Wells (mgd)						
	"Take" Periods	6.84	6.90	6.84	6.84	6.90
	"Put" Periods	6.84	1.38	6.84	6.84	1.38
	"Hold" Periods	6.84	6.90	6.84	6.84	6.90
GSR Project Proposed Municipal Wells (mgd)						
	"Take" Periods	0.0	7.23	0.0	0.0	7.23
	"Put" Periods	0.0	0.04	0.0	0.0	0.04
	"Hold" Periods	0.0	0.04	0.0	0.0	0.04
SFGW Project Proposed Municipal Wells (mgd)						
	Year-Round Pumping	0.0	0.0	3.0	4.0	4.0
Total Municipal Pumping (PA + GSR + SFGW)						
	"Take" Periods	***6.84***	***14.13***	***9.84***	***10.84***	***18.13***
	"Put" Periods	***6.84***	***1.42***	***9.84***	***10.84***	***5.42***
	"Hold" Periods	***6.84***	***6.94***	***9.84***	***10.84***	***10.94***
Irrigation and Other Non-Potable Pumping Assumptions (mgd)[1]						
Golden Gate Park	Elk Glen (GGP)	0.081	0.081	0.081	0.000	0.000
	South Windmill (GGP)	0.498	0.498	0.498	0.000	0.000
	North Lake (GGP)	0.563	0.563	0.563	0.000	0.000
	Sub-Total	***1.142***	***1.142***	***1.142***	***0.000***	***0.000***
Golf Courses	Burlingame Golf Club	0.150	0.150	0.150	0.150	0.150
	California Golf No. 02	0.192	0.192	0.192	0.192	0.192
	Green Hills No. 05	0.099	0.099	0.099	0.099	0.099
	Lake Merced Golf No. 01	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 02	0.004	0.004	0.004	0.004	0.004
	Lake Merced Golf No. 03	0.010	0.010	0.010	0.010	0.010
	Olympic Club No. 09[2]	0.002	0.002	0.002	0.002	0.002
	SF Golf West	0.035	0.035	0.035	0.035	0.035
	Sub-Total	***0.495***	***0.495***	***0.495***	***0.495***	***0.495***
Cemeteries	Cypress Lawn No. 02	0.020	0.020	0.020	0.020	0.020
	Cypress Lawn No. 03	0.144	0.144	0.144	0.144	0.144
	Eternal Home	0.013	0.013	0.013	0.013	0.013
	Hills of Eternity No. 02	0.020	0.020	0.020	0.020	0.020
	Holy Cross No. 03[3]	0.190	0.190	0.190	0.190	0.230
	Home of Peace No. 02	0.039	0.039	0.039	0.039	0.039
	Italian Cemetery	0.033	0.033	0.033	0.033	0.033
	Olivet	0.098	0.098	0.098	0.098	0.098
	Woodlawn No. 02	0.085	0.085	0.085	0.085	0.085
	Sub-Total	***0.641***	***0.641***	***0.641***	***0.641***	***0.681***
Other	Hillsborough Residents No. 1-12	0.291	0.291	0.291	0.291	0.291
	Edgewood Development Ctr.	0.009	0.009	0.009	0.009	0.009
	Zoo No.05	0.321	0.321	0.321	0.321	0.321
	Stern Grove	0.004	0.004	0.012	0.013	0.013
	Sub-Total	***0.626***	***0.626***	***0.634***	***0.635***	***0.635***
Total Irrigation and Other Non-Potable Pumping		***2.90***	***2.90***	***2.91***	***1.77***	***1.81***

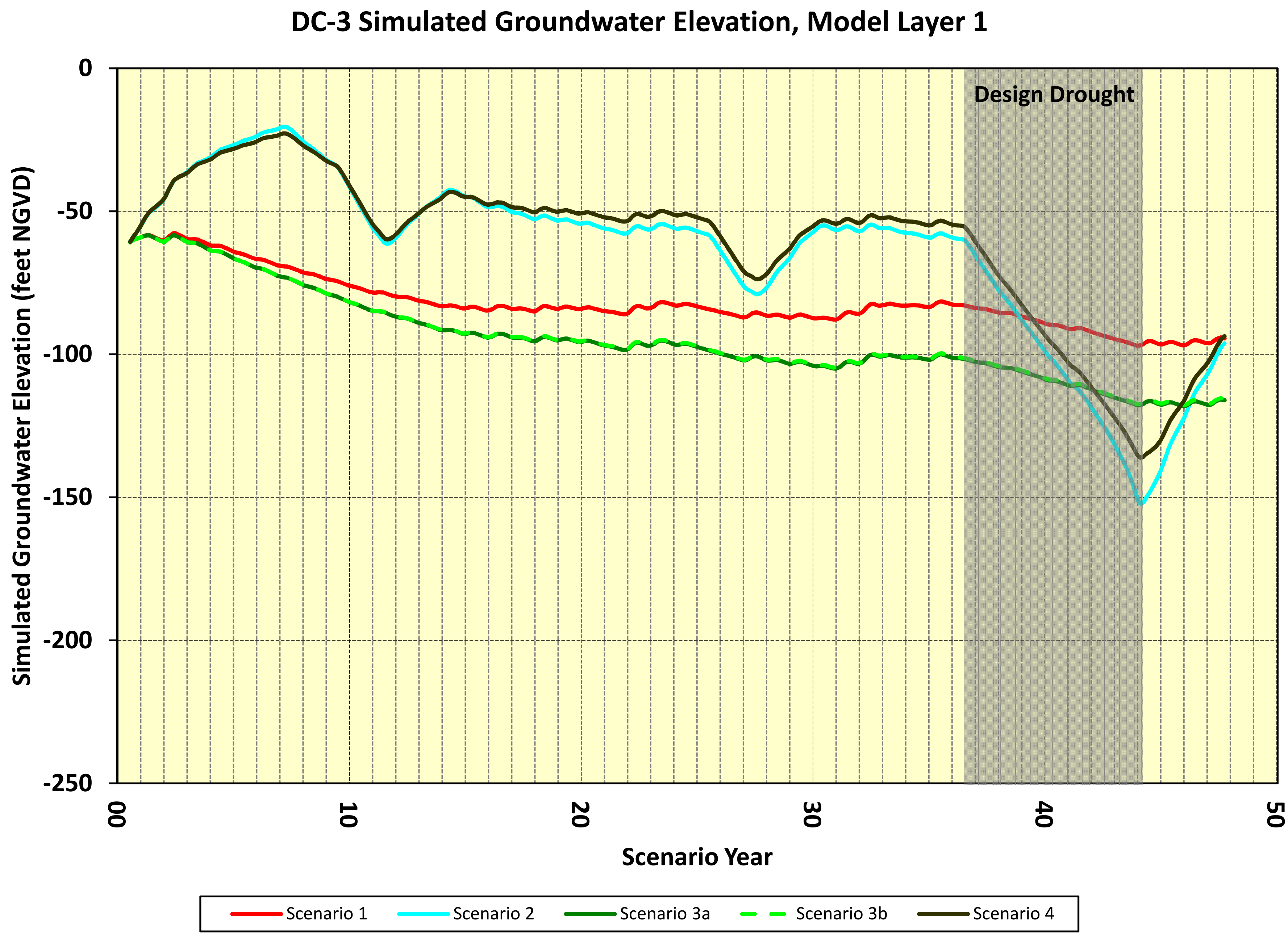
Key:
afy - acre-feet per year
mgd - million gallons per day
PA - Partner Agencies
GGP - Golden Gate Park
GSR - Regional Groundwater Storage and Recovery
SFGW - San Francisco Groundwater Supply
SFPUC - San Francisco Public Utilities Commission

Notes:
(1) Pumping wells that are listed identify the wells in the model scenarios whose pumping assumptions were modified compared to the 2008 No-Project Scenario by HydroFocus (May, 2011, ver. 3.1), as a result of revised Soil Moisture Budget (SMB). Pumping rates for the three wells in the GGP, California Golf No. 02, Edgewood Development Center, Zoo No. 05, and Stern Grove wells were further modified compared to the results of revised SMB.
(2) Olympic Club No. 09 values include pumping for both Olympic Golf Club wells.
(3) Holy Cross No. 3 well irrigation pumping for Scenarios 1, 2, 3a, and 3b is based on the results of revised SMB. Based on the projected future build-out at the Holy Cross cemetery, an additional pumping of 0.04 mgd (45 afy) was estimated to occur under Scenario 4 (Cumulative).

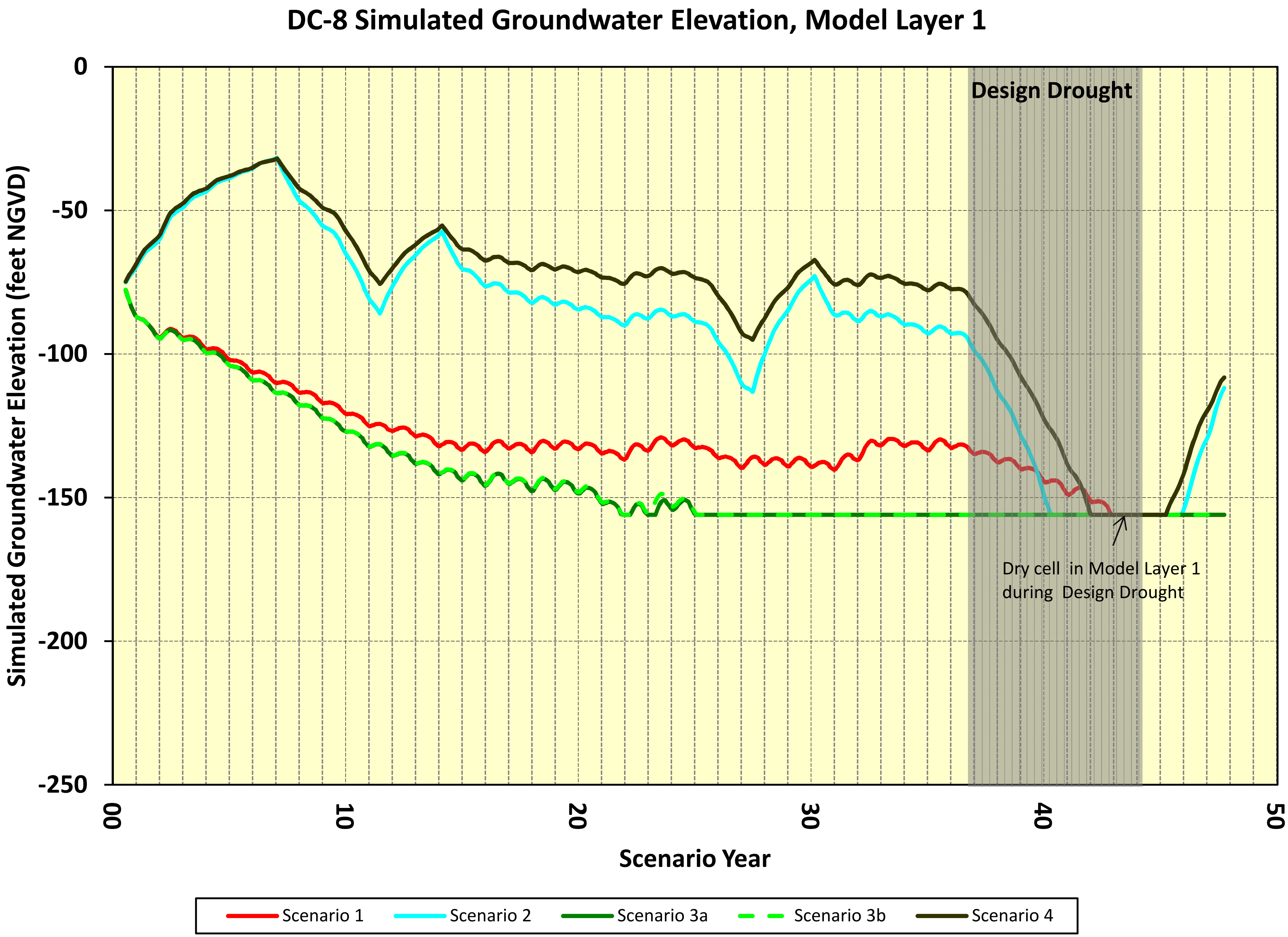
Attachment 10.6-A

Model Scenario Hydrographs for Selected Locations

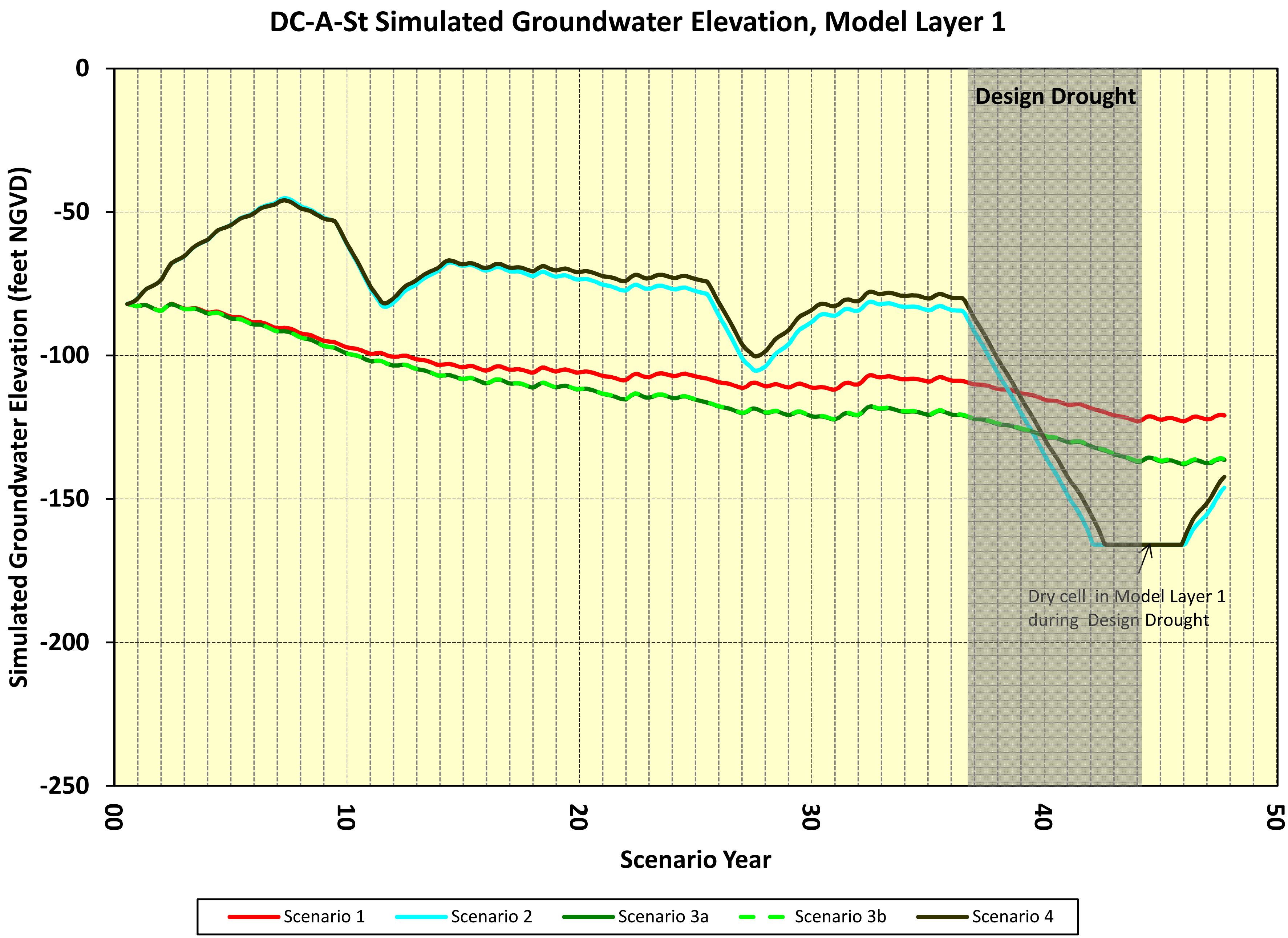

DC-2-Westlake Simulated Groundwater Elevation, Model Layer 1
Simulated Groundwater Elevation (feet NGVD)
0
-20
-40
-60
-80
-100
-120
-140
-160
Design Drought
Dry cell in Model Layer 1
during Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



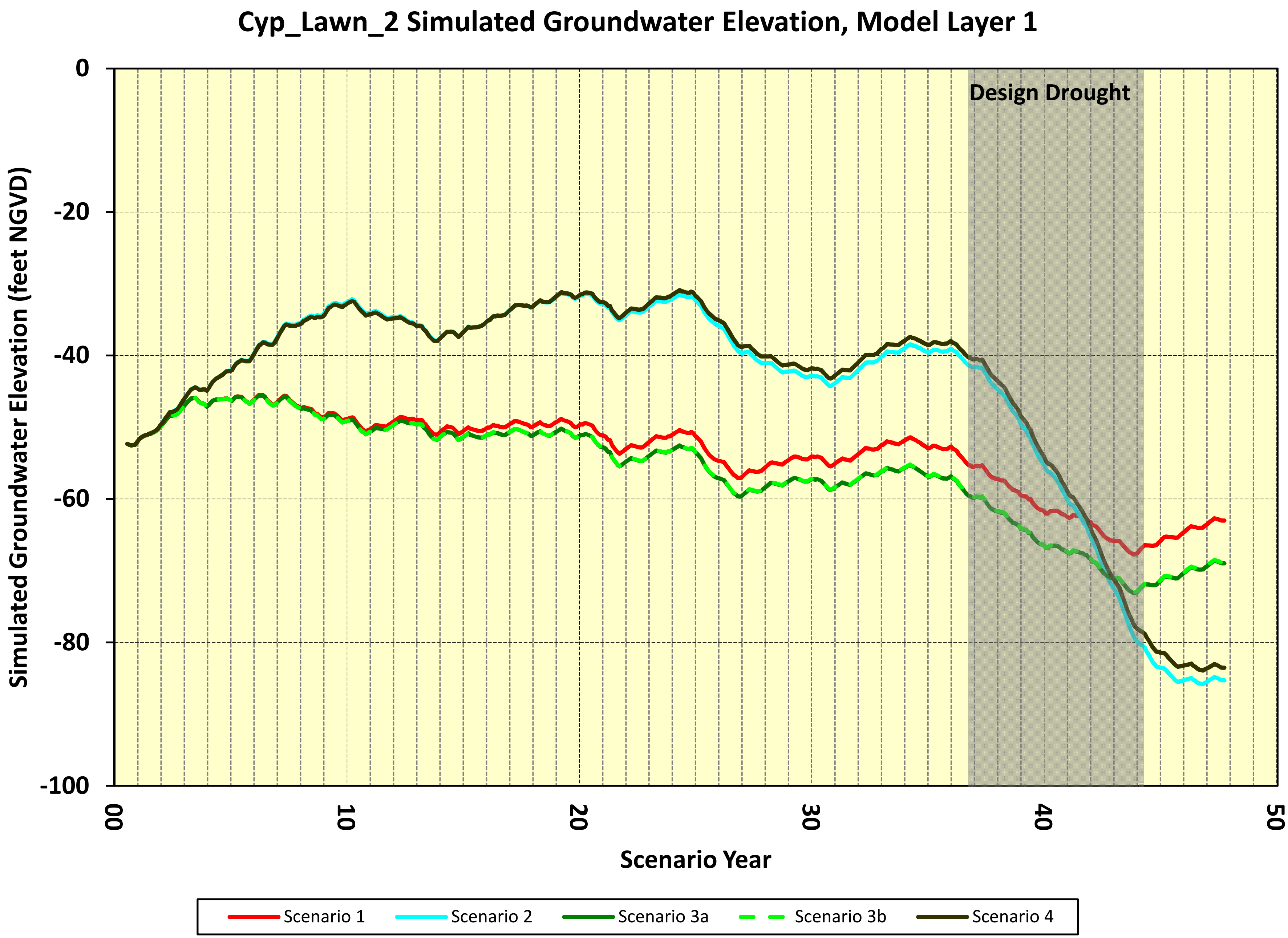
DC-3 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



DC-8 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Dry cell in Model Layer 1
during Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

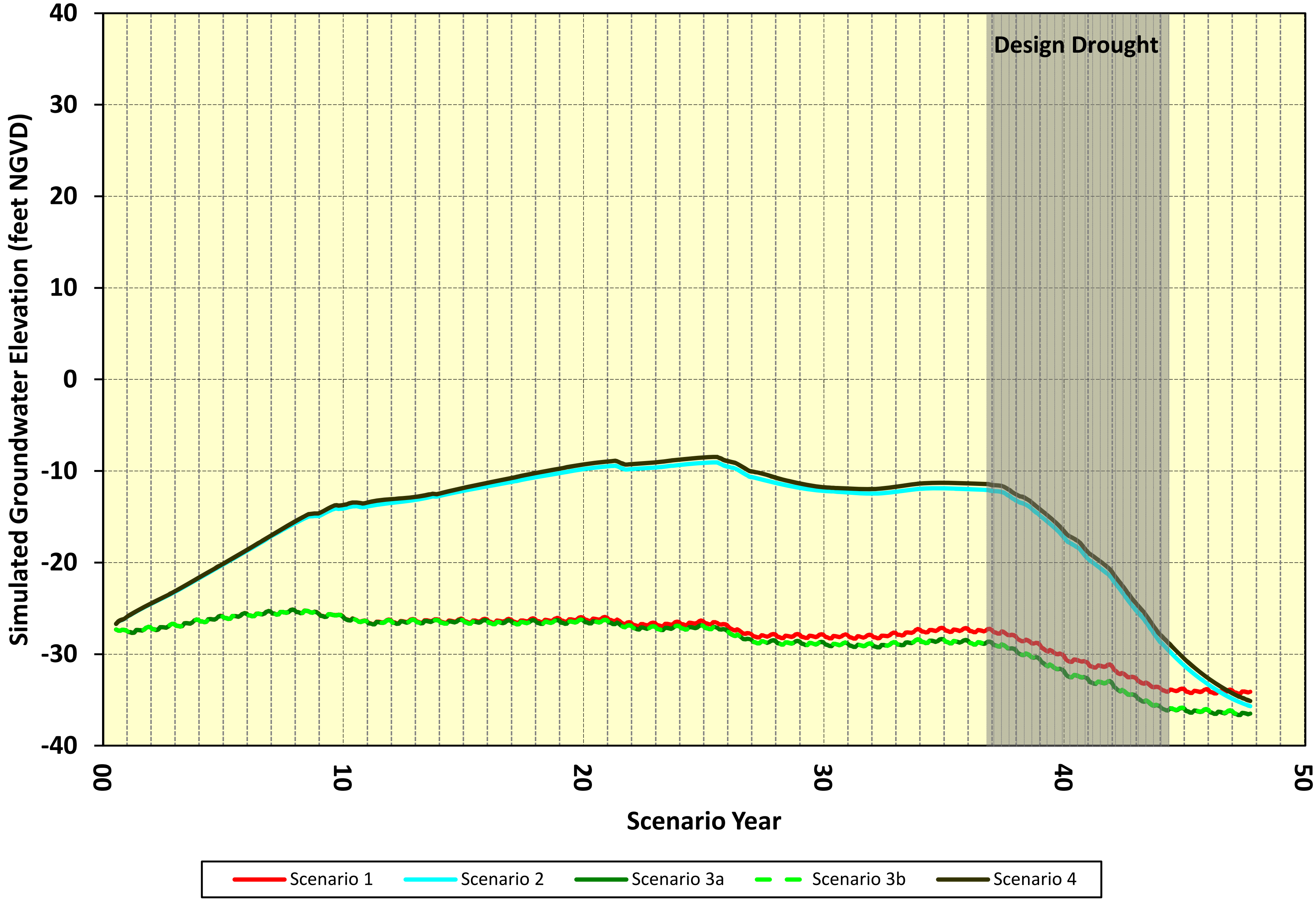


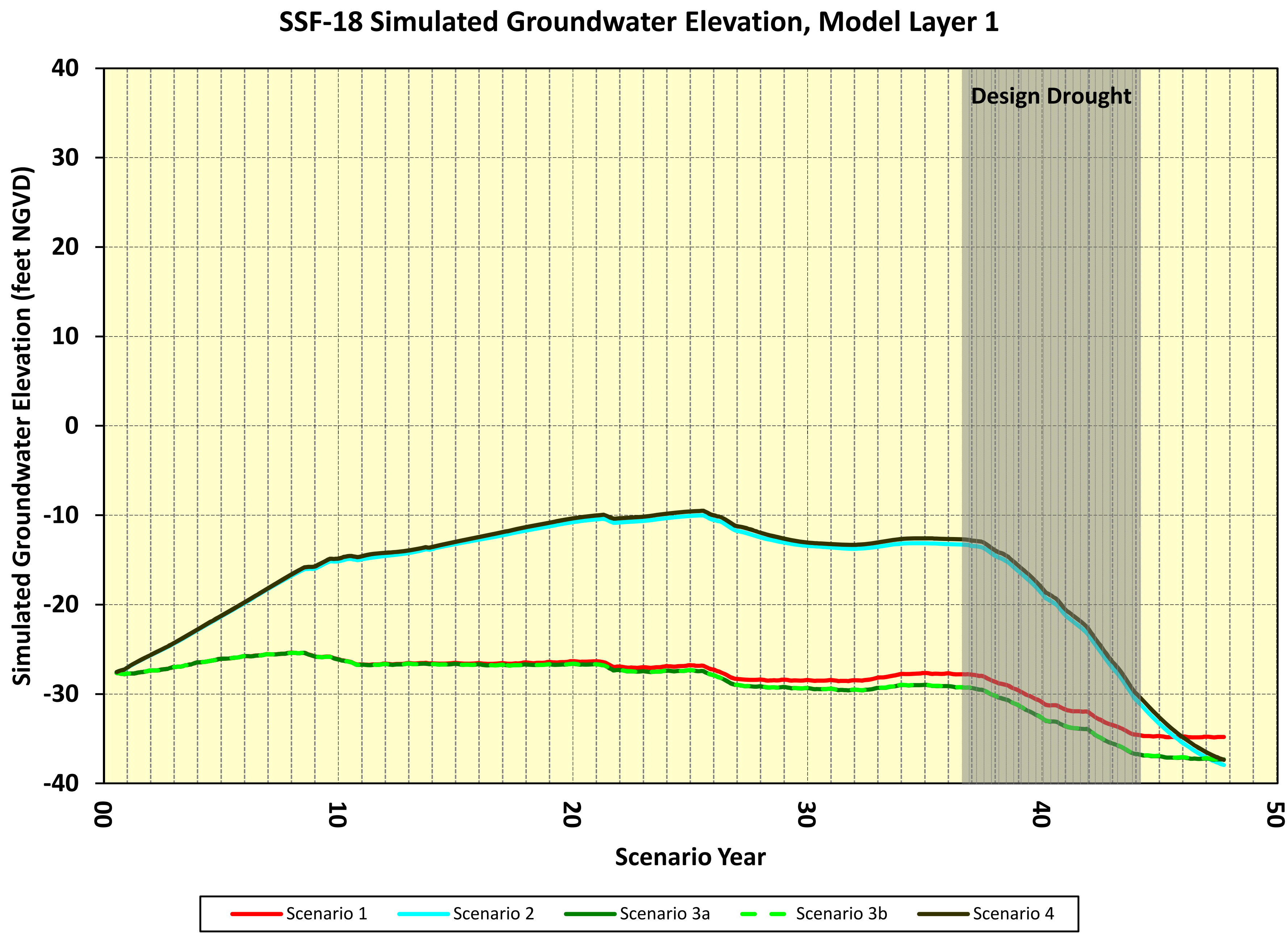
DC-A-St Simulated Groundwater Elevation, Model Layer 1
Design Drought
Dry cell in Model Layer 1
during Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



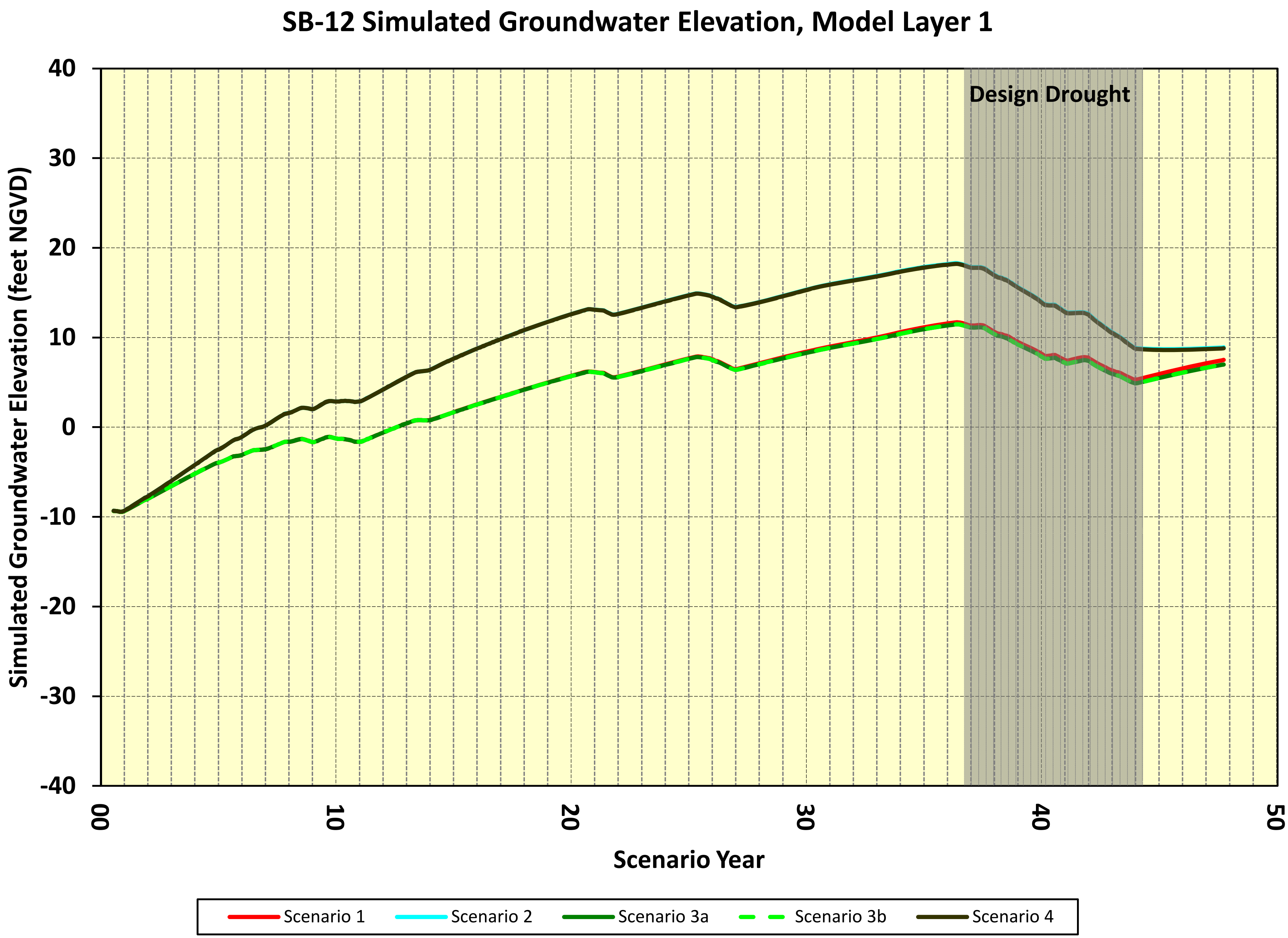
Cyp_Lawn_2 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-20
-40
-60
-80
-100
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

SSF-02 Simulated Groundwater Elevation, Model Layer 1

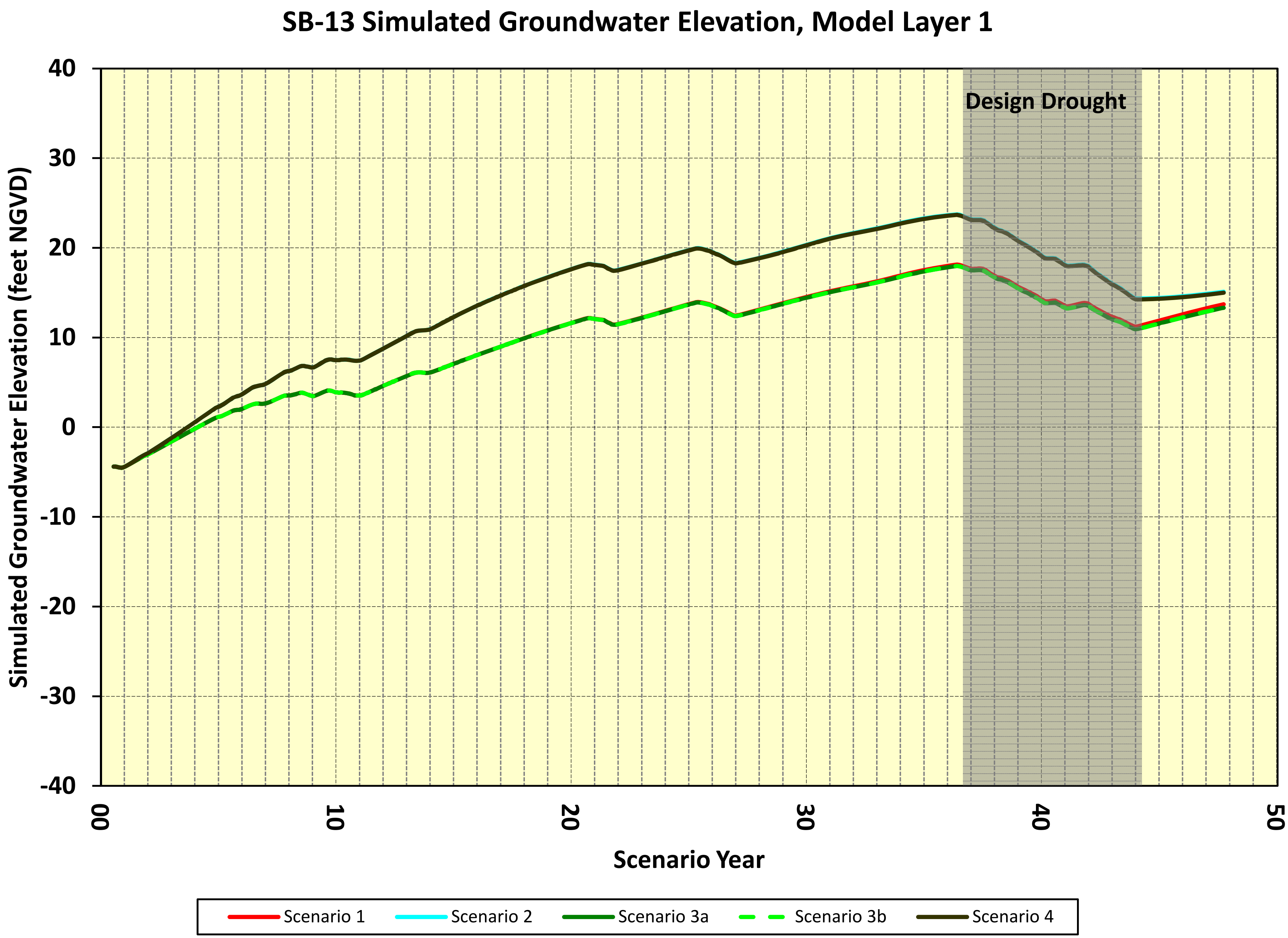




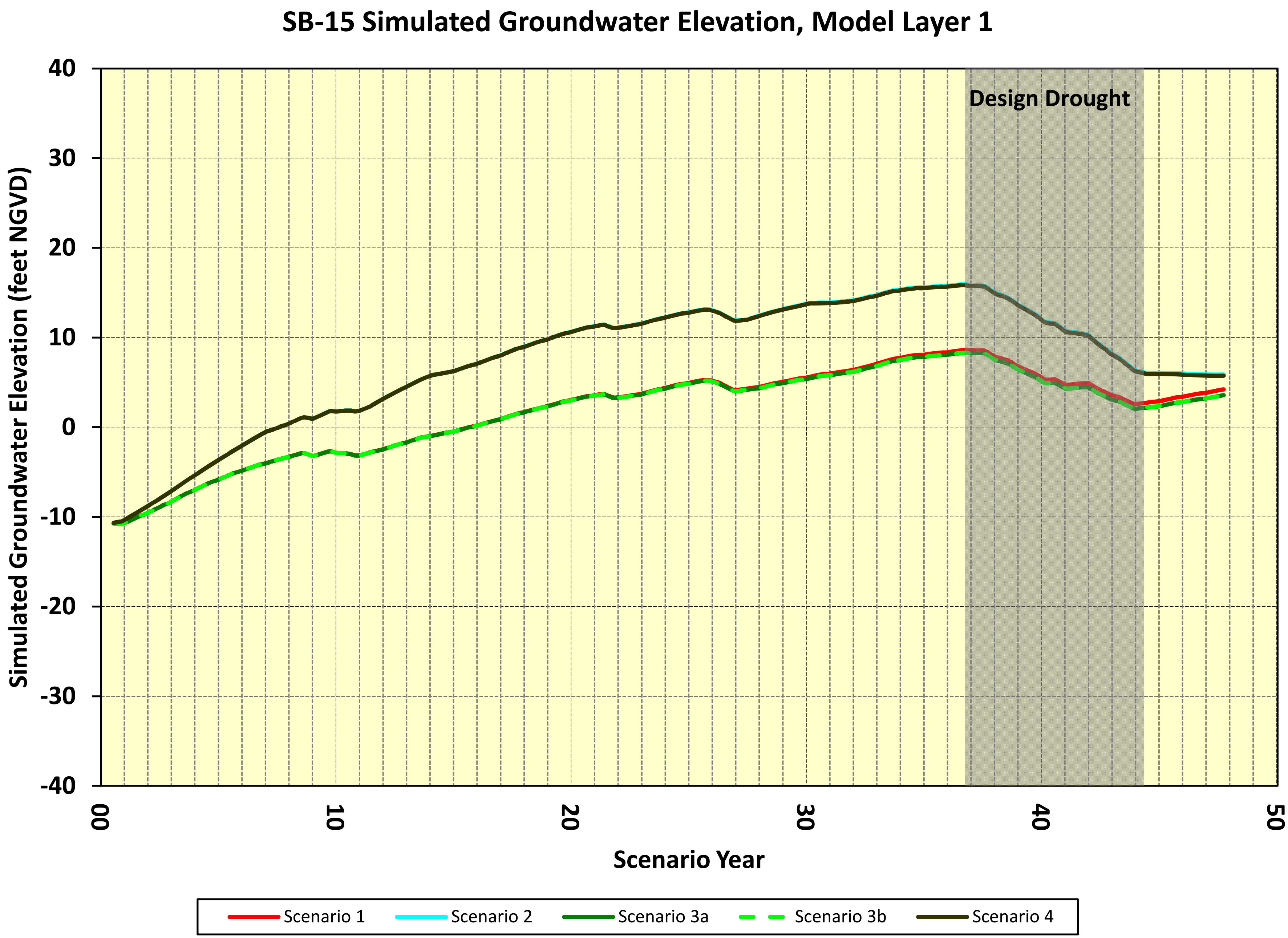
SSF-18 Simulated Groundwater Elevation, Model Layer 1
Simulated Groundwater Elevation (feet NGVD)
40
30
20
10
0
-10
-20
-30
-40
00
10
20
30
40
50
Scenario Year
Design Drought
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

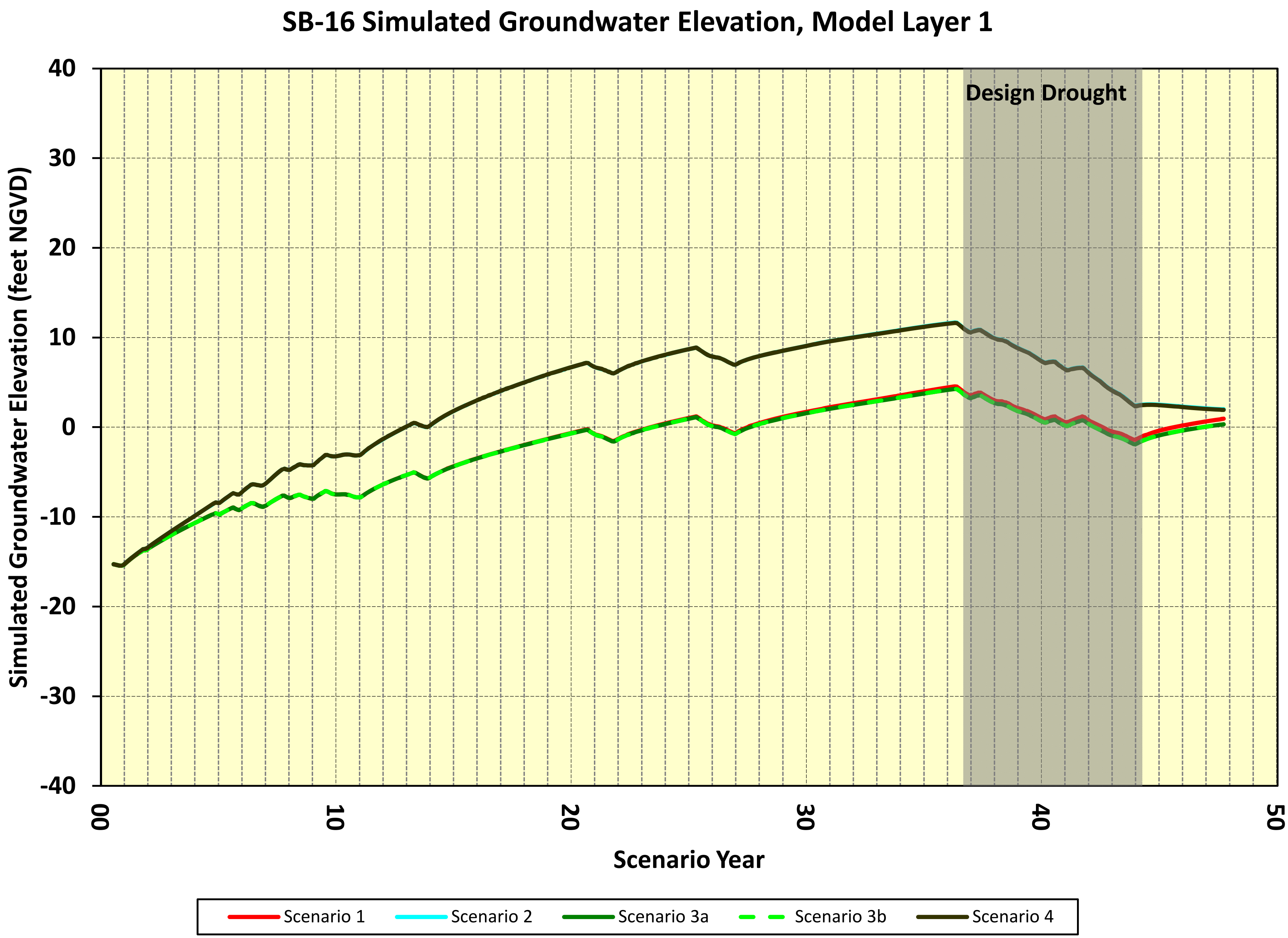


SB-12 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
30
20
10
0
-10
-20
-30
-40
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

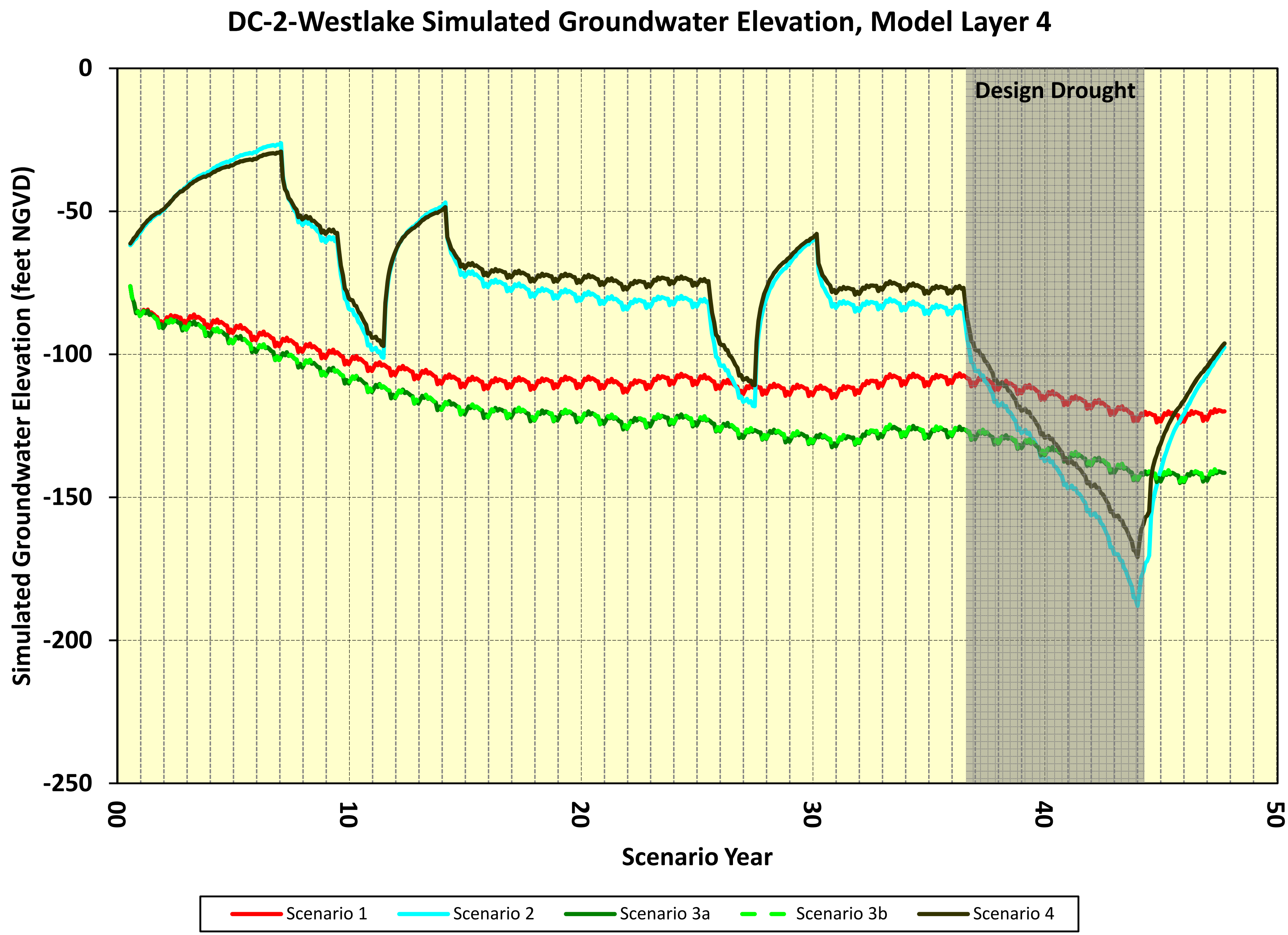


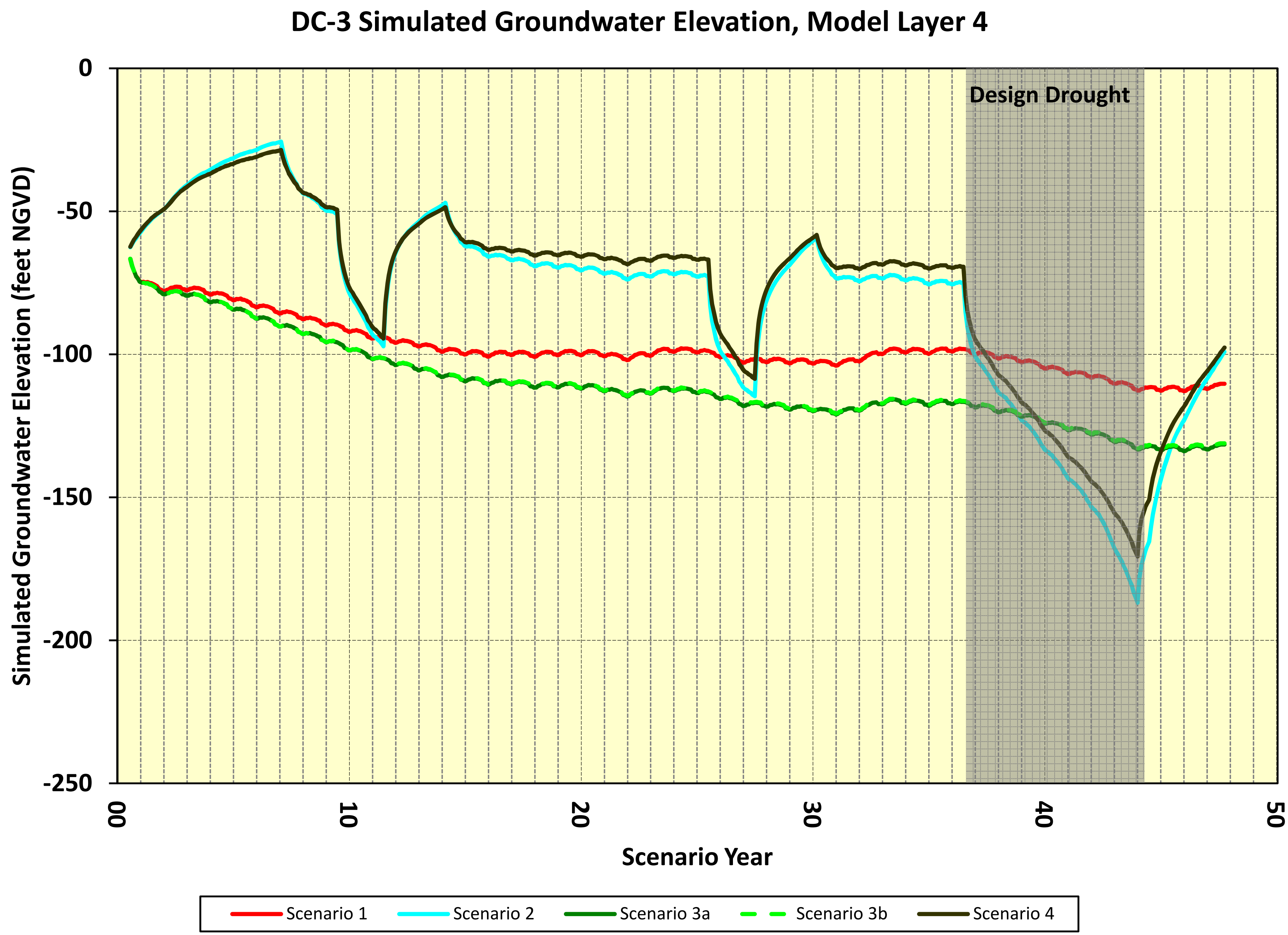
SB-13 Simulated Groundwater Elevation, Model Layer 1
Simulated Groundwater Elevation (feet NGVD)
40
30
20
10
0
-10
-20
-30
-40
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4


SB-15 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
30
20
10
0
-10
-20
-30
-40
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

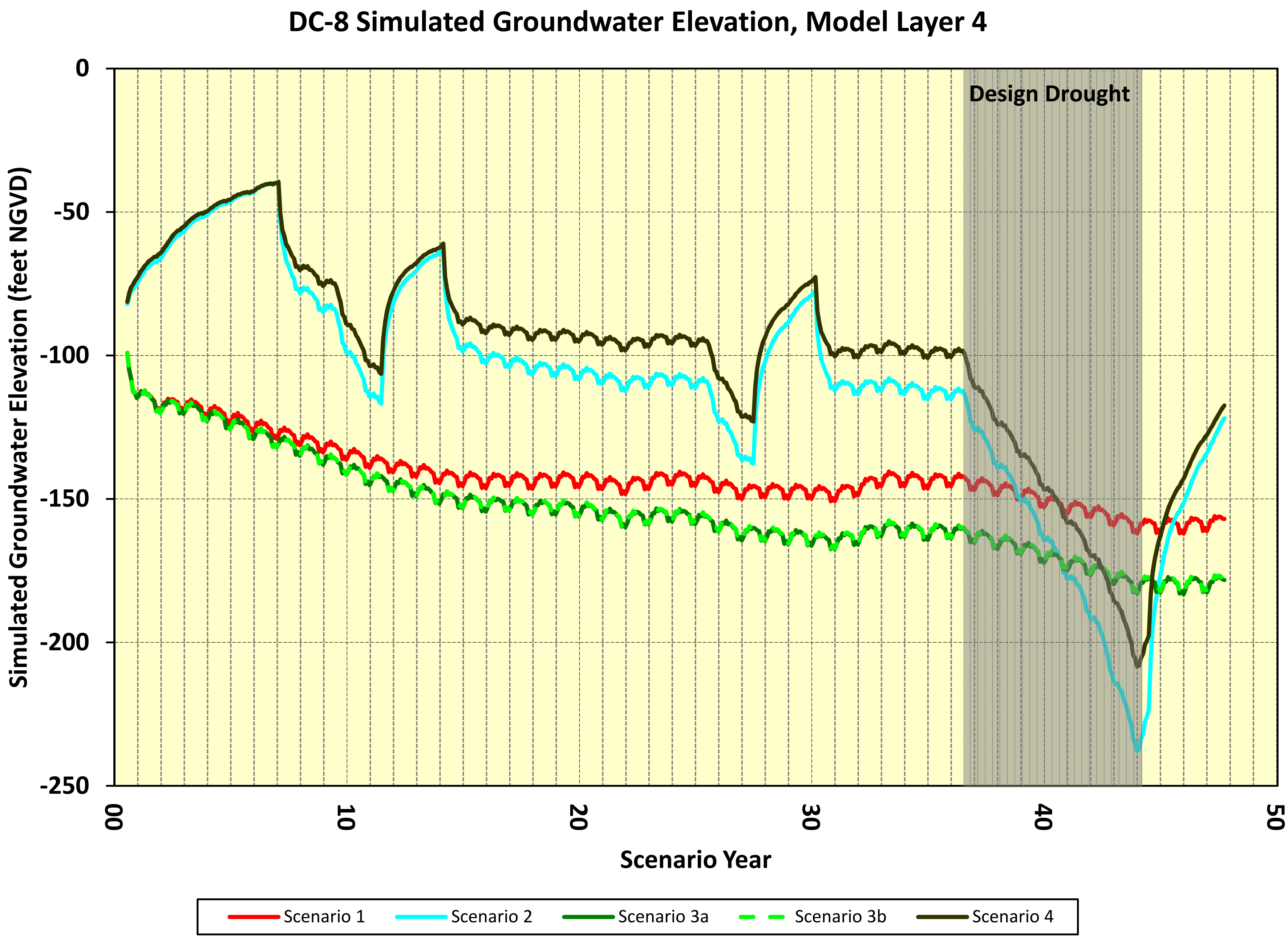


SB-16 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Simulated Groundwater Elevation (feet NGVD)
40
30
20
10
0
-10
-20
-30
-40
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

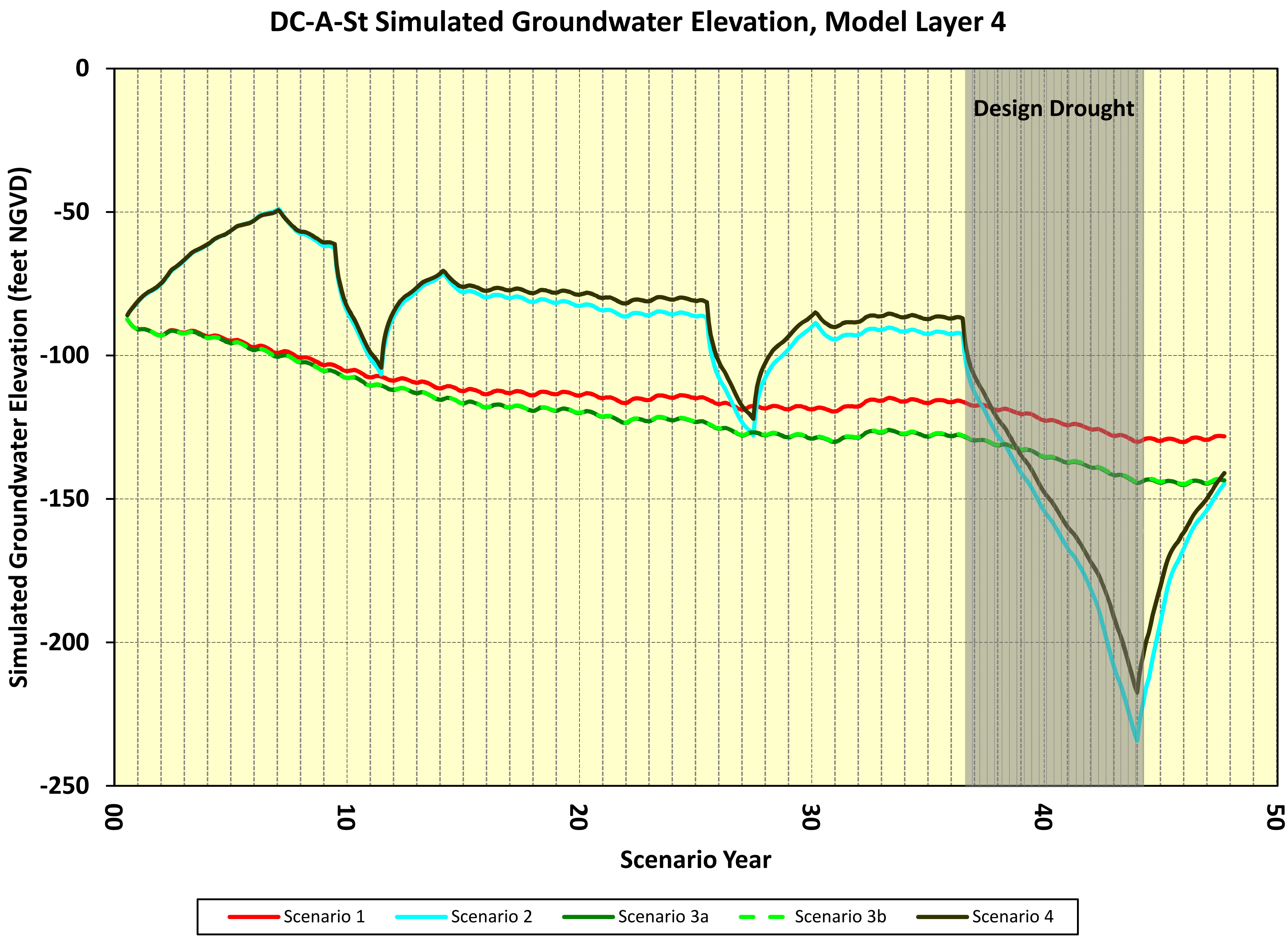

DC-2-Westlake Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



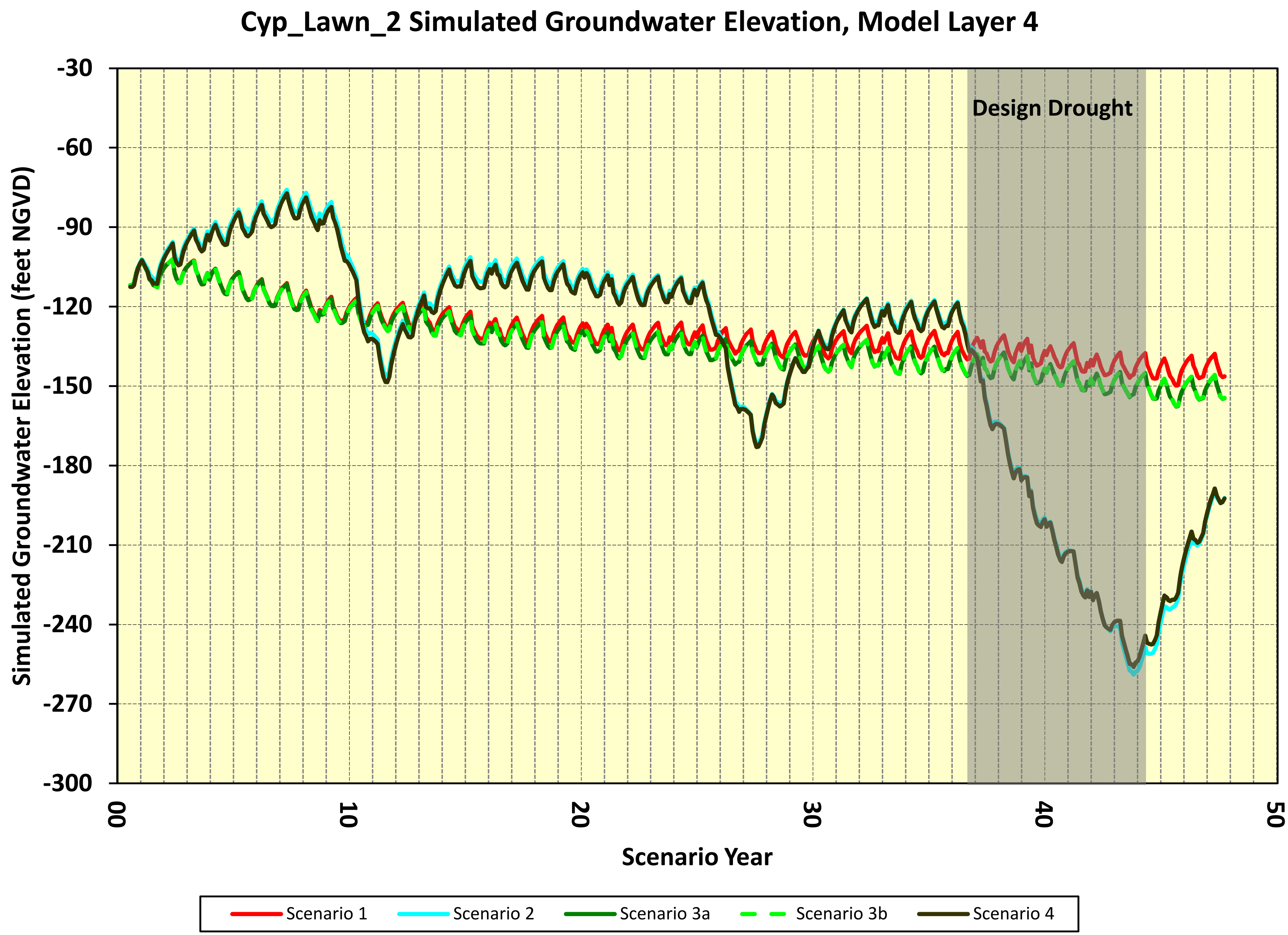
DC-3 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



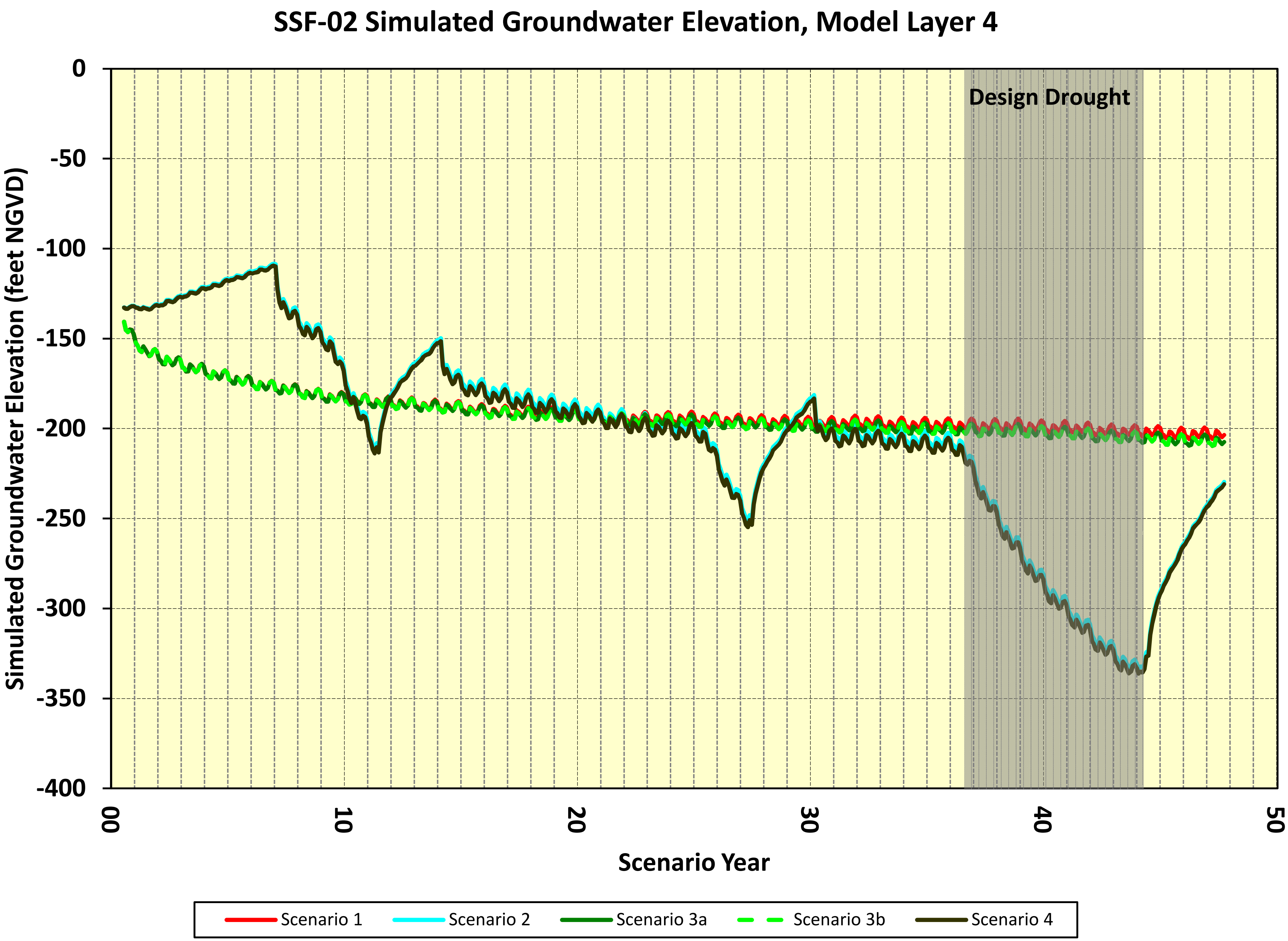
DC-8 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

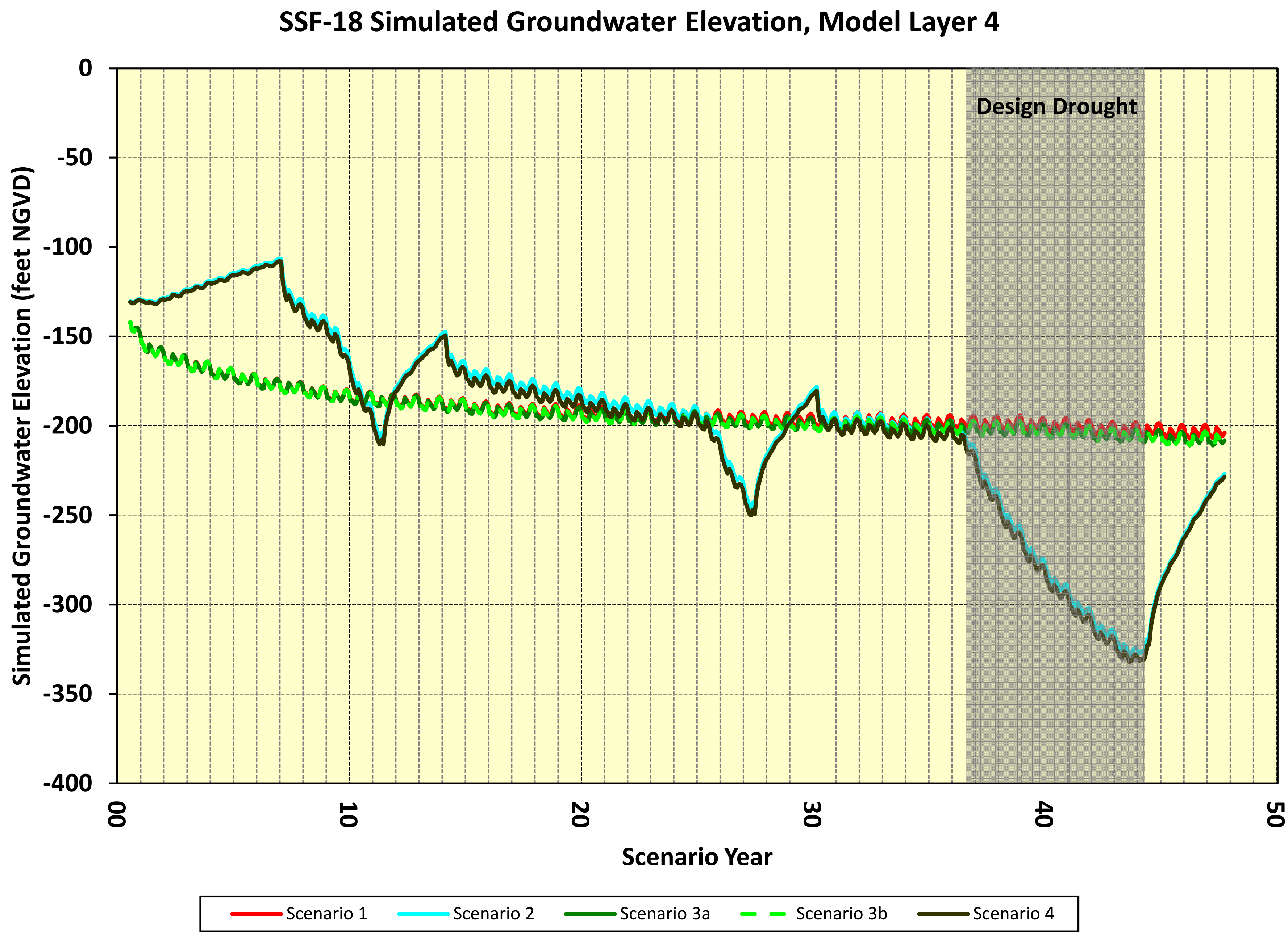


DC-A-St Simulated Groundwater Elevation, Model Layer 4
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

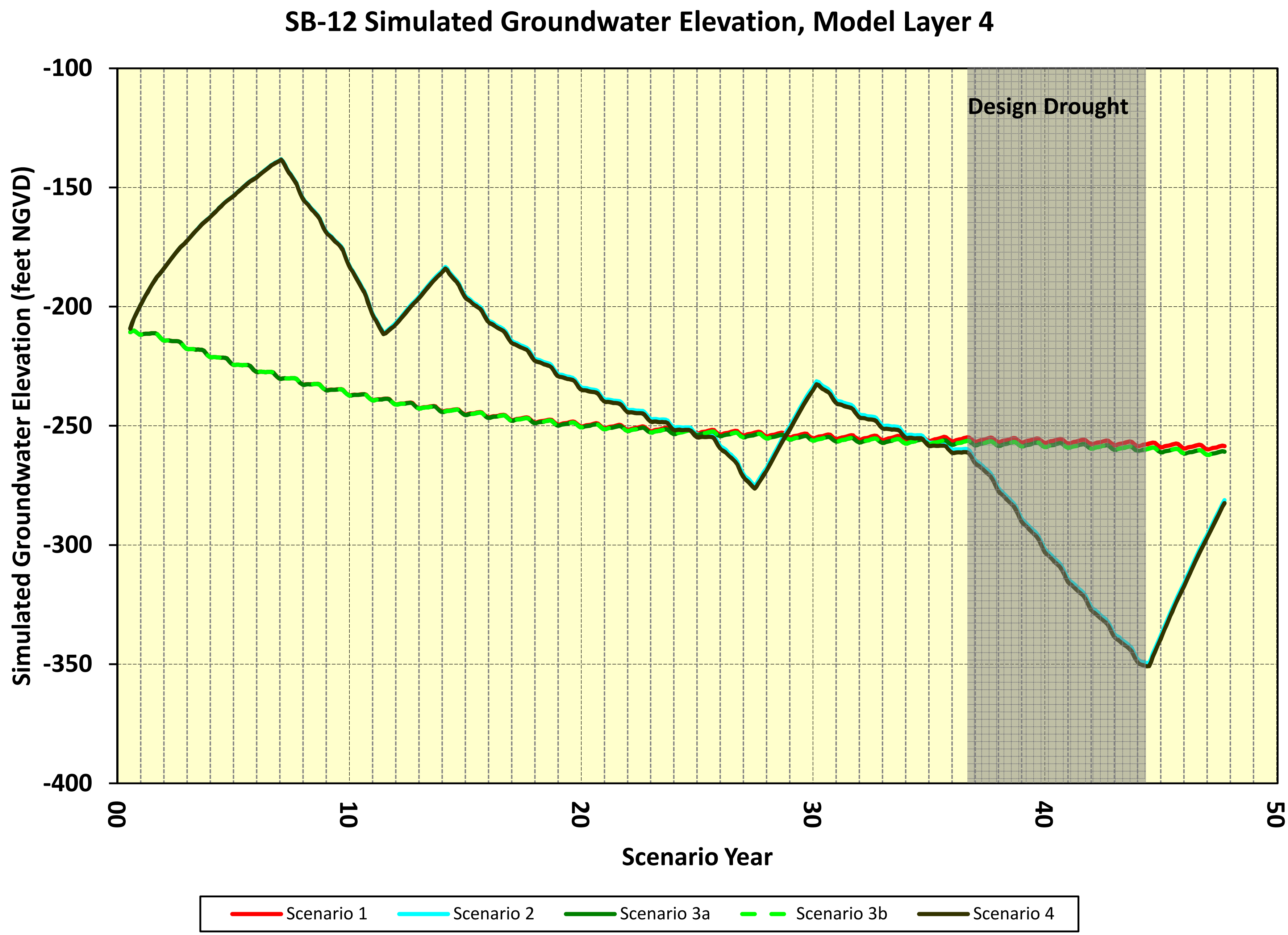


Cyp_Lawn_2 Simulated Groundwater Elevation, Model Layer 4
Simulated Groundwater Elevation (feet NGVD)
-30
-60
-90
-120
-150
-180
-210
-240
-270
-300
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4


SSF-02 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

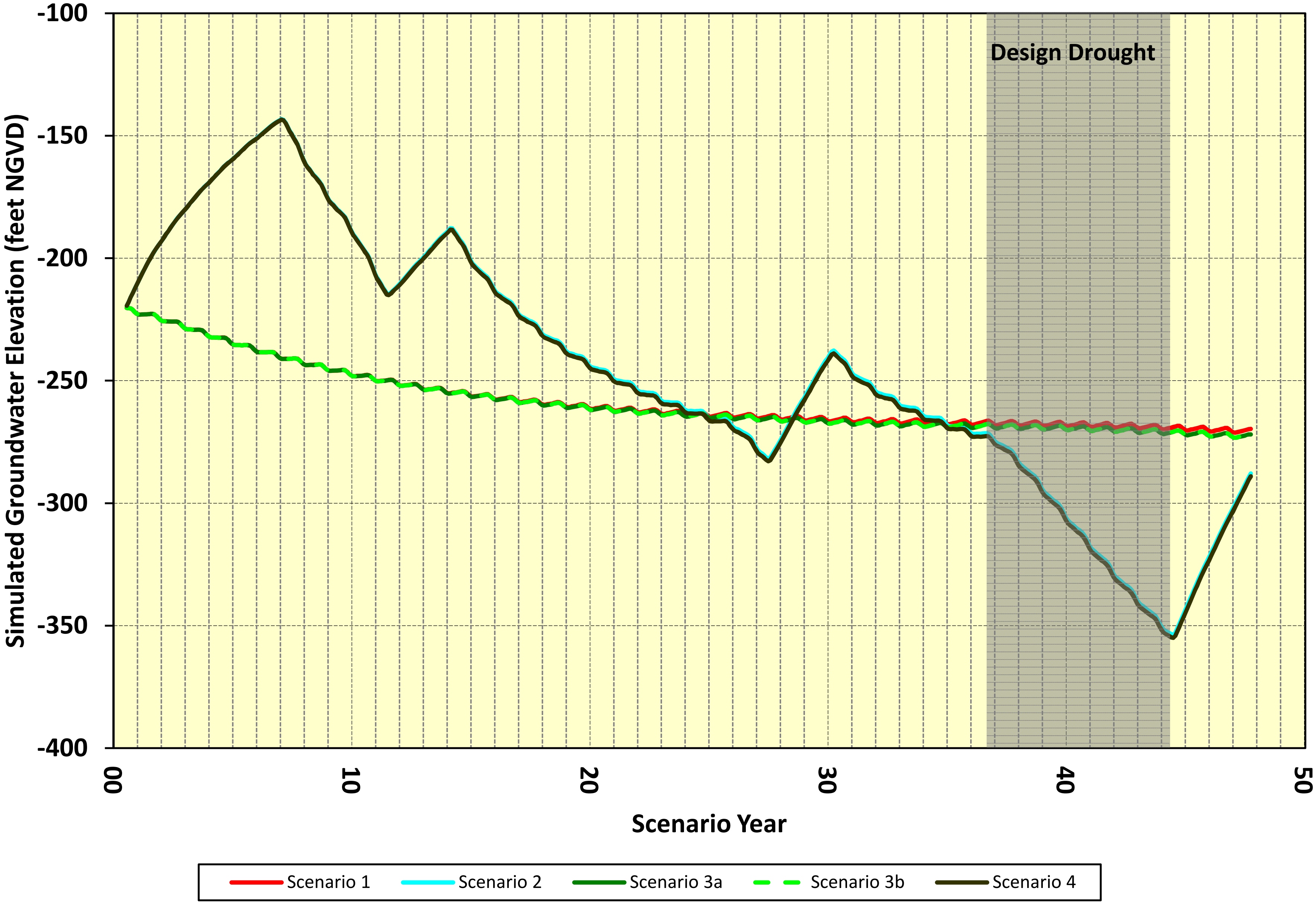


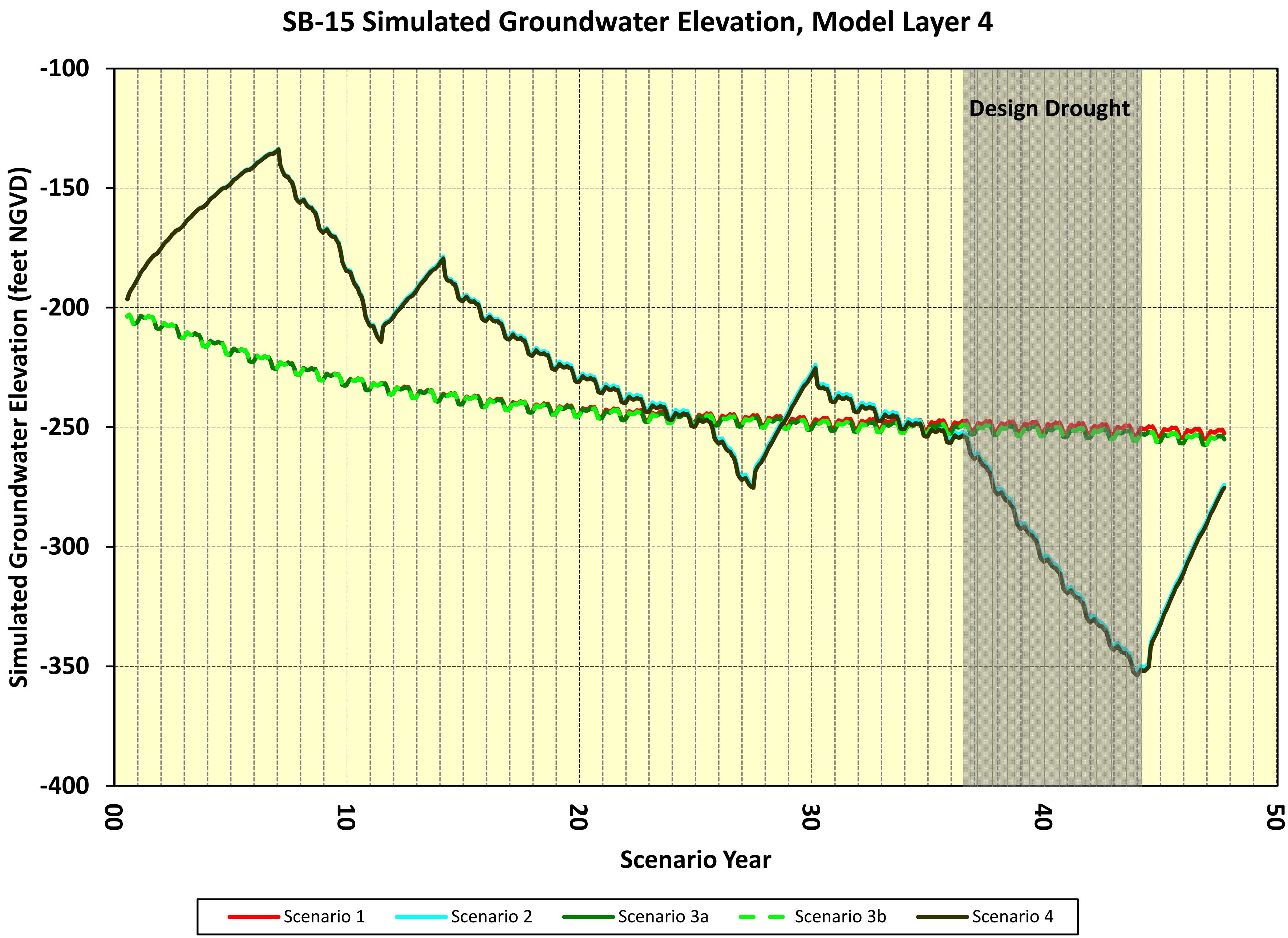
SSF-18 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
0
-50
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

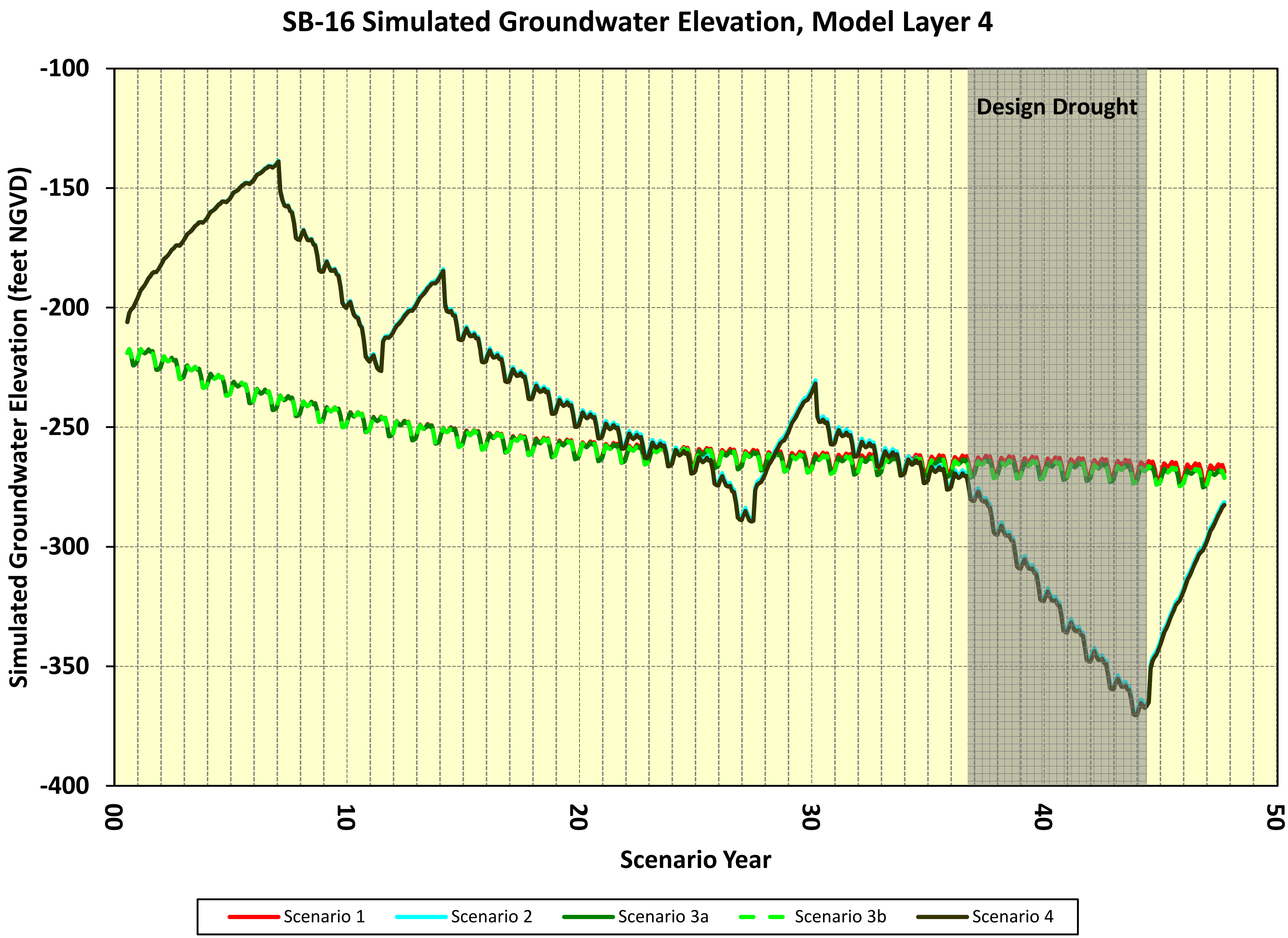


SB-12 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Simulated Groundwater Elevation (feet NGVD)
-100
-150
-200
-250
-300
-350
-400
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

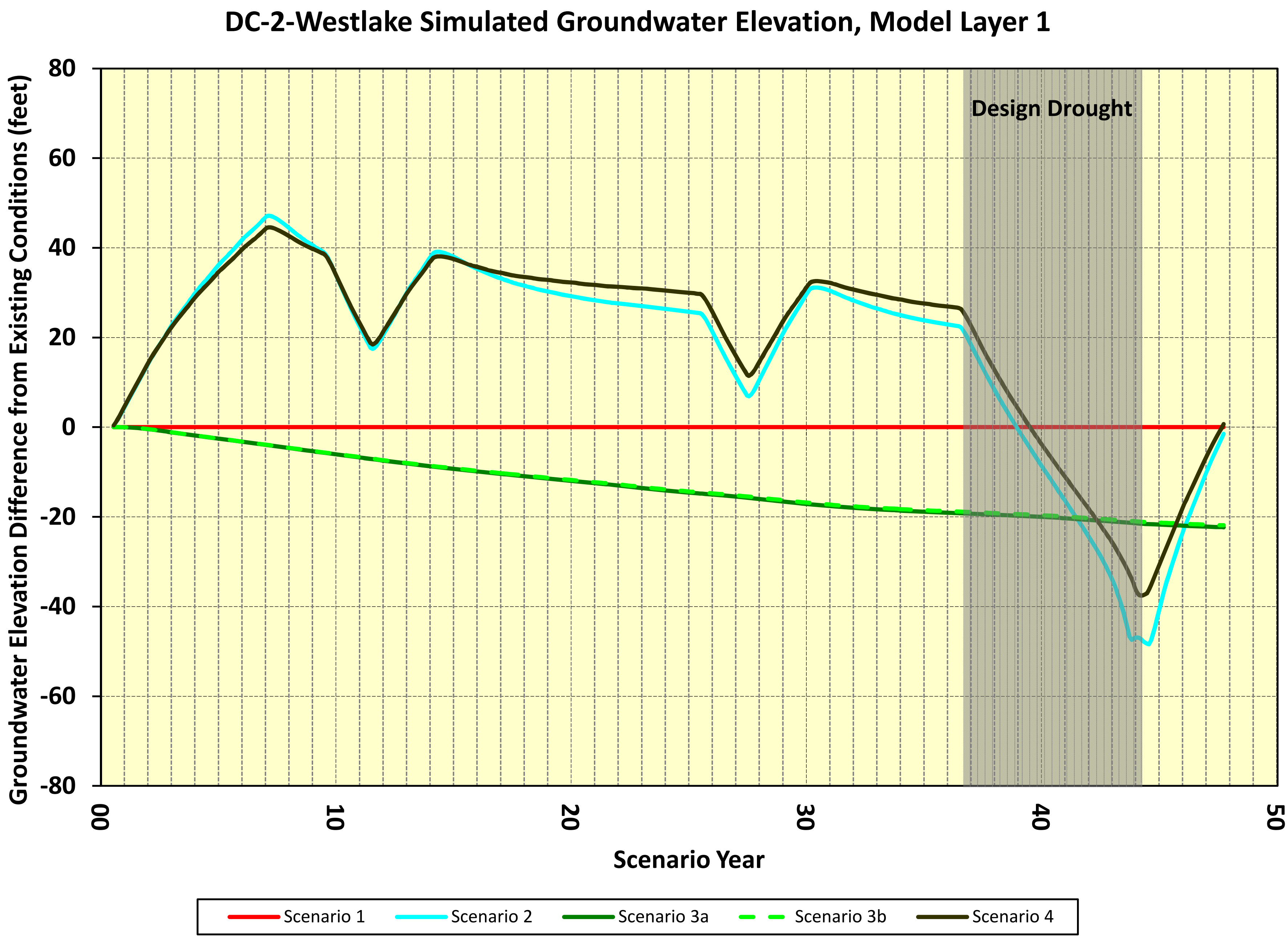
SB-13 Simulated Groundwater Elevation, Model Layer 4

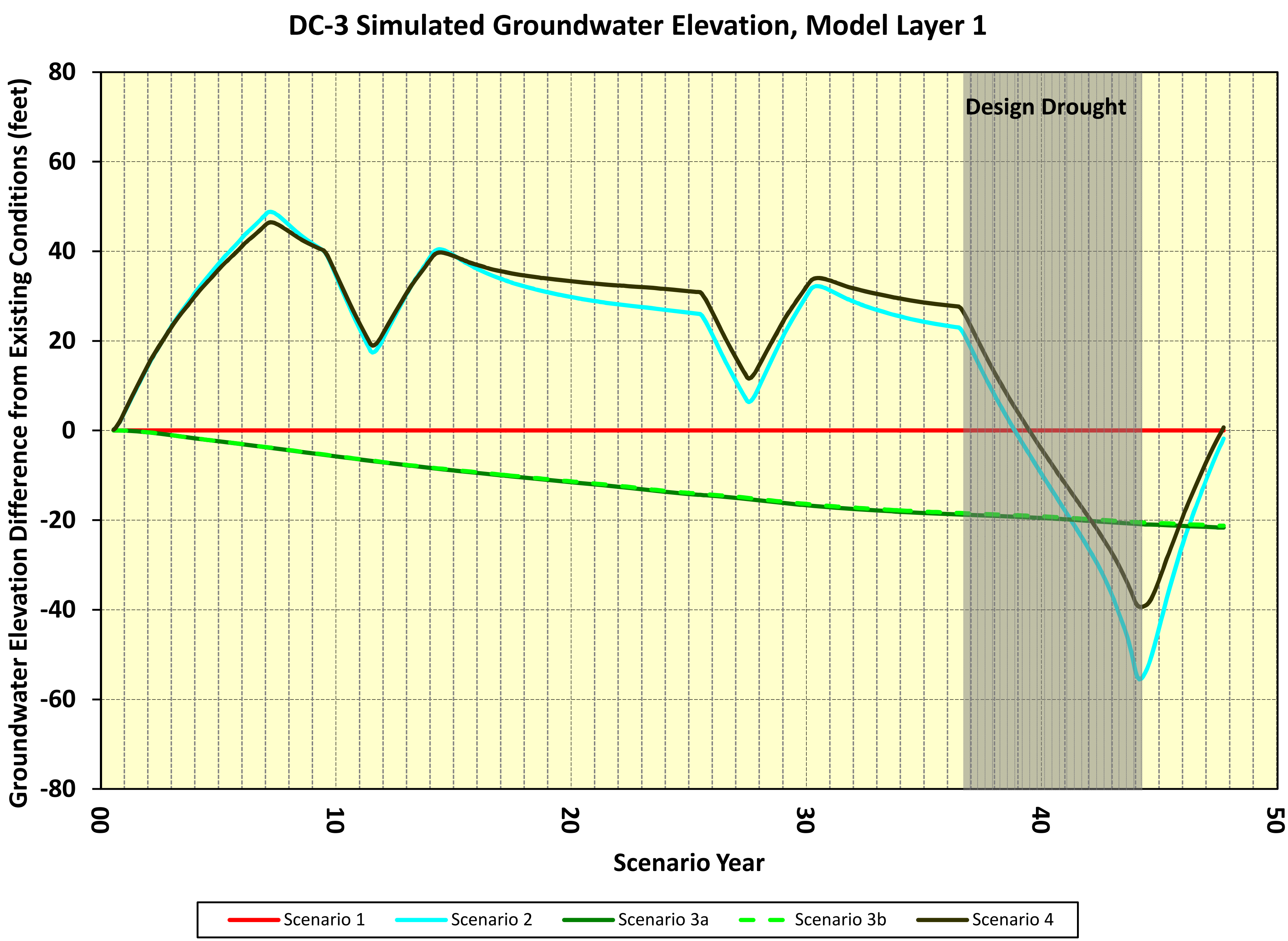


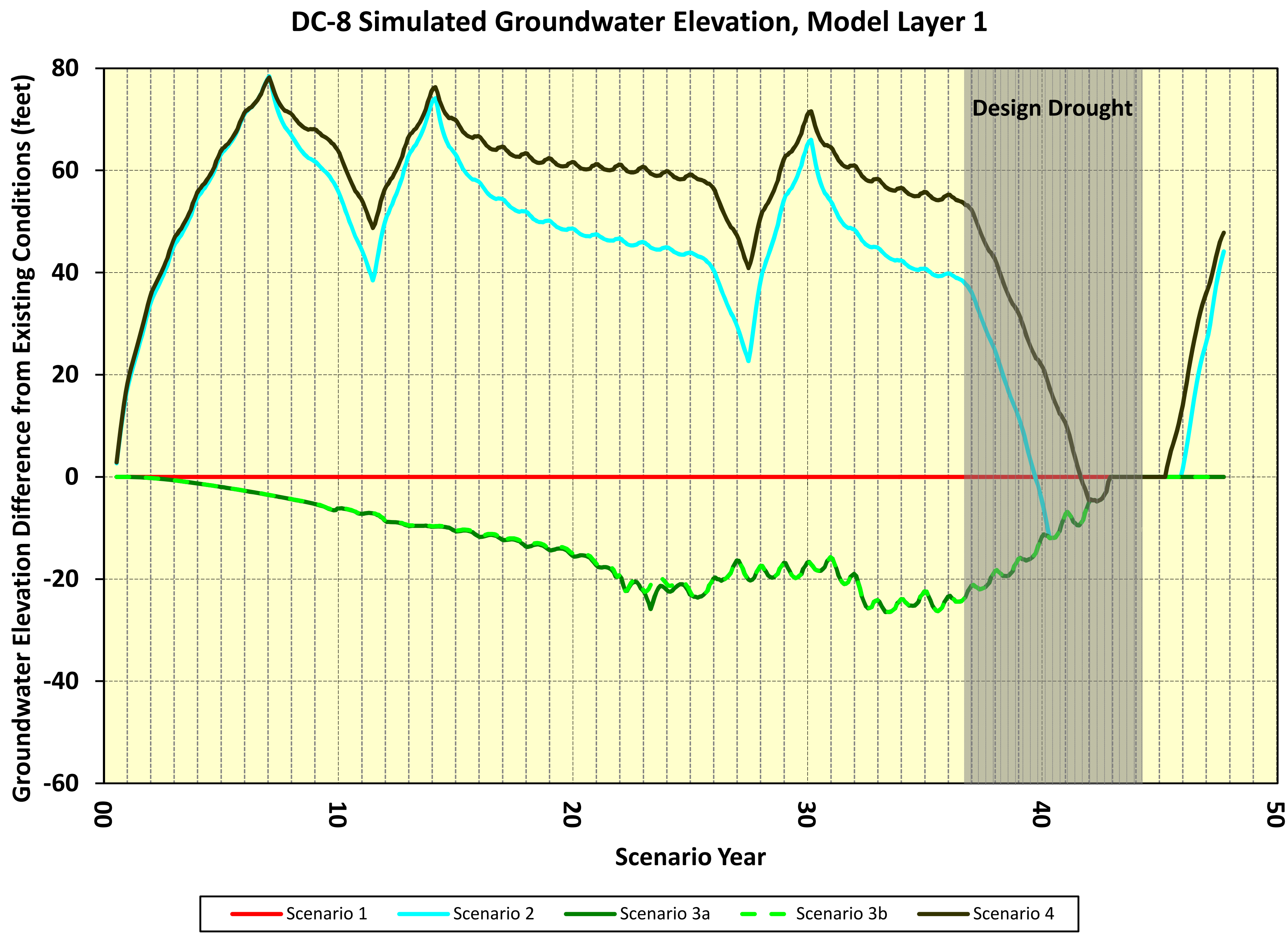

SB-15 Simulated Groundwater Elevation, Model Layer 4
Design Drought
-100
-150
-200
-250
-300
-350
-400
Simulated Groundwater Elevation (feet NGVD)
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



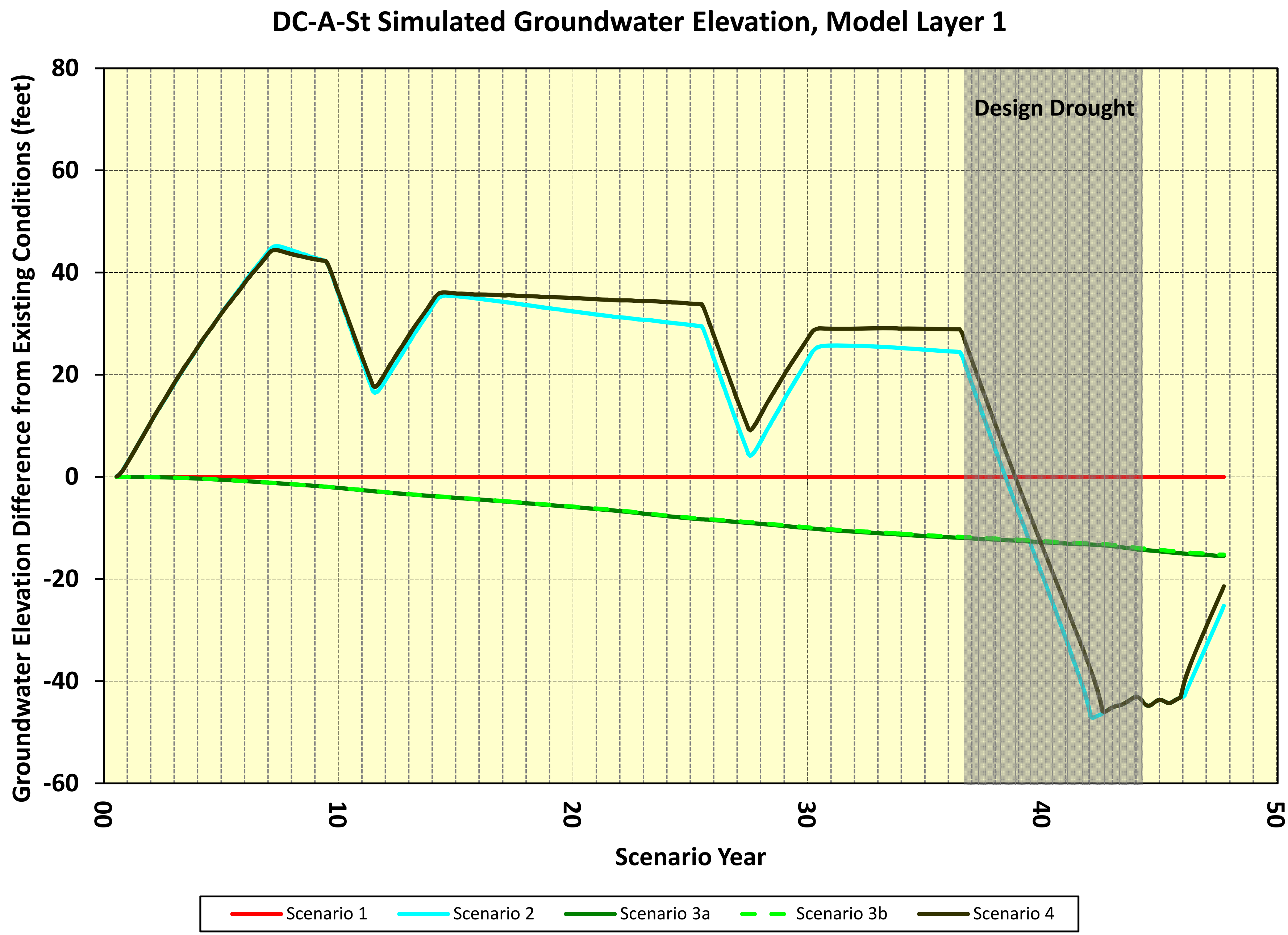
SB-16 Simulated Groundwater Elevation, Model Layer 4
Simulated Groundwater Elevation (feet NGVD)
-100
-150
-200
-250
-300
-350
-400
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4


DC-2-Westlake Simulated Groundwater Elevation, Model Layer 1
Groundwater Elevation Difference from Existing Conditions (feet)
80
60
40
20
0
-20
-40
-60
-80
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

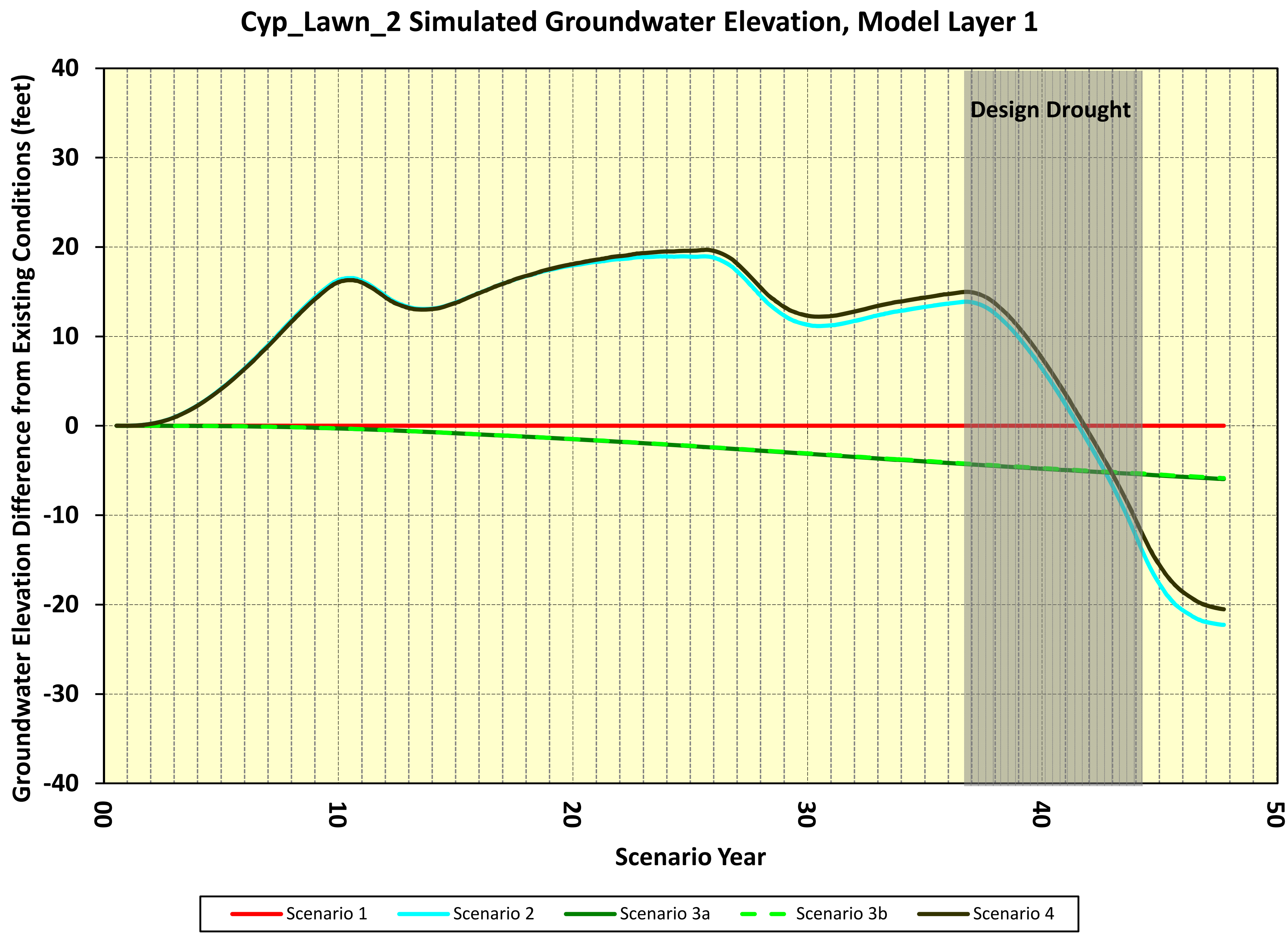

DC-3 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Groundwater Elevation Difference from Existing Conditions (feet)
80
60
40
20
0
-20
-40
-60
-80
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



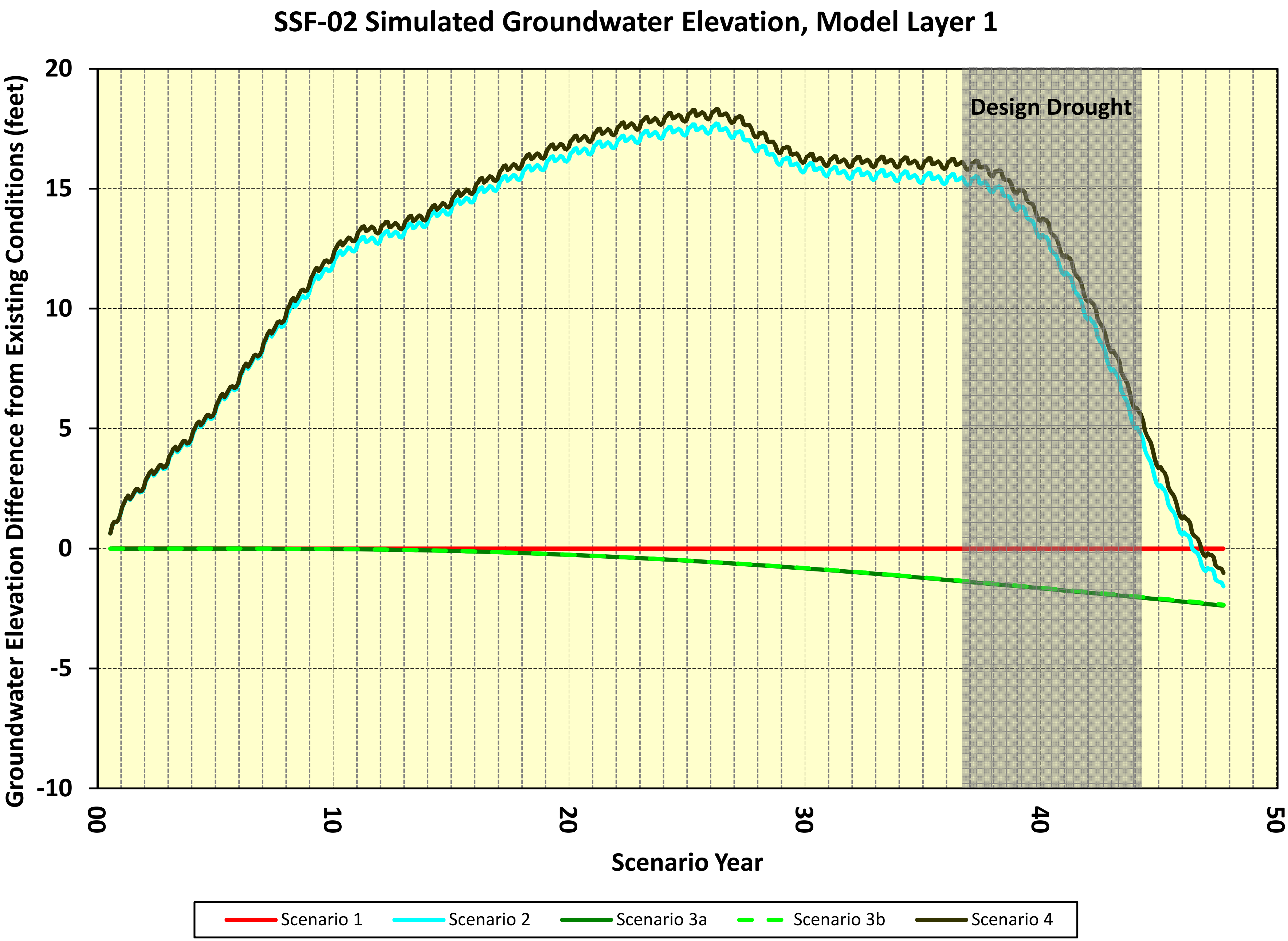
DC-8 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Groundwater Elevation Difference from Existing Conditions (feet)
80
60
40
20
0
-20
-40
-60
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



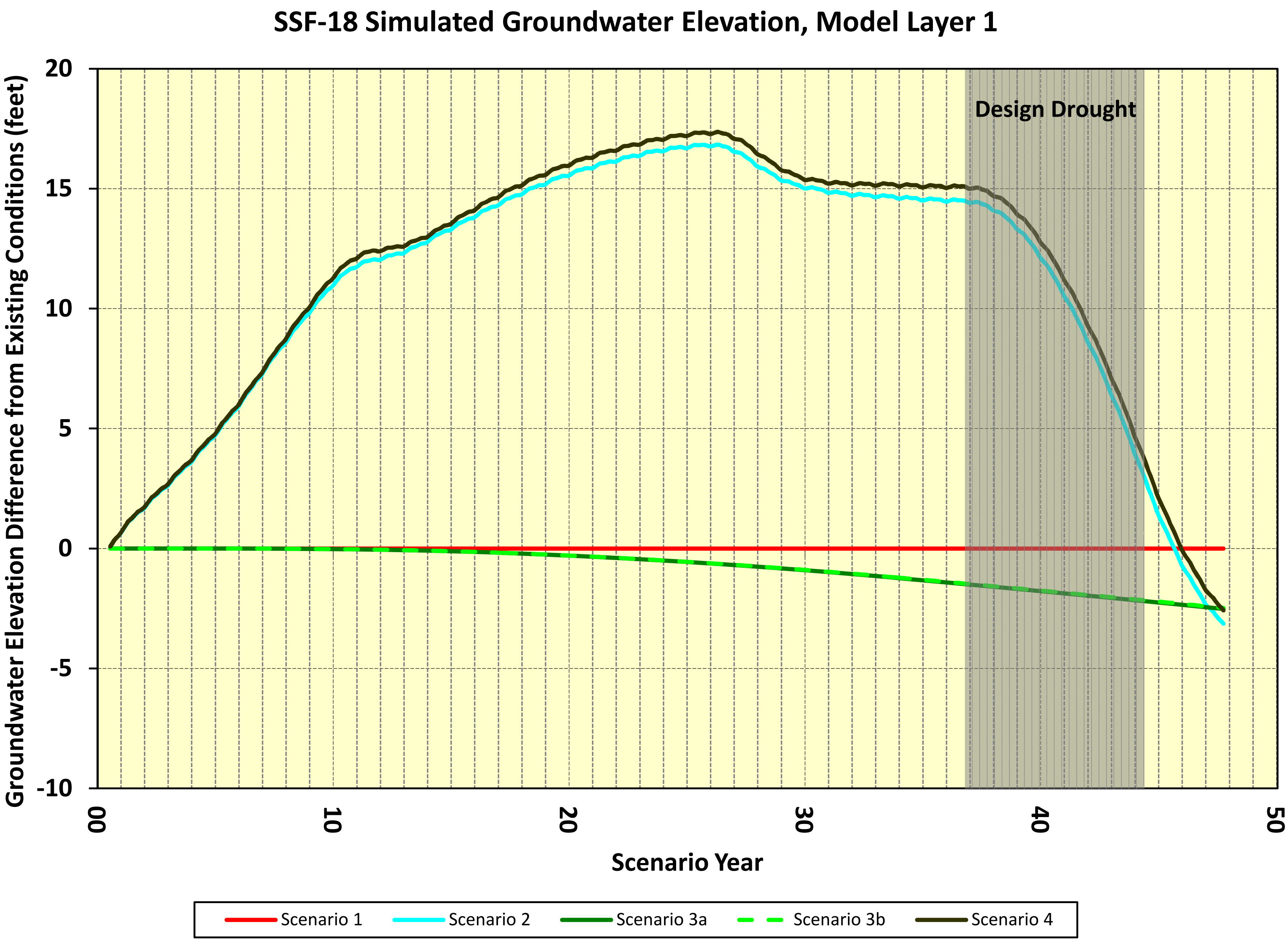
DC-A-St Simulated Groundwater Elevation, Model Layer 1
Design Drought
Groundwater Elevation Difference from Existing Conditions (feet)
80
60
40
20
0
-20
-40
-60
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

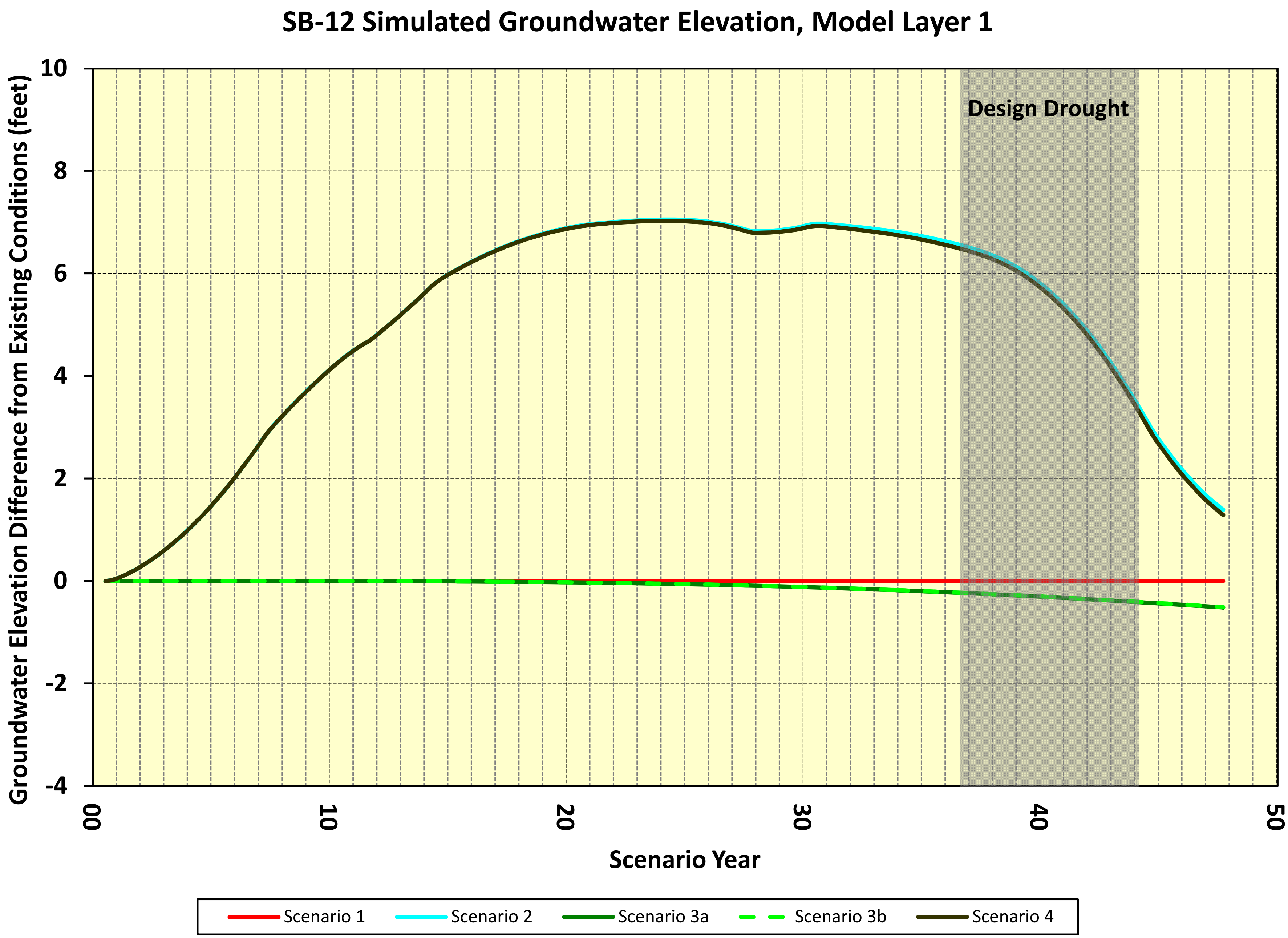


Cyp_Lawn_2 Simulated Groundwater Elevation, Model Layer 1
Groundwater Elevation Difference from Existing Conditions (feet)
40
30
20
10
0
-10
-20
-30
-40
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

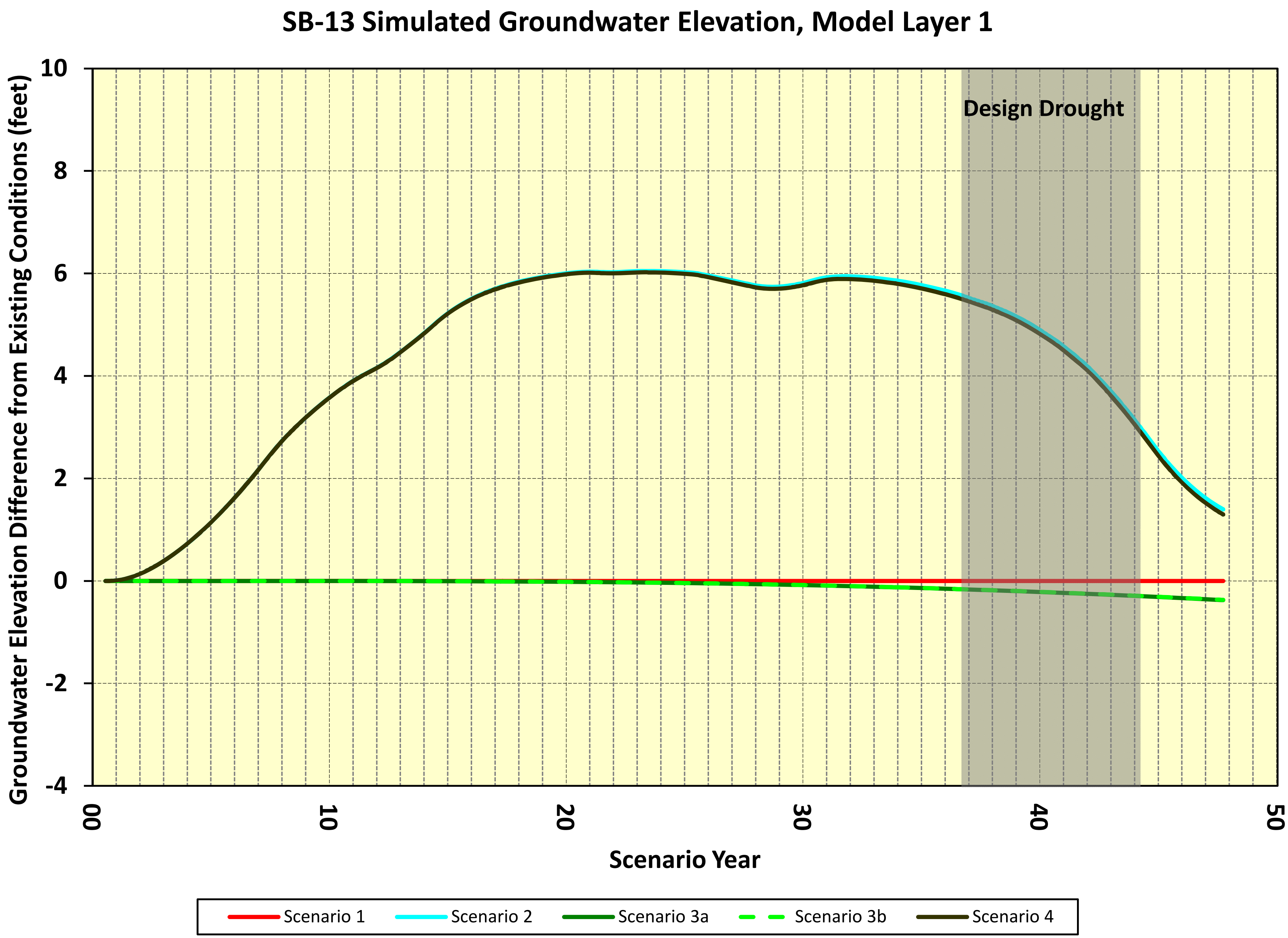


SSF-02 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Groundwater Elevation Difference from Existing Conditions (feet)
20
15
10
5
0
-5
-10
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

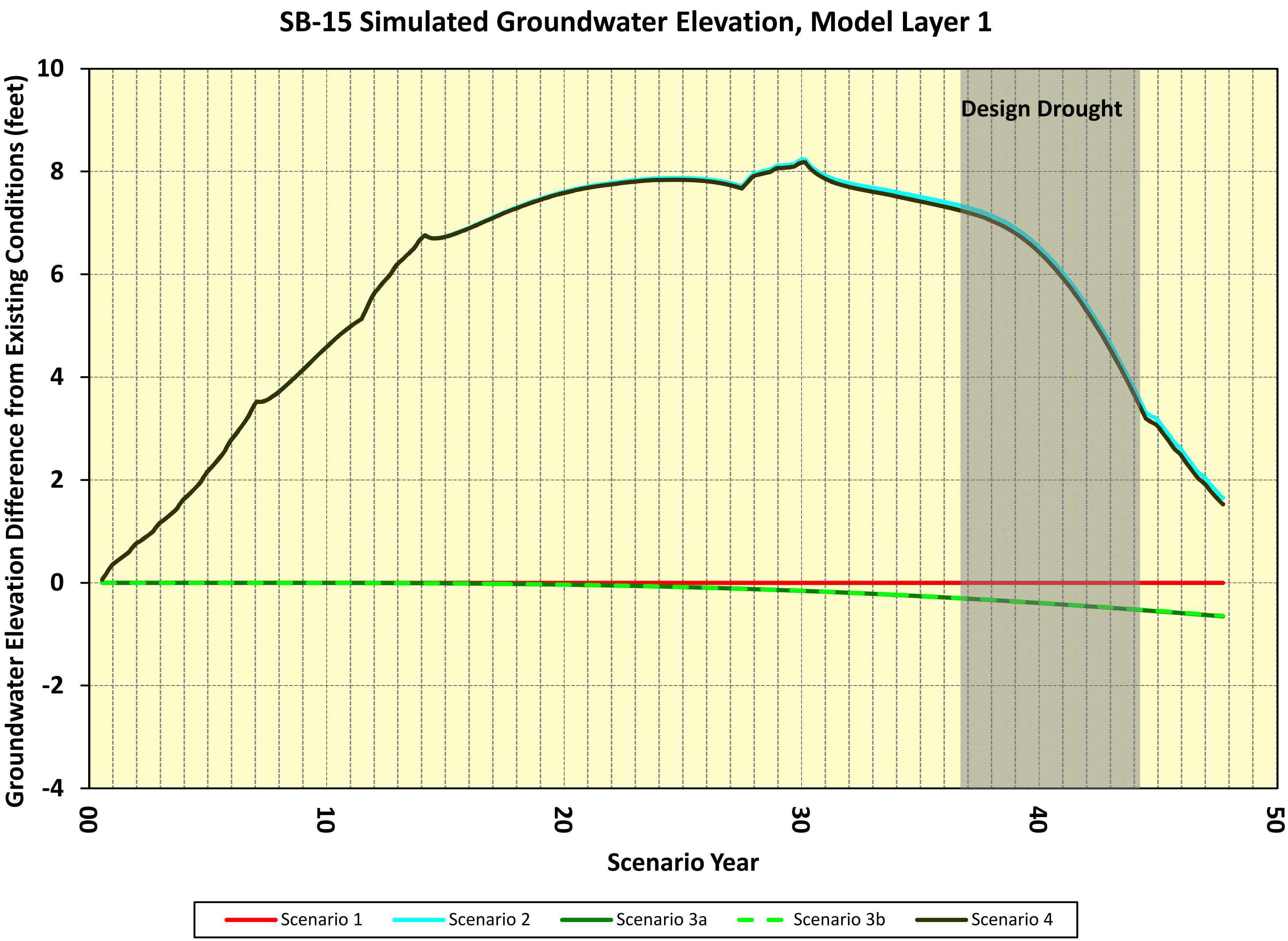

SSF-18 Simulated Groundwater Elevation, Model Layer 1
Groundwater Elevation Difference from Existing Conditions (feet)
20
15
10
5
0
-5
-10
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



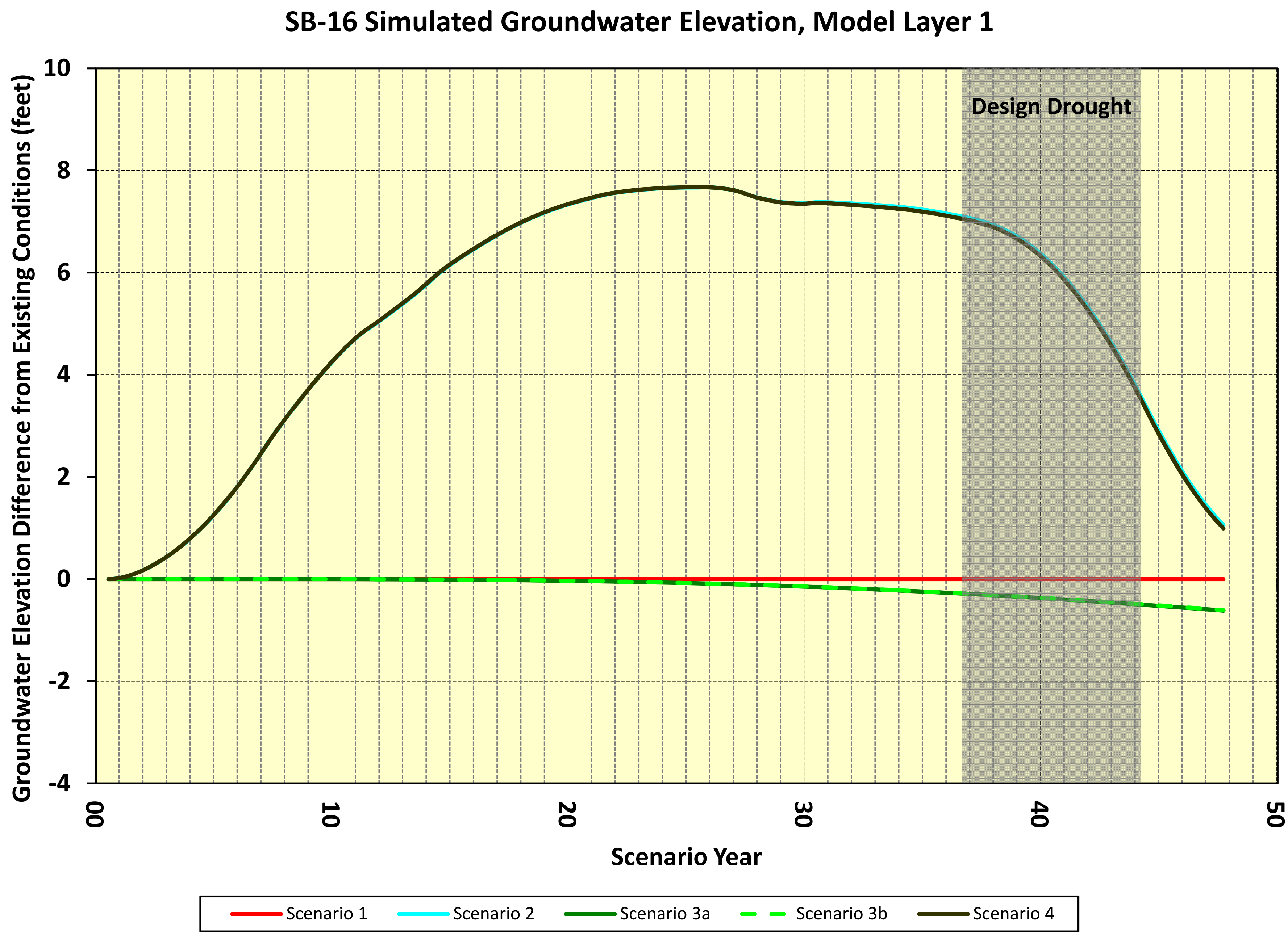
SB-12 Simulated Groundwater Elevation, Model Layer 1
Groundwater Elevation Difference from Existing Conditions (feet)
10
8
6
4
2
0
-2
-4
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



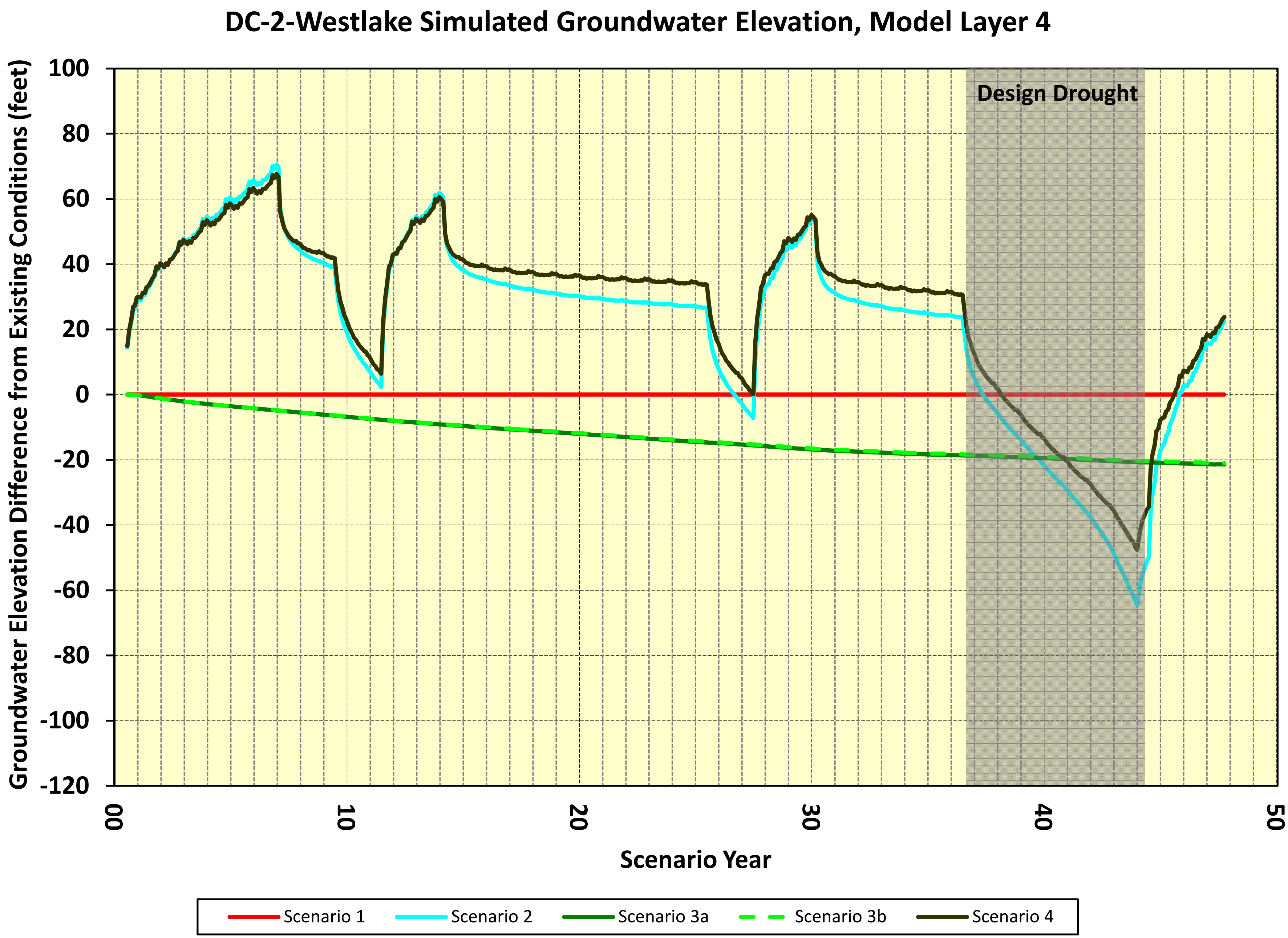
SB-13 Simulated Groundwater Elevation, Model Layer 1
Design Drought
Groundwater Elevation Difference from Existing Conditions (feet)
10
8
6
4
2
0
-2
-4
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



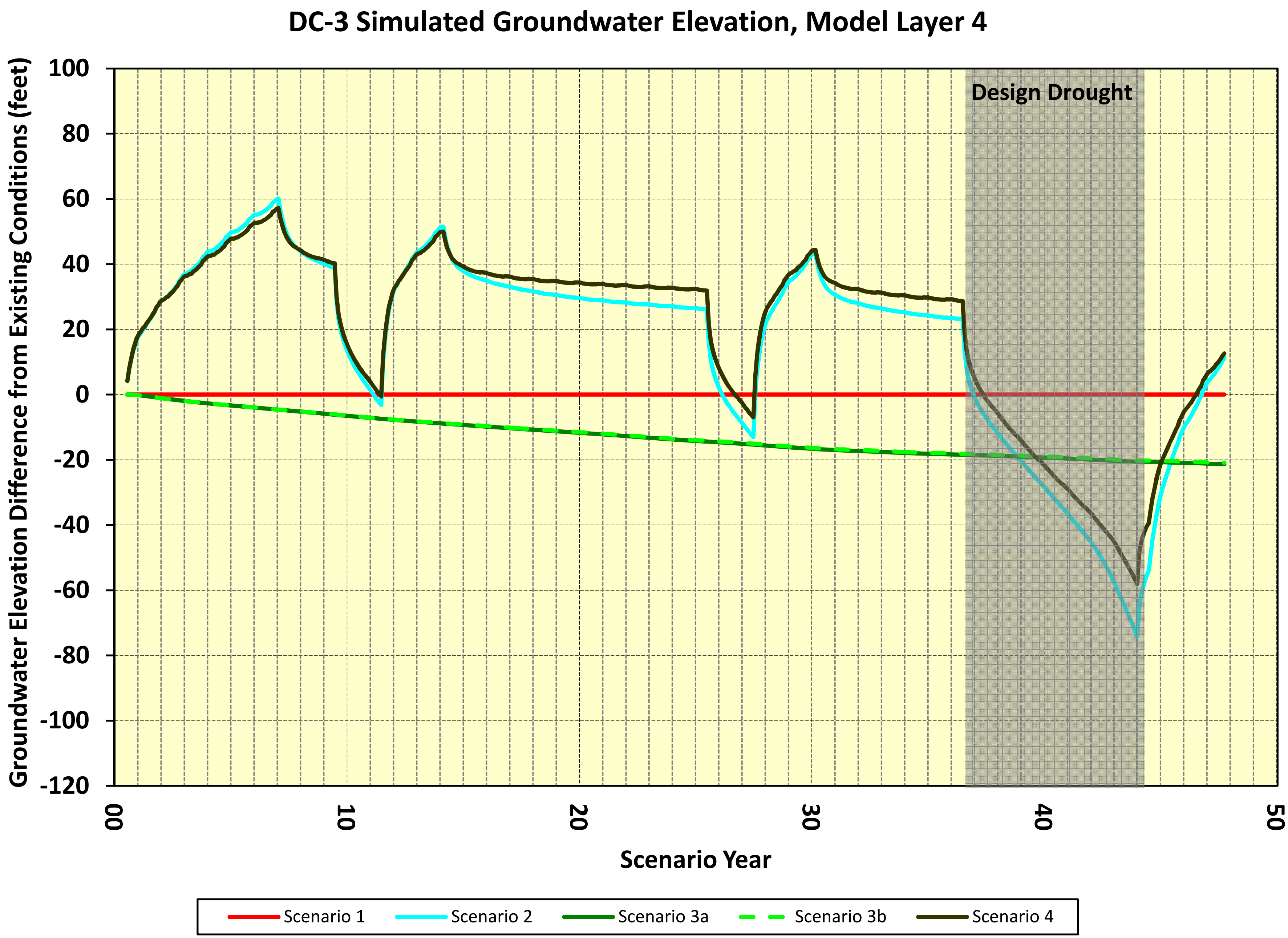
SB-15 Simulated Groundwater Elevation, Model Layer 1
Groundwater Elevation Difference from Existing Conditions (feet)
10
8
6
4
2
0
-2
-4
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



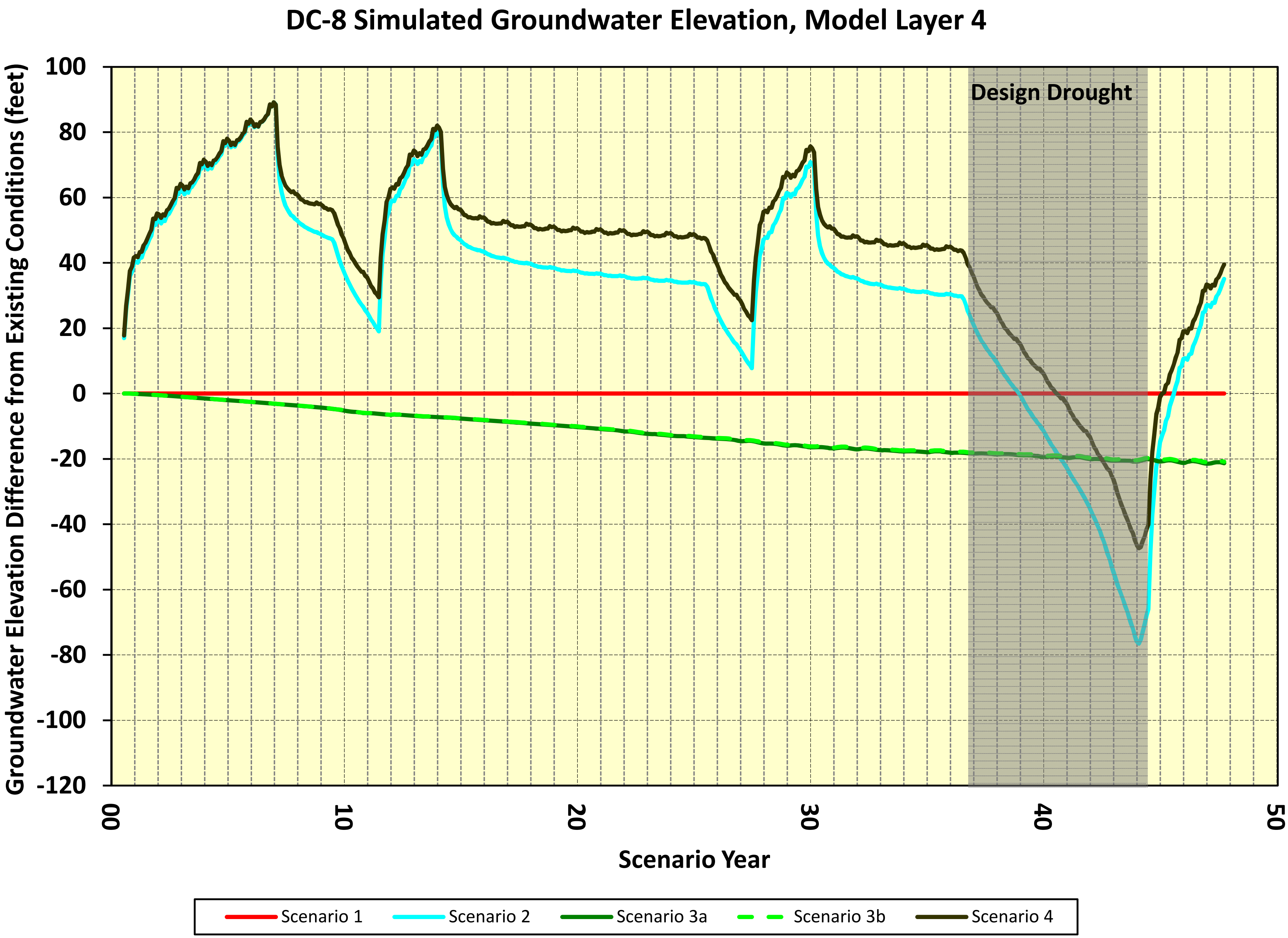
SB-16 Simulated Groundwater Elevation, Model Layer 1
Groundwater Elevation Difference from Existing Conditions (feet)
10
8
6
4
2
0
-2
-4
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



DC-2-Westlake Simulated Groundwater Elevation, Model Layer 4
Groundwater Elevation Difference from Existing Conditions (feet)
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

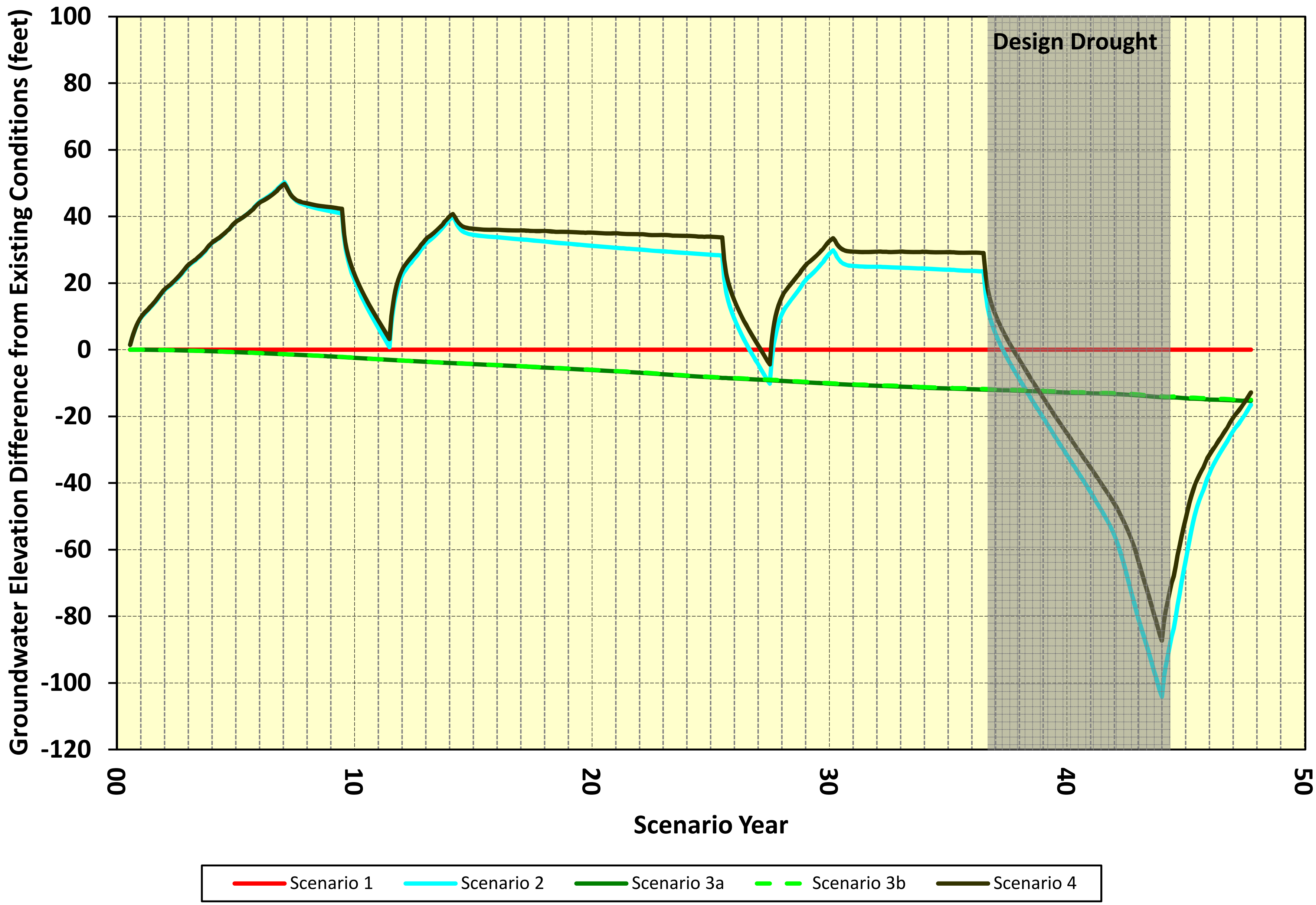


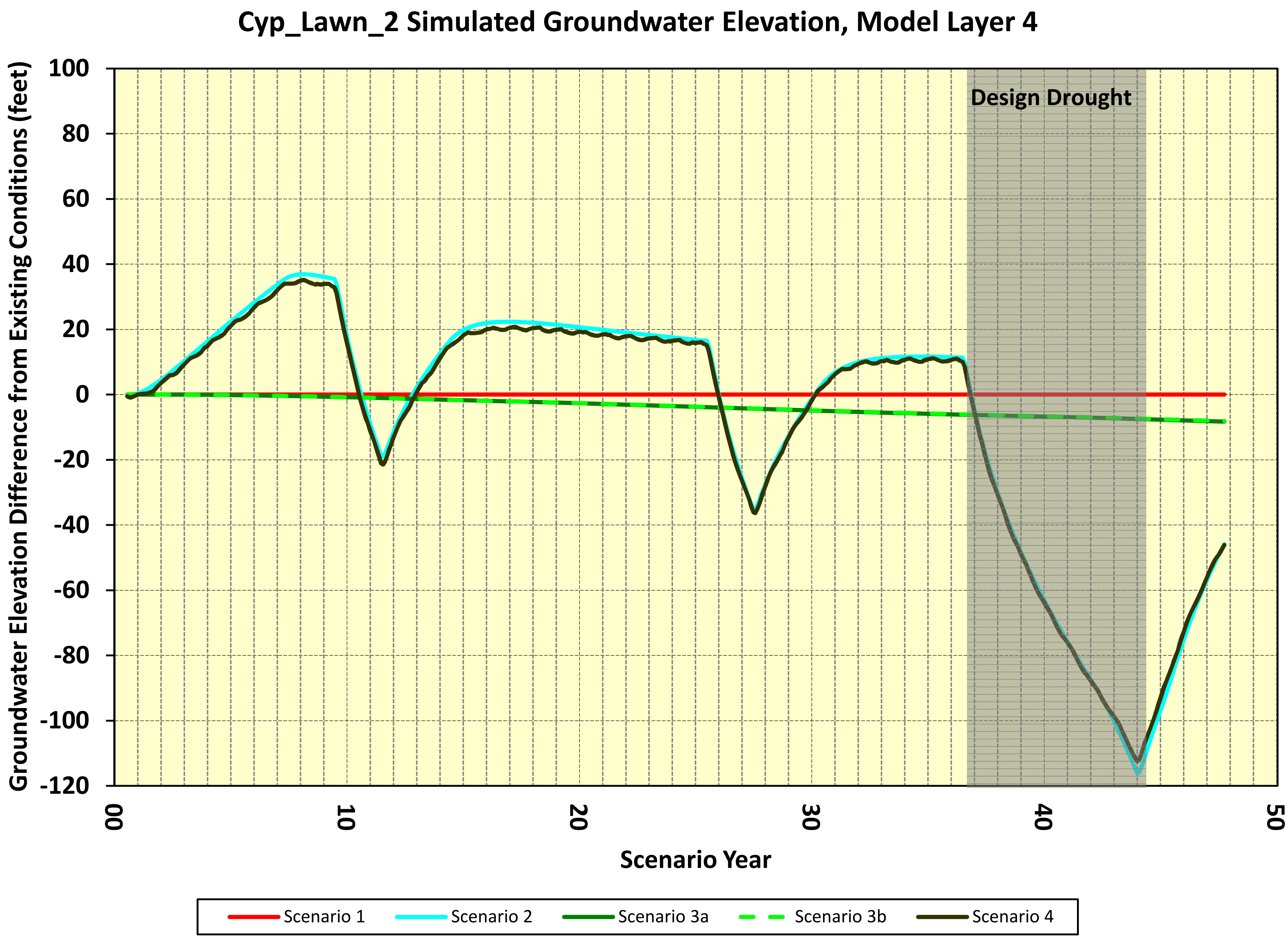
DC-3 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Groundwater Elevation Difference from Existing Conditions (feet)
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



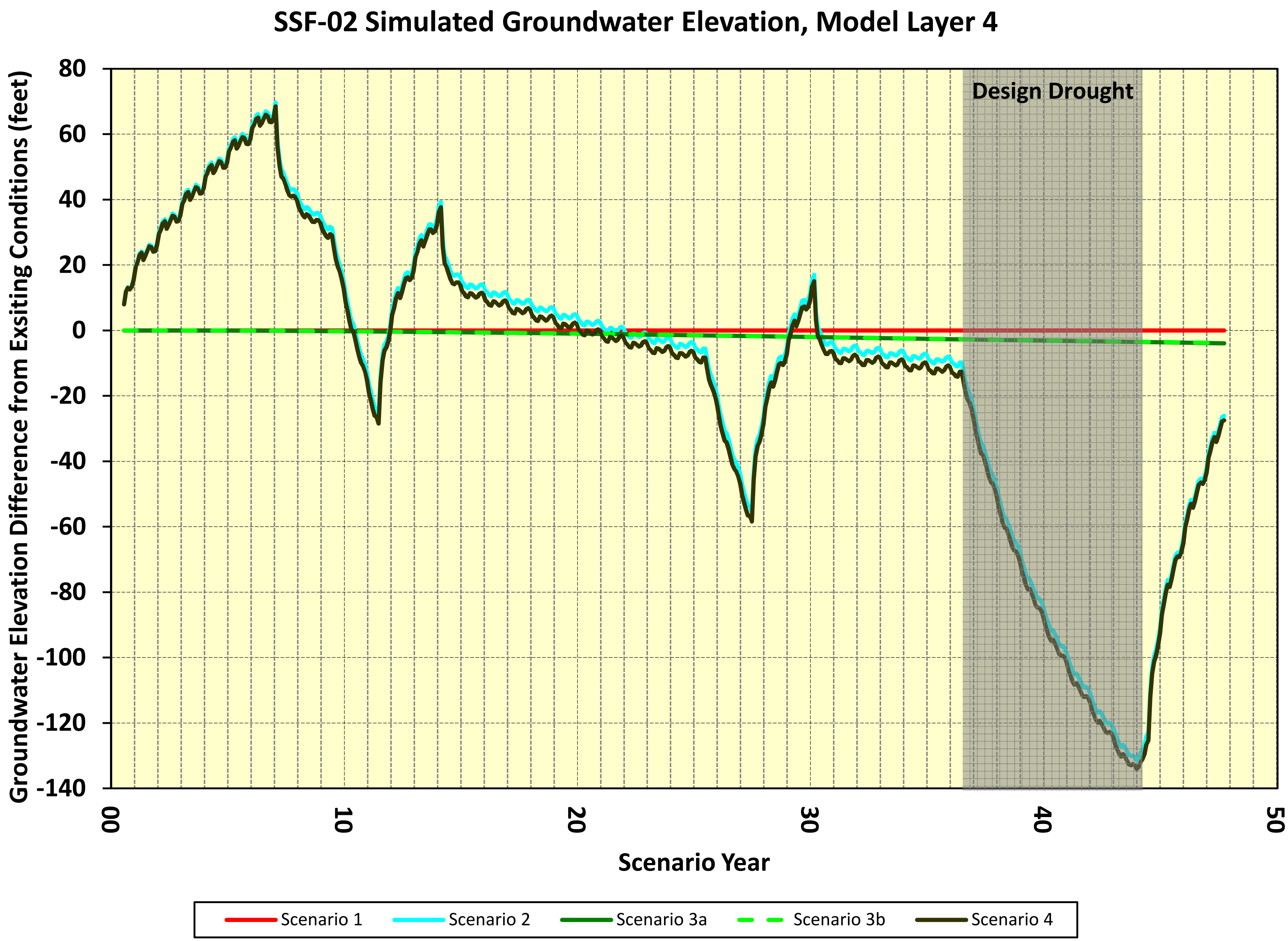
DC-8 Simulated Groundwater Elevation, Model Layer 4
Groundwater Elevation Difference from Existing Conditions (feet)
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

DC-A-St Simulated Groundwater Elevation, Model Layer 4

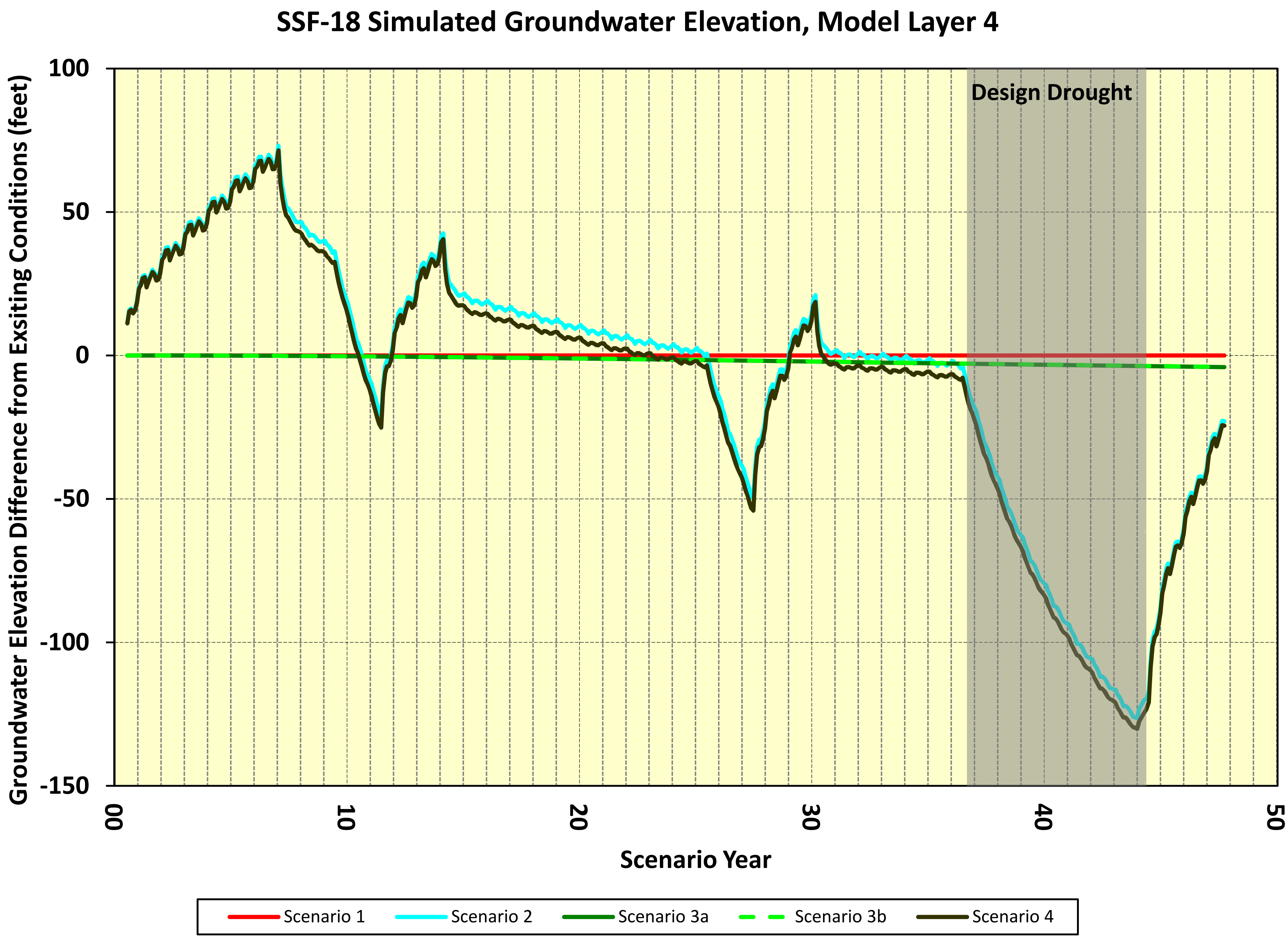


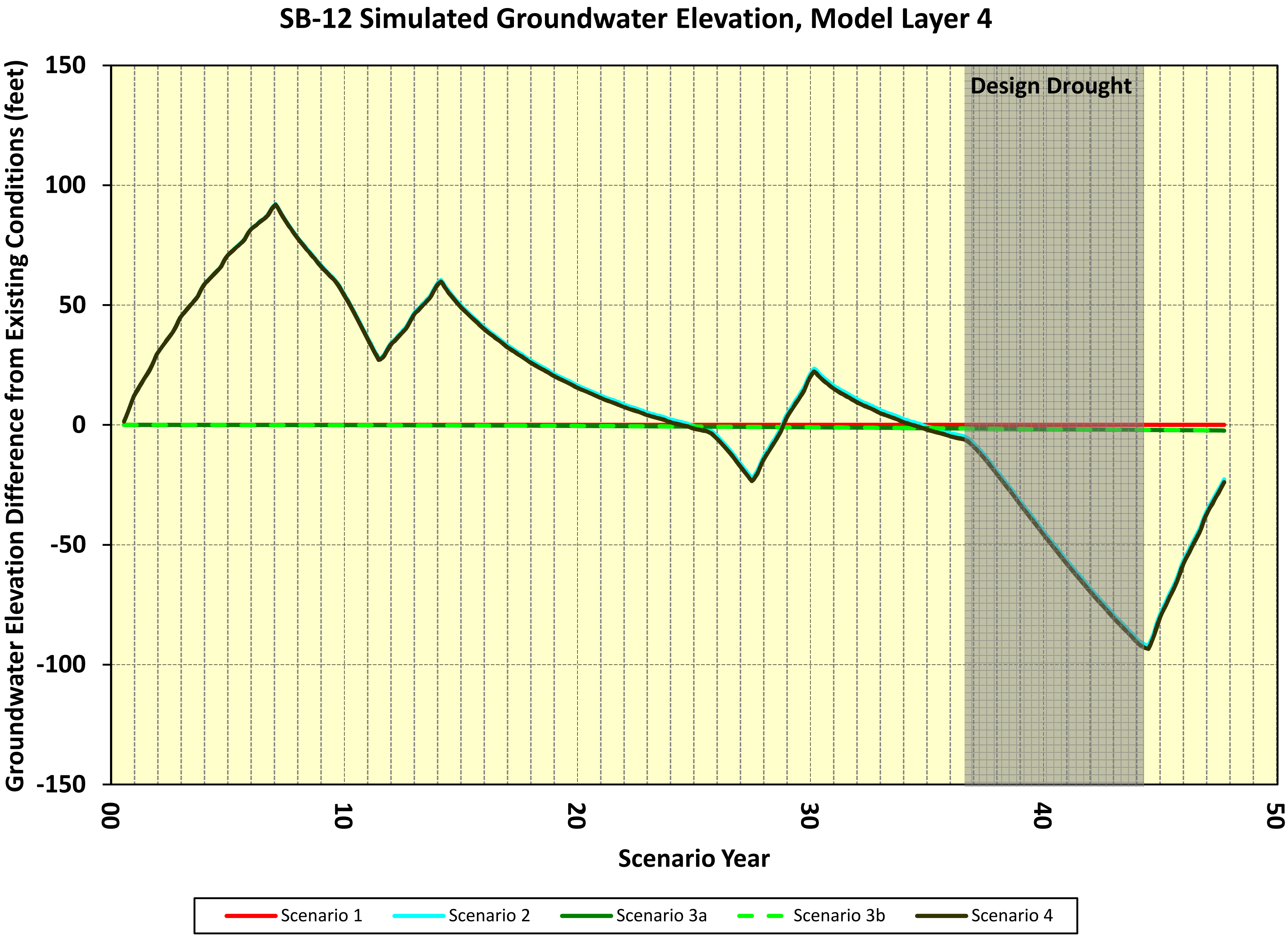


Cyp_Lawn_2 Simulated Groundwater Elevation, Model Layer 4
Groundwater Elevation Difference from Existing Conditions (feet)
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

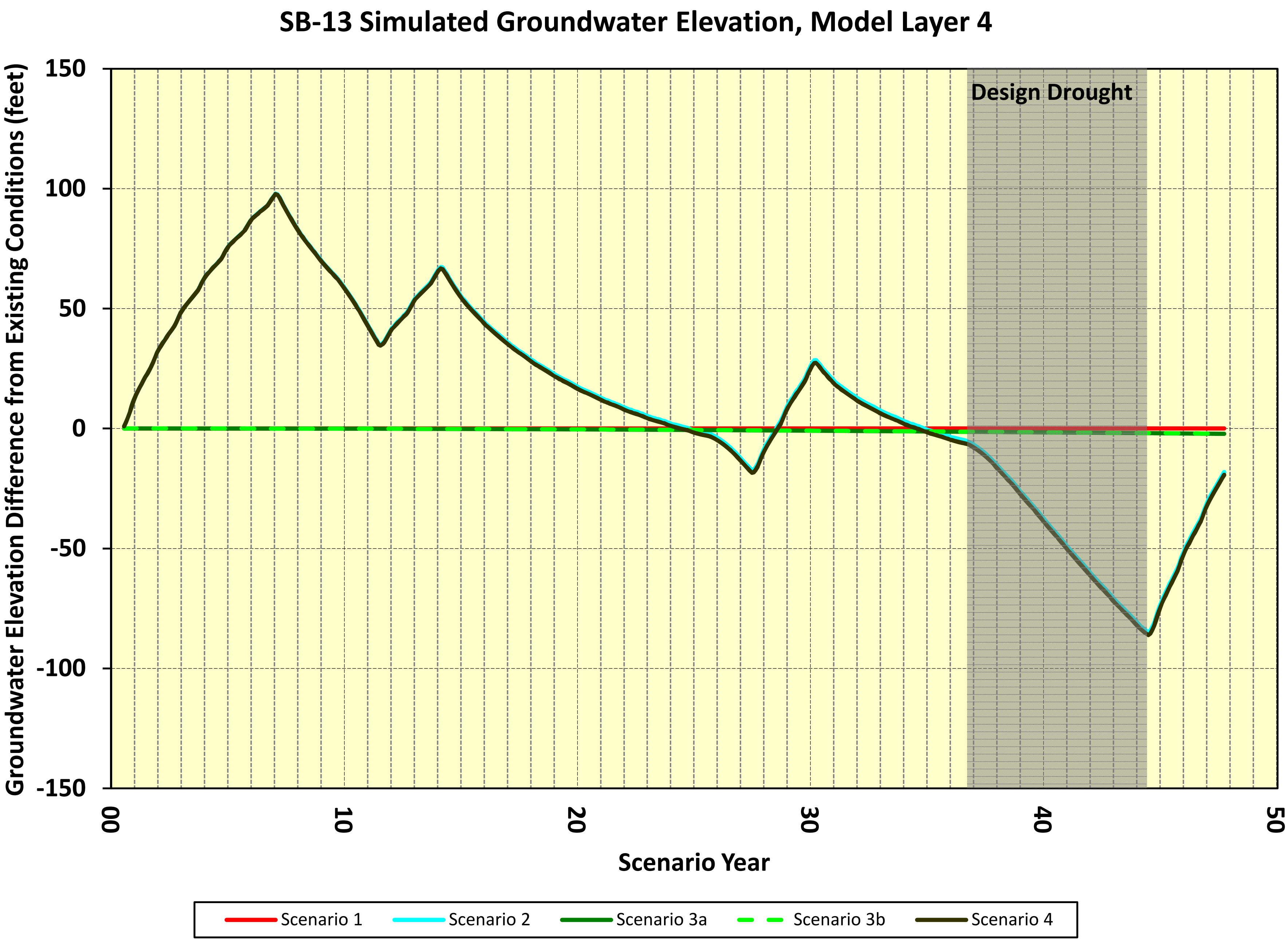


SSF-02 Simulated Groundwater Elevation, Model Layer 4
Groundwater Elevation Difference from Exsiting Conditions (feet)
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

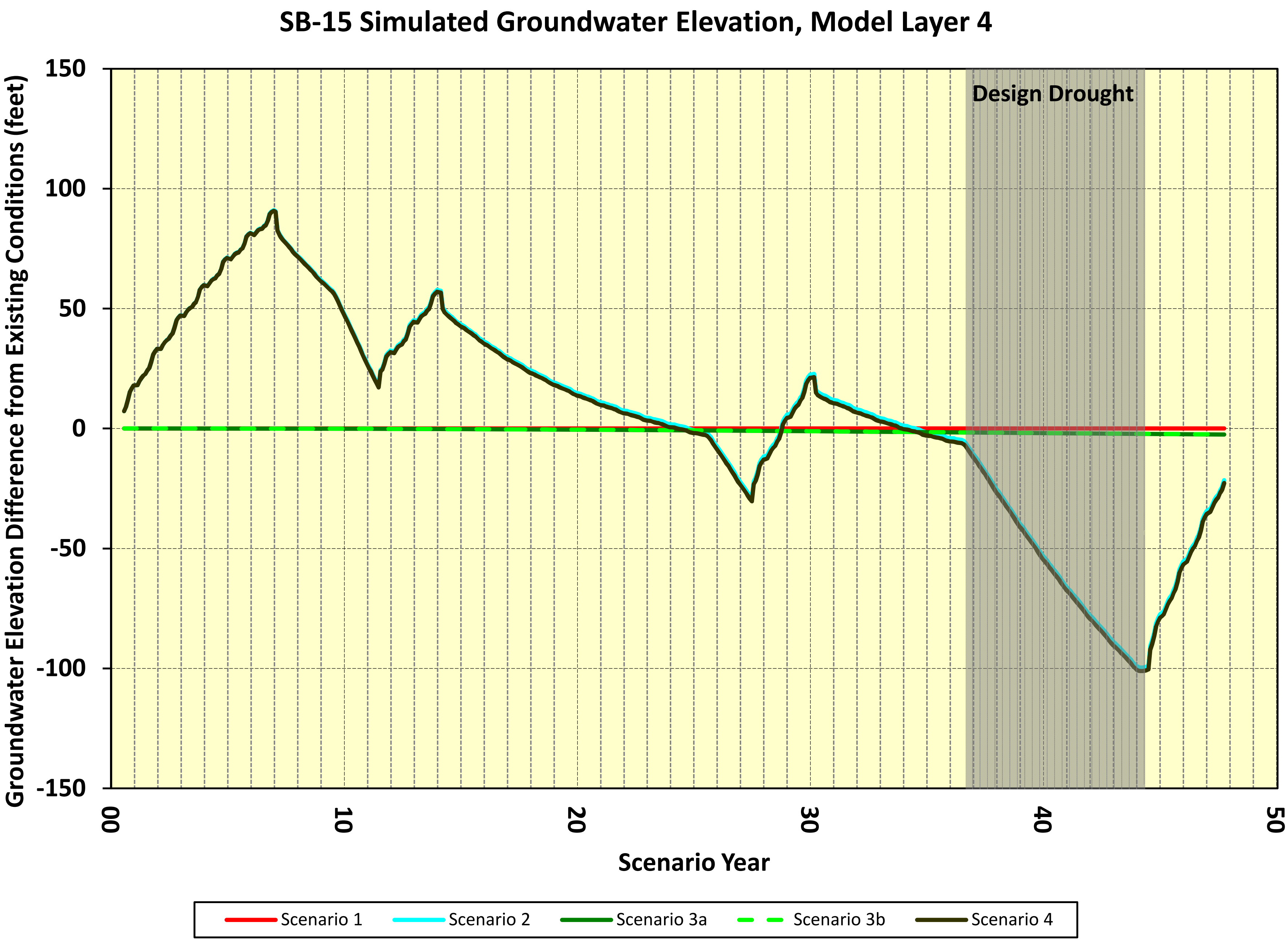

SSF-18 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Groundwater Elevation Difference from Exsiting Conditions (feet)
100
50
0
-50
-100
-150
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

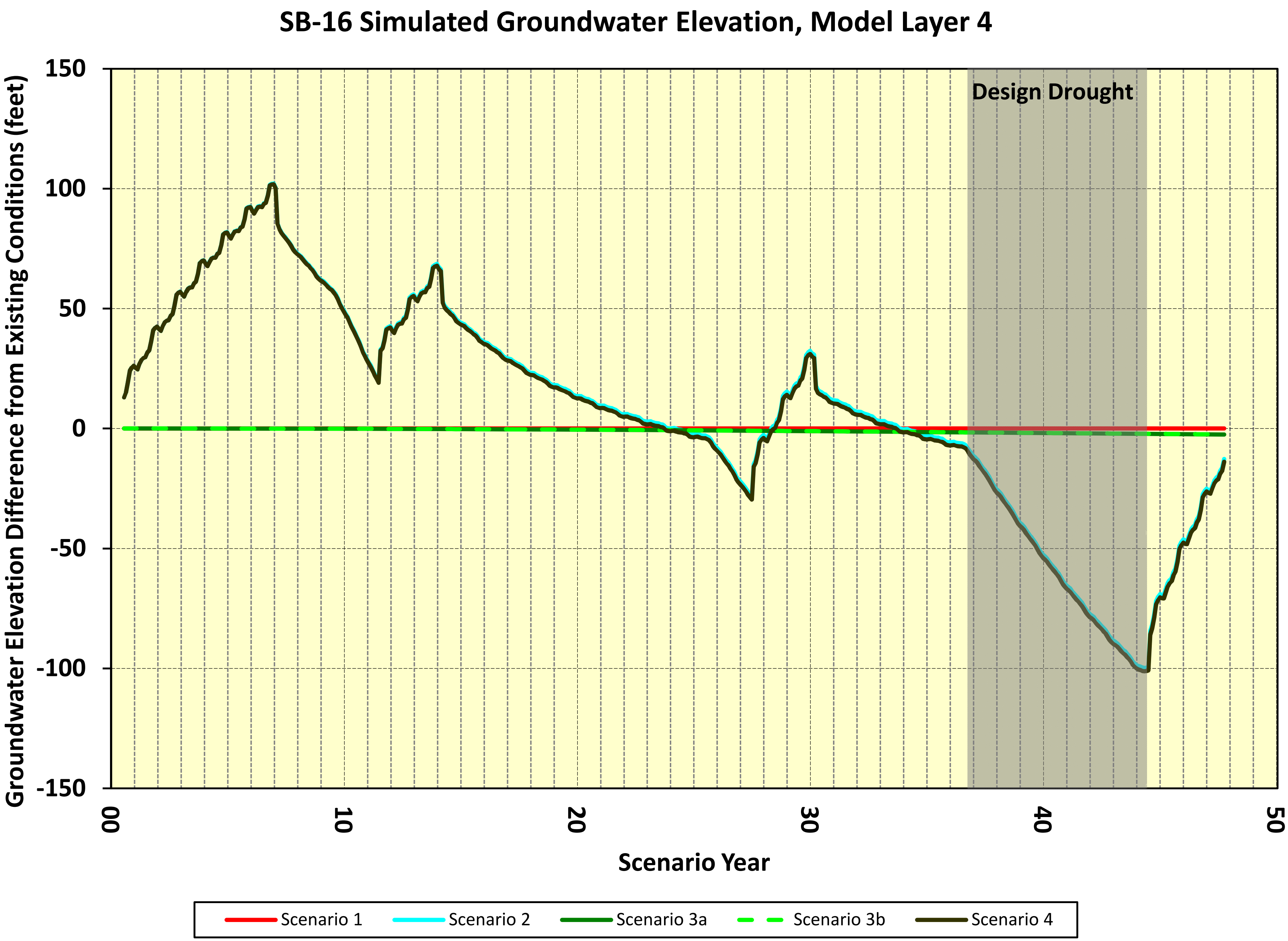


SB-12 Simulated Groundwater Elevation, Model Layer 4
Groundwater Elevation Difference from Existing Conditions (feet)
150
100
50
0
-50
-100
-150
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4



SB-13 Simulated Groundwater Elevation, Model Layer 4
Groundwater Elevation Difference from Existing Conditions (feet)
150
100
50
0
-50
-100
-150
Design Drought
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

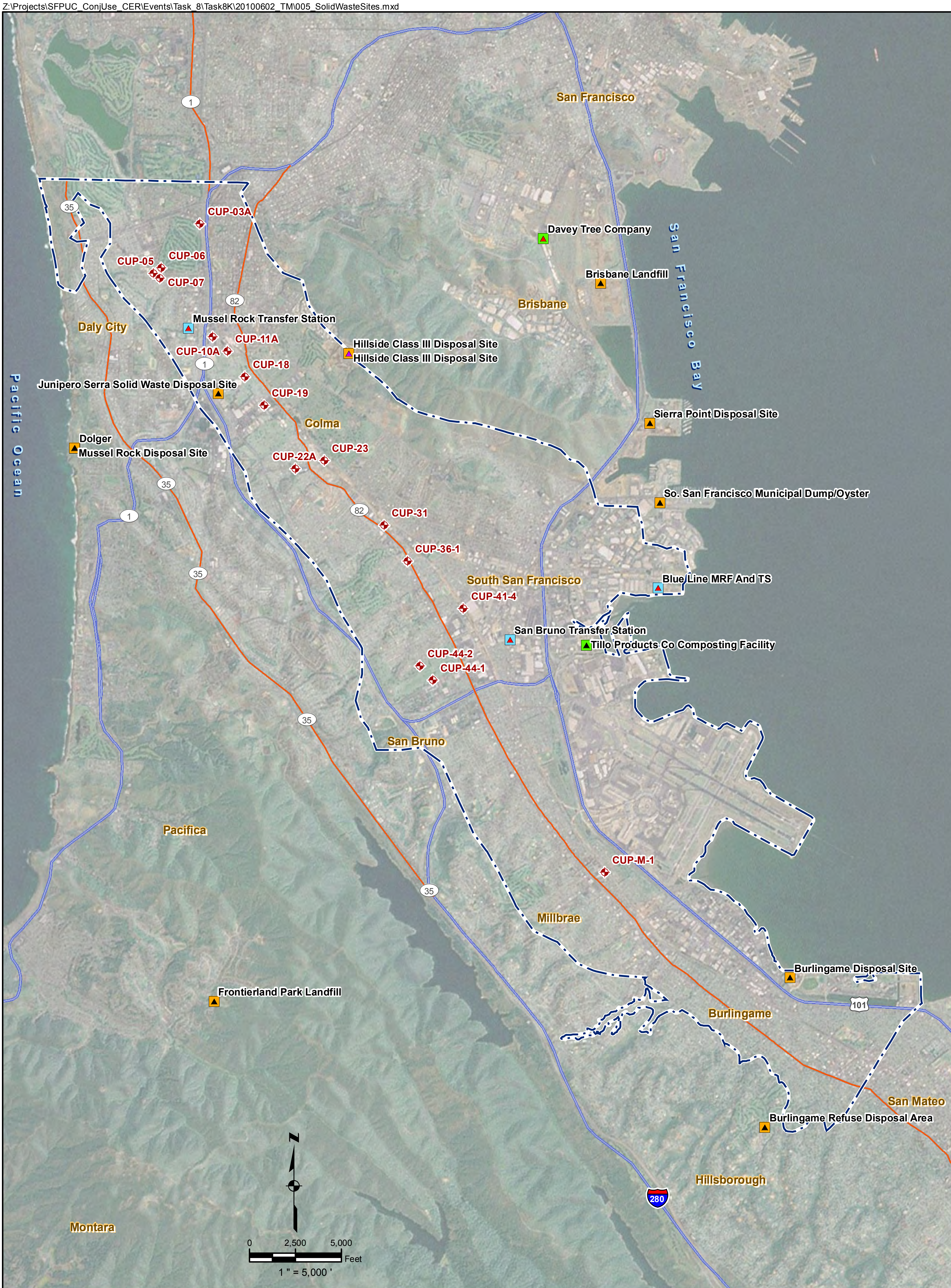

SB-15 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Groundwater Elevation Difference from Existing Conditions (feet)
150
100
50
0
-50
-100
-150
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4


SB-16 Simulated Groundwater Elevation, Model Layer 4
Design Drought
Groundwater Elevation Difference from Existing Conditions (feet)
150
100
50
0
-50
-100
-150
00
10
20
30
40
50
Scenario Year
Scenario 1
Scenario 2
Scenario 3a
Scenario 3b
Scenario 4

Attachment 10.6-B

Existing Regulated Sites – GeoTracker, SWIS, DTSC, and SLIC

Z:\Projects\SFPUC_ConjUse_CER\Events\Task_8\Task8K\20100602_TM\005_SolidWasteSites.mxd



Legend

Solid Waste Facility Status	Solid Waste Facility Category	
Active	Composting	GSR Proposed Municipal Wells
Closed	Disposal	South Westside Groundwater Basin
Closing	Transfer/Processing	

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

SOLID WASTE FACILITY LOCATION

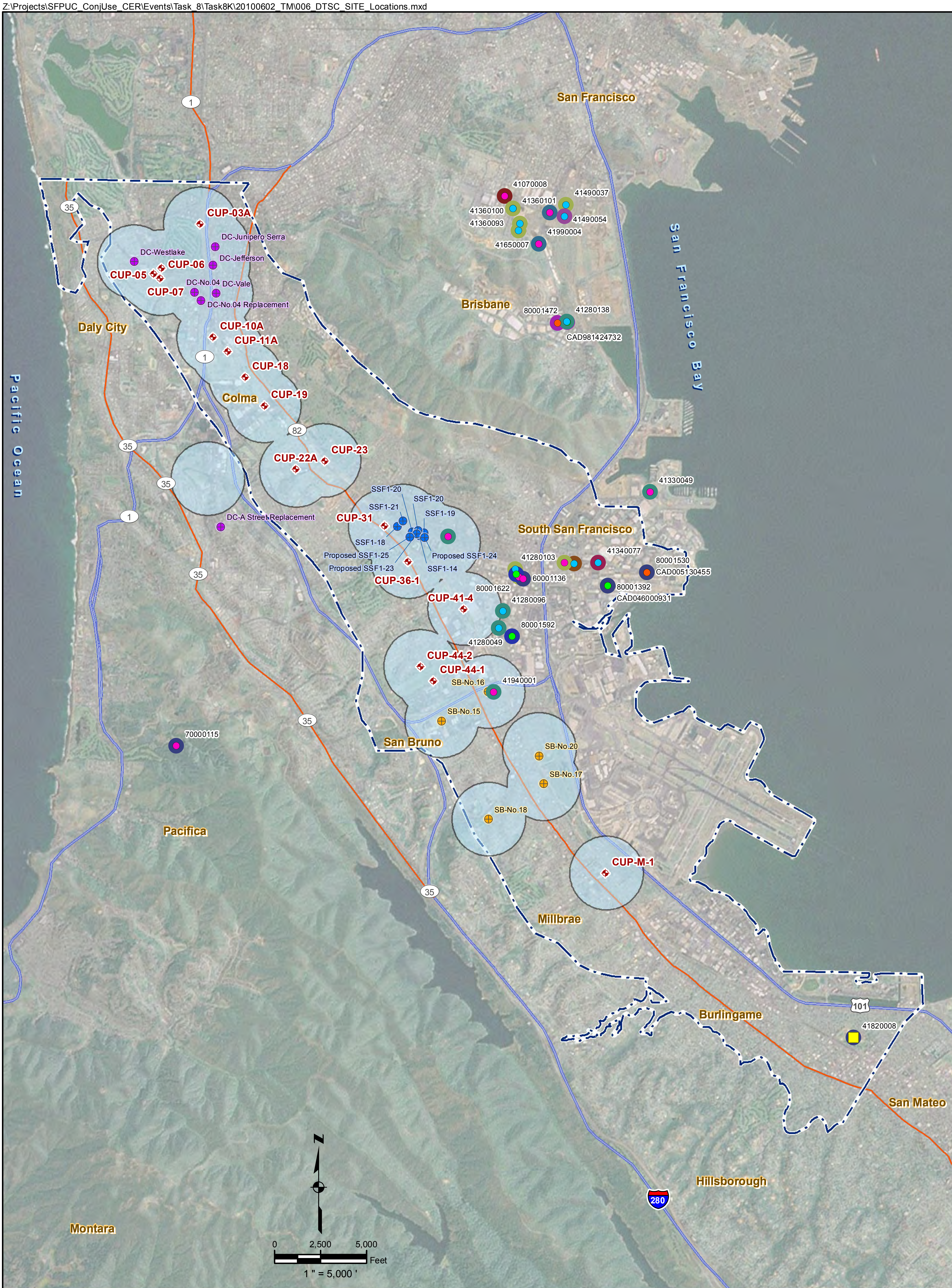
Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Regional Groundwater Storage and Recovery Project

Figure
B-1

Date
April 2012

Z:\Projects\SFPUC_ConjUse_CER\Events\Task_8\Task8K\20100602_TM\006_DTSC_SITE_Locations.mxd



Legend

DTSC Site/Facility Type

- CORRECTIVE ACTION
- HAZ WASTE - NON-OPERATING
- SCHOOL CLEANUP
- STATE RESPONSE
- VOLUNTARY CLEANUP

DTSC CLEANUP_STATUS

- ACTIVE
- ACTIVE - LAND USE RESTRICTIONS
- BACKLOG
- CERTIFIED
- CERTIFIED / OPERATION & MAINTENANCE
- CERTIFIED/OP & MAINT-LAND USE RESTRIC
- COMPLETED
- INACTIVE
- INACTIVE - NEEDS EVALUATION
- NO FURTHER ACTION
- REFER: LOCAL AGENCY
- REFER: RWQCB

- GSR Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- 2000 feet Radius Buffer
- South Westside Groundwater Basin

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

DTSC SITE LOCATIONS

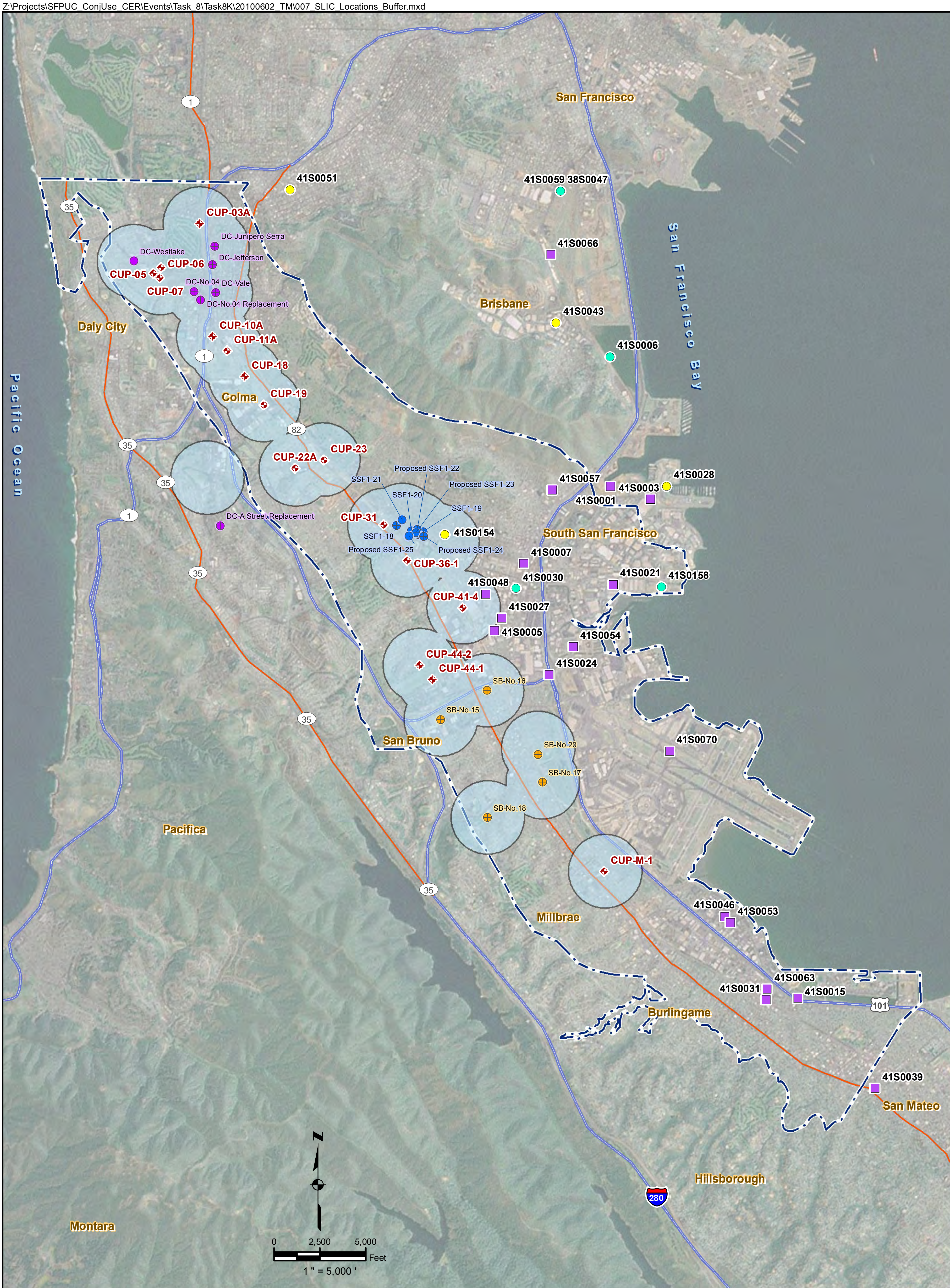
Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Regional Groundwater Storage and Recovery Project

Figure **B-2**

Date April 2012

Z:\Projects\SFPUC_ConjUse_CER\Events\Task_8\Task8K\20100602_TM\007_SLIC_Locations_Buffer.mxd



Legend

SLIC (Spills, Leaks, Investigations, and Cleanup Database) Locations and Site Number

- Active (3)
- Inactive (18)
- Refered to Others Agency (4)

- GSR Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- 2000 feet Radius Buffer
- South Westside Groundwater Basin

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

PRODUCTION WELLS AND CLEANUP SITES

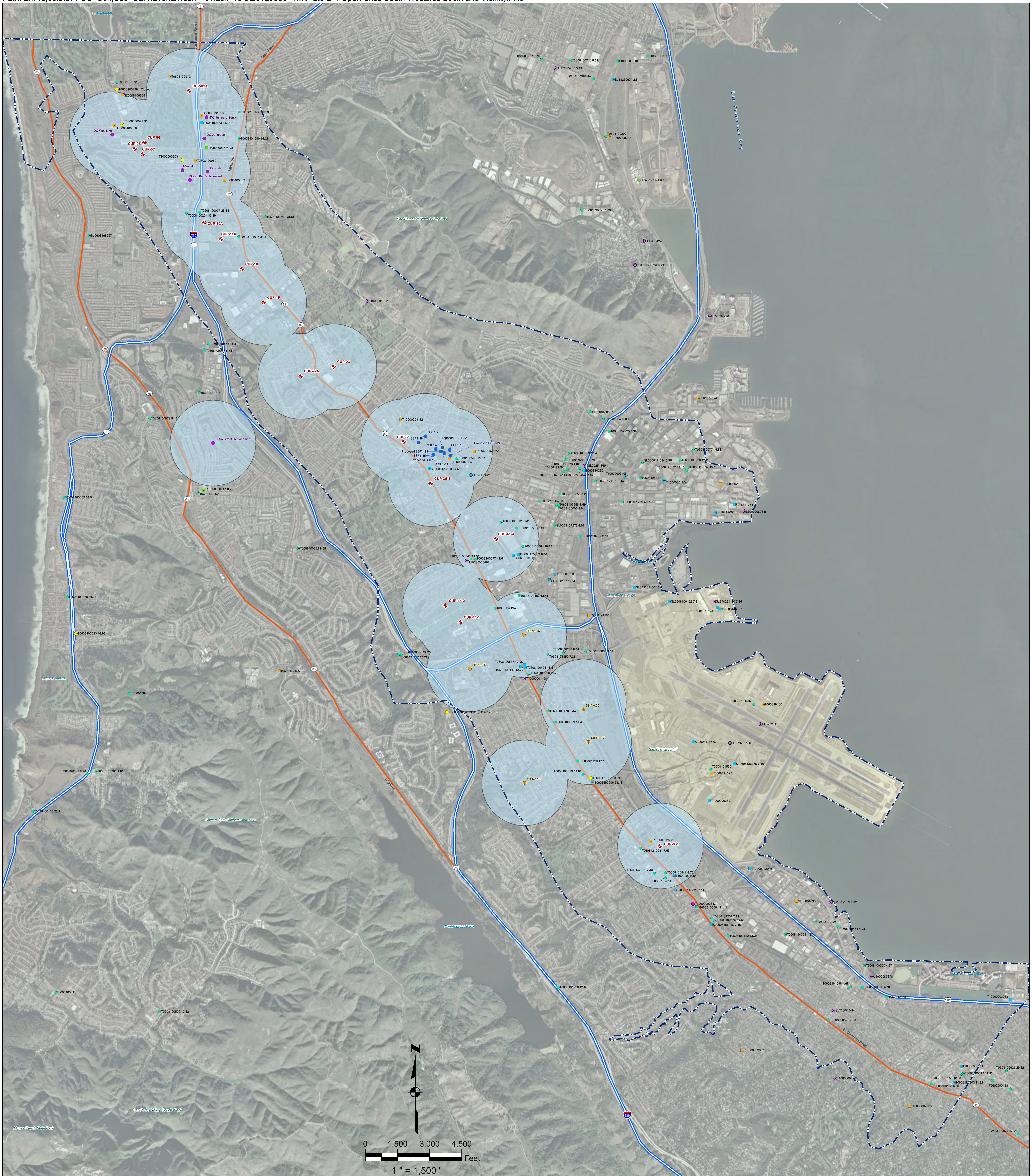
Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Regional Groundwater Storage and Recovery Project

Figure **B-3**

Date April 2012

Path: Z:\Projects\SFPUC_ConjUse_CER\Events\Task_10\Task_10.6\20120309_TM\Plate B-1 Open Sites South Westside Basin and Vicinity.mxd



Legend

Potential Media Affected Near Project Area

- Other Groundwater (uses other than drinking water)
- Soil
- Soil/Other Groundwater (uses other than drinking water)
- Soil/Other Groundwater (uses other than drinking water)/Aquifer or Well used for drinking water supply
- Soil/Aquifer used for drinking water supply
- Well used for drinking water supply
- Aquifer used for drinking water supply
- Under Investigation
- Unknown

T0608194016 **21.8**
Global ID Depth to Water (feet)

- GSR Project Proposed Municipal Wells
- San Bruno Municipal Wells
- Daly City Municipal Wells
- Cal Water Municipal Wells
- South Westside Groundwater Basin
- 2000 feet Radius Buffer

CITY AND COUNTY OF SAN FRANCISCO
PUBLIC UTILITIES COMMISSION
ENGINEERING MANAGEMENT BUREAU

"OPEN" REGULATED SITES IN THE SOUTH WESTSIDE BASIN AND VICINITY AND RECORDED DEPTHS TO WATER

Kennedy/Jenks Consultants
303 Second Street, Suite 300 South
San Francisco, CA 94107

Figure
Plate B-1

Regional Groundwater Storage and Recovery Project

Date
April 2012

GLOBAL_ID	BUSINESS NAME	CASE TYPE	STATUS	STATUS DATE	POTENTIAL	POTENTIAL 1	PROTECTION ZONE	FIELD_POIN	STATUS_1	GW_MEAS_DA	DTW
L10002089336	O'BRIEN-HASKINS FORMER SAN BRUNO CHANNEL	Land Disposal Site	Open	1/9/2008							
L10008912226	HILLSIDE LNDFL COLMA DUMP	Land Disposal Site	Open	1/1/1965							
L10009873781	BURLINGAME LANDFILL	Land Disposal Site	Open - Verification Monitoring	9/25/2009							
SL0002020085	SHELL OIL SFO SATELLITE PLANT, SOUTH SF (former)	Cleanup Program Site	Open - Assessment & Interim Remedial Action	12/29/2009			Inside 2000ft Protection Zone				
SL0608101503	416 Browning (fmr Goss-Jewett facility)	Cleanup Program Site	Open - Site Assessment	9/17/2007	Tetrachloroethylene (PCE)	Other Groundwater (uses other than drinking water), Soil, Soil Vapor, Under	Inside 2000ft Protection Zone				
SL0608104752	SOFOS PROPERTY	Cleanup Program Site	Completed - Case Closed	6/23/2010	Nickel	Aquifer used for drinking water supply, Other Groundwater (uses other than					
SL0608106162	SFIA - UNITED AIRLINES MAINTENANCE CENTER AT SF AIRPORT	Cleanup Program Site	Open - Remediation	1/1/2007	* Solvents, Aviation	Other Groundwater (uses other than drinking water), Soil, Well used for drinking		MW-3C	ACT	8/8/2005	7.3
SL0608106505	WESTLAKE FRENCH CLEANERS	Cleanup Program Site	Open - Site Assessment	6/4/2008	Tetrachloroethylene (PCE)	Soil	Inside 2000ft Protection Zone				
SL0608107611	CITIBANK/BETTY-BRITE CLEANERS (FORMER)	Cleanup Program Site	Open - Site Assessment	4/28/2004	Tetrachloroethylene (PCE)	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
SL0608111084	GRAND ROEBLING PROPERTY	Cleanup Program Site	Open - Site Assessment	10/5/2005	Tetrachloroethylene (PCE)	Other Groundwater (uses other than		MW-3	ACT	10/25/2006	5.95
SL0608115344	COEN COMPANY	Cleanup Program Site	Completed - Case Closed	11/20/2006	Diesel	Other Groundwater (uses other than					
SL0608116110	MATTISON & SHIDLER	Cleanup Program Site	Completed - Case Closed	11/29/1995		Soil					
SL0608123509	CHEVRON, FORMER STANDARD OIL SUBSTATION	LUST Cleanup Site	Open - Verification Monitoring	3/9/2010	Gasoline	Other Groundwater (uses other than drinking water), Soil	Inside 2000ft Protection Zone	MW-1	ACT	2/2/2010	30.58
SL0608127237	SFIA - SAN FRANCISCO AIRPORT BOARDING AREA E	Cleanup Program Site	Open - Remediation	1/1/2004	Aviation	Other Groundwater (uses other than drinking water), Soil					
SL0608128898	GEORGIA PACIFIC	Cleanup Program Site	Completed - Case Closed	12/22/2009	Tetrachloroethylene (PCE)	Other Groundwater (uses other than		MW-1S	ACT	3/20/2007	7
SL0608131398	PACIFIC PLAZA III	Cleanup Program Site	Open - Remediation	7/6/2009	Arsenic	Soil	Inside 2000ft Protection Zone				
SL0608136265	SFIA - SF AIRPORT BOARDING AREA D	Cleanup Program Site	Open - Remediation	1/1/2005	Aviation	Other Groundwater (uses other than drinking water), Soil		BM-4	ACT	12/5/2005	9.56
SL0608137279	UNION PACIFIC	Cleanup Program Site	Open - Site Assessment	2/14/2007	* Solvents	Other Groundwater (uses other than		MW-1	ACT	2/23/2009	6.02
SL0608146307	SFIA - CHEVRON BULK FUEL TERMINAL @ S.F. INT' AIRPORT	Cleanup Program Site	Open - Verification Monitoring	1/1/1999	Diesel, Aviation, Gasoline	Other Groundwater (uses other than drinking water), Soil		2	NOACC	3/16/2006	
SL0608147763	STANDARD ELECTRIC	Cleanup Program Site	Completed - Case Closed	8/15/2006	* Solvents	Other Groundwater (uses other than drinking water)					
SL0608148825	former PENINSULA CLEANERS - offsite	Cleanup Program Site	Open - Assessment & Interim Remedial Action	12/6/2010	Tetrachloroethylene (PCE)	Other Groundwater (uses other than drinking water), Soil, Soil Vapor, Under		MW-1	ACT	3/2/2004	7.11
SL0608156926	HOLIDAY CLEANERS	Cleanup Program Site	Open - Site Assessment	11/8/2007	Tetrachloroethylene (PCE), Trichloroethylene (TCE), Vinyl chloride	Indoor Air, Other Groundwater (uses other than drinking water), Soil		MW-1	ACT	6/15/2009	9.45
SL0608164408	BAYHILL 7 FACILITY	Cleanup Program Site	Completed - Case Closed	6/16/2009	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
SL0608165957	OTTOBONI NURSERY	Cleanup Program Site	Completed - Case Closed	12/4/2003		Soil					
SL0608169862	735 COMMERCIAL	Cleanup Program Site	Open - Site Assessment	7/10/2003	* Pesticides/Herbicides	Soil	Inside 2000ft Protection Zone				
SL0608169865	855 MALCOLM ROAD	Cleanup Program Site	Open - Verification Monitoring	12/29/2009	Tetrachloroethylene (PCE)	Soil					
SL0608174279	ASSOCIATED ROAD PARCEL	Cleanup Program Site	Open - Site Assessment	10/26/2007	* Solvents	Other Groundwater (uses other than drinking water)		MW-1	ACT	10/14/2009	5.62
SL0608175536	SFIA - SAN FRANCISCO AIRPORT BOARDING AREA F	Cleanup Program Site	Open - Remediation	1/1/2004	Aviation	Other Groundwater (uses other than drinking water), Soil					
SL0608175553	290 South Maple	Cleanup Program Site	Open - Assessment & Interim Remedial Action	4/14/2008	Tetrachloroethylene (PCE)	Other Groundwater (uses other than drinking water), Soil	Inside 2000ft Protection Zone	MW-2	ACT	5/20/2008	6.56
SL0608182371	SFIA - PS TRADING BULK TERMINAL AT SFIA	Cleanup Program Site	Open - Verification Monitoring	10/30/2009	Aviation	Other Groundwater (uses other than drinking water), Soil		P-4	DRY	9/6/2005	
SL0608187305	PARKING CORPORATION OF AMERICA	Cleanup Program Site	Completed - Case Closed	5/26/2010	Gasoline	Other Groundwater (uses other than drinking water)		MW-2	ACT	9/16/2005	1.99
SL0608187730	1245 MONTGOMERY AVE	Cleanup Program Site	Open - Remediation	10/31/2007	Benzene, Other Solvent or Non-Petroleum Hydrocarbon, Trichloroethylene (TCE)	Other Groundwater (uses other than drinking water), Soil, Soil Vapor		MW-7	ACT	6/29/2005	4.93
SL0608188827	Rollin J. Lobaugh	LUST Cleanup Site	Open - Site Assessment	3/31/2009	Stoddard Solvent / Mineral Spirits / Distillates	Other Groundwater (uses other than drinking water)					
SL0608188850	SOUTHGATE CLEANERS	Cleanup Program Site	Open - Site Assessment	6/4/2008	Tetrachloroethylene (PCE)	Soil	Inside 2000ft Protection Zone				
SL0608189867	SATURN OF COLMA	Cleanup Program Site	Completed - Case Closed	12/2/2005	Diesel	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
SL1821A600	HASKINS JAMIE COURT	Cleanup Program Site	Open - Site Assessment	1/14/2000	Lead, Asphalt	Other Groundwater (uses other than drinking water), Sediments, Soil					
SL18251672	SFIA - SAN FRANCISCO INTERNATIONAL AIRPORT	Cleanup Program Site	Open - Remediation	7/1/1995	1,1,1-Trichloroethane (TCA), Aviation, Diesel, Gasoline	Other Groundwater (uses other than drinking water), Soil	Inside 2000ft Protection Zone				
SL18341761	OBRIEN CORP	Cleanup Program Site	Open - Verification Monitoring	7/6/2009	Other Chlorinated Hydrocarbons, Arsenic, Lead	Other Groundwater (uses other than drinking water), Sediments, Soil, Surface					
SL20251869	W C PROPERTIES	Cleanup Program Site	Open - Inactive	3/20/1995							
SL20261879	US STEEL FACILITY (FORMER)	Cleanup Program Site	Completed - Case Closed	9/17/2009	Polychlorinated biphenyls (PCBs), Lead, Diesel, Waste Oil / Motor / Hydraulic / Lubricating, Polynuclear aromatic	Other Groundwater (uses other than drinking water), Sediments, Soil	Inside 2000ft Protection Zone				
SL20292909	COIT CLEANERS	Cleanup Program Site	Open - Verification Monitoring	9/1/2009				MW 1	ACT	3/17/1998	0.32
SL373231180	Shell (Equilon) South San Francisco Terminal	Cleanup Program Site	Open - Remediation	7/1/2002	Benzene, Toluene, Xylene, Aviation, Diesel, Fuel Oxygenates, Gasoline	Other Groundwater (uses other than drinking water), Soil, Surface water		MW-13	ACT	9/26/2005	10.3
SL373261183	CHEVRON USA SFO	Cleanup Program Site	Open - Site Assessment	7/1/2002							

SL373291186	SFO TAXIWAY C PROJECT	Cleanup Program Site	Open - Assessment & Interim Remedial Action	12/29/2009	* Petroleum - Automotive gasolines, * Petroleum - Diesel fuels, * Petroleum - Jet Fuel / Aviation, * Volatile Organic Compounds						
SL374231190	SHELL OIL BARGE PLANT SFO (Plot 22)	Cleanup Program Site	Open - Assessment & Interim Remedial Action	12/29/2009				S-3	ACT	9/8/2006	7.65
SLT2O04349	DESERT PETROLEUM	Cleanup Program Site	Open - Inactive	6/2/2009							
SLT2O319210	PRICE COMPANY	Cleanup Program Site	Completed - Case Closed	1/1/1970							
SLT2O321212	HILLSIDE BOULEVARD E NURSERY	Cleanup Program Site	Completed - Case Closed	1/1/1970			Inside 2000ft Protection Zone				
SLT2O322213	EXIDE CORP	Cleanup Program Site	Completed - Case Closed	1/1/1970							
SLT2O324940	INTERNATIONAL PAINT COURTALD COATINGS	Cleanup Program Site	Completed - Case Closed	11/22/2002							
SLT2O326216	HOMART DEV CORP EDWARDS WIRE & ROPE	Cleanup Program Site	Open - Inactive	5/12/2010			Inside 2000ft Protection Zone				
SLT2O327217	BACON PROPERTY	Cleanup Program Site	Completed - Case Closed	1/1/1970			Inside 2000ft Protection Zone				
SLT2O330220	POETSCH PETERSON TANNERS	Cleanup Program Site	Completed - Case Closed	1/1/1970			Inside 2000ft Protection Zone				
T0608100003	AAMCO TRANSMISSION	LUST Cleanup Site	Open - Site Assessment	1/5/1988	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100005	OLYMPIAN SSF TERMINAL	LUST Cleanup Site	Open - Site Assessment	11/8/2006	Gasoline	Other Groundwater (uses other than drinking water)		MW-9	ACT	6/18/2002	8.9
T0608100010	ALAMO RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	10/10/1991	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100011	ALAMO RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	9/4/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100012	ALLAN BAKER COMPANY	LUST Cleanup Site	Completed - Case Closed	10/25/2000	Gasoline	Soil					
T0608100015	ALQUEST PROPERTY	LUST Cleanup Site	Completed - Case Closed	5/23/1994	Diesel	Other Groundwater (uses other than drinking water)					
T0608100017	AMERICAN AIRLINES SUPERBAY HANGER	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Kerosene	Other Groundwater (uses other than drinking water)		B-3	ACT	9/9/2005	5.56
T0608100024	ARC ELECTRIC	LUST Cleanup Site	Completed - Case Closed	11/25/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100027	ARCO #0465	LUST Cleanup Site	Open - Site Assessment	9/9/2003	Benzene, Toluene, Xylene, Fuel Oxygenates,	Aquifer used for drinking water supply	Inside 2000ft Protection Zone	MW-4	ACT	6/27/2002	56
T0608100029	ARCO #0743	LUST Cleanup Site	Open - Site Assessment	6/13/1984	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-5	ACT	6/25/2002	35.84
T0608100033	ARCO #2090	LUST Cleanup Site	Completed - Case Closed	5/27/2011	Gasoline	Aquifer used for drinking water supply, Soil, Soil Vapor	Inside 2000ft Protection Zone	MW-1	ACT	6/27/2002	48.85
T0608100046	AUTO TEKNIK	LUST Cleanup Site	Completed - Case Closed	4/23/2002	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100047	AUTOHAUS	LUST Cleanup Site	Completed - Case Closed	4/24/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100050	AVIS RENT A CAR	LUST Cleanup Site	Completed - Case Closed	9/16/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100051	AVIS RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	3/6/2002	Diesel	Other Groundwater (uses other than drinking water)					
T0608100053	B & B TRANSMISSION	LUST Cleanup Site	Completed - Case Closed	2/27/1992	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100056	BART	LUST Cleanup Site	Completed - Case Closed	1/27/1992	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100057	SFIA - San Francisco International Airport TWA CARGO FACILITY	LUST Cleanup Site	Completed - Case Closed	6/21/1999	Kerosene	Other Groundwater (uses other than drinking water)					
T0608100061	BAYSTAR MEDICAL SERVICES	LUST Cleanup Site	Completed - Case Closed	3/18/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100071	BISCAY AUTO REPAIR	LUST Cleanup Site	Completed - Case Closed	8/11/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100073	DEITER BLUHM	LUST Cleanup Site	Completed - Case Closed	9/30/1991		Soil					
T0608100077	BP #11202 (FORMER)	LUST Cleanup Site	Open - Site Assessment	4/20/1987	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	6/11/2003	29.34
T0608100080	BP #11200	LUST Cleanup Site	Open - Site Assessment	4/14/2009	Gasoline	Other Groundwater (uses other than drinking water)		MW-2	ACT	6/7/2002	3.14
T0608100081	BRESSIE & CO.	LUST Cleanup Site	Completed - Case Closed	6/11/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100084	BROADMOOR LUMBER & PLYWOOD CO	LUST Cleanup Site	Completed - Case Closed	7/3/1995	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100087	BUDGET RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	9/13/2002	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100089	BURLINGAME FIRE STA. #3	LUST Cleanup Site	Completed - Case Closed	10/19/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100091	BURLINGAME POST OFFICE	LUST Cleanup Site	Completed - Case Closed	11/28/1995	Gasoline	Soil					
T0608100093	BURLINGTON AIR EXPRESS	LUST Cleanup Site	Completed - Case Closed	1/31/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100094	BROADWAY LOCKSMITH	LUST Cleanup Site	Completed - Case Closed	3/30/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100105	CARLIN CO	LUST Cleanup Site	Completed - Case Closed	6/27/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100107	CARUFF CALIFORNIA CORP	LUST Cleanup Site	Completed - Case Closed	10/10/1993	Gasoline	Other Groundwater (uses other than drinking water)					

T0608100108	CAULKING WATERPROOFING INC.	LUST Cleanup Site	Completed - Case Closed	2/9/1993	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100110	CHEVRON 9-4000	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100113	CHEVRON 9-1909	LUST Cleanup Site	Completed - Case Closed	7/6/2005	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	3/1/2002	5.12
T0608100114	CHEVRON 9-1626	LUST Cleanup Site	Completed - Case Closed	10/25/2005	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-10	ACT	5/31/2002	28.08
T0608100115	CHEVRON 9-7640	LUST Cleanup Site	Completed - Case Closed	12/5/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100116	CHEVRON 9-5131	LUST Cleanup Site	Completed - Case Closed	6/27/2002	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100118	CHEVRON 9-0723	LUST Cleanup Site	Completed - Case Closed	1/18/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100122	CHEVRON 9-8165	LUST Cleanup Site	Open - Site Assessment	7/22/1985	Gasoline	Other Groundwater (uses other than drinking water)		C-3R	ACT	2/16/2002	12.24
T0608100125	CHEVRON 9-7455	LUST Cleanup Site	Completed - Case Closed	5/28/1999	Waste Oil / Motor / Hydraulic / Lubricating	Soil	Inside 2000ft Protection Zone				
T0608100126	CHEVRON 9-0781	LUST Cleanup Site	Completed - Case Closed	10/6/2010	Gasoline	Aquifer used for drinking water supply					
T0608100128	CHEVRON 9-0571	LUST Cleanup Site	Open - Verification Monitoring	4/27/2009	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	3/14/2002	6.86
T0608100132	CHEVRON 9-0206	LUST Cleanup Site	Completed - Case Closed	7/22/2004	Gasoline	Other Groundwater (uses other than drinking water)		EA-1	ACT	2/16/2002	3.16
T0608100137	CHEVRON 9-0645	LUST Cleanup Site	Completed - Case Closed	1/18/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100144	CHEVRON 9-0248	LUST Cleanup Site	Completed - Case Closed	12/19/2001	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100145	CHEVRON 9-5669	LUST Cleanup Site	Completed - Case Closed	4/9/2007	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-5	ACT	2/16/2002	38.88
T0608100147	CHEVRON 9-2759 ECR SB COMINGLED	LUST Cleanup Site	Open - Assessment & Interim	5/21/2010	Benzene, Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	C-1	ACT	3/25/2002	12.72
T0608100148	CHEVRON 9-6982	LUST Cleanup Site	Completed - Case Closed	12/27/2011	Gasoline	Aquifer used for drinking water supply		MW-2	DRY	5/14/2004	
T0608100149	CHEVRON 9-0858	LUST Cleanup Site	Completed - Case Closed	12/4/2000	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100152	CITY OF DALY CITY	LUST Cleanup Site	Completed - Case Closed	5/28/1991	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100153	FEDERAL EXPRESS FLYNG TIGERS	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Diesel	Other Groundwater (uses other than drinking water)					
T0608100157	CITY OF MILLBRAE CORP YARD	LUST Cleanup Site	Completed - Case Closed	4/28/1997	Diesel	Other Groundwater (uses other than					
T0608100165	CODON (GRAND/ROEBLING INV)	LUST Cleanup Site	Completed - Case Closed	11/13/1991	Gasoline	Soil					
T0608100167	COLUMBUS SALAME INC.	LUST Cleanup Site	Completed - Case Closed	6/13/1991	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100170	Mobil 99-ELM (Former)	LUST Cleanup Site	Open - Site Assessment	6/13/1990	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	GW-1	ACT	10/22/2002	8.44
T0608100171	COYNE CYLINDER CO	LUST Cleanup Site	Completed - Case Closed	7/20/2011	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-4	ACT	7/25/2003	6.55
T0608100172	CORTANA CORPORATION	LUST Cleanup Site	Completed - Case Closed	2/17/1993	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100173	COULTERS CARPETS	LUST Cleanup Site	Completed - Case Closed	11/14/2002	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100178	CYPRESS LAWN CEMETERY	LUST Cleanup Site	Completed - Case Closed	8/27/2001	Diesel	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608100179	DALY CITY CORP YARD	LUST Cleanup Site	Completed - Case Closed	1/24/2003	Gasoline	Aquifer used for drinking water supply	Inside 2000ft Protection Zone				
T0608100180	DALY CITY SERVICE	LUST Cleanup Site	Completed - Case Closed	4/19/1996	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100181	DALY CITY WASTEWATER PLANT	LUST Cleanup Site	Open - Verification Monitoring	2/1/1990	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100188	KEN FUNK PROPERTY	LUST Cleanup Site	Completed - Case Closed	12/3/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100191	SAN BRUNO CORP. YARD	LUST Cleanup Site	Completed - Case Closed	11/7/2001	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100193	EARLY AMERICAN PAINT	LUST Cleanup Site	Completed - Case Closed	5/11/2000	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100194	OLYMPIC EAST GRAND CARDTOL	LUST Cleanup Site	Completed - Case Closed	4/23/2009	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	12/12/2002	5.25
T0608100195	EMERY AIR FREIGHT	LUST Cleanup Site	Completed - Case Closed	8/22/1996	Diesel	Other Groundwater (uses other than drinking water)					
T0608100196	ENCORE THEATER	LUST Cleanup Site	Completed - Case Closed	9/23/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100199	ESCHELBACH PROPERTIES	LUST Cleanup Site	Completed - Case Closed	6/12/2001	Gasoline	Other Groundwater (uses other than drinking water)					

T0608100202	EUROPEAN CAR SERVICE	LUST Cleanup Site	Completed - Case Closed	10/17/2002	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100204	EXXON 7-0207, FORMER	LUST Cleanup Site	Open - Site Assessment	4/23/2009	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW1	ACT	9/12/2001	32.69
T0608100207	EXXON 7-0107 (Former)	LUST Cleanup Site	Open - Remediation	11/22/2006	Gasoline	Other Groundwater (uses other than drinking water)		MW7A	ACT	11/25/2002	8.04
T0608100214	FEDERAL SUPPLY WAREHOUSE	LUST Cleanup Site	Completed - Case Closed	4/28/1997	Gasoline	Other Groundwater (uses other than					
T0608100215	FINLEY CONSTRUCTION CO	LUST Cleanup Site	Completed - Case Closed	7/9/1992	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100220	FLAT RATE RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	8/11/1999	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100223	SFIA - AMERICAN AIRLINES PLOT 9	LUST Cleanup Site	Completed - Case Closed	1/1/2004	Aviation	Other Groundwater (uses other than drinking water)					
T0608100226	FOUR STAR AUTOMOTIVE, INC.	LUST Cleanup Site	Completed - Case Closed	6/28/1996	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100228	GALLO SALES CO.	LUST Cleanup Site	Open - Verification Monitoring	1/1/2011	Gasoline	Other Groundwater (uses other than drinking water)		MW-G1	ACT	3/26/2002	12.26
T0608100229	UNITED TRANSMISSION INC	LUST Cleanup Site	Completed - Case Closed	11/20/1996	Stoddard Solvent / Mineral Spirits / Distillates	Other Groundwater (uses other than drinking water)					
T0608100230	GASCO SERVICE STATION	LUST Cleanup Site	Completed - Case Closed	1/23/2002	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100231	GELCO TRUCK LEASING	LUST Cleanup Site	Completed - Case Closed	8/4/1992	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100233	GEORGIA PACIFIC	LUST Cleanup Site	Completed - Case Closed	11/10/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100238	PENSKE TRUCK LEASING II	LUST Cleanup Site	Completed - Case Closed	1/17/2003	Gasoline	Other Groundwater (uses other than					
T0608100239	GRACE HONDA	LUST Cleanup Site	Completed - Case Closed	6/30/1994	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100240	GRANITE ROCK CO	LUST Cleanup Site	Completed - Case Closed	4/1/2008	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than		MW-1	ACT	3/28/2002	5.32
T0608100241	GREEN HILLS COUNTRY CLUB	LUST Cleanup Site	Completed - Case Closed	9/2/1993	Gasoline	Soil					
T0608100243	CITY OF DALY CITY	LUST Cleanup Site	Completed - Case Closed	5/28/1991		Soil	Inside 2000ft Protection Zone				
T0608100244	GREYHOUND EXPOSITION SERVICES	LUST Cleanup Site	Completed - Case Closed	7/28/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100248	H.S. CROCKER CO.	LUST Cleanup Site	Completed - Case Closed	10/14/1998	Gasoline	Other Groundwater (uses other than					
T0608100250	HAMMETT & EDISON REAL ESTATE	LUST Cleanup Site	Completed - Case Closed	2/8/1994	Diesel	Soil					
T0608100252	HARMON SHRAGGE CO	LUST Cleanup Site	Completed - Case Closed	8/22/1996	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100253	HARRIS PROPERTY	LUST Cleanup Site	Open - Remediation	8/1/1989	Gasoline	Other Groundwater (uses other than drinking water)		PSB-5	ACT	4/28/2003	12.88
T0608100255	HUMBER REALTY	LUST Cleanup Site	Completed - Case Closed	12/29/1993	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100256	HERTZ	LUST Cleanup Site	Completed - Case Closed	7/19/2001	Gasoline	Other Groundwater (uses other than					
T0608100257	HERTZ RENTAL CAR	LUST Cleanup Site	Completed - Case Closed	9/16/1998	Gasoline	Under Investigation					
T0608100259	HIRAM WALKER	LUST Cleanup Site	Completed - Case Closed	1/27/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100261	HOFFMAN BROTHERS	LUST Cleanup Site	Completed - Case Closed	4/18/2000	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100266	HOME SAVINGS OF AMERICA	LUST Cleanup Site	Completed - Case Closed	3/26/2002	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100269	HOUSING CONSTRUCTION	LUST Cleanup Site	Completed - Case Closed	7/27/2000	Diesel	Other Groundwater (uses other than drinking water)					
T0608100274	GEORGIA GERRITSEN	LUST Cleanup Site	Completed - Case Closed	11/10/2005	Gasoline	Other Groundwater (uses other than		MW-1	INACT	12/31/2003	
T0608100276	SFIA - SIGNITURE FLIGHT	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Kerosene	Under Investigation					
T0608100283	J.R. FLYNN CO.	LUST Cleanup Site	Completed - Case Closed	7/6/1998	Gasoline	Other Groundwater (uses other than					
T0608100288	SHOPPING STRIP MALL	LUST Cleanup Site	Completed - Case Closed	10/8/1998	Gasoline	Soil					
T0608100291	DELANO NURSERY	LUST Cleanup Site	Completed - Case Closed	9/14/1993	Gasoline	Soil					
T0608100296	KPR PROPERTIES	LUST Cleanup Site	Completed - Case Closed	3/19/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100300	LA MARK TRANSPORTATION	LUST Cleanup Site	Completed - Case Closed	1/2/2003	Gasoline	Other Groundwater (uses other than					
T0608100307	OYSTER POINT	LUST Cleanup Site	Completed - Case Closed	5/21/2009	Waste Oil / Motor / Hydraulic / Lubricating	Soil					
T0608100310	LONATI PROPERTIES	LUST Cleanup Site	Completed - Case Closed	12/1/2004	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	9/16/2002	8.62
T0608100312	LUBRIVAN TRUCK SERVICES	LUST Cleanup Site	Completed - Case Closed	3/7/2003	Gasoline	Other Groundwater (uses other than drinking water)					

T0608100313	LUCCA PACKING CORP.	LUST Cleanup Site	Completed - Case Closed	8/16/2001	Diesel	Other Groundwater (uses other than drinking water)					
T0608100318	MIZRA/SETO PROPERTY	LUST Cleanup Site	Completed - Case Closed	7/24/2000	Gasoline	Other Groundwater (uses other than					
T0608100322	MCCLENNAN PROPERTY	LUST Cleanup Site	Completed - Case Closed	4/20/1990	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100332	MIKE HARVEY CHRYSLER	LUST Cleanup Site	Completed - Case Closed	7/21/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100341	MOBIL 04-FT7	LUST Cleanup Site	Completed - Case Closed	1/26/1999	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100350	BP #11204	LUST Cleanup Site	Open - Verification Monitoring	9/30/1988	Benzene, Toluene, Xylene, Diesel, Fuel Oxygenates, Gasoline, Waste Oil / Motor /	Other Groundwater (uses other than drinking water)		MW-1	ACT	6/19/2003	4.27
T0608100351	MONROE SCHNEIDER ASSOC.	LUST Cleanup Site	Completed - Case Closed	5/6/1992	Xylene	Other Groundwater (uses other than drinking water)					
T0608100353	MR DETAIL	LUST Cleanup Site	Completed - Case Closed	2/19/1999	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100355	MYERS AIR CONDITIONING	LUST Cleanup Site	Completed - Case Closed	6/7/1996	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100356	NATIONAL CAR RENTAL SYSTEM INC	LUST Cleanup Site	Completed - Case Closed	2/23/1998	Gasoline	Other Groundwater (uses other than					
T0608100362	OLIVET MEMORIAL PARK	LUST Cleanup Site	Completed - Case Closed	10/12/1994	Gasoline	Soil					
T0608100363	OLYMPIAN	LUST Cleanup Site	Completed - Case Closed	2/23/1996	Gasoline	Other Groundwater (uses other than					
T0608100366	OLYMPIAN OIL	LUST Cleanup Site	Completed - Case Closed	5/12/2003	Gasoline	Aquifer used for drinking water supply					
T0608100369	OLYMPIC AUTO SERVICE	LUST Cleanup Site	Open - Remediation	3/31/2003	Gasoline	Other Groundwater (uses other than drinking water)		MW1	ACT	2/4/2002	12.49
T0608100370	CHEVRON 209437, FORMER	LUST Cleanup Site	Completed - Case Closed	12/3/2002	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100376	PACIFIC BELL	LUST Cleanup Site	Completed - Case Closed	8/12/2010	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	12/12/2002	26.13
T0608100377	PACIFIC BELL	LUST Cleanup Site	Completed - Case Closed	7/9/1992	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100380	PACIFIC CONSTRUCTION	LUST Cleanup Site	Completed - Case Closed	11/13/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100385	SFIA - San Francisco International Airport UAL OGDEN FORMER PAN	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Diesel	Other Groundwater (uses other than					
T0608100389	PENINSULA PROPERTIES	LUST Cleanup Site	Completed - Case Closed	12/1/1993	Gasoline	Soil					
T0608100391	PENINSULA TOW SERVICE	LUST Cleanup Site	Completed - Case Closed	6/13/2002	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100393	PERIN COMPANY	LUST Cleanup Site	Completed - Case Closed	6/26/1997	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100401	GENERAL RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	3/19/1998	Gasoline	Other Groundwater (uses other than					
T0608100402	PONY EXPRESS	LUST Cleanup Site	Completed - Case Closed	3/16/2000	Gasoline	Soil					
T0608100406	PRESSURE GROUT COMPANY	LUST Cleanup Site	Completed - Case Closed	8/9/1993	Gasoline	Other Groundwater (uses other than					
T0608100407	PRICE COMPANY	LUST Cleanup Site	Completed - Case Closed	7/29/1992	Gasoline	Under Investigation					
T0608100411	COLOR CRAFT	LUST Cleanup Site	Completed - Case Closed	1/2/2001	Gasoline	Other Groundwater (uses other than					
T0608100415	RAGNI CONSTRUCTION	LUST Cleanup Site	Completed - Case Closed	3/20/1991	Gasoline	Soil					
T0608100418	RECTOR CADILLAC	LUST Cleanup Site	Completed - Case Closed	6/9/1992	Waste Oil / Motor / Hydraulic / Lubricating	Soil					
T0608100429	RON PRICE MOTORS	LUST Cleanup Site	Completed - Case Closed	1/8/1996	Waste Oil / Motor / Hydraulic / Lubricating	Soil	Inside 2000ft Protection Zone				
T0608100431	RPM RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	10/25/1995	Diesel	Other Groundwater (uses other than drinking water)					
T0608100434	SAGE TRANSPORTATION	LUST Cleanup Site	Completed - Case Closed	6/27/2001	Diesel	Other Groundwater (uses other than drinking water)					
T0608100436	SAM TRANS (VACANT)	LUST Cleanup Site	Completed - Case Closed	4/10/2000	Gasoline	Other Groundwater (uses other than					
T0608100438	SAN BRUNO CABLE TV	LUST Cleanup Site	Completed - Case Closed	12/11/1997	Waste Oil / Motor / Hydraulic / Lubricating	Soil	Inside 2000ft Protection Zone				
T0608100439	SAN BRUNO FORD	LUST Cleanup Site	Completed - Case Closed	12/20/2001	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100440	SAN BRUNO GLASS CENTER	LUST Cleanup Site	Completed - Case Closed	10/11/2002	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100441	SAN BRUNO LUMBER	LUST Cleanup Site	Completed - Case Closed	1/3/2002	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100443	SAN FRANCISCO NEWSPAPER AGENCY	LUST Cleanup Site	Completed - Case Closed	11/27/2002	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100444	MOSQUITO ABATEMENT OFFICE	LUST Cleanup Site	Completed - Case Closed	10/9/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100452	SEARS AUTOMOTIVE CENTER	LUST Cleanup Site	Open - Site Assessment	4/10/1985	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-4	ACT	4/30/2003	12.43
T0608100455	SERRAMONTE FORD	LUST Cleanup Site	Completed - Case Closed	9/17/1992	Gasoline	Soil	Inside 2000ft Protection Zone				

T0608100456	SF GARDEN MART	LUST Cleanup Site	Completed - Case Closed	8/7/1991	Gasoline	Soil					
T0608100458	SHAFFER'S TIRE CENTER	LUST Cleanup Site	Completed - Case Closed	1/14/1992	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100461	SHELL OIL	LUST Cleanup Site	Open - Remediation	2/6/2001	Gasoline	Other Groundwater (uses other than drinking water)		MW-2	ACT	12/17/2001	2.11
T0608100463	HICKEY FAMILY PARTNERSHIP	LUST Cleanup Site	Completed - Case Closed	5/20/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100464	SHELL	LUST Cleanup Site	Open - Site Assessment	7/1/2009	Gasoline	Other Groundwater (uses other than drinking water)		S-4	ACT	1/9/2002	4.02
T0608100465	SHELL OIL	LUST Cleanup Site	Completed - Case Closed	6/24/2005	Diesel	Other Groundwater (uses other than drinking water)		MW-6	ACT	1/10/2002	6.65
T0608100468	SHELL	LUST Cleanup Site	Completed - Case Closed	8/21/2001	Gasoline	Other Groundwater (uses other than					
T0608100487	SHELL	LUST Cleanup Site	Completed - Case Closed	10/10/1991	Gasoline	Soil					
T0608100490	SHELL	LUST Cleanup Site	Completed - Case Closed	6/24/2005	Waste Oil / Motor / Hydraulic / Lubricating	Soil	Inside 2000ft Protection Zone	MW-1	ACT	2/14/2002	40.14
T0608100491	SHELL ECR SB COMINGLED	LUST Cleanup Site	Open - Verification Monitoring	3/8/2010	Gasoline	Other Groundwater (uses other than drinking water), Soil Vapor	Inside 2000ft Protection Zone	MW-1	ACT	10/16/2001	16.2
T0608100492	SHELL	LUST Cleanup Site	Open - Site Assessment	1/12/2009	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	1/15/2002	8.68
T0608100494	SHELL	LUST Cleanup Site	Completed - Case Closed	4/7/1992	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than					
T0608100498	SIMEON PROPERTIES	LUST Cleanup Site	Completed - Case Closed	2/24/2000	Diesel	Soil					
T0608100504	SOUTH CITY DODGE	LUST Cleanup Site	Completed - Case Closed	10/27/1992	Diesel	Soil	Inside 2000ft Protection Zone				
T0608100505	SOUTH CITY FORD	LUST Cleanup Site	Completed - Case Closed	8/9/2001	Gasoline	Other Groundwater (uses other than					
T0608100506	SOUTH CITY LUMBER	LUST Cleanup Site	Completed - Case Closed	12/14/1992	Gasoline	Soil					
T0608100507	TEXACO, SOUTH CITY (INDEP)	LUST Cleanup Site	Completed - Case Closed	11/17/2003	Gasoline	Other Groundwater (uses other than		MW-1	ACT	8/15/2002	1.33
T0608100508	S.S.F. HIGH SCHOOL	LUST Cleanup Site	Completed - Case Closed	8/4/1993	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100510	GARY HIRSCH	LUST Cleanup Site	Completed - Case Closed	10/18/1994	Gasoline	Soil					
T0608100512	SPRUCE CAR WASH	LUST Cleanup Site	Open - Remediation	5/12/2006	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-9	ACT	2/20/2002	8.52
T0608100516	STEWART CHEVROLET	LUST Cleanup Site	Completed - Case Closed	10/10/1991	Waste Oil / Motor / Hydraulic / Lubricating	Soil	Inside 2000ft Protection Zone				
T0608100517	THE PROPERTY	LUST Cleanup Site	Completed - Case Closed	11/21/2000	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100526	SUPER CROWN CATERING	LUST Cleanup Site	Completed - Case Closed	6/12/2009	Gasoline	Other Groundwater (uses other than drinking water)		MW-1R	ACT	1/9/2003	5.81
T0608100530	STUMP PROPERTY	LUST Cleanup Site	Open - Remediation	9/12/2000	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	9/28/2001	19.59
T0608100537	EXXON 7-0259 (FORMER) ECR SB COMINGLED	LUST Cleanup Site	Open - Verification Monitoring	3/8/2010	Benzene, Other Chlorinated Hydrocarbons, Gasoline	Other Groundwater (uses other than drinking water), Soil Vapor	Inside 2000ft Protection Zone	MW16B	ACT	3/25/2002	12.06
T0608100541	THOMPSON AIR CRAFT TIRE CORP	LUST Cleanup Site	Completed - Case Closed	3/7/2003	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100543	HANSEN PROPERTY	LUST Cleanup Site	Completed - Case Closed	9/24/1992	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100545	TONY'S SERVICES	LUST Cleanup Site	Open - Remediation	12/18/2006	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-8	ACT	2/3/2003	45.56
T0608100548	TRADITIONAL WOOD WORKS	LUST Cleanup Site	Completed - Case Closed	6/27/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100549	TRAFFIC INTERNATIONAL CORP.	LUST Cleanup Site	Completed - Case Closed	10/4/2002	Gasoline	Other Groundwater (uses other than					
T0608100550	TREASURE ISLAND TRAILER COURT	LUST Cleanup Site	Completed - Case Closed	9/15/1993	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100551	TRUX AIRLINE CARGO SERVICE	LUST Cleanup Site	Completed - Case Closed	12/28/1992	Gasoline	Other Groundwater (uses other than					
T0608100552	TORNBERG ENTERPRISES	LUST Cleanup Site	Completed - Case Closed	6/12/1992	Gasoline	Soil					
T0608100554	U-FREIGHT AMERICA INC	LUST Cleanup Site	Completed - Case Closed	6/26/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100558	UNION CARBIDE CORP.	LUST Cleanup Site	Open - Remediation	12/21/2005	Acetone, Other Chlorinated Hydrocarbons, Vinyl chloride, Diesel, Gasoline	Other Groundwater (uses other than drinking water)		MW-4	ACT	5/1/2002	8.25
T0608100559	SFIA - UNITED AIRLINES SERVICE CENTER	LUST Cleanup Site	Completed - Case Closed	7/6/2009	Diesel	Other Groundwater (uses other than drinking water)					
T0608100566	UNOCAL STATION #3885	LUST Cleanup Site	Open - Site Assessment	6/26/1997	Gasoline	Other Groundwater (uses other than drinking water)		U-1	ACT	3/18/2002	4.78
T0608100567	UNOCAL #4527, FORMER	LUST Cleanup Site	Open - Site Assessment	12/30/1985	Gasoline	Other Groundwater (uses other than drinking water)		U-6	ACT	3/20/2002	78.81
T0608100570	UNOCAL STATION #0670	LUST Cleanup Site	Open - Site Assessment	11/1/1987	Gasoline	Other Groundwater (uses other than drinking water)		MW-4	ACT	4/7/2002	7.58
T0608100573	UNOCAL #3857	LUST Cleanup Site	Completed - Case Closed	4/4/2002	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				

T0608100575	UNOCAL STATION #3798	LUST Cleanup Site	Open - Site Assessment	6/1/1989	Gasoline	Other Groundwater (uses other than drinking water)		MW-3	ACT	3/28/2002	10.58
T0608100577	UNOCAL #6980 (FORMER)	LUST Cleanup Site	Open - Site Assessment	3/2/1993	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	10/13/2003	41.5
T0608100579	UNOCAL STATION #1020	LUST Cleanup Site	Open - Site Assessment	9/1/1991	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	9/14/2002	4.67
T0608100584	UNOCAL STATION #3676	LUST Cleanup Site	Open - Site Assessment	11/10/2000	Gasoline	Other Groundwater (uses other than		MW-2	ACT	5/1/2002	21.11
T0608100585	UNOCAL	LUST Cleanup Site	Completed - Case Closed	12/11/1995	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100586	TOSCO #4113 (FORMER UNOCAL)	LUST Cleanup Site	Completed - Case Closed	9/3/2008	Gasoline	Under Investigation	Inside 2000ft Protection Zone				
T0608100593	UNOCAL STATION #4524 (FORMER)	LUST Cleanup Site	Completed - Case Closed	7/7/2011	Gasoline	Other Groundwater (uses other than		MW-7	ACT	8/1/2006	6.71
T0608100597	USCG	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Diesel	Under Investigation					
T0608100598	CITY OF SSF CORP YARD	LUST Cleanup Site	Open - Site Assessment	12/19/2011	Fuel Oxygenates, Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-1	ACT	11/4/2002	15.67
T0608100602	VALLEY SHEET METAL	LUST Cleanup Site	Completed - Case Closed	11/12/1991	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100613	WALL STREET PROPERTIES	LUST Cleanup Site	Completed - Case Closed	3/19/2001		Other Groundwater (uses other than drinking water)					
T0608100614	WAREHOUSE I	LUST Cleanup Site	Completed - Case Closed	8/26/1999	Gasoline	Other Groundwater (uses other than					
T0608100616	WESCO MANAGEMENT	LUST Cleanup Site	Completed - Case Closed	12/15/2000	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100619	WILL-STA, INC.	LUST Cleanup Site	Completed - Case Closed	1/17/1996	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100626	W. J. BRITTON COMPANY	LUST Cleanup Site	Completed - Case Closed	6/30/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100628	YELLOW FREIGHT SYSTEM	LUST Cleanup Site	Completed - Case Closed	4/26/2002	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100631	ZELLERBACH PAPER CO	LUST Cleanup Site	Completed - Case Closed	10/16/2001	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608100635	PACIFIC BELL	LUST Cleanup Site	Completed - Case Closed	9/18/2002	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100640	HILLSIDE SERVICE STATION	LUST Cleanup Site	Completed - Case Closed	2/20/1996	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100642	BURLINGAME FIRE DEPT.	LUST Cleanup Site	Completed - Case Closed	8/9/2002	Gasoline	Other Groundwater (uses other than					
T0608100645	PACIFIC BELL	LUST Cleanup Site	Completed - Case Closed	11/13/2000	Gasoline	Soil					
T0608100646	R.E.H. PROPERTIES	LUST Cleanup Site	Open - Remediation	1/12/2005	Gasoline	Other Groundwater (uses other than		MW-1	ACT	5/13/2003	
T0608100649	PLATH NURSERY, FORMER	LUST Cleanup Site	Completed - Case Closed	10/4/2000	Gasoline	Soil					
T0608100650	BAY BRIDGE HARDWARE SUPPLY	LUST Cleanup Site	Completed - Case Closed	6/6/1995	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100651	SEE's CANDIES	LUST Cleanup Site	Completed - Case Closed	1/18/2001	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608100652	ABBEY HOMESTEAD NURSERY	LUST Cleanup Site	Completed - Case Closed	12/13/1999	Gasoline	Soil					
T0608100653	CALIFORNIA GOLF CLUB	LUST Cleanup Site	Completed - Case Closed	10/4/2000	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100658	DUPONT	LUST Cleanup Site	Completed - Case Closed	10/6/2011	Arsenic, Stoddard Solvent / Mineral Spirits / Distillates	Other Groundwater (uses other than drinking water)		MW-1	ACT	6/5/2002	7.16
T0608100659	BLANKENHORN PROPERTY	LUST Cleanup Site	Completed - Case Closed	6/12/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100660	BP #11206	LUST Cleanup Site	Open - Site Assessment	2/2/1993	Gasoline	Other Groundwater (uses other than		MW-1	ACT	5/15/2003	22.75
T0608100664	VW AUTO REPAIR	LUST Cleanup Site	Completed - Case Closed	7/21/2000	Waste Oil / Motor / Hydraulic / Lubricating	Soil	Inside 2000ft Protection Zone				
T0608100668	WESTLAKE PONTIAC	LUST Cleanup Site	Completed - Case Closed	9/27/1991	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100674	ALQUEST PROPERTY CORP	LUST Cleanup Site	Completed - Case Closed	10/12/1994	Gasoline	Soil					
T0608100675	CALIF. FEDERAL SAVINGS BANK	LUST Cleanup Site	Completed - Case Closed	11/12/1995	Gasoline	Other Groundwater (uses other than					
T0608100693	CATERAIR INTERNATIONAL	LUST Cleanup Site	Completed - Case Closed	1/15/1995	Gasoline	Soil					
T0608100695	EL CAMINO LINES	LUST Cleanup Site	Completed - Case Closed	12/30/1996	Gasoline	Other Groundwater (uses other than					
T0608100696	STAN THE ROOF MAN	LUST Cleanup Site	Completed - Case Closed	8/10/2000	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100697	DALY CITY SCAVENGER	LUST Cleanup Site	Completed - Case Closed	12/2/1994	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100701	GUY F. ATKINSON CO.	LUST Cleanup Site	Completed - Case Closed	5/27/1997	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100704	TOWN OF HILLSBOROUGH	LUST Cleanup Site	Completed - Case Closed	3/5/1999	Gasoline	Other Groundwater (uses other than					
T0608100705	LEROY GREENWOOD PROPERTY	LUST Cleanup Site	Completed - Case Closed	12/29/1993	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100712	BUBBLE MACHINE	LUST Cleanup Site	Completed - Case Closed	12/7/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100713	SWINERTON & WALBERG	LUST Cleanup Site	Completed - Case Closed	4/3/1996	Gasoline	Other Groundwater (uses other than drinking water)					

T0608100720	VOLONTE AUTOMOTIVE	LUST Cleanup Site	Completed - Case Closed	9/27/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100721	SOUTH CITY SCAVENGER	LUST Cleanup Site	Completed - Case Closed	4/19/2011	Gasoline	Other Groundwater (uses other than drinking water)		MW-2	ACT	6/16/2003	4.95
T0608100723	SAMTRANS NORTH BASE	LUST Cleanup Site	Completed - Case Closed	7/26/2002	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100725	HORN INVESTMENT & REALTY	LUST Cleanup Site	Completed - Case Closed	11/30/1995	Diesel	Other Groundwater (uses other than drinking water)					
T0608100727	CYCLE SHACK,INC	LUST Cleanup Site	Completed - Case Closed	11/13/2000	Gasoline	Other Groundwater (uses other than					
T0608100728	GARRATT CALLAHAN COMPANY	LUST Cleanup Site	Completed - Case Closed	1/26/1995	Gasoline	Soil					
T0608100736	WAREHOUSE II	LUST Cleanup Site	Completed - Case Closed	9/27/1996	Gasoline	Other Groundwater (uses other than					
T0608100738	INTERSTATE GRADING	LUST Cleanup Site	Completed - Case Closed	8/13/1999	Gasoline	Soil					
T0608100740	TOWN OF COLMA	LUST Cleanup Site	Completed - Case Closed	4/11/1994	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100742	MCKINLEY SCHOOL	LUST Cleanup Site	Completed - Case Closed	12/5/1994	Gasoline	Soil					
T0608100743	REPO DEPOT	LUST Cleanup Site	Completed - Case Closed	5/4/1994	Gasoline	Soil					
T0608100748	KLIX CORP.	LUST Cleanup Site	Completed - Case Closed	6/12/2003	Gasoline	Soil					
T0608100752	MERCY PENINSULA AMBULANCE	LUST Cleanup Site	Completed - Case Closed	12/26/2001	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100753	BOB LEECH'S AUTO RENTAL	LUST Cleanup Site	Completed - Case Closed	3/15/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100760	EFL TRANSPORTATION	LUST Cleanup Site	Completed - Case Closed	12/3/1996	Diesel	Other Groundwater (uses other than					
T0608100761	COLMA FIRE PROTECTION DIST.	LUST Cleanup Site	Completed - Case Closed	5/31/2002	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100765	SERBIAN CEMETERY	LUST Cleanup Site	Completed - Case Closed	2/17/2003	Gasoline	Soil					
T0608100766	SAN BRUNO FORD II	LUST Cleanup Site	Completed - Case Closed	8/21/1995	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100768	BCBM	LUST Cleanup Site	Completed - Case Closed	3/18/1996	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100772	SEWAGE PUMP STATION #4	LUST Cleanup Site	Completed - Case Closed	8/21/2003	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	5/31/2002	9.28
T0608100774	MONFREDINI PROPERTY	LUST Cleanup Site	Open - Site Assessment	3/9/2005	Diesel	Other Groundwater (uses other than		MW-1	ACT	12/17/2002	9.88
T0608100777	BLUES ROOFING	LUST Cleanup Site	Completed - Case Closed	6/28/1994	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100779	S F ENGINE RE-MANUFACTURING	LUST Cleanup Site	Completed - Case Closed	2/28/2001		Other Groundwater (uses other than					
T0608100782	MATTISON & SHIDLER	LUST Cleanup Site	Completed - Case Closed	11/29/1995	Gasoline	Soil					
T0608100783	OLYMPIAN WESTLAKE	LUST Cleanup Site	Open - Assessment & Interim	10/16/2008	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-1	ACT	5/5/2009	12.78
T0608100785	PACIFIC CAR RENTAL	LUST Cleanup Site	Completed - Case Closed	9/28/1994	Gasoline	Soil					
T0608100791	AIRPORT BOULEVARD SERVICE STATION	LUST Cleanup Site	Completed - Case Closed	8/12/1997	Gasoline	Other Groundwater (uses other than					
T0608100794	FOUR STAR AUTOMOTIVE II	LUST Cleanup Site	Completed - Case Closed	6/12/1995	Gasoline	Soil					
T0608100795	COIT CLEANERS	Cleanup Program Site	Open - Inactive	1/1/2011	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100799	THRIFTY RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	6/19/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100801	PRIVATE RESIDENCE	LUST Cleanup Site	Completed - Case Closed	3/27/1995	Heating Oil / Fuel Oil	Other Groundwater (uses other than					
T0608100802	NERLI CONSTRUCTION	LUST Cleanup Site	Completed - Case Closed	11/9/2000	Gasoline	Soil					
T0608100806	EMERGENCY GENER DIESEL TANKS	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Diesel	Other Groundwater (uses other than drinking water)					
T0608100807	GOOTNICK PROPERTY	LUST Cleanup Site	Completed - Case Closed	10/27/2011	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	3/20/2003	9.37
T0608100808	UNITED AIRLINES MAINTENANCE OPS CENTER	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100813	KING YEE PROPERTY	LUST Cleanup Site	Open - Remediation	3/3/1994	Gasoline	Other Groundwater (uses other than drinking water)		EW-15	ACT	4/24/2002	14.55
T0608100821	LIBERTY MARKET	LUST Cleanup Site	Completed - Case Closed	6/11/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100822	MOBIL, FORMER	LUST Cleanup Site	Completed - Case Closed	9/22/1997	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100824	TRICOR	LUST Cleanup Site	Completed - Case Closed	9/22/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100828	DIADOTI CONSTRUCTION	LUST Cleanup Site	Completed - Case Closed	11/10/1998	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100829	NICOLET PROPERTY	LUST Cleanup Site	Completed - Case Closed	9/20/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100831	THE SERVICE ZONE	LUST Cleanup Site	Completed - Case Closed	4/24/2006	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				

T0608100835	FOLGER COFFEE CO	LUST Cleanup Site	Completed - Case Closed	10/12/1994	Diesel	Other Groundwater (uses other than drinking water)					
T0608100836	MIDAS MUFFLER	LUST Cleanup Site	Completed - Case Closed	5/13/1998		Other Groundwater (uses other than drinking water)					
T0608100837	PEKING HANDICRAFT	LUST Cleanup Site	Completed - Case Closed	8/18/1998	Gasoline	Other Groundwater (uses other than					
T0608100841	AGUNDIS TIRE SHOP	LUST Cleanup Site	Completed - Case Closed	11/28/2000	Waste Oil / Motor / Hydraulic / Lubricating	Soil					
T0608100842	JERAIR SHELL (FORMER)	LUST Cleanup Site	Open - Site Assessment	10/1/1995	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	3/31/2003	6.75
T0608100845	HOBART CORP	LUST Cleanup Site	Completed - Case Closed	12/6/1996		Other Groundwater (uses other than					
T0608100855	PENINSULA TRANSMISSION	LUST Cleanup Site	Completed - Case Closed	10/15/1997	Diesel	Aquifer used for drinking water supply	Inside 2000ft Protection Zone				
T0608100856	FEDERAL EXPRESS	LUST Cleanup Site	Completed - Case Closed	12/1/2004	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100863	BELL ELECTRICAL SUPPLY	LUST Cleanup Site	Completed - Case Closed	7/31/1995	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100864	CHEVRON 9-7875	LUST Cleanup Site	Completed - Case Closed	12/11/2002	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	7/10/2002	1.18
T0608100865	SO. SAN FRANCISCO TIRE SERVICE	LUST Cleanup Site	Completed - Case Closed	8/21/2003	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100868	UNOCAL #6329	LUST Cleanup Site	Completed - Case Closed	2/22/1996	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100872	ROBINSONS CARPET	LUST Cleanup Site	Completed - Case Closed	8/1/2005	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-2	ACT	12/10/2004	9.92
T0608100873	AVIS RENT A CAR SYSTEM	LUST Cleanup Site	Completed - Case Closed	8/5/2003	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608100884	PELLEGRINI BROS WINES INC	LUST Cleanup Site	Open - Remediation	2/10/2004	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	9/13/2002	10.27
T0608100889	UNOCAL STATION #0109	LUST Cleanup Site	Open - Site Assessment	2/21/2000	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	3/5/2002	10.43
T0608100890	MELODY TOYOTA	LUST Cleanup Site	Open - Site Assessment	2/2/2005	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-3	ACT	6/12/2003	11.7
T0608100893	SILVER TERRACE NURSERY II	LUST Cleanup Site	Completed - Case Closed	4/29/1996	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100904	DEVINCENZI METAL PRODUCTS	LUST Cleanup Site	Completed - Case Closed	5/23/2006	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	3/20/2003	4.22
T0608100905	CALEGARI PROPERTY	LUST Cleanup Site	Completed - Case Closed	6/29/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100908	S. F. DEPT. OF PUBLIC WORKS	LUST Cleanup Site	Completed - Case Closed	8/12/2009	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100911	OROWEAT	LUST Cleanup Site	Completed - Case Closed	1/25/2005	Diesel	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608100912	UNOCAL STATION #3816	LUST Cleanup Site	Open - Remediation	7/13/2010	Gasoline	Soil, Soil Vapor	Inside 2000ft Protection Zone				
T0608100916	PRIVATE RESIDENCE	LUST Cleanup Site	Completed - Case Closed	9/17/1996	Heating Oil / Fuel Oil	Soil					
T0608100917	BUDGET RENT A CAR	LUST Cleanup Site	Completed - Case Closed	9/13/2002							
T0608100936	MARTINELLI PROPERTY	LUST Cleanup Site	Completed - Case Closed	5/17/2000	Gasoline	Other Groundwater (uses other than					
T0608100938	PRIVATE RESIDENCE	LUST Cleanup Site	Completed - Case Closed	4/1/1997		Soil					
T0608100945	DONS AUTO WRECKERS	LUST Cleanup Site	Completed - Case Closed	1/22/1997	Gasoline	Under Investigation					
T0608100946	KING COLE HOMES	LUST Cleanup Site	Completed - Case Closed	4/1/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100949	HAMDI PROPERTY	LUST Cleanup Site	Completed - Case Closed	1/7/2005	Gasoline	Other Groundwater (uses other than drinking water)					
T0608100953	KIRKBRIDE PROPERTY	LUST Cleanup Site	Completed - Case Closed	12/9/1997	Diesel	Other Groundwater (uses other than drinking water)					
T0608100954	AUTOPRIDE CAR WASH	LUST Cleanup Site	Completed - Case Closed	6/30/2011	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	3/18/2002	4.9
T0608100963	CHEVRON 9-1035	LUST Cleanup Site	Completed - Case Closed	5/17/2011	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-1	ACT	9/10/2002	8.86
T0608100965	PRICE DEALERSHIP	LUST Cleanup Site	Completed - Case Closed	6/11/2001	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100966	BEST WESTERN EL RANCHO INN	LUST Cleanup Site	Completed - Case Closed	2/29/2000	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608100969	PIMENTEL PROPERTY	LUST Cleanup Site	Open - Verification Monitoring	11/6/2009	Benzene, Toluene, Xylene, Fuel Oxygenates,	Soil	Inside 2000ft Protection Zone				
T0608100970	HOLY CROSS CEMETERY	LUST Cleanup Site	Completed - Case Closed	1/8/1998	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608100990	VINCE'S SHELLFISH	LUST Cleanup Site	Completed - Case Closed	1/1/2002	Diesel	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608100992	GOLDEN GATE DRYWALL	LUST Cleanup Site	Completed - Case Closed	10/4/2002	Gasoline	Other Groundwater (uses other than					
T0608100994	CAPUCHINO HIGH SCHOOL	LUST Cleanup Site	Completed - Case Closed	7/13/2000	Diesel	Soil					
T0608101008	FIRE STATION #1	LUST Cleanup Site	Completed - Case Closed	6/27/2001	Diesel	Other Groundwater (uses other than drinking water)					

T0608101013	GROSVENOR AIRPORT INN	LUST Cleanup Site	Completed - Case Closed	6/26/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608101015	PRIVATE RESIDENCE	LUST Cleanup Site	Completed - Case Closed	9/1/2000	Diesel	Other Groundwater (uses other than					
T0608101018	F ST LIFT STATION	LUST Cleanup Site	Completed - Case Closed	1/6/2000	Diesel	Soil	Inside 2000ft Protection Zone				
T0608101023	CTC FOOD INTERNATIONAL	LUST Cleanup Site	Completed - Case Closed	8/10/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608101028	MILLBRAE SCHOOL WAREHOUSE	LUST Cleanup Site	Completed - Case Closed	6/1/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608101044	ARATA PROPERTY	LUST Cleanup Site	Completed - Case Closed	12/27/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608101045	PACIFIC BELL	LUST Cleanup Site	Completed - Case Closed	1/9/1991		Other Groundwater (uses other than					
T0608101051	CRESTMOOR HIGH SCHOOL	LUST Cleanup Site	Completed - Case Closed	1/9/1998	Diesel	Soil					
T0608101056	A-1 TRANSFER CO	LUST Cleanup Site	Completed - Case Closed	5/1/1991		Soil	Inside 2000ft Protection Zone				
T0608101058	PRIVATE RESIDENCE	LUST Cleanup Site	Completed - Case Closed	10/10/1991		Soil					
T0608101063	MOOSEHEAD INC	LUST Cleanup Site	Completed - Case Closed	10/30/1998	Gasoline	Soil					
T0608101069	LEXUS OF SERRAMONTE	LUST Cleanup Site	Completed - Case Closed	10/12/1994	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608101074	GOLDEN GATE NATIONAL CEMETERY	LUST Cleanup Site	Completed - Case Closed	4/12/2005	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608101083	AMERICAN AIRLINES FACILITY	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Diesel	Other Groundwater (uses other than drinking water)					
T0608101086	CHEVRON (CORPORATE HANGAR)	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Gasoline	Other Groundwater (uses other than drinking water)					
T0608101088	SHELL OIL	LUST Cleanup Site	Completed - Case Closed	9/19/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608101089	MILLBRAE CORP YARD	LUST Cleanup Site	Completed - Case Closed	4/28/1997	Gasoline	Other Groundwater (uses other than drinking water)					
T0608101090	CIRCLE K #5638 (TOSCO)	LUST Cleanup Site	Open - Site Assessment	9/9/1999	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-1S	ACT	3/20/2002	15.21
T0608101091	MILLS HIGH SCHOOL	LUST Cleanup Site	Completed - Case Closed	1/12/1998	Diesel	Soil					
T0608101096	SFIA - NORTH TERMINAL AREA	LUST Cleanup Site	Completed - Case Closed	7/6/2009	Aviation	Other Groundwater (uses other than					
T0608101102	UNITED AIRLINES MOC	LUST Cleanup Site	Completed - Case Closed	7/22/2009	Diesel	Under Investigation					
T0608101103	SFIA - FAA - Runway 28 Right San Francisco International Airport	LUST Cleanup Site	Completed - Case Closed	7/6/2009	Aviation	Other Groundwater (uses other than drinking water), Soil					
T0608101111	SPRINT	LUST Cleanup Site	Completed - Case Closed	10/4/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608101120	AL'S OLYMPIC	LUST Cleanup Site	Open - Verification Monitoring	4/7/2011	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	7/5/2005	47.19
T0608101122	MERCEDES BENZ	LUST Cleanup Site	Completed - Case Closed	6/27/2000		Other Groundwater (uses other than drinking water)					
T0608102301	CALTRANS MAINTENANCE STATION	LUST Cleanup Site	Open - Site Assessment	7/9/2008	Diesel	Other Groundwater (uses other than					
T0608105263	PRESSURE GROUT COMPANY	LUST Cleanup Site	Completed - Case Closed	6/4/1996	Waste Oil / Motor / Hydraulic / Lubricating	Soil					
T0608105470	ALAMO RENT A CAR, FORMER	LUST Cleanup Site	Completed - Case Closed	5/19/2000		Other Groundwater (uses other than					
T0608105654	STEEG PROPERTY	Cleanup Program Site	Completed - Case Closed	10/5/2001		Soil	Inside 2000ft Protection Zone				
T0608106256	OLYMPIAN SSF TERMINAL	LUST Cleanup Site	Open - Assessment & Interim Remedial Action	8/15/2006	Gasoline	Other Groundwater (uses other than drinking water)		MW-5	ACT	11/3/2006	7.59
T0608106763	CONTRERAS PAINTING	Cleanup Program Site	Completed - Case Closed	6/23/2011	Stoddard Solvent / Mineral Spirits / Distillates	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-3	ACT	3/29/2007	11.06
T0608108772	REAL ESTATE NORTH INVESTMENT PARTNERSHIP LP	LUST Cleanup Site	Completed - Case Closed	1/12/2012	Gasoline	Other Groundwater (uses other than		MW-1	ACT	10/9/2009	8.12
T0608110422	LOPEZ PROPERTY	Cleanup Program Site	Completed - Case Closed	1/17/2003	Lead	Soil					
T0608110689	D&M TOWING	LUST Cleanup Site	Completed - Case Closed	11/30/2001		Other Groundwater (uses other than drinking water)					
T0608111410	WINSTON TIRE #100	LUST Cleanup Site	Completed - Case Closed	5/26/2010	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	11/14/2008	16.09
T0608116637	STELLING PROPERTY	Cleanup Program Site	Open - Remediation	6/10/2005	* Solvents	Other Groundwater (uses other than drinking water)		MW-1	ACT	10/24/2005	13.5
T0608117321	AMPHLETT PRINTING	Cleanup Program Site	Completed - Case Closed	3/9/2005		Other Groundwater (uses other than drinking water)					
T0608117395	SHELL	LUST Cleanup Site	Completed - Case Closed	1/26/1995	Gasoline	Other Groundwater (uses other than					
T0608118237	BAUTISTA PROPERTY	LUST Cleanup Site	Completed - Case Closed	8/31/2000		Soil					
T0608119056	AGBAYANI CONSTRUCTION CORP	LUST Cleanup Site	Completed - Case Closed	2/25/2011	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	6/3/2005	18.97
T0608121993	ROB BAKER'S OLYMPIC	LUST Cleanup Site	Open - Site Assessment	2/9/2000	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	12/2/2003	17.53

T0608122176	THE CROSSING	LUST Cleanup Site	Completed - Case Closed	2/25/2004	Heating Oil / Fuel Oil	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608125206	AVIS RENT A CAR SYSTEM	LUST Cleanup Site	Completed - Case Closed	7/8/2010	Gasoline	Other Groundwater (uses other than drinking water)		MW-1R	ACT	8/19/2003	6.04
T0608126439	OLYMPIAN PRODUCE MKT CARD LOCK	LUST Cleanup Site	Open - Remediation	10/16/2003	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	7/19/2002	2.55
T0608128052	KB SOUTH SAN FRANCISCO	LUST Cleanup Site	Completed - Case Closed	3/11/2010	Diesel	Other Groundwater (uses other than drinking water)		MW-1	ACT	10/22/2008	9.5
T0608131587	ROLLINGWOOD AUTO SERVICE	LUST Cleanup Site	Open - Site Assessment	2/27/2002	Gasoline	Other Groundwater (uses other than		MW-1SP	ACT	12/16/2004	26.78
T0608138236	COLMA BART STATION APARTMENTS	Cleanup Program Site	Completed - Case Closed	4/8/2003	Lead	Soil	Inside 2000ft Protection Zone				
T0608138359	SOFOS PROPERTY	LUST Cleanup Site	Completed - Case Closed	6/23/2010	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than drinking water)					
T0608139599	AVIS RENT A CAR (TEMP FAC)	LUST Cleanup Site	Completed - Case Closed	9/25/2000	Gasoline	Other Groundwater (uses other than drinking water)					
T0608140024	CALIFORNIA GOLF CLUB OF SAN FRANCISCO	LUST Cleanup Site	Completed - Case Closed	8/17/2006	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608141952	WELCH PROPERTY	LUST Cleanup Site	Completed - Case Closed	2/11/2003	Diesel	Soil	Inside 2000ft Protection Zone				
T0608144136	CITY OF BURLINGAME	LUST Cleanup Site	Completed - Case Closed	7/30/2004	Gasoline	Other Groundwater (uses other than drinking water)					
T0608145778	SCHULZE MANUFACTURING	Cleanup Program Site	Completed - Case Closed	12/5/2003	* Solvents	Other Groundwater (uses other than drinking water)					
T0608147901	JIFFY CLEANERS	Cleanup Program Site	Open - Site Assessment	4/1/2001	* Solvents	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-2	ACT	3/25/2005	7.43
T0608148945	BINKS MANUFACTURING CO	Cleanup Program Site	Completed - Case Closed	12/16/1997		Other Groundwater (uses other than drinking water)					
T0608149730	OLYMPIAN GATEWAY	LUST Cleanup Site	Completed - Case Closed	2/26/2004	Diesel	Other Groundwater (uses other than drinking water)					
T0608150511	COSTCO	LUST Cleanup Site	Completed - Case Closed	8/8/2001	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608150735	SSF BART PROPERTY (FORMER COSTCO)	Cleanup Program Site	Completed - Case Closed	12/29/2003	Gasoline	Soil	Inside 2000ft Protection Zone				
T0608151141	GEMIGNANI NURSERY	Cleanup Program Site	Completed - Case Closed	6/25/1996		Soil					
T0608151779	TROYER AUTOMATIC DOORS, INC	LUST Cleanup Site	Open - Site Assessment	4/10/2008	Stoddard Solvent / Mineral Spirits / Distillates	Other Groundwater (uses other than drinking water)		MW-1S	ACT	6/29/2009	4.27
T0608151808	ACUTEC AUTOS	LUST Cleanup Site	Completed - Case Closed	5/13/2003	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608152226	BRESSIE & CO.	LUST Cleanup Site	Open - Site Assessment	7/25/2007	Diesel	Other Groundwater (uses other than		MW-12	ACT	3/22/2011	6.39
T0608152524	DELANO NURSERY II	Cleanup Program Site	Completed - Case Closed	6/25/1996	Polychlorinated biphenyls (PCBs)	Soil					
T0608153743	SHELL SERVICE STATION	LUST Cleanup Site	Completed - Case Closed	8/29/2006	Gasoline	Other Groundwater (uses other than		MW-1	ACT	6/14/2005	4.58
T0608153758	STANDARD BRANDS	Cleanup Program Site	Completed - Case Closed	12/31/1996		Soil	Inside 2000ft Protection Zone				
T0608158624	SSF WATER TREATMENT	Cleanup Program Site	Completed - Case Closed	12/2/1999		Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608161472	PIERCE TRUCKING	LUST Cleanup Site	Completed - Case Closed	1/14/2000	Gasoline	Soil					
T0608164207	Texaco Service Station 35-2469, Former	LUST Cleanup Site	Open - Site Assessment	5/1/2008	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	2/5/2010	7.89
T0608164698	ARCO #0508	LUST Cleanup Site	Open - Site Assessment	5/29/2001	Benzene, Toluene, Xylene, Fuel Oxygenates, Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	6/28/2002	4.68
T0608165213	AUTO SERVICE PROPERTY	LUST Cleanup Site	Completed - Case Closed	10/5/1998		Other Groundwater (uses other than drinking water)					
T0608165551	BARBER-GREENE CO.	LUST Cleanup Site	Completed - Case Closed	9/27/2001	Gasoline	Other Groundwater (uses other than					
T0608171378	SILVER TERRACE NURSERY	Cleanup Program Site	Completed - Case Closed	6/6/1996		Soil	Inside 2000ft Protection Zone				
T0608174310	BAYHILL OFFICE CENTER	LUST Cleanup Site	Completed - Case Closed	6/12/1997	Waste Oil / Motor / Hydraulic / Lubricating	Soil	Inside 2000ft Protection Zone				
T0608174722	BRIDGESTONE/FIRESTONE	LUST Cleanup Site	Completed - Case Closed	2/14/2002	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608175368	REST PARKING GARAGE	Cleanup Program Site	Completed - Case Closed	8/8/2011	* Solvents	Other Groundwater (uses other than drinking water)		8245-MW1	ACT	3/10/2005	7.6
T0608175400	SHELL SERVICE STATION	LUST Cleanup Site	Completed - Case Closed	11/10/2009	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone				
T0608175868	WRIGHT CLEANERS	Cleanup Program Site	Open - Site Assessment	3/4/2004	Tetrachloroethylene (PCE), *	Other Groundwater (uses other than		MW-1	ACT	3/6/2006	10.79
T0608178422	MCLELLAN NURSERY	LUST Cleanup Site	Completed - Case Closed	5/11/2000		Soil					
T0608179229	NATIONAL CAR RENTAL	LUST Cleanup Site	Completed - Case Closed	9/9/2002	Diesel	Other Groundwater (uses other than drinking water)					
T0608179893	THRIFTY RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	4/8/2009	Gasoline	Other Groundwater (uses other than					
T0608179897	CHEVRON 9-5584, FORMER	LUST Cleanup Site	Open - Remediation	2/1/2005	Gasoline	Aquifer used for drinking water supply	Inside 2000ft Protection Zone	MW-1	ACT	12/29/2003	33.71
T0608182194	SHELL STATION	LUST Cleanup Site	Open - Remediation	3/15/2010	Benzene, Fuel Oxygenates, Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-1	DRY	5/29/2003	

T0608182660	SAN MATEO HOUSING AUTHORITY	LUST Cleanup Site	Completed - Case Closed	4/5/2000		Soil	Inside 2000ft Protection Zone				
T0608184609	OLIVET MEMORIAL PARK	LUST Cleanup Site	Completed - Case Closed	5/27/2011	Gasoline	Aquifer used for drinking water supply, Soil		MW-3	ACT	1/5/2007	24.15
T0608185252	OTTOBONI PROPERTY	Cleanup Program Site	Completed - Case Closed	8/24/2004		Soil	Inside 2000ft Protection Zone				
T0608186803	BERENSTEIN ASSOC. PROPERTY	Cleanup Program Site	Open - Site Assessment	10/19/2005	Tetrachloroethylene (PCE)	Other Groundwater (uses other than drinking water), Soil		MW-5	ACT	4/6/2009	11.62
T0608189277	DOLLAR RENT-A-CAR	LUST Cleanup Site	Completed - Case Closed	12/20/2002	Gasoline	Other Groundwater (uses other than					
T0608189622	LES VOGEL	LUST Cleanup Site	Completed - Case Closed	4/28/2000	Waste Oil / Motor / Hydraulic / Lubricating	Soil					
T0608190888	ALFRED MOLAKDIS PROPERTIES	Cleanup Program Site	Completed - Case Closed	12/31/1993		Soil					
T0608191137	STELLING PROPERTY	LUST Cleanup Site	Open - Verification Monitoring	9/20/2011	Gasoline	Other Groundwater (uses other than drinking water)		MW-6	ACT	6/13/2002	13.13
T0608191183	WEST ORANGE LIBRARY	LUST Cleanup Site	Completed - Case Closed	8/9/2001	Diesel	Other Groundwater (uses other than	Inside 2000ft Protection Zone				
T0608191578	SUN CHEMICAL	Cleanup Program Site	Completed - Case Closed	1/1/1990	Waste Oil / Motor / Hydraulic / Lubricating	Soil					
T0608191581	TEEVAN EXTERIOR CONTRACTORS	Cleanup Program Site	Open - Inactive	6/4/2009		Other Groundwater (uses other than					
T0608191585	DELUXE PACKAGES	Cleanup Program Site	Open - Inactive	6/4/2009	Alcohols	Soil					
T0608191588	INTERNATIONAL PAINT COURTALD COATINGS	Cleanup Program Site	Open - Inactive	6/4/2009	* Solvents	Other Groundwater (uses other than drinking water)					
T0608191592	COYNE CYLINDER COMPANY	Cleanup Program Site	Open - Inactive	6/4/2009	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-2	ACT	7/25/2003	7.19
T0608191596	SFIA - SIGNATURE FLIGHT	Cleanup Program Site	Open - Inactive	5/13/2009	* Solvents	Other Groundwater (uses other than drinking water)					
T0608191597	UAL HYDRANT LEAK SHELL CHEVRON	Cleanup Program Site	Open - Inactive	5/13/2009	* Solvents	Other Groundwater (uses other than					
T0608191598	FUEL HYDRANT SYSTEM UNITED PARKING LOT	Cleanup Program Site	Open - Inactive	5/13/2009	Kerosene	Soil					
T0608191600	SFIA - GHILOTTI BROS SPILL	Cleanup Program Site	Completed - Case Closed	1/1/1999	Kerosene	Soil					
T0608191601	MILLBRAE AVE GATE	Cleanup Program Site	Open - Inactive	5/13/2009	Diesel	Soil					
T0608191820	SAN BRUNO FIRE	LUST Cleanup Site	Completed - Case Closed	9/28/2011	Gasoline	Other Groundwater (uses other than drinking water)		MW-1	ACT	9/27/2002	6.89
T0608191865	BAY CITIES BUILDING MATERIALS	LUST Cleanup Site	Completed - Case Closed	8/27/2001	Diesel	Other Groundwater (uses other than drinking water)					
T0608192381	ANZA PARK & FLY	LUST Cleanup Site	Completed - Case Closed	3/17/2000	Diesel	Other Groundwater (uses other than drinking water)					
T0608192685	SAN BRUNO CAR WASH	LUST Cleanup Site	Completed - Case Closed	7/1/2010	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	9/19/2005	7.18
T0608192695	BACON PROPERTY	LUST Cleanup Site	Completed - Case Closed	3/14/2007	Gasoline	Other Groundwater (uses other than drinking water)					
T0608192696	A-1 BODY SHOP	LUST Cleanup Site	Open - Site Assessment	8/14/2000	Gasoline	Other Groundwater (uses other than	Inside 2000ft Protection Zone	MW-1	ACT	9/13/2002	23.13
T0608192697	DALY CITY FIRE DEPT	LUST Cleanup Site	Completed - Case Closed	9/25/2000		Soil					
T0608192721	FRIMER REALTY/APTMNT COMPLEX	LUST Cleanup Site	Completed - Case Closed	8/11/2000	Diesel	Other Groundwater (uses other than drinking water)					
T0608192783	MILLS PENINSULA MEDICAL CENTER	LUST Cleanup Site	Completed - Case Closed	9/7/2000	Diesel	Other Groundwater (uses other than drinking water)					
T0608193859	TOSCO #3857	LUST Cleanup Site	Open - Site Assessment	8/1/2003	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-9	ACT	3/29/2007	7.25
T0608194008	BLANDINI TRUST	LUST Cleanup Site	Completed - Case Closed	9/28/2001	Gasoline	Other Groundwater (uses other than drinking water)					
T0608194016	L.BOCCI & SONS INC	LUST Cleanup Site	Open - Site Assessment	4/14/2004	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	2/14/2003	21.8
T0608194021	TIMPAC	LUST Cleanup Site	Open - Verification Monitoring	3/25/2006	Gasoline	Other Groundwater (uses other than		MW-3	ACT	6/20/2002	1.57
T0608194029	U-SAVE PLUMBING HARDWARE	LUST Cleanup Site	Completed - Case Closed	2/21/2003	Gasoline	Aquifer used for drinking water supply					
T0608194030	CHEVRON, FORMER/EAGLE GAS STA	LUST Cleanup Site	Completed - Case Closed	5/17/2006	Gasoline	Other Groundwater (uses other than		C-5	ACT	1/13/2002	11.24
T0608194884	PRIVATE RESIDENCE	LUST Cleanup Site	Completed - Case Closed	3/14/1994		Soil					
T0608195324	BRITANNIA DEVELOPMENTS	Cleanup Program Site	Open - Verification Monitoring	6/7/2004	Lead	Other Groundwater (uses other than drinking water)					
T0608196820	PATEL PROPERTY	LUST Cleanup Site	Completed - Case Closed	3/27/2002		Other Groundwater (uses other than drinking water)					
T0608198948	OLYMPIAN JUNIPERO SERRA	LUST Cleanup Site	Open - Site Assessment	7/27/2004	Gasoline	Other Groundwater (uses other than drinking water)	Inside 2000ft Protection Zone	MW-1	ACT	2/11/2004	12.83
T0608199177	PENSKE TRUCK LEASING II	LUST Cleanup Site	Completed - Case Closed	1/17/2003	Gasoline	Other Groundwater (uses other than drinking water)					
T0608199761	MARY RUANE PROPERTY	LUST Cleanup Site	Completed - Case Closed	6/21/2002	Gasoline	Other Groundwater (uses other than drinking water)					
T10000000282	BRESSIE & CO.	Cleanup Program Site	Completed - Case Closed	3/15/2011	* Solvents	Other Groundwater (uses other than		MW-12	ACT	7/6/2010	7.25

T10000000968	Chevron AST Facility (Former)	Cleanup Program Site	Completed - Case Closed	2/16/2010	Lead, Diesel	Soil					
T10000001104	ARE San Francisco No. 12	Cleanup Program Site	Open - Assessment & Interim	5/7/2009	Heating Oil / Fuel Oil	Other Groundwater (uses other than					
T10000001468	Mills Park Cleaners	Cleanup Program Site	Open - Site Assessment	8/4/2009	Tetrachloroethylene (PCE)						
T10000001754	SFIA - SAN FRANCISCO AIRPORT BOARDING AREA B (eastern portion, TWA site)	Cleanup Program Site	Completed - Case Closed	7/6/2011	Aviation	Indoor Air, Other Groundwater (uses other than drinking water), Soil					
T10000002006	B and B Transmission	LUST Cleanup Site	Open - Site Assessment	5/6/2010	Diesel, Gasoline	Other Groundwater (uses other than					
T10000002008	Colson Residence	LUST Cleanup Site	Open - Site Assessment	5/6/2010	Diesel, Heating Oil / Fuel Oil	Soil, Surface water					
T10000002366	Parcels Northwest of Orange Park	Cleanup Program Site	Open - Site Assessment	8/11/2010	Chlordane, Endrin, Other Insecticides / Pesticides / Fumigants / Herbicides	Soil	Inside 2000ft Protection Zone				
T10000002568	San Francisco Water Department	Cleanup Program Site	Open - Assessment & Interim Remedial Action	9/29/2010	Diesel	Soil, Under Investigation	Inside 2000ft Protection Zone				
T10000002674	Agbayani Construction	Cleanup Program Site	Open - Assessment & Interim Remedial Action	12/6/2010	Tetrachloroethylene (PCE), Trichloroethylene (TCE), Vinyl chloride	Aquifer used for drinking water supply, Indoor Air, Other Groundwater (uses other	Inside 2000ft Protection Zone	MW-1	ACT	8/31/2011	22
T10000002807	California Water Service Company, Reservoir #1	Cleanup Program Site	Open - Assessment & Interim Remedial Action	2/8/2011	Mercury (elemental)	Soil, Under Investigation					
T10000002827	SFIA - SAN FRANCISCO AIRPORT BOARDING AREA B (western portion)	Cleanup Program Site	Open - Remediation	6/21/1999	Aviation	Other Groundwater (uses other than drinking water), Soil					
T10000002842	Unocal #1020	LUST Cleanup Site	Open - Site Assessment	2/17/2011	Waste Oil / Motor / Hydraulic / Lubricating	Other Groundwater (uses other than		MW-1	ACT	1/17/2011	2.82
T10000002843	39-49 El Camino Real	Cleanup Program Site	Open - Site Assessment	2/4/2011	Tetrachloroethylene (PCE)	Under Investigation					
T10000002916	City of Millbrae Corporation Yard	Cleanup Program Site	Open - Assessment & Interim Remedial Action	3/17/2011	Diesel	Other Groundwater (uses other than drinking water), Soil					
T10000003031	Gas & Wash Partners	LUST Cleanup Site	Open - Site Assessment	5/20/2011	Benzene, Toluene, Xylene, Gasoline	Aquifer used for drinking water supply, Soil, Soil Vapor, Under Investigation	Inside 2000ft Protection Zone				
T10000003038	Real Estate North Investment Partnership LP	Cleanup Program Site	Open - Site Assessment	5/26/2011	Tetrachloroethylene (PCE), Trichloroethylene (TCE), Vinyl chloride	Other Groundwater (uses other than drinking water), Soil, Soil Vapor					
T10000003068	Bishop Property	LUST Cleanup Site	Open - Assessment & Interim Remedial Action	6/23/2011	Diesel, Gasoline	Other Groundwater (uses other than drinking water), Soil	Inside 2000ft Protection Zone				
T10000003112	Grand Avenue Gas	LUST Cleanup Site	Open - Assessment & Interim Remedial Action	7/5/2011	Gasoline	Soil, Under Investigation	Inside 2000ft Protection Zone				
T10000003211	Sterling Cleaners (Former)	LUST Cleanup Site	Open - Site Assessment	8/11/2011	Stoddard Solvent / Mineral Spirits / Distillates	Other Groundwater (uses other than					
T10000003461	One Hour Dry Cleaning	Cleanup Program Site	Open - Site Assessment	10/19/2011	Tetrachloroethylene (PCE), Trichloroethylene (TCE)		Inside 2000ft Protection Zone				
T10000003495	Golden Gate Petroleum	LUST Cleanup Site	Open - Assessment & Interim	1/19/2012	Diesel	Other Groundwater (uses other than					
T10000003522	SFIA - San Francisco Airport Taxiway F Spill Cleanup	Cleanup Program Site	Completed - Case Closed	8/9/2011	Aviation	Soil					

FUGRO CONSULTANTS, INC.

1000 Broadway, Suite 440
Oakland, California 94607
Tel: (510) 268-0461
Fax: (510) 268-0137

April 26, 2012
Project No. 0103.128

TECHNICAL MEMORANDUM 10-7 (Rev., Final)

To: Mr. Greg Bartow
San Francisco Public Utilities Commission

From: Peter Leffler, C.Hg.

Subject: **SFPUC Regional Groundwater Storage and Recovery Project; South Westside Basin Third Party Well Survey and Well Interference Analysis**

INTRODUCTION

This Technical Memorandum (TM) was prepared to document work performed by Fugro as part of contract CS-879A with Kenned/Jenks Consultants (Kennedy/Jenks) for the San Francisco Public Utilities Commission (SFPUC) pursuant to the amended Task Order authorizations CUW30103-TO-1.12 of the Regional Groundwater Storage and Recover (GSR) Project. This project is funded by the SFPUC's Water System Improvement Program (WSIP).

The San Francisco Public Utilities Commission is conducting environmental review for the proposed Regional Groundwater Storage and Recovery (GSR) Project in the South Westside Groundwater Basin in northern San Mateo County. The proposed GSR Project involves a partnership between SFPUC and the City of Daly City, California Water Service Company (Cal Water), and the City of San Bruno. The study area encompasses a portion of San Mateo County located between Millbrae and Daly City. Each of the Partner Agencies (Daly City, Cal Water, and San Bruno) has historically obtained municipal water supplies from a combination of groundwater and SFPUC surface water. In the proposed project, the SFPUC would provide a greater allocation (supplemental supply) of surface water to Partner Agencies (PAs) during average and wet years in order to allow Partner Agencies to reduce groundwater pumping. The project would create in-lieu groundwater recharge, which would be tapped during drought cycles via new wells installed by the SFPUC between Millbrae and Daly City. For reference, put/take/hold periods are defined as follows (see Kennedy/Jenks, 2012, Section 2.1.1 for more details):

- A put period is when the PAs would receive supplemental surface water from the SFPUC "in-lieu" of groundwater pumping. The reduced pumping would effectively increase the volume of groundwater in storage that would be available during dry years or an extended drought.
- A take period is when water shortages are triggered and water is recovered from the SFPUC Storage Account. During take periods, both the proposed GSR Project

wells and the PA wells would extract groundwater. The SFPUC would recover "stored" groundwater by pumping the proposed 16 GSR project wells. In addition, the PAs would return to their typical groundwater pumping.

- A hold period is when there are no water shortages, but the SFPUC Storage Account is "full" and supplemental water deliveries do not occur. During hold periods, the PAs would return to their typical groundwater pumping, and the GSR Project wells would pump only small amounts to exercise the wells.

Purpose of Study

The proposed project would only extract groundwater up to the amount in the SFPUC Storage Account. However, due to the possibility for localized effects, this study is being conducted as part of the effort to evaluate the localized cones of depression around proposed GSR wells that may potentially affect individual existing third-party wells. The other purpose of this Technical Memorandum is to provide the SFPUC with a well inventory (e.g., identification of existing wells, well location) of private third party irrigation wells in the South Westside Groundwater Basin. The well data in this memo were used as input to a third-party well interference (drawdown) analysis conducted by MWH related to proposed new GSR Project wells (labeled as CUP-X) to be installed by the SFPUC for extraction of in-lieu groundwater recharge stored under the GSR Project in the South Westside Groundwater Basin. The MWH well interference results were then superimposed on future regional groundwater levels to estimate how proposed GSR pumping would affect future static water levels of third party wells. MWH previously completed a well interference analysis for municipal wells (MWH, 2008) and was retained by the SFPUC to complete a similar analysis for third party wells as part of this study.

Background

The third-party (i.e., irrigation) groundwater pumpers in the South Westside Groundwater Basin that are the subject of this TM include the Colma cemeteries, California Golf Club, and Lake Merced Golf Club (Figures 1 and 2). In addition, this study provides GSR-related well interference calculations for the Olympic Golf Club and San Francisco Golf Club located near or within San Francisco City/County limits. A separate well interference study was conducted previously for Partner Agency municipal wells and included in the Conceptual Engineering Report (MWH, 2008).

The SFPUC invited cemetery and golf course owners/representatives to a Workshop that was held on June 25, 2009 at the Colma Town Hall Council Chamber. A presentation was given by SFPUC regarding plans for the proposed GSR Project. Attendees were informed that the SFPUC was conducting a survey of third party well owners as part of a series of studies in the groundwater basin to evaluate potential effects of the proposed project. A data request list pertaining to the well survey was made available to all attendees. As a follow-up, individual meetings were held with all known large irrigation well owners.

It is our understanding that some private homeowner irrigation wells exist in Hillsborough (HydroFocus 2007, 2011), however the GSR Project is not expected to affect these wells due to their distance from proposed GSR wells (about two miles south of CUP-M-1). The Green Hills Golf Club operates irrigation wells in Millbrae that are located about 0.75 miles from the nearest proposed GSR well (CUP-M-1) and greater than two miles from the next closest GSR well. In general, MWH determined that well interference effects on wells greater than 1.5 miles from a proposed GSR well would be negligible (Appendix B). Review of well logs for Green Hills Golf Club indicate that aquifer (sand) layers are within the depth interval from 120 to 260 feet below ground surface. The depth to water from 140 to 170 feet at these wells indicates unconfined aquifer conditions. Well CUP-M-1 has sand layers from 190 to 410 feet below ground surface with a depth to water of 160 feet. Theis calculations using an unconfined storage coefficient (0.05) and transmissivity value of 8,000 gpd/ft (derived from CUP-M-1 pumping test) show mutual interference drawdown of less than 5 feet after 7.5 years of continuous pumping. Given the distances from GSR wells and the small proposed pumping capacity of CUP-M-1 (about 150 gpm), the offsetting benefits of the GSR Put cycles, and differences in screen intervals and geologic conditions, mutual interference drawdown effects from GSR wells on Green Hills Golf Club wells are expected to be negligible.

Mr. Don Curry of CSW/Stuber-Strough was retained to facilitate contacting third party cemetery well owners due to his history of working with the cemeteries on their wells and water distribution facilities. Site visits were conducted with the California Golf Club and all Colma cemeteries that use groundwater for irrigation. The site visits included requests for well information, and measurement of water levels if an access port was available. Cypress Lawn did not provide a field visit to their irrigation wells nor provide any information regarding their wells. The SFPUC conducted site visits with the Olympic and San Francisco golf clubs. Multiple meetings were conducted with Lake Merced Golf Club, but they did not provide a field visit to their wells. Pump Repair Service (which services pumps in many of the third party wells) was also contacted to request data for various third party wells they service for owners that gave their approval for release of the information.

Previous Studies

Department of Water Resources (DWR) driller's logs and existing hydrogeologic reports and additional information obtained from the SFPUC were reviewed for purposes of undertaking the analysis in this Technical Memorandum. The Recycled Water Feasibility Study (Carollo, 2008) includes information that was used to help identify existing owners of wells that pump groundwater for irrigation purposes.

DATA COLLECTION

Site Visits

Owners of third party wells were contacted and site visits arranged as follows:

Holy Cross Cemetery - A site visit was conducted on September 11, 2009 and included a meeting with Mr. Roger Appleby (General Manager). Locations were obtained for four existing wells, and groundwater levels were measured in three of the four wells. A new (replacement) well was drilled in 2008, which would serve as the primary well in the future (Holy Cross 4). The current existing primary well (Holy Cross 1) is expected to become a secondary well. Available data from the 1999 to 2001 time period indicated the pumping rate for Holy Cross 1 was approximately 725 to 760 gpm. The existing emergency well (Holy Cross 2) would be maintained as a backup well, and the existing secondary well (Holy Cross 3) is planned for abandonment. The well interference analysis was conducted using Holy Cross 4 as the primary well and Holy Cross 1 as the secondary well.

A brief follow-up site visit was conducted on March 8, 2010 to obtain a groundwater level in the primary well that could not be obtained during the September 2009 site visit, and also to obtain groundwater levels in the other Holy Cross Cemetery wells.

Italian Cemetery - A site visit was conducted on January 22, 2010 and included a meeting with Giuseppe Timpano (Facility Manager). The location and a groundwater level were obtained for one existing primary well (IC-5). This is the only well utilized by the Italian Cemetery and they have no secondary or backup well. Available data from the 1999 to 2001 time period indicated the pumping rate was approximately 260 gpm. Future plans are to continue using this one primary well, and this primary well was used in the well interference analysis.

Woodlawn Cemetery - A site visit was conducted on January 22, 2010 and included a meeting with Margaret Hambrick. Locations were obtained for two existing wells (primary and backup), and a groundwater level was obtained in the primary well. Future plans are to continue using the same two wells. Available information from 2008 indicated that the primary well pumped at approximately 500 gpm. The well interference analysis was conducted using the primary well and backup well.

Eternal Home Cemetery - A site visit was conducted on February 4, 2010 and included a meeting with Lisa Matson (Office Manager). The location and a groundwater level were obtained for one existing primary well (ET-2). This is the only well utilized by the Eternal Home Cemetery and they have no secondary or backup well. Future plans are to continue using this one primary well. The well pumps water to an approximately 10,000 gallon storage tank located uphill from the well. At the time of our site visit, the well was reported to pump at an instantaneous rate of approximately 100 gpm. Available data from the 1999 to 2001 time period indicated the pumping rate ranged from 150 to 200 gpm. The well interference analysis used this one primary well.

Hills of Eternity/Home of Peace/Salem Cemeteries - A site visit was conducted on February 8, 2010 and included a meeting with James Carlson (Executive Director). Locations were obtained for two existing wells (HE-2 at Hills of Eternity and HP-3 at Home of Peace) and one proposed replacement well at Home of Peace Cemetery. Groundwater levels could not be obtained from the two existing wells. Historic operations have utilized the two existing wells to serve the three cemeteries, with the Home of Peace well being the primary well and Hills of Eternity well being the secondary well. Recently the primary (Home of Peace) well went out of service , and the Hills of Eternity well is currently the only well in operation. Available data from the 1999 to 2001 time period for the Hills of Eternity well indicated the pumping rate ranged from 170 to 180 gpm.

The proposed replacement well was drilled in 2010, and additional information on that well was obtained from Don Curry in 2011. Future plans are to use the new replacement well located at Home of Peace as the primary well to serve all three cemeteries (Hills of Eternity/Home of Peace/Salem). The future backup well would be the existing Hills of Eternity well (HE-2). The well interference analysis was based on the new replacement well at Home of Peace as the primary well and the existing Hills of Eternity well as the back-up well.

Cypress Lawn Cemetery - A site visit was conducted on February 4, 2010 and included a meeting with Ken Varner (President and CEO). We were not given a site visit to the wells and were not provided with a map of well locations. Ken said that they operate a primary well that is approximately six years old that pumps into the lake, and have a back-up well known as the South Well. The primary well is used to irrigate approximately 140 acres. They have an additional 32 acres of land on Hillside irrigated with water obtained from Cal-Water. Apparently two wells were damaged and/or lost during the BART construction process, including a well known as the North Well. Due to the lack of well data obtained for this study, well interference calculations for Cypress Lawn were conducted for historic wells known as Cypress 3 and 4. General well locations and construction data necessary to conduct the analysis were obtained from a review of DWR well logs and previous studies. Although specific current well locations could not be obtained, the selected well locations should provide representative well interference drawdowns for potential well locations on Cypress Lawn property.

California Golf Club - A site visit was conducted November 17, 2009 and included a meeting with Rick Kavakoff and Dennis Mahoney (General Manager). Locations were obtained for four existing wells, and groundwater levels were obtained in three of the four wells. Well 8 is considered the primary well (90% of pumping), Well 7 is a secondary well (10% of pumping), and Wells 5 and 6 are backup wells. Well 7 was tested at a rate of 200 gpm at the time of installation (1994), and Well 8 was originally tested at 800 gpm (2001). Future plans are to continue use of the wells as described above. The well interference analysis used Well 8 as the primary well and Well 7 as the secondary well.

Olivet Cemetery - A site visit was conducted on March 8, 2010 and included a meeting with Mario Falla, who is in charge of maintenance at the cemetery. A location was obtained for the one existing primary well. The port was not able to be accessed at the well head to obtain a groundwater level in the well. The well was tested at 480 gpm at the time of installation (1999). The well interference analysis used the one existing well which serves as the sole source of irrigation water supply for the cemetery.

Lake Merced Golf Club (LMGC) – Meetings were conducted March 5, 2010, March 11, 2011, and June 21, 2011 with Donna Lowe (General Manager) and other golf club representatives. LMGC did not provide a site visit to their wells and did not have any information on their wells, although they did provide a map with golf course well locations and indicated that essentially Well 3 is the only active well. Attempts were made to arrange for access to Pump Repair Service files for LMGC wells; however, multiple attempts at doing so were not successful. It is not clear whether or not Pump Repair Service is the most recent provider of pump contracting services, as LMGC indicated in our meetings that multiple pump service providers have been used over the years. The well interference analysis used Well 3 as the primary and only well. The majority of water utilized by LMGC has been recycled water since 2005.

Olympic Golf Club - A site visit and data collection effort for Olympic Golf Club were conducted by SFPUC. Data obtained by SFPUC were compiled and provided in this TM for use in MWH well interference calculations. Olympic Golf Club Well No.1 and Well No. 2 were used in the well interference analysis.

San Francisco Golf Club - A site visit and data collection effort for San Francisco Golf Club were conducted by SFPUC. Data obtained by SFPUC were compiled and provided in this TM for use in MWH well interference calculations. San Francisco Golf Club Well No. 2 was used in the well interference analysis.

Other Data Sources

CSW/Stuber-Strough assisted in making contacts with the cemetery owners and providing historic well data from their files related to their work for certain cemeteries. Some of the historic well data provided by CSW was related to well testing completed as follow-up work to the Colma area BART EIR. In addition, CSW/Stuber-Strough provided recent data regarding two new cemetery well installation projects with which they have been involved - one at Holy Cross and one at Home of Peace.

Pump Repair Service has historically been and continues to be the primary contractor providing pump services for several third party well owners in northern San Mateo County. Permission was obtained from each cemetery and golf course owner (with the exception of Cypress Lawn and Lake Merced Golf Club) to contact Pump Repair Service to ask for available well and pump data. At least some data were obtained from Pump Repair Service for the following cemeteries: Holy Cross, Hills of Eternity, Olivet, Eternal Home, Italian, Woodlawn, and California Golf Club.

Fugro submitted a request to California DWR for copies of well completion reports in the Colma area. The package of well completion reports obtained from DWR includes several reports for wells associated with the cemeteries and golf courses that are the subject of this survey. These reports were reviewed for purposes of undertaking this study for the SFPUC.

Well Inventory

A well inventory spreadsheet was compiled from the data obtained for this study (Table 1). The spreadsheet generally includes information on the following: well name and use, top of well screen, and specific capacity calculations. Well head elevation data were uniformly not available for any of the wells in this survey; thus, reference point elevations were estimated from Google Earth. Despite certain limitations in data availability mentioned above, it is our opinion that the available data are sufficient to allow for an adequate assessment of effects on third party wells from the proposed GSR Project.

General locations for each well identified in the field are plotted in Figures 1 and 2. The Colma cemeteries that pump groundwater extend from Woodlawn Cemetery in the north to Holy

Cross Cemetery in the south (Figure 2). The proposed GSR wells nearest to the Colma cemetery wells include CUP-11A at the northern end, CUP-18, CUP-19, CUP-22A, and CUP-23 at the southern end of the Colma cemeteries. Lake Merced Golf Club is located about 7,000 feet northwest of Woodlawn Cemetery, and the nearest proposed GSR wells are CUP-3A, 5, 6, and 7. Olympic and San Francisco golf clubs are located about 12,000 feet northwest of Woodlawn Cemetery, and about 4,000 to 5,000 feet from the nearest GSR wells (CUP-3A, 5, 6, and 7). California Golf Club wells are located about 6,000 feet southeast of Holy Cross Cemetery, and the nearest proposed GSR wells are CUP-31 and CUP-36-1.

Well screen information was obtained for most wells. CSW/Stuber-Strough provided the well screen information for the newly constructed Home of Peace well. The recently installed wells have top of screen intervals at 420 feet below ground surface (bgs) for the Holy Cross Replacement Well (Primary Well 4), and 400 feet bgs for the Home of Peace (Hills of Eternity and Salem) Replacement Well. These two new wells appear to be screened both above and below the W clay. In terms of the numerical model, these two wells are assumed to have screens in both Model Layer 4 and Model Layer 5. Other active wells such as Hills of Eternity, Olivet, Eternal Home, and Italian cemeteries have top of screens at depths ranging from as shallow as 224 feet bgs to as deep as 308 feet bgs, and all appear to be screened above the W clay in Model Layers 2, 3, and 4. The Holy Cross Secondary Well 1 is screened in from 368 feet bgs, likely contains screens both above and below the W clay, and is assumed to have screens in Model Layers 3, 4, and 5.

The Woodlawn primary well is screened from 275 feet bgs, which appears to encompass and extend slightly below the W clay. The Woodlawn primary well screen intervals are assumed to correspond primarily to Model Layers 2, 3, and 4. Lake Merced Golf Club Well 3 is screened from 294 feet bgs, and may extend into but not below the W clay. The Lake Merced Golf Club Well 3 screen intervals are assumed to correspond primarily to Model Layers 2, 3, and 4. California Golf Club Well 8 is screened from 320 feet bgs in an area of the basin where the W clay is not present. CGC8 well screen intervals correspond to Model Layers 3, 4, and 5.

It was assumed that Cypress Lawn Wells 3 and 4 are sufficient to represent the existing active wells for the cemetery. Cypress Lawn Well 3 is located at a higher surface elevation and screened at various depth intervals from 191 feet bgs (assumed to correspond to Model Layers 2, 3, and 4). Cypress Lawn Well 4 is located at a lower surface elevation and screened from 330 feet bgs (assumed to correspond to Model Layers 3, 4, and 5).

Based upon the well data collected for this study (and making certain assumptions about Cypress Lawn Cemetery and Lake Merced Golf Club wells), the wells tend to fall into two groups: one with relatively shallow elevations for the top of screen and one with deep elevations for the top of screen. Five cemeteries that have wells with tops of screens ranging from -100 feet (NGVD 29) to -166 feet (NGVD 29) include Eternal Home, Italian, Hills of Eternity, Woodlawn, and Olivet. Cypress Lawn Well 3 is assumed to have a top of screen elevation of about -40 feet (NGVD 29). Lake Merced Well 3 is assumed to have a top of screen elevation of -140 feet (NGVD 29). Two cemeteries that installed wells within the last two years having deeper top of screens at -274 and -279 feet (NGVD 29) include Holy Cross and Home of Peace (which also would serve Hills of Eternity and Salem). The assumed representative primary

Cypress Lawn well (No. 4) being used for this study has a somewhat intermediate depth top of screen at about -240 feet (NGVD 29), and California Golf Club Well 8 has top of screen at -259 feet (NGVD 29).

In terms of groundwater level measurements, some historic data are available from the time each well was installed. Other historic groundwater level data for several wells encompass the 1999-2001 time period. In addition, groundwater level measurements were obtained from the wells with accessible sounding ports during the site visits for this study. In general, groundwater levels increased 35 to 36 feet on average between spring 2001 and spring 2010 (Table 2). As discussed further below, this increase in water levels is generally attributed to the In-Lieu Recharge Demonstration Study, which started in 2002 (L&S, 2005).

Specific capacity calculations for this study are summarized in Table 1. Well specific capacities generally range from about 5 to 15 gallons per minute per foot of drawdown. The third party wells are generally operated at pumping rates ranging from about 150 to 800 gpm, with typical drawdowns in the range of 20 to 100 feet.

Data were obtained for several wells with respect to the type of pumps installed, capacity/head ratings, and pump curves. These data are summarized in Table 3. Pump models, pump curves, and capacity/head ratings were obtained for the following wells: Holy Cross 1, Holy Cross 4, Woodlawn, Italian, Eternal Home of Peace, Hills of Eternity, Olivet, and California Golf Club. Similar pump data were also available for Olympic Club and San Francisco Golf Club Wells (LSCE, 2012). As discussed further below, pump data were used to estimate changes in pumping rates under the maximum depth to water conditions during future Take cycles.

GROUNDWATER FLOW MODEL SCENARIO RESULTS

A numerical groundwater flow model for the Westside Groundwater Basin was developed over a period of time from 2000 to 2011 by HydroFocus and Gus Yates, who were retained by Daly City (HydroFocus 2007, 2009, 2011). It has been a collaborative effort sponsored by Daly City with review by the SFPUC, Cal Water, San Bruno and their respective consultants. Groundwater studies being conducted by the SFPUC for the San Francisco Groundwater project and the GSR Project have utilized the calibrated Westside Basin Groundwater Flow Model as one of the tools for evaluating potential project effects. Kennedy/Jenks Consultants have been the lead in applying the existing model to future project scenarios for the groundwater studies with review and input by Luhdorff & Scalmanini and Fugro.

Other studies currently being conducted by SFPUC include application of the groundwater flow model to a future scenario developed for the GSR Project. These model scenarios and results are described in detail in a Technical Memo prepared by Kennedy/Jenks (2012). Although the analyses conducted for this TM primarily are based upon analytical techniques, some applicable groundwater model scenario results are provided herein for comparison. In particular, model scenario 2 for the GSR Project is shown for comparison purposes in some of the graphical plots of analytical results for specific wells.

ANALYTICAL DATA ANALYSIS RESULTS

Colma Cemetery Wells

The analytical data analysis for the Colma area wells included in this study involved the following steps:

1. Based upon review of water level data from 2001 to 2010 for cemetery wells (cemetery well water level data was only available for early 2010 and was assumed to be similar to 2009 levels), it was concluded that an appropriate groundwater level recovery rate for the Colma area is 8.6 feet per 4,300 acre-feet of in-lieu recharge (this represents the amount of in-lieu recharge in the Daly City and Cal Water areas during a future Put Year). The rationale for this conclusion is that the SFPUC storage account calculations provided by SFPUC indicate that it had accumulated 17,987 acre-feet (af) of in-lieu recharge (as of the end of 2009) in Daly City and Cal Water areas since 2002 (Appendix A). It is assumed that the approximately 18,000 af of increased storage correlates with the 36-foot rise in groundwater levels at the cemetery wells between 2001 and 2010. Thus, dividing 18,000 af of Put by a total water level rise of 36 feet equals 500 af of Put per foot of groundwater level rise.
2. Under the proposed project, a year of Put is equal to about 6,180 af for the three Partner Agencies. However, factoring out Put for the San Bruno wells (due to the significant distance from Colma) results in a total in-lieu recharge of about 4,300 acre- feet per year (AFY) during a proposed project Put year in the Daly City and Cal Water areas. Using the above logic, a year of Put at 4,300 af divided by 500 af per foot of water level rise results in a Put year groundwater level rise of 8.6 feet.
3. The proposed GSR well locations were reviewed for proximity to Colma to determine the amount of Take from GSR wells in the Colma region. The only wells excluded from the Take calculation were CUP-41-4, CUP-44-1, CUP-44-2, and CUP-M-1 due their considerable distance from the Colma area (greater than two miles). Assuming a total Take year extraction of 7.23 MGD (8,100 AFY), and subtracting the Take amounts from the four wells listed above results in about 6,460 af of extraction from GSR wells in the Daly City, Colma, and Cal Water areas. Assuming that Take year extraction works in reverse of the recovery of water levels during Put years yields a one foot water level drop per every 500 af removed during a Take year. Dividing 6,460 af by 500 af per 1 foot of groundwater level decline yields 12.9 feet of groundwater level decline during a proposed Take year due to GSR pumping.
4. The background groundwater level decline due to regional groundwater (i.e., Partner Agency and third party wells) pumping was evaluated using both available cemetery well groundwater level data prior to 2002 (and the onset of the In-Lieu Recharge Demonstration Study) and groundwater flow model simulation results. Tabulation of pre-2002 cemetery well groundwater level data is provided in Appendix A. Data available from wells at three cemeteries (Eternal Home, Hills of Eternity, and Holy Cross) indicate groundwater level decline rates ranging from 1 to 2 feet per year between 1960 and 2001. The HydroFocus (May 2011) Historical Simulation (1958-2009) showed an average water level decline of about 1 foot/year, and the

HydroFocus 2008 No Project Scenario showed decline rates of 0.6 to 0.8 feet/year. The Existing Conditions Scenario (Scenario 1) by KJ (2012) showed a background groundwater level decline rate of about 0.75 feet/year in the Colma cemetery area. Based on available field data and model simulations, a background groundwater level decline rate of 0.75 feet/year is considered to be representative of future Hold year Partner Agency and cemetery well pumping effects on Colma area groundwater levels.

5. Combining the values above, we have a Put Year recovery rate of 8.6 feet/year, a Take Year decline rate of 12.9 feet/year, and a Hold Year decline rate of 0.75 feet/year. The Take Year decline rate of 12.9 feet/year is assumed to already include the background (Hold Year) decline rate related to basin pumping because many of the years in the 2001 to 2010 time frame used in the analysis did not have in-lieu recharge.

Using an example cemetery well (Eternal Home), a starting depth to water of 225 feet below ground surface was measured in early February 2010 (assumed representative of 2009 conditions). Based on the amount of in-lieu SFPUC storage account being approximately 20,000 af, another 40,500 af is required to achieve a full SFPUC Storage Account. Thus, it would require 6.5 years of Put at a rate of 6,180 AFY (4,300 AFY in Daly City and Cal Water areas) to achieve 60,500 af of in-lieu storage when starting with 20,000 af of storage. 6.5 years of Put at the proposed rate would increase groundwater levels another 56 feet at the Eternal Home well, resulting in the regional static water level associated with a Full SFPUC Storage Account being 169 feet bgs (the high point on Figure 3 in future scenario year 7).

The proposed Put/Hold/Take year sequence for the GSR scenario (Table 4) was used to develop a plot of future groundwater levels (depth to water and groundwater elevation) for the Eternal Home well (Figures 3 and 4). Both the Existing Conditions (Scenario 1) and the GSR scenario (Scenario 2) include the Design Drought. Using the annual changes in groundwater levels associated with Put, Hold, and Take years described above, Figures 3 and 4 show how regional groundwater levels are estimated to fluctuate at the Eternal Home well over the course of 47 future years based on the assumptions and calculations used in this analysis.

The next step was to add in the local GSR drawdown as calculated by MWH (Appendix B) to regional groundwater level fluctuations shown in Figures 3 and 4. Local well interference drawdowns ranged from 41 feet after one year of Take to 76 feet after 7.5 years of Take. The resulting new (end of water year) static water level for the Eternal Home Cemetery Well ranged from approximately 169 feet bgs (-41 feet NGVD 29) to 361 feet bgs (-233 feet NGVD 29). The background water level decline (i.e., existing conditions from 2009/2010 water level or 20,000 AF SFPUC storage account starting condition) would result in a static water level decline from 225 feet bgs (-97 feet NGVD 29) to 258 feet bgs (-130 feet NGVD 29) at the end of the Design Drought (Year 44). The background water level decline for existing conditions was calculated by applying an annual groundwater level decline of 0.75 feet per year (i.e., equal to Hold Year groundwater level decline). The annual background water level decline in this analysis is assumed to be linear for purposes of this analysis; however, in reality, depletion of aquifer storage and the related rate of decline in groundwater levels will generally decrease over time if groundwater extraction remains constant and there is available recharge. Therefore, the assumption of a consistent rate of decline is conservative.

The groundwater model results for Scenario 2 are plotted on Figure 4 for comparison with analytical results. There is general agreement between analytical and groundwater model results in terms of both short-term and longer term groundwater level fluctuations. The analytical results generally show equal or lower static water levels during Take cycles than Layer 4 groundwater model results and can be considered more conservative (i.e., more of a worst case) in evaluating potential effects of the GSR Project on the Eternal Home well.

Figures 3 and 4 show that Take-Year static water levels fall below existing conditions between the first and second year of drought. Scenario 2 static water levels (SWLs) for the Eternal Home Cemetery Well with implementation of the GSR Project are estimated to reach a maximum depth of 105 feet below the existing conditions (i.e., without the GSR Project) SWLs. The maximum decline in groundwater levels for the Eternal Home Cemetery well occurs at the end of the Design Drought in future scenario year 44 (middle of the eighth consecutive year of Take). The static water level in the well declined to 285 feet bgs (before factoring in local GSR well interference drawdown). Addition of the local well interference effects results in a SWL declining to a low of 363 feet bgs (compared to an existing conditions level of 258 feet bgs).

It should be noted that the absolute lowest static water level occurs in the middle of scenario year 44 (when the Design Drought ends and SFPUC Storage Account is empty) and not at the end of the year (361 feet bgs) as shown in the figures. The lowest level occurs when Take ends within future scenario year 44 at a SWL of 363 feet bgs (groundwater elevation of -235 feet NGVD 29).

Similar analytical analyses as described above were conducted for other Colma cemetery wells and the tables and figures with results for these wells are provided in Appendix C. In general and as described above, after the first year of Take static water levels begin to decline to below the level expected without the project (20,000 acre-feet SFPUC storage account starting condition). However, it should be noted that static water levels are generally positive (i.e., higher than would be expected under existing conditions) under all other conditions except the three years of recovery needed after the Design Drought to return to Existing Conditions water levels. Overall, GSR Project static water levels in cemetery wells are higher than existing conditions for 75% of years.

Analysis of Installed Pump Capacities for Colma Cemetery Wells

Limited data were obtained concerning the specific pumps installed in the various cemetery and golf course irrigation wells. Although complete data sets were unable to be obtained for any of the wells, the available data combined with certain assumptions were used to obtain estimates of how GSR-related effects on static water levels might alter pumping capacities for wells that had sufficient pump data. Wells with sufficient data available for analysis were Italian Cemetery Well, Olivet Cemetery Well, Home of Peace Well, Hills of Eternity Well, Holy Cross Cemetery Wells 1 and 4, Eternal Home Well, Woodlawn Primary Well, and California Golf Club wells and the results are summarized in Table 5.

The pump in the Italian Cemetery well has a capacity/head rating of 260 gpm at 420 feet. It was assumed that the pump had a total dynamic head of 420 feet and was pumping at 260 gpm at the time of the spring 2001 groundwater level measurement (294 feet bgs). Based upon a specific capacity of 4.8 gpm/ft and a pumping rate of 260 gpm, the pumping drawdown in the well was estimated to be 54 feet - resulting in a pumping water level of 348 feet bgs (294 + 54 feet) as of spring 2001. Thus, the discharge head needed to achieve 420 feet of total dynamic head (TDH) was estimated to be 72 feet (420 - 348 feet).

Utilizing the data and assumptions outlined above, a calculation was first made for the existing conditions. Under this future condition, the new static water level was calculated to be 290 feet, a decline of 33 feet from the initial SWL. Analysis of this condition using the pump curve for the well suggests a pumping capacity of 265 gpm with a pumping water level of 345 feet. The new pumping water level of 345 feet plus the 72 feet of discharge head yields a total dynamic head of 417 feet.

A similar analysis/calculation as described above was applied to the estimated maximum depth to water for the GSR Scenario. In this case, the SWL declines to 400 feet bgs. Analysis of this condition using the pump curve suggests that the Italian well pump capacity would decline to 145 gpm with a pumping water level of about 430 feet. Addition of the discharge head of 72 feet yields a TDH of 502 feet.

A similar logic/analysis as described above for the Italian Cemetery well was applied to the Olivet Cemetery Well, Home of Peace Well, Hills of Eternity Well, Holy Cross Cemetery Well 1 and 4, Eternal Home Well, and Woodlawn Primary Well, and results are provided in Table 5. The overall results indicate that the lowest point during a Design Drought would result in pump capacity declines ranging from about 10 to 50 percent from existing conditions for all wells except Woodlawn (87% decline). The encroachment of pumping water levels into the well screen intervals under the two different water level conditions described above (Existing Conditions and GSR Project) varies depending on well construction details. In the case of the Italian Cemetery, Eternal Home, and possibly Olivet Cemetery wells, it appears that they have historically had pumping water levels within the upper portion of the screen interval. However, existing conditions and GSR Project conditions would result in much greater decline of pumping water levels into the screen intervals, which might be expected to result in decreasing specific capacity (i.e., estimated future pumping capacities could be somewhat lower than described above). The Holy Cross Well 1 maintains pumping water levels above the top of screen under historic conditions and the existing conditions scenario; and then pumping water level declines approximately 25 feet into the screen interval by the end of the GSR Project scenario. These differences with respect to decline of pumping water levels into screen intervals reflect the generally shallow top of screen settings for the Italian and Olivet wells compared to the somewhat deeper (intermediate) top of screen setting for the Holy Cross Well 1. Schematic examples of what could be typical water levels in third party well under both Existing Conditions and GSR Project Conditions are provided in Appendix D.

The Holy Cross Well 4 has a significantly lower specific capacity (6 gpm/ft) than the Holy Cross Well 1 (11 gpm/ft). Therefore, although the top of screen in Holy Cross Well 4 is deeper than in Well 1, the end of Design Drought pumping well level declines all the way through the upper screen interval in Well 4. This condition of pumping water levels remaining above the top of screen without the GSR project versus declining through the upper well screen with the GSR project could result in a lower specific capacity during the latter half of the Design Drought with GSR wells pumping. The Home of Peace Replacement well has a specific capacity of 11 to 12 gpm/ft and the analysis presented herein shows that the pumping water level only encroaches into the uppermost portion of the well screen by about 5 feet at the end of the Design Drought.

The pump curve for the Woodlawn Primary Well indicates that the installed pump is apparently designed to operate within a relatively narrow range of water levels compared to other pumps in cemetery wells. The dramatic decline in pumping capacity estimated for future end of Design Drought GSR conditions for the Woodlawn Well (87%) compared to other cemetery wells (10 to 50%) is largely due to the particular pump installed in the well as opposed to differences in water level declines (e.g., about 15 feet more at Woodlawn than other cemetery wells) .

California Golf Club Wells

The data analysis for the California Golf Club wells is similar to the Colma cemetery wells and involved the following steps:

1. Based upon review of water level data from 2001 to 2010 for the CGC wells and the Colma area well data analysis (recovery rate of 8.6 feet/year), it was concluded that an appropriate recovery rate of CGC wells is approximately 8.5 feet/year.
2. Based upon review of the Colma area well data GSR Take Year analysis (decline rate of 12.9 feet/year) along with the estimated Take-Year groundwater level decline rate of up to 24 feet/year estimated by L&S for the Cal Water Well Field area (personal communication, Will Halligan), it was concluded that an appropriate decline rate for CGC wells is approximately 18.5 feet/year (average of Colma area 12.9 feet/year and 24 feet/year).
3. The groundwater level decline due to Partner Agency/third party pumping was estimated based upon the Colma area analysis (0.75 feet/year) and the groundwater model result for Model Layer 4 at the California Golf Club well (about 0.7 feet/year). Thus, it is concluded that the Hold year decline rate at the California Golf Club is 0.75 feet/year.
4. Summarizing the values above, the Put Year recovery rate is 8.5 feet/year, the Take Year decline rate is 18.5 feet/year, and the Hold Year decline rate is 0.75 feet/year.

A depth to water of 235 feet below ground surface (-174 feet NGVD 29) was measured in 2001 (pre In-Lieu Recharge Demonstration Study). Based upon a Fall 2009 measured depth to water of 214 feet and other data collected for this study, it is estimated that a representative Spring 2010 depth to water in CGC Well 8 is 200 feet. The proposed Put/Hold/Take year sequence for the GSR Project scenario (Table 6) was used to develop a plot of future (depth to water) groundwater levels for California Golf Club Well 8 (Figure 5). Using the annual changes in groundwater levels associated with Put, Hold, and Take years described above, Figure 5 shows how regional groundwater levels are estimated to fluctuate at the California Golf Club

Well 8 over the course of 47 future years based on the assumptions and calculations used in this analysis. A similar analysis was completed for California Golf Club Well 7 (Figure C-19 in Appendix C).

The next step was to add in the local GSR drawdown as calculated by MWH (Appendix B). This value ranged from 43 feet after one year of Take to 74 feet after 7.5 years of Take. The resulting new static water level for California Golf Club Well 8 ranged from approximately 145 feet bgs (-84 feet NGVD 29) to 400 feet bgs (-339 feet NGVD 29) (Figure 6). The background water level decline (i.e., existing conditions) would result in a static water level decline from 200 feet bgs (-139 feet NGVD 29) to 233 feet bgs (-172 feet NGVD 29) at future scenario year 44 without the GSR project. A similar analysis was completed for California Golf Club Well 7 (Figure C-20 in Appendix C).

Review of Figures 5 and 6 shows that Take-Year static water levels fall below the static water level without the project during the first year of drought. Subsequent years of drought continue to reduce static water levels further below where static water levels would be without the project. The static water levels reach a maximum depth of 169 feet below the existing conditions SWL.

As described above, during the first year of Take static water levels for the GSR Project scenario begin to decline to below the level expected without the project. However, it should be noted that static water levels are generally positive (i.e., higher than would be expected under existing conditions) during non-Take years leading up to the Design Drought. Overall, GSR Project static water levels at California Golf Club wells are higher than existing conditions for 68 percent of years.

Analysis of changes in pumping capacity using the California Golf Club Well 8 pump curve indicate that the lowest well pumping capacity under the GSR Project would be about 475 gpm compared to the existing conditions capacity of 800 gpm. The decline in pumping capacity at Well 8 amounts a maximum of 41 percent for the GSR Project as compared to existing conditions without the GSR project. The pumping capacity analysis for California Golf Club Well 7 shows a greater decline of 78 percent from 200 to 45 gpm. The difference in pumping capacity decline at the two California Golf Club wells is mostly a function of the characteristics of the pump curve for the specific pumps installed in each well.

Lake Merced Golf Club Wells

The data analysis for the Lake Merced Golf Club wells included in this study is similar to the Colma cemetery wells and involved the following steps:

1. Based upon the Colma area well data analysis (recovery rate of 8.6 feet/year) along with the estimated groundwater level recovery rate (11 to 15 feet/year) in Park Plaza and other Daly City wells during the in-lieu recharge demonstration study, it was concluded that an appropriate recovery rate of LMGC wells is approximately 10.5 feet/year.

2. Based upon review of the Colma area well data GSR Take year analysis (decline rate of 12.9 feet/year) along with an estimated groundwater level decline rate during Take Years for Daly City wells of 16 to 21 feet (personal communication, Will Halligan), it was concluded that an appropriate decline rate for LMGC wells is approximately 15 feet/year.
3. The groundwater level decline due to Partner/third party pumping was estimated based upon the Colma area analysis (0.75 feet/year) and the groundwater model result for Model Layer 4 at CUP-6 (about 1.0 feet/year). Thus, it is concluded that the Hold year decline rate at the Lake Merced Golf Club is 0.75 feet/year.
4. Summarizing the values above, the Put Year recovery rate is 10.5 feet/year, the Take Year decline rate is 15 feet/year, and the Hold Year decline rate is 0.75 feet/year.

Based upon review of water level data from 2001 to 2010 for the two wells near LMGC (CUP-6-420 and DC-8), the Winter/Spring 2010 groundwater elevation was estimated to be 238 feet bgs (-84 feet NGVD 29). The initial 6.5 Put Years result in an initial full SFPUC Storage Account regional groundwater elevation of -16 feet (NGVD 29) (DTW of 170 feet bgs) as indicated in Figure 8.

The proposed Put/Hold/Take year sequence for the GSR scenario (Table 7) was used to develop plots of future (depth to water) groundwater levels for Lake Merced Golf Club Well 3 (Figures 7 and 8). Using the annual changes in groundwater levels associated with Put, Hold, and Take years described above, Figures 7 and 8 show how regional groundwater levels are estimated to fluctuate at the Lake Merced Golf Club Well 3 over the course of 47 future years based on the assumptions and calculations used in this analysis.

The next step was to add in the local GSR drawdown as calculated by MWH (Appendix B). This value ranged from 29 feet after 1 year of Take to 56 feet after 7.5 years of Take. The resulting new static water level for the Lake Merced Golf Club well ranged from approximately 170 feet bgs (-16 feet NGVD 29) to 356 feet bgs (-202 feet NGVD 29) (Figure 8). The background water level decline (i.e., existing conditions) would result in a static water level decline from 238 feet bgs (-84 NGVD 29) to 271 feet bgs (-117 feet NGVD 29).

Review of Figures 7 and 8 shows that Take-Year static water levels initially stay above the static water level without the project at least through the end of the second year of drought. The third year of Design Drought brings the static water level below the existing conditions. Static water levels reach a maximum depth of 87 feet below the existing conditions SWLs. As described above, it takes at least until after the third year of Take for static water levels to decline to below the level expected without the project. However, it should be noted that static water levels are generally positive (i.e., higher than would be expected under existing conditions) under all other conditions except for initial recovery after the Design Drought. Overall, GSR Project static water levels at Lake Merced Golf Club are higher than existing conditions in 83 percent of years.

No pump information could be obtained for Lake Merced Well 3. However, given the magnitude of water level declines (87 feet) at Lake Merced Well 3 compared to the range of water level declines at cemetery wells (95 to 116 feet), it is anticipated that the range of pump capacity reduction is likely in the lower end (i.e., 10 to 30%) of the 10% to 50% range in pump capacity reduction at most cemetery wells.

Olympic Club Wells

The analytical data analysis for the Olympic Club area wells included in this study is similar to the Colma cemetery wells and involved the following steps:

1. Based upon review of water level data from January 2002 to January 2005 for Lake Merced area wells LMMW-3D and LMMW-6D, it was concluded that an appropriate groundwater level recovery rate for the Olympic Club area is 3.6 feet per 3,070 acre-feet of in-lieu recharge (this represents the amount of in-lieu recharge in the Daly City area during a future Put Year). The rationale for this conclusion is that the SFPUC storage account calculations provided by SFPUC indicate that it had accumulated 5,665 af of in-lieu recharge (as of the end of January 2005) in the Daly City area since 2002 (Appendix A). The study period for this analysis stopped as of January 2005 to avoid any groundwater level bias associated with the initiation of Daly City recycled water deliveries to the Olympic Club, Lake Merced Golf Club, and San Francisco Golf Club. It was also necessary to account for Lake Merced water additions during the January 2002 to January 2005 period, and this was accomplished by treating the total additions of 1,160 af to Lake Merced the same as in-lieu recharge in the Daly City area. Thus, the total amount of in-lieu recharge used in this calculation is 6,825 af (5,665 af + 1,160 af). It is assumed that the 6,825 af of increased storage correlates with the approximate 8-foot rise in groundwater levels at the Lake Merced wells near Olympic Club between January 2002 and January 2005. Thus, dividing 6,825 af of in-lieu recharge (Put) by a total water level rise of 8 feet equals 850 af of Put per foot of groundwater level rise.
2. Under the proposed project, a year of Put is equal to about 6,180 af for the three Partner Agencies. However, factoring out Put for the Cal Water and San Bruno wells (due to the significant distance from Olympic Club) results in a total in-lieu recharge of about 3,070 AFY during a proposed project Put year in the Daly City area. Using the above logic, a year of Put at 3,070 af divided by 850 af per foot of water level rise results in a Put year groundwater level rise of 3.6 feet.
3. The proposed GSR well locations were reviewed for proximity to Olympic Club to determine the amount of Take from GSR wells in the region. The wells included in the Take calculation were CUP-3A, CUP-5, CUP-6, CUP-7, CUP-10A, and CUP-11A. Assuming Take year of 7.23 MGD (8,100 AFY), and subtracting the Take amounts from the 11 wells not listed above results in about 3,360 af of extraction from GSR wells in the Daly City area. Assuming that Take year extraction works in reverse of the recovery of water levels during Put years yields a one foot water level drop per every 850 af removed during a Take year. Dividing 3,360 af by 850 af per 1

foot of groundwater level decline yields 4.0 feet of groundwater level decline during a proposed Take year due to GSR pumping.

4. The background groundwater level decline due to regional groundwater pumping was evaluated using both available groundwater level data prior to 2002 (and the onset of the In-Lieu Recharge Demonstration Study) and groundwater flow model simulation results. Available measured pre-2002 groundwater level data in this area for Olympic Club were collected primarily during the 1987 to 1992 drought. Available data indicate groundwater level decline rates of about one foot per year during the drought. The HydroFocus (May 2011) Historical Simulation (1959-2009) showed a water level decline of 0 to 0.2 in the Olympic Club area, and the HydroFocus 2008 No Project Scenario showed essentially no change in groundwater levels. The Existing Conditions Scenario (Scenario 1) by KJ (2012) showed a background groundwater level decline rate of about 0.5 feet/year in the Olympic Club area. Based on available field data and model simulations, a background groundwater level decline rate of 0.5 feet/year is considered to be representative of Hold year groundwater level declines in this area.

5. Combining the values above, we have a Put Year recovery rate of 3.6 feet/year and a Take Year decline rate of 4.0 feet/year, and a Hold Year decline rate of 0.5 feet/year.

A depth to water of 120 feet below ground surface (-45 feet NGVD 29) was measured in July 2001 (pre In-Lieu Recharge Demonstration Study) in Olympic Club Well 1 (#9). Because the water level was measured in mid-summer, it was assumed a representative Spring water level would be somewhat higher at 115 feet (-40 feet NGVD 29). The measured rise in water levels in this area from 2002 to 2009 is about 15 feet in LMMW-3D/6D; thus, a representative Spring 2010 depth to water is assumed to be 100 feet (-25 feet NGVD 29) in Olympic Club Well 1. The proposed Put/Hold/Take year sequences for the GSR scenario (Table 8) was used to develop a plot of future (depth to water) groundwater levels for Olympic Golf Club Well 9/No. 1 (Figure 9). Using the annual changes in groundwater levels associated with Put, Hold, and Take years described above, Figure 9 shows how regional groundwater levels are estimated to fluctuate at the Olympic Golf Club Well 1 (#9) over the course of 47 future years based on the assumptions and calculations used in this analysis.

The next step was to add in the local GSR drawdown as calculated by MWH (Appendix B). This value ranged from 7 feet after one year of Take to 23 feet after 7.5 years of Take. The resulting new static water level for the Olympic Golf Club well ranged from 77 feet bgs (-2 feet NGVD 29) to 136 feet bgs (-61 feet NGVD 29) (Figure 10). The background water level decline (i.e., existing conditions) would result in a static water level decline from 100 feet bgs (-25 feet NGVD 29) to 122 feet bgs (-47 feet NGVD 29) at future scenario year 44 without the GSR project.

Review of Figures 9 and 10 shows that Take-Year static water levels fall below the static water level without the project during the fifth year of drought. Subsequent years of Design Drought continue to reduce static water levels further below where static water levels would be without the project. The static water levels reach a maximum depth of 14 below the existing conditions SWLs.

As described above, after the fourth year of Take static water levels for the GSR Project begin to decline to below the level expected without the project. However, it should be noted that static water levels are positive (i.e., higher than would be expected under existing conditions) under all other conditions.

Analysis of changes in pumping capacity for using the Olympic Club Well No. 1 (#9) pump curve indicate that the well pumping capacity under the GSR Project at the end of the Design Drought would be about 660 gpm compared to the existing conditions capacity of 685 gpm. The decline in pumping capacity at Well 1 amounts to 4 percent for the end of the Design Drought with the GSR project as compared to existing conditions without the GSR project.

A similar analysis of changes in pumping capacity for using the Olympic Club Well No. 2 (#8) pump curve indicate that the well pumping capacity under the GSR Project at the end of the Design Drought would be about 935 gpm compared to the existing conditions capacity of 970 gpm. The decline in pumping capacity at Well 1 amounts to 4 percent for the end of the Design Drought with the GSR project as compared to existing conditions without the GSR project.

Alternative GSR Well Site Analysis

Three of the proposed 16 GSR well sites (CUP-3A, 7, and 44-1) were replaced by the three alternative well sites (CUP-20A, 22, and 36-2) and mutual interference drawdowns were calculated by MWH (Appendix B). Given the locations of wells removed (two at the northern end and one at the southern end of the GSR Project area) versus alternative well locations added (generally in the middle of the GSR Project area), the alternative well configuration analyzed in this study results in more drawdown in the Colma/South San Francisco area and less in the Daly City and San Bruno areas. The alternative well configuration could probably be viewed as a worst case for the Colma and South San Francisco areas, whereas the original 16 well configuration could likely be viewed as the worst case for the Daly City and San Bruno areas.

The amount of mutual interference drawdown in the alternative well site configuration scenario increased by 9 to 33 feet at Colma Cemetery wells, and 10 to 14 feet at the California Golf Club wells after 7.5 years of GSR Project pumping as compared to the original well site configuration. Drawdown at Lake Merced Golf Club wells for the alternative well site configuration (compared to the original well site configuration) decreased by 21 to 22 feet, and drawdowns at the Olympic and San Francisco Golf Clubs decreased by 11 to 13 feet after 7.5 years of GSR Project pumping. Detailed calculations on a well by well basis for both the original and alternative well site configurations are provided in the MWH memo in Appendix B.

Transfers among GSR Partner Agencies

Operation of the GSR project allows transfer of up to 10% of each partner's allowable pumping between partner agencies under certain conditions. However, transfers among partner agencies are not expected to occur during the later years of the design drought and therefore would not exacerbate the adverse effects reported from the GSR Project without the transfer. Transfers during the later years of the design drought are unlikely because:

- In Daly City, the designated quantity is 3.43 million gallons per day (mgd). Based on the analyses conducted previously, the City of Daly City's aggregate discharge capacity from their entire well field is estimated to be 3.3 mgd at the end of the Design Drought. This would suggest that any transfer of designated quantity from San Bruno and/or Cal Water to Daly City would not be able to be conducted near the later stages of the Design Drought, since Daly City would not have excess well capacity to handle such an increase in production (4 mgd). Therefore, additional well interference from a transfer during a Design Drought would not be able to be conducted to a degree that would exacerbate anticipated well interference effects that have been evaluated for the GSR Project.
- In the South San Francisco area, Cal Water has a designated quantity of 1.37 mgd. This designated quantity is slightly less than the maximum capacity of Cal Water's treatment plant (1.4 mgd). At the end of the Design Drought, Cal Water's design well capacities are estimated to be 0.8 mgd and 1.2 mgd if replacement pumps are installed. Similar in nature to Daly City, Cal Water would not have any excess design well capacity to accept a transfer from Daly City and/or San Bruno, nor would Cal Water have excess treatment plant capacity. Therefore, it is highly unlikely that transfers to Cal Water could occur with the existing well and treatment plant constraints. Therefore well interference effects would not exceed those already evaluated for the GSR Project
- In the San Bruno area, it is estimated that there would be a limited amount of excess design capacity at the end of the Design Drought. This excess is about 0.2 mgd (140 gpm) above the 2.1 mgd designated quantity. It is highly unlikely that Daly City and/or Cal Water would transfer 10 percent of their designated quantity near the end of the Design Drought, because they would likely want to use as much of their designated quantity as possible since any transfer would likely be met with opposition from ratepayers who will likely be subject to water rationing. However, in the remote chance such a transfer was to be conducted, the additional capacity pumped by San Bruno would not result in additional interference on third-party wells, since there are not any identified third-party wells in the main portion of the basin in San Bruno within 1.5 miles of San Bruno municipal supply wells.

CUMULATIVE WELL INTERFERENCE ANALYSIS

Introduction

In addition to the proposed SFPUC GSR project, the proposed San Francisco Groundwater (SFGW) Supply Project involves groundwater extraction of 3 million gallons per day (MGD) from four new wells installed in the vicinity of Lake Merced, the Sunset District, and Golden Gate Park (Scenario 3a) and possibly an additional 1 MGD from conversion of two existing irrigation wells in Golden Gate Park to municipal use for a combined total of 4 MGD (Scenario 3b). The study area for the SFGW Supply Project encompasses the western portion of San Francisco between the San Francisco/San Mateo county line and Golden Gate Park. The capacity of the proposed SFGW project, 3 or 4 MGD, would depend upon whether or not recycled water would become the source of irrigation water in Golden Gate Park. If the recycled water project is implemented, two existing irrigation wells at the west end of Golden Gate Park would be converted to municipal supply wells, and four additional municipal supply wells would be brought online to pump a total of 4 MGD from six wells on an average annual basis. If the recycled water project is not implemented, the two Golden Gate Park irrigation wells would continue irrigation pumping and only the four new municipal supply wells would be used to pump 3 MGD on an average annual basis for the SFGW project. This cumulative well interference analysis does not account for future additions of water to Lake Merced.

Background

In addition to GSR Project impacts to third-party wells described in this TM, Luhdorff and Scalmanini Consulting Engineers (LSCE) estimated well interference effects on third-party wells in San Francisco and the northern part of Daly City from the SFGW Supply Project (LSCE, 2012). The cumulative analysis includes assessment of well interference on third-party wells located in the SFGW Supply Project study area that may result from pumping of GSR wells. These calculations are added to well interference estimates from the SFGW Supply Project to obtain the total estimated well interference drawdown at the third-party wells, which incorporates pumping influences from both GSR and SFGW Supply Project wells.

The third-party wells in the South Westside Groundwater Basin that are the subject of this cumulative analysis include Lake Merced Golf Club Well 3 and two wells at Olympic Golf Club. The third-party wells in the North Westside Groundwater Basin that are considered in the cumulative analysis include one well at the San Francisco Golf Club. Other third party wells in the North Westside Groundwater Basin (e.g., Zoo well, Edgewood Development Center well, Pine Lake well) are too far away to warrant consideration in the cumulative analysis.

Previous Studies

As stated above, the third-party wells included in the GSR Project well interference analysis that are considered close enough to the subbasin boundary (between North and South Westside Basins) to show possible influence from SFGW Supply Project wells are the well at Lake Merced Golf Club, two wells at Olympic Club, and the San Francisco Golf Club well. GSR-related gross well interference estimates were 56 feet for Lake Merced Golf Club wells, 23 feet for Olympic Club wells, and 22 feet for San Francisco Golf Club well (Appendix B) as summarized in Table 10. Gross well interference estimates are the values derived directly from Theis calculations. Net well interference estimates provided in Table 11 are defined as the difference between gross estimates and water level declines associated with future existing conditions. The cumulative analysis provides estimates of drawdown at the golf club wells from the proposed SFGW Supply Project wells and the combined effects from both proposed projects. The Colma cemetery wells are located 2.6 to 3.8 miles from the nearest SFGW Project well at the Lake Merced Pump Station (LMPS) and the California Golf Club wells are about 5 miles from the LMPS well. As discussed further below, these other third-party wells are not considered in this study because interference effects would be negligible at these distances.

The LSCE study on third-party well Interference employed both Theis analytical and MODFLOW groundwater model-based calculations of well interference drawdown from proposed SFGW Supply Project wells (LSCE, 2012). Third-party wells included in that analysis that are considered close enough to the subbasin boundary (between North and South Westside Basins) to show possible influence from GSR Project wells include the Lake Merced Golf Club, Olympic Club, and San Francisco Golf Club. SFGW Supply project well interference estimates ranged from 4 to 6 feet for these well locations, as summarized in Table 12.

The two project-specific well interference analyses both provided estimated well interference effects at the Lake Merced, San Francisco, and Olympic Golf Club wells. Those previous results are combined in the current study to estimate total well interference effects from both proposed projects.

CUMULATIVE WELL INTERFERENCE CALCULATIONS

GSR Project Wells

The GSR wells located closest to the SFGW Project are in Daly City (CUP-3A, 5, 6, and 7). A 1.5-mile radius from the furthest north GSR well (CUP-3A) is shown on Figure 11 and encompasses the Olympic Club and San Francisco Golf Club. A 1.5-mile radius from the furthest south SFGW Project well (Lake Merced Pump Station) is also shown on Figure 11 and encompasses the Lake Merced Golf Club. These two 1.5-mile radii define the cumulative analysis study area and incorporate wells at the three golf courses.

As described in more detail below, due to the distances between the Daly City GSR wells and most San Francisco third-party wells (i.e., greater than 1.5 miles), combined with the presence of Lake Merced and associated vertical leakiness and areal recharge in the SFGW project area, the interference effects on third-party wells located north of Lake Merced (e.g., Zoo, Edgewood, Pine Lake) from GSR pumping south of Lake Merced (from CUP-3A, 5, 6, and 7) are considered to be negligible.

Previous Theis calculations of well interference effects by MWH for the GSR project conceptual engineering report (MWH, 2008) considered pumping wells within a 1.5-mile radius. The limitation of 1.5 miles was selected to represent a reasonable extent for a cone of depression given consideration of vertical leakage from one aquifer to another, groundwater recharge (that occurs related to precipitation, irrigation, and leaky pipes), interception of groundwater flow that otherwise discharges from the aquifer (e.g., coastal outflow), and/or encountering a surface water body (e.g., Lake Merced). As described by Driscoll (1986), the vertical leakage from upper to lower aquifers (and from underlying aquifers vertically upward to the pumped aquifer), groundwater recharge, and possibly other factors listed above, are expected to cause the cone of depression to stop expanding and stabilize.

SFGW Supply Project Wells

The SFGW Supply Project well interference study utilized Theis calculations (with a lower storativity value than used in the GSR Project calculations) and a sub-regional MODFLOW groundwater model to estimate well interference effects on third-party wells in the

Westside Basin within 1.5 miles of the SFGW Supply Project wells (LSCE, 2012). As discussed below, the study concluded that results from the sub-regional MODFLOW groundwater model provided more realistic estimates of potential interference effects for hydrogeologic conditions in the SFGW Supply project area. For the cumulative analysis, SFGW drawdown estimates for the Olympic Club and San Francisco Golf Club wells were obtained from the LSCE groundwater model results, and these model results were also used to provide SFGW drawdown estimates for the Lake Merced Golf Club wells. LSCE's report documents the model inputs in terms of pumping rates, transmissivity, storativity, and pumping durations. The MODFLOW model also accounts for vertical leakage that occurs from the Shallow Aquifer to deeper aquifers, which allows for a more realistic simulation of drawdown effects over long pumping durations than does the Theis analysis (which does not account for vertical leakage). Modeling was used because leakage was considered particularly important in the SFGW project area due to the hydrogeologic setting, which includes potential interaction between shallow and deeper aquifer units. The results of the well interference drawdown estimates are summarized in Table 12, and drawdown contour maps from the LSCE report are provided in Appendix E. The Theis analytical solution was used in the LSCE study to support assumptions that the cone of depression that developed did not appreciably expand after a one-year pumping duration.

The numerical flow model was constructed specifically for the SFGW Project well interference study using MODFLOW, to assess potential pumping influences in a multiple aquifer system more complex in nature than can be incorporated in the Theis solution. This model is a sub-regional model developed specifically for the evaluation of pumping influences for the SFGW Project. This model is not the basin-wide numerical groundwater flow model developed by Daly City (HydroFocus, 2011). The numerical model developed for this evaluation consists of multiple (3) layers separated by aquitards with assigned values of leakiness, in which vertical movement of water occurs. Unlike the Theis solution, the numerical model incorporates variations in hydrogeologic conditions north and south of Lake Merced where confinement decreases (i.e., due to pinch-outs of the "-100 Foot" and "X" Clay units). The numerical model provides a means to simulate how the pumping cones of depression around Project wells would be affected by changes in confinement as they expand beyond the lake footprint.

Well Interference Calculation Methodologies

The GSR Project and SFGW Supply Project well interference calculations described above utilize somewhat different approaches in that the GSR Project is based strictly upon Theis analytical calculations, whereas the SFGW Supply Project utilizes both Theis analytical calculations and a MODFLOW groundwater model for well interference analysis. The approach used for the GSR Project is considered appropriate for hydrogeologic conditions in the South Westside Groundwater Basin (SWB), and the SFGW Supply Project approach is considered appropriate for the North Westside Basin (NWB) hydrogeologic conditions. Important hydrogeologic differences between the North and South Westside Basins include generally shallower groundwater levels in the NWB, the presence of Lake Merced in the NWB, and multiple aquifers in the NWB (especially beneath and adjacent to Lake Merced) that result in greater vertical leakage in the NWB. There are also more open (fewer no-flow) hydrogeologic boundary conditions, higher aquifer hydraulic conductivities, and more rainfall recharge in the

NWB. A sensitivity analysis was conducted by LSCE on the Theis analytical solution storativity input value used in the SFGW Project analysis of well interference. The storativity value was changed to be consistent with the value used in the GSR Project analysis and the results were similar in nature to the numerical model results. This exercise provided greater certainty that the primary methods for analyzing well interference results for the GSR and SFGW projects are similar in nature.

The differences in basin hydrogeologic characteristics are such that the Theis analytical approach is generally adequate (although possibly slightly conservative) in evaluating mutual interference effects in the SWB; however, the Theis approach alone does not adequately simulate the nature of recharge, vertical leakage, and boundary conditions in the NWB. A MODFLOW groundwater flow model is necessary in the NWB to adequately simulate the effect of vertical leakage influences on well interference. The wells of concern in the cumulative analysis in terms of having measureable effects from both projects are the three golf clubs – Lake Merced, Olympic, and San Francisco. All of the golf club wells are located near the border between the NWB and SWB. The application of the MODFLOW groundwater flow model to these wells as part of the cumulative analysis is considered appropriate because the pumping wells in the SFGW project are located two-thirds of a mile or further north of the golf club wells where NWB hydrogeologic conditions described above serve to limit the areal extent of the cones of depression around pumping wells (e.g., vertical leakiness, Lake Merced is between SFGW pumping wells and golf club wells). GSR Project wells are located two-thirds mile or further south of the Olympic and San Francisco golf club wells in a different hydrogeologic regime where conditions are less conducive to limiting the extent of the cones of depression and where Theis analytical calculations with a higher storativity value than used in the SFGW well interference analysis would be more applicable.

Given the locations of the respective project wells and the golf club wells at issue in the cumulative analysis, it is likely that inaccuracies in the cumulative mutual well interference calculations at a given golf club well would be weighted toward being overestimated. The reasoning for this conclusion is that the cones of depression predicted for GSR wells by Theis analytical calculations do not account for likely increases in vertical leakiness (that would result in less drawdown) expected to occur in the vicinity of the Olympic and San Francisco golf clubs.

Combined Well Interference Drawdown Effects

The results from the two project-specific studies and additional calculations made for the cumulative analysis are summarized in Tables 10 and 11 for the GSR Project and Table 12 for the SFGW Supply Project. These results were added to obtain the combined well interference drawdown effects by both projects as summarized in Tables 13 and 14. Tables 13 and 14 show results for the 3-MGD and 4-MGD pumping scenarios under the SFGW project, as described previously. As indicated in Table 13, the results show the gross combined well interference drawdown of 28 feet at San Francisco Golf Club, 29 feet at Olympic Club, and 60 feet at Lake Merced Golf Club. The well sites influenced by the GSR project show a net drawdown impact as follows: 20 feet at Olympic and San Francisco Golf Clubs, and 91 feet at Lake Merced Golf Club (Tables 14 and 15).

CUMULATIVE WELL CAPACITY ANALYSIS

The consequences of the estimated interference drawdown effects are determined by considering well construction features and pump head-capacity relationships. Construction features and pump information for third-party wells subject to cumulative analysis are provided in Appendix F. The well capacity analysis method applied in this cumulative analysis evaluates the change, or reduction, in pumping capacity because of predicted increased drawdown from proposed project wells. The increased drawdown would represent additional head, or lift, for the pump and translates to reduced capacity according to the pump head-capacity relationship. When the additional head requirement caused by mutual well interference is small in relation to the total pump head (the sum of lift below ground surface, system discharge head, and other friction losses), there may be little discernible effect on the third-party well capacity. When the effect amounts to a substantial fraction of the total pump head, or when the pump head-capacity relationship is relatively flat, the interference effect may result in a large percentage change in operating capacity for the well. The potential operational effects on existing well capacities for the combined GSR and SFGW project influences are discussed below and summarized in Table 16.

San Francisco Golf Club

The San Francisco Golf Club (SFGC) irrigation well was drilled in 1985. As presented in the 2012 LSCE memorandum on SFGW project influences, the well is equipped with a 700-gpm well pump set to 350 feet, which is 10 feet above the top of the well screen. While the SFGW influences were estimated to have a negligible effect on pumping capacity, 28 feet of gross drawdown interference is estimated for the combined projects. This would have the effect of reducing the pump capacity by approximately 45 gpm from the reported design capacity, or 6 percent. However, due to a predicted slight decline in background water levels over the next 44 years, the net drawdown impacts for the cumulative scenario at the end of the Design Drought are estimated to be 20 feet. The estimated net reduction in well capacity in this case is 20 gpm or 3 percent (when comparing future end of Design Drought conditions to existing conditions without the projects). The net reduction in well capacity would be 20 gpm (or 3 percent) compared to the current pumping rate of 675 gpm.

The predicted decreases in capacity caused by the estimated interference drawdown do not indicate a loss in supply, but only slightly longer pumping times to produce the same quantity of water.

Olympic Club Wells

The active Olympic Club irrigation wells (Wells No.2/8 and No.1/9) were drilled in 1994 and 2001, respectively. Well 8 is equipped with a pump with a reported design capacity of 1,000 gpm and a setting depth of 270 feet, which is below the top of the screen interval (the well is screened from 200 feet bgs). Well 9 is equipped with a nominal 700-gpm pump with a setting depth of 250 feet, which is 10 feet above the top of screen in the well.

As is the case for the San Francisco Golf Club well, SFGW influences were previously determined to have a negligible effect on well capacity based on mutual well interference drawdown of 6 feet. The estimated gross well interference drawdown for the combined GSR and SFGW projects at these well sites is 29 feet (Table 13). Examination of the pump curve for Well 8 indicates that cumulative mutual well interference would reduce its capacity by about 90 gpm, or 9 percent, from the design capacity of 1,000 gpm. The reduction in capacity for Well 9 is 60 gpm with a similar percentage change of 9 percent for the design capacity of 700 gpm.

However, due to a predicted slight decline in background water levels over the next 44 years, the net drawdown impacts at the end of the Design Drought (Table 14) are estimated to be 20 feet (when comparing future end of Design Drought conditions to existing conditions without the projects). The estimated net reduction in Well 9 capacity in this case is 45 gpm or 7 percent. The estimated net reduction in Well 8 capacity is 60 gpm or 6 percent.

Lake Merced Golf Club Well

Interference drawdown effects at the Lake Merced Golf Club (LMGC) Well 3 from the combined projects are estimated to be 60 feet (Table 13). The GSR Project alone is expected to account for over 90 percent of the well interference drawdown at Lake Merced Golf Club well. Therefore, the effect on well capacity for the combined projects is very similar to the effect on well capacity for just the GSR Project, which was addressed in the GSR Project well interference section of this TM. Pump information from LMGC Well 3 is not available; thus, the actual reduction in pumping capacity cannot be estimated at this time. However, the well capacity reduction was estimated to be in the range of 10 to 30% in the GSR section of this TM. The cumulative project well capacity reduction is estimated to also fall within the range of 10 to 30%.

SUMMARY AND CONCLUSIONS

The primary purpose of this study was to evaluate the pumping of GSR wells on individual existing third-party wells. The third-party (i.e., irrigation) groundwater pumpers in the South Westside Groundwater Basin that are the subject of this TM include the Colma cemeteries, California Golf Club, and Lake Merced Golf Club (Figures 1 and 2). In addition, as part of the Cumulative Project Analysis, this study provides GSR-related well interference calculations for the Olympic Golf Club and San Francisco Golf Club located near or within San Francisco City/County limits.

GSR Project Analysis

The GSR project would only extract groundwater up to the amount that has been stored in the SFPUC Storage Account. However, due to the possibility for localized effects, this study was conducted as part of the effort to evaluate the localized cones of depression around proposed GSR wells that may potentially affect individual existing third-party wells. The results presented herein represent "worst case" with respect to being calculated at the end of the Design Drought (7.5 years continuous pumping) for the GSR Project wells. The Design Drought is two years longer than the historic drought of record (1987 to 1992).

The results of the data analysis for the GSR Project are summarized in Table 9. The analytical calculations indicate that the proposed GSR Project would cause cemetery well static water levels to be from 95 to 116 feet lower than would occur without the project at the end of the Design Drought. The effects are greatest at the Woodlawn Cemetery well at the northern end of the group of Colma cemeteries, and least in the vicinity of Home of Peace, Hills of Eternity, and Cypress Lawn cemeteries. There is a gradual decline in GSR Project influence on cemetery wells from Woodlawn to Home of Peace. The project effects begin to increase again to the south of Cypress Lawn for the Holy Cross wells. Review of Figure 2 indicates that the pattern of project effects observed at the cemetery wells corresponds to the presence of three GSR wells at the north end near Woodlawn (CUP-10, CUP-11A, and CUP-18), one GSR well near the middle of the cemetery wells (CUP-19), and two GSR wells at the south end near Holy Cross (CUP-22A and CUP-23).

The maximum project effect at the Lake Merced Golf Club well amounts to about 87 feet compared to existing conditions. The Lake Merced Golf Club well is influenced primarily by GSR wells CUP-3A, CUP-5, CUP-6, and CUP-7. The maximum project effects at the California Golf Club wells amount to about 169 feet compared to existing conditions. The California Golf Club wells are influenced primarily by GSR wells CUP-31 and CUP-36-1 (and to a lesser extent by CUP-41-4 and CUP-44-2). While there are fewer GSR wells in vicinity of the California Golf Club, the area has greater overall drawdown due to an estimated Take year regional decline rate of 18.5 feet compared to 12.9 feet in the Colma area and 15 feet for Lake Merced Golf Club.

Pump curves and other pump information were obtained for most wells and certain assumptions were made to estimate how project-related changes in water levels may affect pumping rates (i.e., well capacity) and pumping water levels. The results indicated that pumping capacities would be reduced by 10 to 50 percent at the end of the Design Drought (with the GSR Project) at most wells. Greater decreases in pumping capacities were calculated for the Woodlawn Primary Well (87 percent) and California Golf Club Well 7 (78 percent) due to the specific characteristics of the pumps installed in these two wells.

It should be noted that the maximum effects described above occur for a short duration (i.e., a few months) in the middle of Future Scenario Year 44 (at the end of the Design Drought when the SFPUC Storage Account is empty). During the majority of the years (68 to 83%) while the project is in place there will be a net benefit (i.e., higher groundwater levels and higher pumping capacities) to third party wells from the proposed GSR Project. At other times during project take cycles, the project effects will be slightly to considerably less than those described above and analyzed in detail in this TM.

Cumulative Project Analysis

The well interference effects on third-party wells were estimated separately for each individual proposed project (Fugro, this TM; LSCE, 2012). The cumulative analysis section of this TM provides additional calculations using results of project-specific well interference studies to estimate combined effects on third-party wells from both proposed SFPUC projects. The results presented herein represent a “worst case” with respect to being calculated at the end of the Design Drought (7.5 years continuous pumping) for the GSR Project wells and incorporate interference estimated for the SFGW Project scenario consisting of 6 wells pumping at 4 MGD.

In summary, there are no well interference effects from pumping GSR Project wells (CUP-3A, 5, 6, and 7) on the Zoo, Edgewood, and Pine Lake wells located north of Lake Merced in San Francisco. The SFGW Supply Project has little effect (about 4 feet) on the Lake Merced Golf Club well located south of Lake Merced in northern San Mateo County. Greater effects from the combined projects occur for the San Francisco Golf Club and Olympic Club wells that are located along the San Francisco-San Mateo County line and between proposed wells for the two SFPUC projects.

Pumping capacity reductions from the combined projects were estimated to be 9 percent for the San Francisco Golf Club well and 9 percent for the Olympic Golf Club wells. The cumulative project pumping capacity for Lake Merced Golf Club Well 3 was estimated to decrease by 10 to 30%, primarily due to GSR pumping effects.

As discussed by LSCE (2012) for the SFGW Supply project, where groundwater use from third-party wells has been replaced by recycled water (e.g., golf clubs), mutual interference between high capacity irrigation supply wells no longer occurs (except possibly to a small degree when groundwater is used to supplement the recycled water source). As a result, it is likely that the estimated effects on capacities for some wells will be partially offset by less use of the golf club wells. Additionally, it should be noted that the reductions in well capacities have been evaluated based on the well construction features and the characteristics of the head-capacity relationships of the well pumps. As such, the influences may be eliminated when pumps eventually are replaced (due to normal wear and tear) and the increased drawdown is factored into pump sizing. Therefore, the reductions in well capacities are generally classified as an operational issue, one that is common where multiple pumpers co-exist in a groundwater basin setting.

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LIST OF TABLES

LIST OF FIGURES (CONTINUED)

APPENDICES

TABLES

Table 1. Well Inventory

Well Name	Current Well Name and Use	Future Use of Well	Top of Screen (feet bgs)	Pump Test Duration (hours)	Pump Test Q/s (gpm/feet)
Holy Cross 1	Primary Well	Secondary Well	368	4	10.8
				0.5	19.7
				0.5	19.7
				0.5	17.9
				0.5	17.8
Holy Cross 4	Replacement Well	Primary Well	420	1.5	6.0
California Golf Club 7	Secondary Well	Secondary Well	255	24	2.9
California Golf Club 8	Primary Well	Primary Well	320	24	15.1
				?	20.5
Woodlawn	Primary Well	Primary Well	275	3.33	17.5
Woodlawn	Backup well	Backup well			
Cypress Lawn 3	Not Available	Assumed to be secondary well	191	121.5	7.5
Cypress Lawn 4	Not Available	Assumed to be primary well	330	9	5.5
				0.5	2.9
Italian Cemetery	Primary Well	Primary Well	300	4	4.8
				0.5	4.0
				0.5	6.8
				0.5	10.2
				0.5	6.1
Home of Peace	Was Primary Well	To be abandoned	224	27	19.2
				0.5	11.9
				0.5	32.7
				0.5	13.2
				0.5	6.3
Will serve Home of Peace, Hills of Eternity, and Salem	Replacement well	Primary Well	400		
Hills of Eternity	Was Secondary Well	Back-up Well	224	108	16.8
	Now Primary Well			0.5	4.0
				0.5	5.1
				0.5	17.6
				0.5	6.2
Eternal Home	Primary Well	Primary Well	280	48	7.1
				0.5	5.5
				0.5	15.8
				24	7.0
				0.5	9.3
				0.5	9.1
Olivet Memorial	Primary Well	Primary Well	308	24	9.1
Olympic Club	No. 1 (#9)	Active	260	24	17.1
Olympic Club	No. 2 (#8)	Active	200	4	15.4
SF Golf Club	No. 1 (East)	Inactive	200		
SF Golf Club	No. 2 (West)	Active	360	1	6.1
LMGC	No. 3	Active	294	8	10.5

Notes: bgs = below ground surface; gpm = gallons per minutes; Q = discharge/pumping rate; Q/s = discharge/foot of drawdown; SF = San Francisco; LMGC = Lake Merced Golf Club

Table 2. Groundwater Level Measurements

Cemetery Well Number	Well Name	Date	Approximate G.E. R.P. (Feet NGVD 29)	DTW (Feet)	Est. GW Elev. (Feet NGVD 29)
Holy Cross 1	Primary Well	5/13/1986	94	202	-108
		5/15/1986	94	218	-124
		1/5/1989	94	203.08	-109
		2/8/1989	94	202.34	-108
		3/15/1989	94	201.61	-108
		4/25/1989	94	202.6	-109
		5/31/1989	94	212.78	-119
		7/7/1989	94	214.68	-121
		8/16/1989	94	217.2	-123
		9/19/1989	94	209.92	-116
		10/27/1989	94	207.68	-114
		11/21/1989	94	207.29	-113
		12/7/1989	94	205.48	-111
		2/7/1990	94	204.2	-110
		3/6/1990	94	204.91	-111
		4/5/1990	94	205.51	-112
		5/1/1990	94	213	-119
		6/5/1990	94	213.97	-120
		7/2/1990	94	214.94	-121
		8/1/1990	94	215.76	-122
		9/5/1990	94	216.62	-123
		10/10/1990	94	213.99	-120
		11/6/1990	94	214.04	-120
		12/4/1990	94	208.08	-114
		2/5/1991	94	204.63	-111
		11/24/1998	94	238	-144
		1/18/1999	94	224	-130
		5/18/1999	94	237.4	-143
		2/7/2000	94	237	-143
		6/26/2000	94	255.7	-162
		3/13/2001	94	236	-142
		3/8/2010	94	199.7	-106
Holy Cross 3	Secondary Well	9/16/1960	138	192	-54
		12/21/1998	138	262	-124
		5/18/1999	138	232	-94
		2/9/2000	138	233.7	-96
		6/26/2000	138	250.5	-113
		3/13/2001	138	264	-126
		8/7/2003	138	262.32	-124
		9/11/2009	138	244.81	-107
		3/8/2010	138	230.63	-93
Holy Cross 2	Emergency Well	11/24/1998	127	238	-111
		5/18/1999	127	238	-111
		2/7/2000	127	252	-125
		6/26/2000	127	264	-137
		3/13/2001	127	252.3	-125
		9/11/2009	127	216.26	-89
		3/8/2010	127	204.73	-78
Holy Cross 4	Replacement Well	11/7/2008	114	232	-118
		9/11/2009	114	243.4	-129
		3/8/2010	114	221.13	-107
Cypress Lawn	Unknown	11/24/1998		223	
		7/8/1999		223	
Cypress Lawn	Unknown	11/25/1998		272	
		7/8/1999		233	
		3/13/2001		272	

Cemetery Well Number	Well Name	Date	Approximate G.E. R.P. (Feet NGVD 29)	DTW (Feet)	Est. GW Elev. (Feet NGVD 29)
Cypress Lawn	Unknown	8/2/1989		228	
		12/3/1998		223	
		7/8/1999		234	
Italian	Primary	4/19/1994	159	300	-141
		4/16/1999	159	276	-117
		7/8/1999	159	276	-117
		12/8/1999	159	295	-136
		6/27/2000	159	300.5	-142
		3/13/2001	159	294	-135
		1/22/2010	159	256.60	-98
Home of Peace		6/16/1998	128	239	-111
		7/8/1999	128	227	-99
		2/9/2000	128	227.9	-100
		6/27/2000	128	229.6	-102
		3/13/2001	128	234	-106
Hills of Eternity		5/15/1985	124	226	-102
		10/15/1996	124	244	-120
		12/16/1996	124	238	-114
		2/11/1999	124	238	-114
		7/8/1999	124	238	-114
		2/9/2000	124	240.3	-116
		6/27/2000	124	253	-129
		3/13/2001	124	242	-118
		10/26/2006	124	224	-100
		10/29/2007	124	214	-90
Eternal Home	Primary	2/15/1978	128	223	-95
		4/8/1999	128	253	-125
		7/15/1999	128	253	-125
		2/9/2000	128	259.5	-132
		6/27/2000	128	265	-137
		3/13/2001	128	261.4	-133
		2/4/2010	128	225.00	-97
Olivet		6/16/1998	150	269	-119
		7/8/1999	150	269	-119
Woodlawn	Primary Well	5/26/1982	135	227.8	-93
		8/6/2008		234.13	-234
		1/22/2010	135	220.00	-85
CGC 5		11/19/1966	53	159	-106
		1/30/1989	53	193.2	-140
		2/23/1989	53	196.3	-143
		11/17/2009	53	186.57	-134
CGC 6		8/8/1984	52	211.5	-160
		1/25/1989		183.8	-184
		11/17/2009	52	173.22	-121
CGC 7		3/14/1994	78	231.68	-154
		11/17/2009	78	NM	
					0
CGC 8		4/24/2001	61	235	-174
		10/26/2006	61	212	-151
		11/17/2009	61	213.85	-153
Olympic Club No. 1		7/9/2001		120	
		11/21/2008		101.76	
Olympic Club No. 2		11/12/1994		99.46	

Cemetery Well Number	Well Name	Date	Approximate G.E. R.P. (Feet NGVD 29)	DTW (Feet)	Est. GW Elev. (Feet NGVD 29)
SF Golf Club No. 1		4/24/1951	143.02	60.02	83.00
		4/5/1990	143.02	176.92	-33.90
		5/2/1990	143.02	178.07	-35.05
		6/5/1990	143.02	177.00	-33.98
		7/2/1990	143.02	178.84	-35.82
		8/1/1990	143.02	178.27	-35.25
		12/4/1990	143.02	178.42	-35.40
		2/5/1991	143.02	177.87	-34.85
		5/1/1991	143.02	178.42	-35.40
		9/17/1991	143.02	179.29	-36.27
		2/4/1992	143.02	178.42	-35.40
SF Golf Club No. 2		8/8/1985	139.10	210	-70.90
		1/5/1989	139.10	192.00	-52.90
		2/8/1989	139.10	190.47	-51.37
		3/20/1989	139.10	192.76	-53.66
		4/25/1989	139.10	202.34	-63.24
		10/25/1989	139.10	200.20	-61.10
		2/7/1990	139.10	198.06	-58.96
		3/6/1990	139.10	198.82	-59.72
		5/2/1990	139.10	213.26	-74.16
		8/1/1990	139.10	210.72	-71.62
		9/5/1990	139.10	203.81	-64.71
		10/10/1990	139.10	203.13	-64.03
		11/6/1990	139.10	203.09	-63.99
		11/1/1993	139.10	211	-71.90

Notes: CGC = California Golf Club; DTW = depth to water; R.P. = Reference Point (ground surface)
G.E. = Google Earth

Table 3. Pump Data

Cemetery Well Number	Well Name	Pump Type	Brand and Model	Horsepower	Capacity/Head Rating	Pump Setting Depth	Top Screen (feet bgs)	1999-2001 Q Range (gpm)	1999-2001 SWL Range (feet bgs)	1999-2001 PWL Range (feet bgs)	1999-2001 Q/s Range (gpd/ft)	2010 SWL (feet bgs)	Other Spec. Cap. Data and Date
Holy Cross 1	Primary Well	Submersible	Bryon Jackson/ 11MQH/12 Stage	200	800 gpm/ 700 ft.	340	368	725-760	236-256	276-296	17.8-19.7	200	10.8 @ 800 gpm (1986)
Holy Cross 4	Replacement Well	Submersible	Byron Jackson / 12EML/ 12 Stage	200	800 gpm/720 ft.	395	420	NA	NA	NA	NA	221	6.0 @ 950 gpm (2008)
Italian	Primary (only) Well	Submersible	Byron Jackson/ 8MQL/ 14 Stage	40	260 gpm/420 ft.	450	300	258-263	276-301	326-340	4.0-10.2	257	4.8 @300 gpm (1994)
Home of Peace	Abandoned						223	166-175	227-234	233-262	6.3-32.7	NA	19.2 @ 615 gpm (1966)
Home of Peace/Hills of Eternity/Salem	Replacement Well		10EMM/ 11 Stage		600 gpm/470 ft.	Unknown	400	NA	NA	NA	NA	240	11.6 @ 800 gpm (2010)
Hills of Eternity	Secondary	Submersible	Goulds/ VIS-T/ 8 Stage	40	235 gpm/500 ft.	305	224	170-181	238-253	263-280	4.0-17.6	NA	16.8 @ 505 gpm (1965)
Eternal Home	Primary (only) Well	Submersible	Byron Jackson/ 7MQH/ 20 Stage	30	Unknown	Unknown	280	155-200	253-265	270-287	5.5-15.8	225	7.1 @ 640 gpm (1978)
Olivet	Primary (only) Well	Submersible	Byron Jackson/ 8MQH/ 19 Stage	75	300 gpm/640 ft.	415	308	NA	267 (3/13/02)	320 (3/13/02)	NA	NA	9.1 @ 480 gpm (2002)
Woodlawn	Primary Well	Submersible	Byron Jackson/ 10MQH/ 6 Stage	50	500 gpm/300 ft.	350	275	550 (1982)	250 (1982)	281 (1982)	NA	220	17.5 @ 550 gpm (1982)
Woodlawn	Backup Well	Submersible		40	375 gpm/275 ft.		NA	NA	NA	NA	NA	NA	NA
Cypress Lawn 4	Primary	NA	NA	NA	NA	NA	330	600 (1989)	228 (1989)	338 (1989)	NA	NA	5.5 @600 gpm (1989)
Cypress Lawn 3	Secondary	NA	NA	NA	NA	NA							
California Golf Club 8	Primary Well		11MQL/ 9 Stage		800 gpm/ 400 ft.		320	800 (2001)	235 (2001)	288 (2001)	15.1 (2001)	214 (2009)	
California Golf Club 7	Secondary Well	NA	7MQH/15 Stage	30	200 gpm/350 ft.	NA	255	200 (1994)	232 (1994)	301 (1994)	NA	NA	2.9 @ 200 gpm (1994)
Lake Merced Golf Club 3	Primary (only active) Well	NA	NA	NA	NA	NA	294	800 (1986)	217 (1986)	293 (1986)	NA	NA	10.5 @ 800 gpm (1986)
Olympic 1 (No. 9)	Primary Well	Vertical Line Shaft Turbine	Byron Jackson/ 10GH/ 6 Stage	NA	700 gpm/276 ft.	250	260	NA	NA	NA	17.1	NA	NA
Olympic 2 (No. 8)	Primary Well	Vertical Line Shaft Turbine	Byron Jackson/ 11MQH/ 4 Stage	NA	1000/ 216 ft.	270	200	NA	NA	NA	15.4	NA	NA
San Francisco Golf Club 2	Primary Well	Vertical Line Shaft Turbine	Byron Jackson/ 10MQH/ 11 Stage	NA	700 gpm/ 390 ft.	350	360	NA	NA	NA	NA	NA	6.1 @ 700 gpm (1985)

Notes: gpm = gallons per minute; ft = feet; NA = Not Available; Q = discharge/pumping rate; Spec. Cap. = Specific Capacity (Q/s)

Table 4. Eternal Home Cemetery Well Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	ET Well DTW (Feet)	ET Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	ET Well SWL (Feet bgs)	ET Well GWE (Feet NGVD 29)	ET Well Background DTW (Feet)	ET Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	214.2	-86.2	27,742				225.8	-97.8	-81.2	-88.2
2	put	205.6	-77.6	33,925				226.5	-98.5	-73.9	-80.9
3	put	197.0	-69.0	40,108				227.3	-99.3	-68.6	-75.3
4	put	188.4	-60.4	46,291				228.0	-100.0	-66.8	-72.1
5	put	179.8	-51.8	52,475				228.8	-100.8	-61.6	-67.8
6	put	171.2	-43.2	58,658				229.5	-101.5	-58.6	-64.3
7	Put/Hold	169.1	-41.1	60,500				230.3	-102.3	-56.2	-62.2
8	Hold	169.9	-41.9	60,500				231.0	-103.0	-52.0	-63.2
9	Hold/Take	173.6	-45.6	58,475				231.8	-103.8	-61.9	-78.7
10	take	186.5	-58.5	50,375	41	227.5	-99.5	232.5	-104.5	-74.3	-101.3
11	Take/Put	194.1	-66.1	45,858	49	243.1	-115.1	233.3	-105.3	-80.2	-104.9
12	put	185.5	-57.5	52,042				234.0	-106.0	-77.0	-93.5
13	put	176.9	-48.9	58,225				234.8	-106.8	-75.0	-88.0
14	Put/Hold	174.2	-46.2	60,430				235.5	-107.5	-70.8	-82.8
15	Hold	175.0	-47.0	60,430				236.3	-108.3	-70.4	-83.0
16	Hold	175.7	-47.7	60,430				237.0	-109.0	-69.7	-82.5
17	Hold	176.5	-48.5	60,430				237.8	-109.8	-69.5	-83.0
18	Hold	177.2	-49.2	60,430				238.5	-110.5	-69.1	-83.1
19	Hold	178.0	-50.0	60,430				239.3	-111.3	-69.9	-84.0
20	Hold	178.7	-50.7	60,430				240.0	-112.0	-70.6	-85.0
21	Hold	179.5	-51.5	60,430				240.8	-112.8	-72.6	-87.4
22	Hold	180.2	-52.2	60,430				241.5	-113.5	-72.6	-87.8
23	Hold	181.0	-53.0	60,430				242.3	-114.3	-71.8	-87.1
24	Hold	181.7	-53.7	60,430				243.0	-115.0	-71.7	-87.4
25	Hold/Take	185.5	-57.5	58,405				243.8	-115.8	-78.9	-101.6
26	take	198.4	-70.4	50,305	41	239.4	-111.4	244.5	-116.5	-91.7	-123.8
27	take/put	205.9	-77.9	45,788	49	254.9	-126.9	245.3	-117.3	-97.5	-125.9
28	put	197.3	-69.3	51,972				246.0	-118.0	-95.0	-115.0
29	put	188.7	-60.7	58,155				246.8	-118.8	-89.7	-106.7
30	Put/Hold	186.1	-58.1	60,360				247.5	-119.5	-86.2	-101.6
31	Hold	186.8	-58.8	60,360				248.3	-120.3	-78.7	-96.4
32	Hold	187.6	-59.6	60,360				249.0	-121.0	-80.3	-95.2
33	Hold	188.3	-60.3	60,360				249.8	-121.8	-81.2	-96.1
34	Hold	189.1	-61.1	60,360				250.5	-122.5	-79.9	-95.7
35	Hold	189.8	-61.8	60,360				251.3	-123.3	-78.8	-95.2
36	hold/take	193.6	-65.6	58,335				252.0	-124.0	-86.4	-108.9
37	take	206.5	-78.5	50,235	41	247.5	-119.5	252.8	-124.8	-98.6	-130.3
38	take	219.4	-91.4	42,135	49	268.4	-140.4	253.5	-125.5	-105.3	-143.6
39	take	232.3	-104.3	34,035	57	289.3	-161.3	254.3	-126.3	-121.2	-158.9
40	take	245.2	-117.2	25,935	65	310.2	-182.2	255.0	-127.0	-131.3	-171.4
41	take	258.1	-130.1	17,835	68	326.1	-198.1	255.8	-127.8	-142.3	-183.9
42	take	271.0	-143.0	9,735	72	343.0	-215.0	256.5	-128.5	-158.1	-201.4
43	take	283.9	-155.9	1,635	75	358.9	-230.9	257.3	-129.3	-185.8	-224.8
44	take/hold/put	285.4	-157.4	1,168	76	361.4	-233.4	258.0	-130.0	-179.1	-209.7
45	put	276.8	-148.8	7,352				258.8	-130.8	-163.8	-188.4
46	put	268.2	-140.2	13,535				259.5	-131.5	-152.1	-171.4
47	put	259.6	-131.6	19,718				260.3	-132.3	-144.4	-160.1

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area
2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area
3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; ET = Eternal Home; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table 5. Analysis of Well Pump Capacities for GSR Project and Cumulative Project

Well	Top of Screen (feet bgs)	Spring 2001 DTW (feet)	2010 DTW (feet)	Pump Setting Depth (feet bgs)	Capacity/Head Rating	Calculated PWL and Q for 2001 Conditions	Calculated Discharge Head (feet)	Existing Conditions DTW at Year 44 (feet)	PWL and Q for Existing Conditions at Year 44 (feet)	GSR Max DTW (feet)	PWL and Q for GSR Max DTW	Cumulative Design Drought Max DTW (feet)	PWL and Q for Cumulative DD Max DTW
Woodlawn Primary	275	256 (Est.)	220	350	500 gpm/300 ft. (1982 SWL=228 ft.)	450 gpm @ 315 ft.	33	253	450 gpm @ 312 ft.	369	60 gpm @ 405 ft.	NA	NA
Italian	300	294	257	450	260 gpm/420 feet	260 gpm @ 348 ft	72	290	265 gpm @345 ft.	400	145 gpm @ 430 ft.	NA	NA
Eternal Home	280	261	225	NA	200 gpm/460 feet (assumed)	200 gpm @283 ft.	177	258	200 gpm @280 ft.	363	100 gpm @ 374 ft.	NA	NA
Olivet	308	NA	NA	415	300 gpm/640 feet	300 gpm @ 300 ft.	340	264	300 gpm @ 297 ft.	363	180 gpm @ 381 ft.	NA	NA
Home of Peace	400	NA	240	NA	600 gpm/470 feet	600 gpm @ 328 ft.	142	273	600 gpm @ 325 ft.	370	440 gpm @ 406 ft.	NA	NA
Hills of Eternity	224	242	NA	310	235 gpm/500 feet	235 gpm @ 256 ft.	254	239	235 gpm @ 253 ft.	334	135 gpm @ 342 ft.	NA	NA
Holy Cross 1	368	236	200	340	800 gpm/700 feet	800 gpm @ 310 ft.	390	233	800 gpm @ 307 ft	337	625 gpm @ 393 ft.	NA	NA
Holy Cross 4	420	NA	221	395	800 gpm/720 feet	800 gpm @ 389 ft.	331	253	800 gpm @ 386 ft.	352	700 gpm @ 467 ft.	NA	NA
California Golf Club 7	255	235 (Est.)	200 (Est.)	NA	200 gpm/350 feet (1994 SWL=232 ft.)	200 gpm @ 301 ft.	49	233	200 gpm @ 302 ft.	401	45 gpm @ 417 ft.	NA	NA
California Golf Club 8	320	236	200 (Est.)	NA	800 gpm/400 feet	800 gpm @ 289 ft.	111	233	800 gpm @ 286 ft.	402	475 gpm @ 433 ft.	NA	NA
Olympic Club 1 (No. 9)	260	115 (Est.)	100	250	700 gpm/276 ft.	700 gpm @ 156 ft.	120	122	685 gpm@ 160 ft	136	660 gpm@ 164 ft	142	640 gpm@ 168 ft
Olympic Club 2 (No. 8)	200	115 (Est.)	100	270	1000 gpm/ 216 ft	1000 gpm @ 180 ft.	36	122	970 gpm@ 185 ft	136	935 gpm@ 195 ft	142	910 gpm@ 200 ft
San Francisco Golf Club 2	360	180 (Est.)	160 (Est.)	350	700 gpm/ 390 ft.	675 gpm @ 218 ft.	186	182	675 gpm@ 217 ft	196	660 gpm@ 228 ft	202	655 gpm@ 230 ft

Notes: DTW = depth to water; gpm = gallons per minute; PWL = pumping water level; Q = discharge/pumping rate; ft = feet

2001 DTW and 2010 DTW for Olympic Club and San Francisco Golf Clubs are estimated (i.e., not measured)

Table 6. California Golf Club Well 8 Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	CGC8 Well DTW (Feet)	CGC8 Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	CGC8 Well SWL (Feet bgs)	CGC8 Well GWE (Feet NGVD 29)	CGC8 Well Background DTW (Feet)	CGC8 Well Background GWE (Feet NGVD 29)	GW Model SC 2-Lay 3 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 5 GWE (Feet NGVD 29)
1	put	189.4	-128.4	27,742				200.8	-139.8	-87.9	-130.7	-133.9
2	put	180.9	-119.9	33,925				201.5	-140.5	-84.6	-125.6	-128.0
3	put	172.4	-111.4	40,108				202.3	-141.3	-81.0	-120.4	-122.5
4	put	163.9	-102.9	46,291				203.0	-142.0	-78.5	-116.8	-119.5
5	put	155.4	-94.4	52,475				203.8	-142.8	-75.1	-112.1	-114.4
6	put	146.9	-85.9	58,658				204.5	-143.5	-72.3	-108.3	-110.8
7	Put/Hold	144.8	-83.8	60,500				205.3	-144.3	-73.3	-117.7	-121.7
8	Hold	145.6	-84.6	60,500				206.0	-145.0	-74.5	-124.3	-125.7
9	Hold/Take	150.8	-89.8	58,475				206.8	-145.8	-81.1	-140.5	-144.9
10	take	169.3	-108.3	50,375	43	212.3	-151.3	207.5	-146.5	-94.6	-169.5	-174.1
11	Take/Put	181.0	-120.0	45,858	50	231.0	-170.0	208.3	-147.3	-107.1	-183.7	-186.6
12	put	172.5	-111.5	52,042				209.0	-148.0	-103.0	-166.9	-170.2
13	put	164.0	-103.0	58,225				209.8	-148.8	-96.3	-153.2	-156.1
14	Put/Hold	161.4	-100.4	60,430				210.5	-149.5	-92.7	-152.8	-156.7
15	Hold	162.2	-101.2	60,430				211.3	-150.3	-93.9	-157.5	-161.6
16	Hold	162.9	-101.9	60,430				212.0	-151.0	-95.3	-160.9	-165.3
17	Hold	163.7	-102.7	60,430				212.8	-151.8	-96.5	-163.9	-168.1
18	Hold	164.4	-103.4	60,430				213.5	-152.5	-97.5	-166.1	-170.2
19	Hold	165.2	-104.2	60,430				214.3	-153.3	-99.0	-169.0	-173.3
20	Hold	165.9	-104.9	60,430				215.0	-154.0	-100.3	-171.4	-175.6
21	Hold	166.7	-105.7	60,430				215.8	-154.8	-101.5	-173.7	-177.4
22	Hold	167.4	-106.4	60,430				216.5	-155.5	-103.1	-176.1	-180.2
23	Hold	168.2	-107.2	60,430				217.3	-156.3	-103.8	-177.3	-181.4
24	Hold	168.9	-107.9	60,430				218.0	-157.0	-104.4	-178.6	-182.7
25	Hold/Take	174.1	-113.1	58,405				218.8	-157.8	-106.5	-186.9	-191.3
26	take	192.6	-131.6	50,305	43	235.6	-174.6	219.5	-158.5	-118.1	-211.5	-216.1
27	take/put	204.3	-143.3	45,788	50	254.3	-193.3	220.3	-159.3	-129.0	-221.7	-224.9
28	put	195.8	-134.8	51,972				221.0	-160.0	-123.8	-202.5	-206.0
29	put	187.3	-126.3	58,155				221.8	-160.8	-115.0	-184.8	-187.6
30	Put/Hold	184.7	-123.7	60,360				222.5	-161.5	-110.4	-182.5	-186.1
31	Hold	185.5	-124.5	60,360				223.3	-162.3	-107.3	-180.4	-181.9
32	Hold	186.2	-125.2	60,360				224.0	-163.0	-108.9	-183.1	-186.9
33	Hold	187.0	-126.0	60,360				224.8	-163.8	-110.2	-185.8	-190.3
34	Hold	187.7	-126.7	60,360				225.5	-164.5	-110.1	-186.1	-190.1
35	Hold	188.5	-127.5	60,360				226.3	-165.3	-109.9	-186.2	-189.7
36	hold/take	193.7	-132.7	58,335				227.0	-166.0	-112.6	-194.9	-199.7
37	take	212.2	-151.2	50,235	43	255.2	-194.2	227.8	-166.8	-123.9	-219.1	-224.3
38	take	230.7	-169.7	42,135	50	280.7	-219.7	228.5	-167.5	-133.9	-237.7	-240.6
39	take	249.2	-188.2	34,035	57	306.2	-245.2	229.3	-168.3	-147.5	-258.6	-264.1
40	take	267.7	-206.7	25,935	64	331.7	-270.7	230.0	-169.0	-157.3	-273.7	-279.2
41	take	286.2	-225.2	17,835	67	353.2	-292.2	230.8	-169.8	-166.4	-287.3	-293.0
42	take	304.7	-243.7	9,735	70	374.7	-313.7	231.5	-170.5	-174.0	-298.7	-304.1
43	take	323.2	-262.2	1,635	73	396.2	-335.2	232.3	-171.3	-181.4	-309.0	-314.1
44	take/hold/put	326.0	-265.0	1,168	74	400.0	-339.0	233.0	-172.0	-182.7	-296.3	-300.0
45	put	317.5	-256.5	7,352				233.8	-172.8	-171.8	-269.2	-272.7
46	put	309.0	-248.0	13,535				234.5	-173.5	-159.4	-245.3	-248.0
47	put	300.5	-239.5	19,718				235.3	-174.3	-148.9	-226.2	-228.8

Assumptions:

1) Put Rate of 5.52 MGD results in 8.5 feet/year increase in groundwater levels in CGC area

2) Take Rate of 7.23 MGD results in 18.5 feet/year decrease in groundwater levels in CGC area

3) Hold Year results in 0.75 feet/year decrease in groundwater levels in CGC area

4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; CGC = California Golf Club; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table 7. Lake Merced Golf Club Well 3 Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	LMGC3 DTW (Feet)	LMGC3 GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	LMGC3 SWL (Feet bgs)	LMGC3 GWE (Feet NGVD 29)	LMGC3 Background DTW (Feet)	LMGC3 Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 3 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	224.9	-70.9	27,742				238.8	-84.8	-45.9	-46.4	-48.9
2	put	214.4	-60.4	33,925				239.5	-85.5	-36.3	-37.1	-40.6
3	put	203.9	-49.9	40,108				240.3	-86.3	-30.8	-31.5	-34.6
4	put	193.4	-39.4	46,291				241.0	-87.0	-26.7	-27.5	-30.4
5	put	182.9	-28.9	52,475				241.8	-87.8	-23.8	-24.5	-27.4
6	put	172.4	-18.4	58,658				242.5	-88.5	-21.3	-22.0	-24.7
7	Put/Hold	169.7	-15.7	60,500				243.3	-89.3	-26.2	-28.5	-35.9
8	Hold	170.5	-16.5	60,500				244.0	-90.0	-31.9	-34.2	-42.5
9	Hold/Take	174.8	-20.8	58,475				244.8	-90.8	-41.7	-45.7	-58.2
10	take	189.8	-35.8	50,375	29	218.8	-64.8	245.5	-91.5	-56.0	-60.5	-75.6
11	Take/Put	198.4	-44.4	45,858	35	233.4	-79.4	246.3	-92.3	-60.5	-62.2	-69.7
12	put	187.9	-33.9	52,042				247.0	-93.0	-50.6	-51.0	-53.5
13	put	177.4	-23.4	58,225				247.8	-93.8	-44.5	-44.9	-47.3
14	Put/Hold	174.1	-20.1	60,430				248.5	-94.5	-45.1	-47.2	-54.5
15	Hold	174.8	-20.8	60,430				249.3	-95.3	-49.0	-51.3	-59.1
16	Hold	175.6	-21.6	60,430				250.0	-96.0	-50.4	-52.8	-60.9
17	Hold	176.3	-22.3	60,430				250.8	-96.8	-53.0	-55.1	-62.8
18	Hold	177.1	-23.1	60,430				251.5	-97.5	-53.4	-55.6	-63.5
19	Hold	177.8	-23.8	60,430				252.3	-98.3	-54.7	-56.7	-64.4
20	Hold	178.6	-24.6	60,430				253.0	-99.0	-55.9	-57.9	-65.4
21	Hold	179.3	-25.3	60,430				253.8	-99.8	-57.5	-59.4	-67.3
22	Hold	180.1	-26.1	60,430				254.5	-100.5	-56.5	-58.7	-66.9
23	Hold	180.8	-26.8	60,430				255.3	-101.3	-55.5	-57.7	-65.9
24	Hold	181.6	-27.6	60,430				256.0	-102.0	-56.6	-58.7	-66.6
25	Hold/Take	185.9	-31.9	58,405				256.8	-102.8	-62.9	-66.6	-79.0
26	take	200.9	-46.9	50,305	29	229.9	-75.9	257.5	-103.5	-74.5	-78.8	-94.2
27	take/put	209.5	-55.5	45,788	35	244.5	-90.5	258.3	-104.3	-77.0	-78.7	-86.3
28	put	199.0	-45.0	51,972				259.0	-105.0	-65.7	-65.9	-68.5
29	put	188.5	-34.5	58,155				259.8	-105.8	-56.3	-56.7	-59.7
30	Put/Hold	185.2	-31.2	60,360				260.5	-106.5	-56.1	-58.2	-65.8
31	Hold	185.9	-31.9	60,360				261.3	-107.3	-57.0	-59.4	-68.1
32	Hold	186.7	-32.7	60,360				262.0	-108.0	-56.3	-58.7	-67.4
33	Hold	187.4	-33.4	60,360				262.8	-108.8	-57.5	-59.7	-67.8
34	Hold	188.2	-34.2	60,360				263.5	-109.5	-58.3	-60.3	-68.8
35	Hold	188.9	-34.9	60,360				264.3	-110.3	-58.1	-60.2	-69.0
36	hold/take	193.2	-39.2	58,335				265.0	-111.0	-64.5	-68.3	-81.1
37	take	208.2	-54.2	50,235	29	237.2	-83.2	265.8	-111.8	-76.4	-80.9	-96.0
38	take	223.2	-69.2	42,135	35	258.2	-104.2	266.5	-112.5	-85.5	-89.8	-105.8
39	take	238.2	-84.2	34,035	41	279.2	-125.2	267.3	-113.3	-96.6	-100.9	-116.1
40	take	253.2	-99.2	25,935	47	300.2	-146.2	268.0	-114.0	-106.4	-110.7	-126.1
41	take	268.2	-114.2	17,835	49	317.2	-163.2	268.8	-114.8	-115.3	-119.9	-135.8
42	take	283.2	-129.2	9,735	52	335.2	-181.2	269.5	-115.5	-127.6	-132.3	-148.7
43	take	298.2	-144.2	1,635	54	352.2	-198.2	270.3	-116.3	-143.3	-148.8	-166.3
44	take/hold/put	299.7	-145.7	1,168	56	355.7	-201.7	271.0	-117.0	-140.4	-141.3	-148.4
45	put	289.2	-135.2	7,352				271.8	-117.8	-121.1	-120.7	-123.3
46	put	278.7	-124.7	13,535				272.5	-118.5	-105.1	-105.0	-108.2
47	put	268.2	-114.2	19,718				273.3	-119.3	-91.4	-91.8	-95.7

Assumptions:

1) Put Rate of 5.52 MGD results in 10.5 feet/year increase in groundwater levels in LMGC area
2) Take Rate of 7.23 MGD results in 15.0 feet/year decrease in groundwater levels in LMGC area
3) Hold Year results in 0.75 feet/year decrease in groundwater levels in LMGC area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; LMGC = Lake Merced Golf Club; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table 8. Olympic Golf Club Well 1 (#9) Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	Oly1 Well DTW (Feet)	Oly1 Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	Oly1 Well SWL (Feet bgs)	Oly1 Well GWE (Feet NGVD 29)	Oly1 Well Background DTW (Feet)	Oly1 Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 3 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	95.5	-20.5	27,742				100.5	-25.5	-8.8	-21.1
2	put	91.9	-16.9	33,925				101.0	-26.0	-4.1	-16.5
3	put	88.3	-13.3	40,108				101.5	-26.5	-0.8	-12.0
4	put	84.7	-9.7	46,291				102.0	-27.0	1.3	-9.0
5	put	81.1	-6.1	52,475				102.5	-27.5	2.6	-6.7
6	put	77.5	-2.5	58,658				103.0	-28.0	3.6	-5.2
7	Put/Hold	76.8	-1.8	60,500				103.5	-28.5	3.4	-5.9
8	Hold	77.3	-2.3	60,500				104.0	-29.0	0.9	-9.6
9	Hold/Take	78.6	-3.6	58,475				104.5	-29.5	-2.4	-13.1
10	take	82.6	-7.6	50,375	7	89.6	-14.6	105.0	-30.0	-8.8	-21.6
11	Take/Put	84.7	-9.7	45,858	12	96.7	-21.7	105.5	-30.5	-13.2	-28.0
12	put	81.1	-6.1	52,042				106.0	-31.0	-10.9	-23.6
13	put	77.5	-2.5	58,225				106.5	-31.5	-9.1	-20.3
14	Put/Hold	76.5	-1.5	60,430				107.0	-32.0	-8.1	-19.2
15	Hold	77.0	-2.0	60,430				107.5	-32.5	-9.2	-21.5
16	Hold	77.5	-2.5	60,430				108.0	-33.0	-9.4	-22.7
17	Hold	78.0	-3.0	60,430				108.5	-33.5	-10.0	-23.5
18	Hold	78.5	-3.5	60,430				109.0	-34.0	-9.9	-24.1
19	Hold	79.0	-4.0	60,430				109.5	-34.5	-9.9	-24.1
20	Hold	79.5	-4.5	60,430				110.0	-35.0	-10.3	-24.5
21	Hold	80.0	-5.0	60,430				110.5	-35.5	-11.4	-25.3
22	Hold	80.5	-5.5	60,430				111.0	-36.0	-10.6	-25.6
23	Hold	81.0	-6.0	60,430				111.5	-36.5	-9.7	-24.9
24	Hold	81.5	-6.5	60,430				112.0	-37.0	-10.0	-24.7
25	Hold/Take	82.9	-7.9	58,405				112.5	-37.5	-11.9	-25.9
26	take	86.9	-11.9	50,305	7	93.9	-18.9	113.0	-38.0	-17.5	-32.8
27	take/put	89.0	-14.0	45,788	12	101.0	-26.0	113.5	-38.5	-20.7	-38.1
28	put	85.4	-10.4	51,972				114.0	-39.0	-17.4	-32.5
29	put	81.8	-6.8	58,155				114.5	-39.5	-14.0	-27.8
30	Put/Hold	80.8	-5.8	60,360				115.0	-40.0	-12.6	-25.7
31	Hold	81.3	-6.3	60,360				115.5	-40.5	-12.1	-26.6
32	Hold	81.8	-6.8	60,360				116.0	-41.0	-10.7	-26.3
33	Hold	82.3	-7.3	60,360				116.5	-41.5	-10.1	-25.6
34	Hold	82.8	-7.8	60,360				117.0	-42.0	-10.6	-25.6
35	Hold	83.3	-8.3	60,360				117.5	-42.5	-10.5	-25.9
36	hold/take	84.7	-9.7	58,335				118.0	-43.0	-11.9	-26.8
37	take	88.7	-13.7	50,235	7	95.7	-20.7	118.5	-43.5	-17.2	-33.4
38	take	92.7	-17.7	42,135	12	104.7	-29.7	119.0	-44.0	-21.9	-39.3
39	take	96.7	-21.7	34,035	15	111.7	-36.7	119.5	-44.5	-27.0	-45.2
40	take	100.7	-25.7	25,935	17	117.7	-42.7	120.0	-45.0	-31.9	-50.9
41	take	104.7	-29.7	17,835	19	123.7	-48.7	120.5	-45.5	-36.6	-56.9
42	take	108.7	-33.7	9,735	21	129.7	-54.7	121.0	-46.0	-42.0	-63.0
43	take	112.7	-37.7	1,635	22	134.7	-59.7	121.5	-46.5	-48.5	-70.6
44	take/hold/put	113.0	-38.0	1,168	23	136.0	-61.0	122.0	-47.0	-50.8	-74.6
45	put	109.4	-34.4	7,352				122.5	-47.5	-45.9	-67.1
46	put	105.8	-30.8	13,535				123.0	-48.0	-40.0	-59.3
47	put	102.2	-27.2	19,718				123.5	-48.5	-34.1	-52.0

Assumptions:

1) Put Rate of 5.52 MGD results in 3.6 feet/year increase in groundwater levels in Olympic Club area
2) Take Rate of 7.23 MGD results in 4.0 feet/year decrease in groundwater levels in the Olympic Club area
3) Hold Year results in 0.5 feet/year decrease in groundwater levels in the Olympic Club area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; Oly = Olympic Club; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table 9. Summary of Analytical Data Analysis for GSR Project

Well	Top of Screen (Feet bgs)	2001/2010 DTW (Feet)	Existing Conditions Max DTW at Year 44 (Feet)	GSR Design Drought End of Water Year Max DTW at Year 44 (Feet)	GSR Design Drought Max DTW Mid-Year 44 (Feet)	Max Depth Below Existing Conditions (Feet)
Woodlawn Primary	275	NA/220	253	367	369	116
Italian	300	294/257	290	398	400	110
Eternal Home	280	261/225	258	361	363	105
Olivet	308	NA/NA	264	361	363	99
Home of Peace	400	NA/240	273	368	370	97
Hills of Eternity	224	242/NA	239	332	334	95
Cypress 3	191	NA/NA	289	382	384	95
Cypress 4	330	272(?)/NA	232	328	330	98
Holy Cross 4	420	NA/221	253	350	352	99
Holy Cross 1	368	236/200	233	335	337	104
Olympic Club No. 1 (#9)	260	NA/NA	122	135	136	14
Olympic Club No. 2 (#8)	200	NA/NA	122	135	136	14
San Francisco Golf Club No. 2	360	NA/NA	182	194	196	14
Lake Merced Golf Club No. 3	294	NA/NA	271	356	358	87
California Golf Club No. 7	255	NA/NA	233	400	401	168
California Golf Club No. 8	320	235/NA	233	400	402	169

Notes: LMGC = Lake Merced Golf Club; CGC = California Golf Club; NA = Not Available;
bgs = below ground surface; DTW = depth to water

Table 10. Summary of Gross GSR Project Well Interference Drawdown Estimates for Third-Party Wells (feet)[3]

Well I.D.	San Francisco Golf Club Well 2	Olympic Golf Club Wells	Lake Merced Golf Club Well 3
Well CUP-3A (pumping at 400 gpm 7.5 years)	8.2	7.2	10.8
Well CUP-5 (pumping at 300 gpm for 7.5 years)	4.6	5.2	10.4
Well CUP-6 (pumping at 300 gpm for 7.5 years)	4.9	5.4	12.4
Well CUP-7 (pumping at 300 gpm for 7.5 years)	4.4	4.9	10.1
Other GSR Wells[1,2]	NA	NA	12.1
Totals	22	23	56

1. "Other GSR Wells" refers to GSR wells located south of CUP-5, 6, 7.
2. NA means not applicable because other GSR wells are too far away.
3. Gross Drawdown is equal to the difference between "Regional SWL with GSR Project" and "SWL with Local GSR Drawdown" as labeled on Figures 3 through 10.

Table 11. Summary of Net GSR Project Well Interference Drawdown Estimates for Third-Party Wells Compared to Existing Conditions (feet)[1]

Baseline Case	San Francisco Golf Club Well 2	Olympic Golf Club Wells	Lake Merced Golf Club Well 3
Existing Conditions – 20,000 AF beginning SFPUC storage account	14	14	87

1. Net Drawdown is equal to the difference between "SWL Under Existing Conditions without Project" and "SWL with Local GSR Drawdown" as labeled on Figures 3 through 10

Table 12. Summary of SFGW Supply Project Well Interference Drawdown Estimates for Third-Party Wells (feet)

Well I.D.	SF Golf Club[1]	Olympic Golf Club[1]	Lake Merced Golf Club[2]
SFGW Project with 4 Wells (3 MGD)	6	6	4
SFGW Project with 6 Wells (4 MGD)	6	6	4

1. Calculations from LSCE (2012).
2. Calculations made in this TM.

Table 13. Combined Gross GSR and SFGW Supply Project Well Interference Drawdown Estimates for Third-Party Wells (feet)

Well I.D.	SF Golf Club[1]	Olympic Golf Club[1]	Lake Merced Golf Club[1]
GSR and SFGW Project with 4 Wells (3-MGD)	28	29	60
GSR and SFGW Project with 6 Wells (4-MGD)	28	29	60

1. Drawdown estimates are sum of results from Tables 10 and 12.

Table 14. Combined Net GSR and SFGW Supply Project Well Interference Drawdown Estimates for Third-Party Wells (feet)

Well I.D.	SF Golf Club[1]	Olympic Golf Club[1]	Lake Merced Golf Club[1]
GSR and SFGW Project with 4 Wells (3-MGD)	20	20	91
GSR and SFGW Project with 6 Wells (4-MGD)	20	20	91

1. Drawdown estimates are sum of results from Tables 11 and 12.

Table 15. Summary of Analytical Data Analysis for Cumulative GSR and SFGW Projects

Well	Top of Screen (Feet bgs)	Estimated Spring 2001/2010 DTW (Feet)	Existing Conditions Future Scenario Year 44 Max DTW (Feet)	Cumulative Project Future Scenario Year 44 End of Water Year Max DTW (Feet)	Cumulative Project Future Scenario Year 44 Mid-Year Max DTW (Feet)	Cumulative Project Max Depth Below Existing Conditions (Feet)
Olympic Club No. 1 (#9)	260	115/100	122	141	142	20
Olympic Club No. 2 (#8)	200	115/100	122	141	142	20
San Francisco Golf Club No. 2	360	180/160	182	200	202	20
Lake Merced Golf Club No. 3	294	273/238	271	360	362	91

Notes: NA = Not Available; bgs = below ground surface; DTW = depth to water

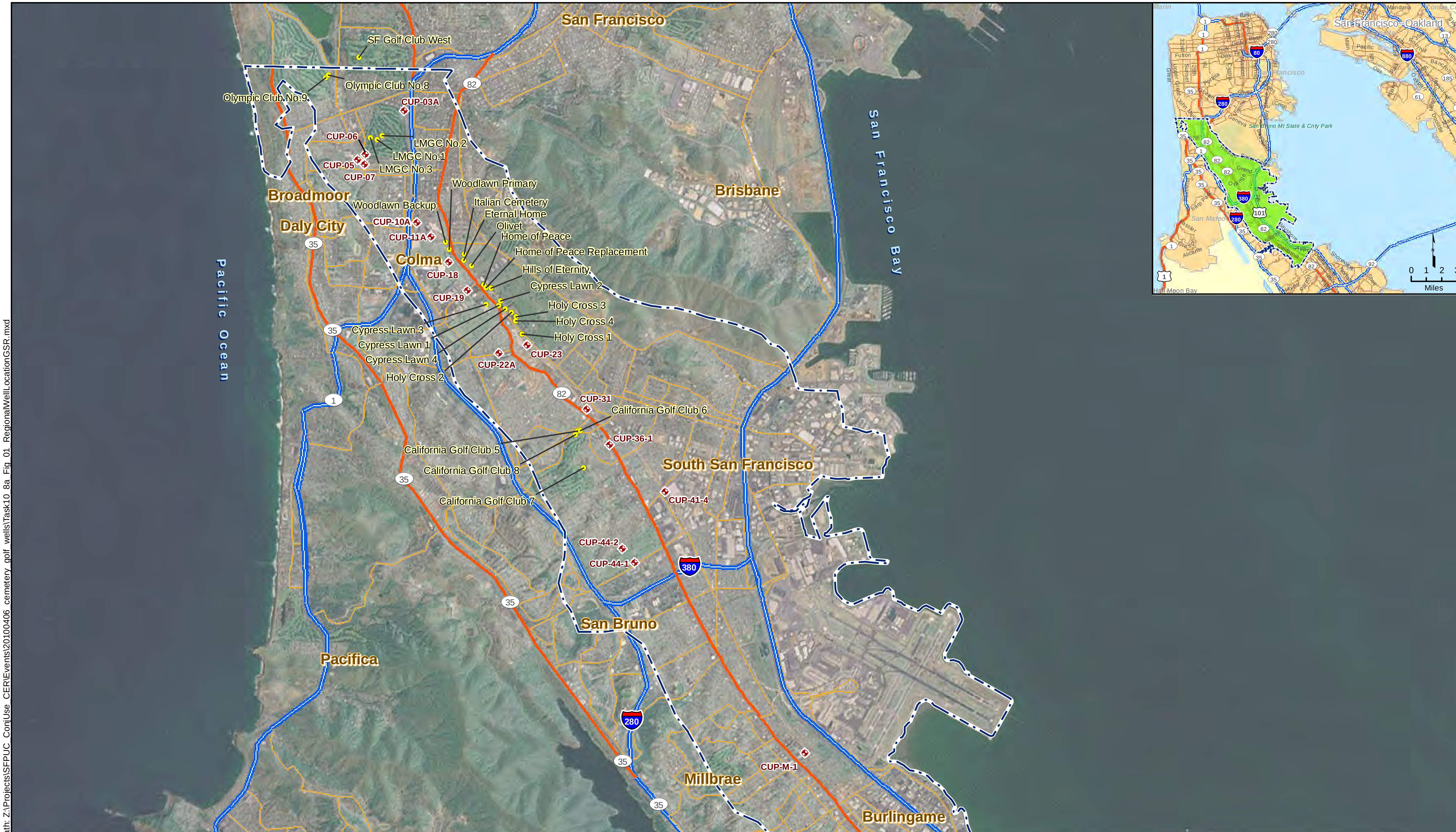
Estimated Spring 2001 DTW for Olympic Club Wells - based upon measured DTW in Olympic Club No. 1 in July 2001 (DTW= 120 feet) and then added 5 feet (115 feet) for presumed higher spring levels
Estimated Spring 2010 DTW for Olympic Club Wells - based upon measured rise in groundwater levels of about 15 feet from 2002 to 2009 observed in LMMW-3D and LMMW-6D (DTW=100 feet)
Estimated Spring 2001/2010 DTW for San Francisco Golf Club Well - personal communication, Jeff Gilman

Table 16. Combined GSR and SFGW Supply Project Well Interference Pumping Capacity Reductions for Third-Party Wells[1]

Well I.D.	SF Golf Club	Olympic Golf Club	Lake Merced Golf Club
Gross GSR and SFGW Project with 6 Wells (4-MGD)	6%	9%	10 –30%
Net GSR and SFGW Project with 6 Wells (4-MGD)	3%	7%	10 –30%

1. Reduction in pumping capacity discharge rates (gpm) are discussed in text where available information allows.

FIGURES



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Note:
Cypress Lawn Cemetery well locations are estimated and not based on gps coordinates.
Other well locations are based on site visits and gps coordinates.

Legend

- GSR Project Proposed Well
- Third Party Well
- South Westside Groundwater Basin

0 2,500 5,000
Scale Feet
1 " = 5,000 '

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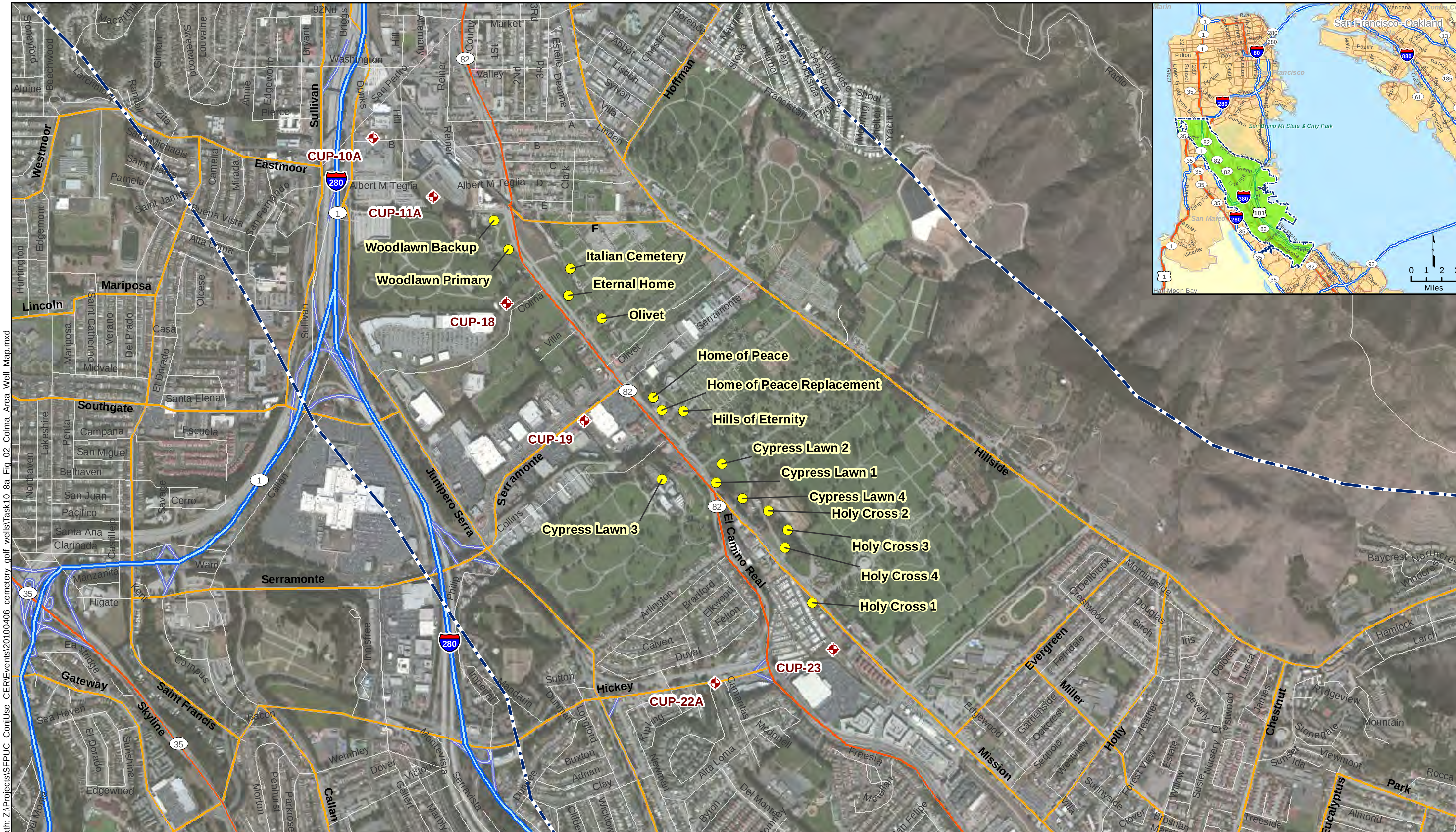
REGIONAL WELL LOCATION MAP FOR GSR PROJECT

FIGURE
1

DATE
April 2012



Path: Z:\Projects\SFPUC ConjUse CER\Events\20100406 cemetery golf wells\Task10 8a Fig 02 Colma Area Well Map.mxd

Note:
Cypress Lawn Cemetery well locations are estimated and not based on gps coordinates.
Other well locations are based on site visits and gps coordinates.

Legend

- GSR Project Proposed Well
- Third Party Well
- South Westside Groundwater Basin

0 600 1,200
Scale Feet
1 " = 1,200 '

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COLMA AREA WELL LOCATION MAP

FIGURE
2

DATE
April 2012

Figure 3. Estimated Static Water Levels at Eternal Home Cemetery Well for GSR Project

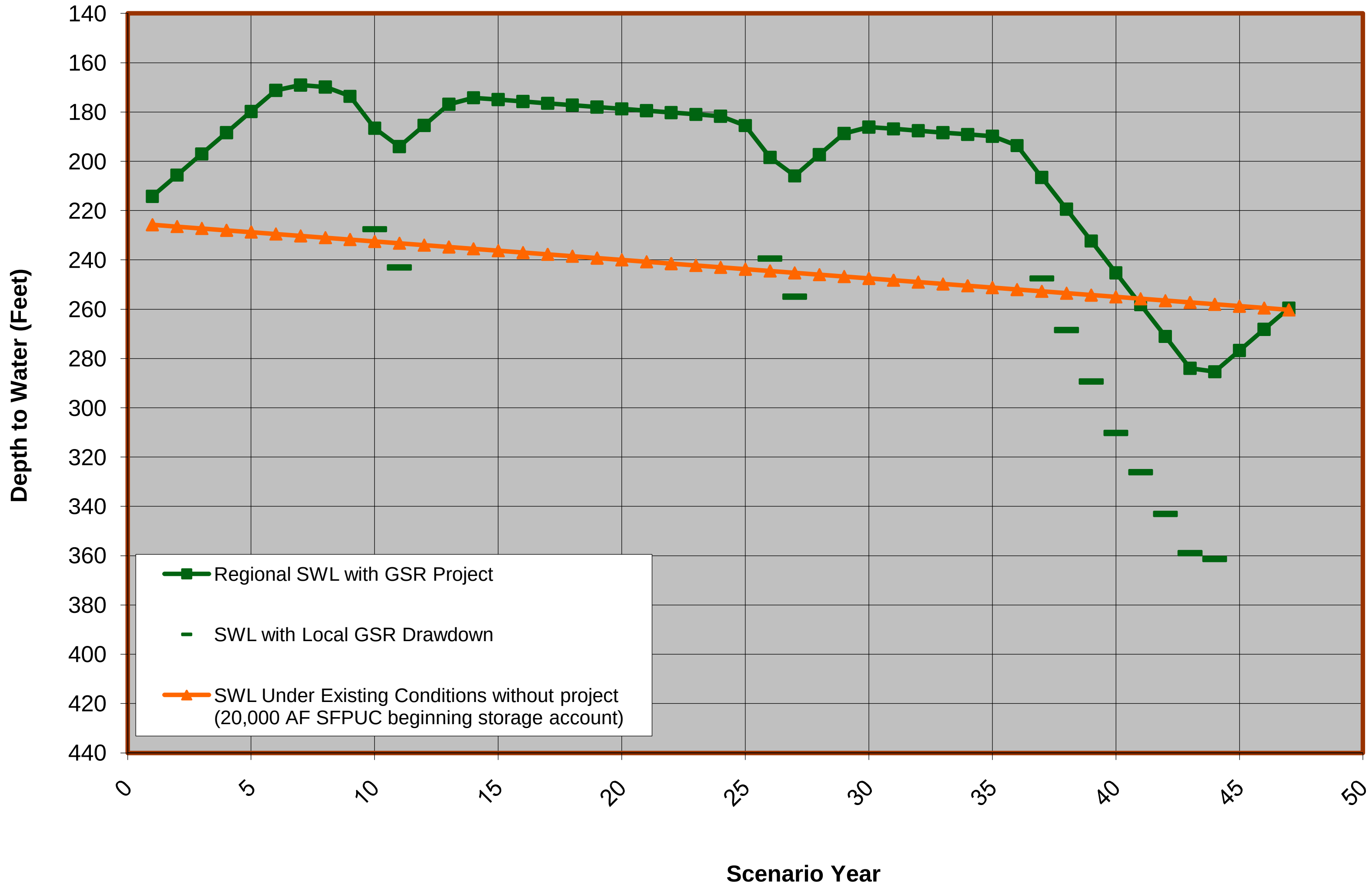


Figure 4. Estimated Groundwater Elevations at Eternal Home Cemetery Well for GSR Project (Scenario 2)

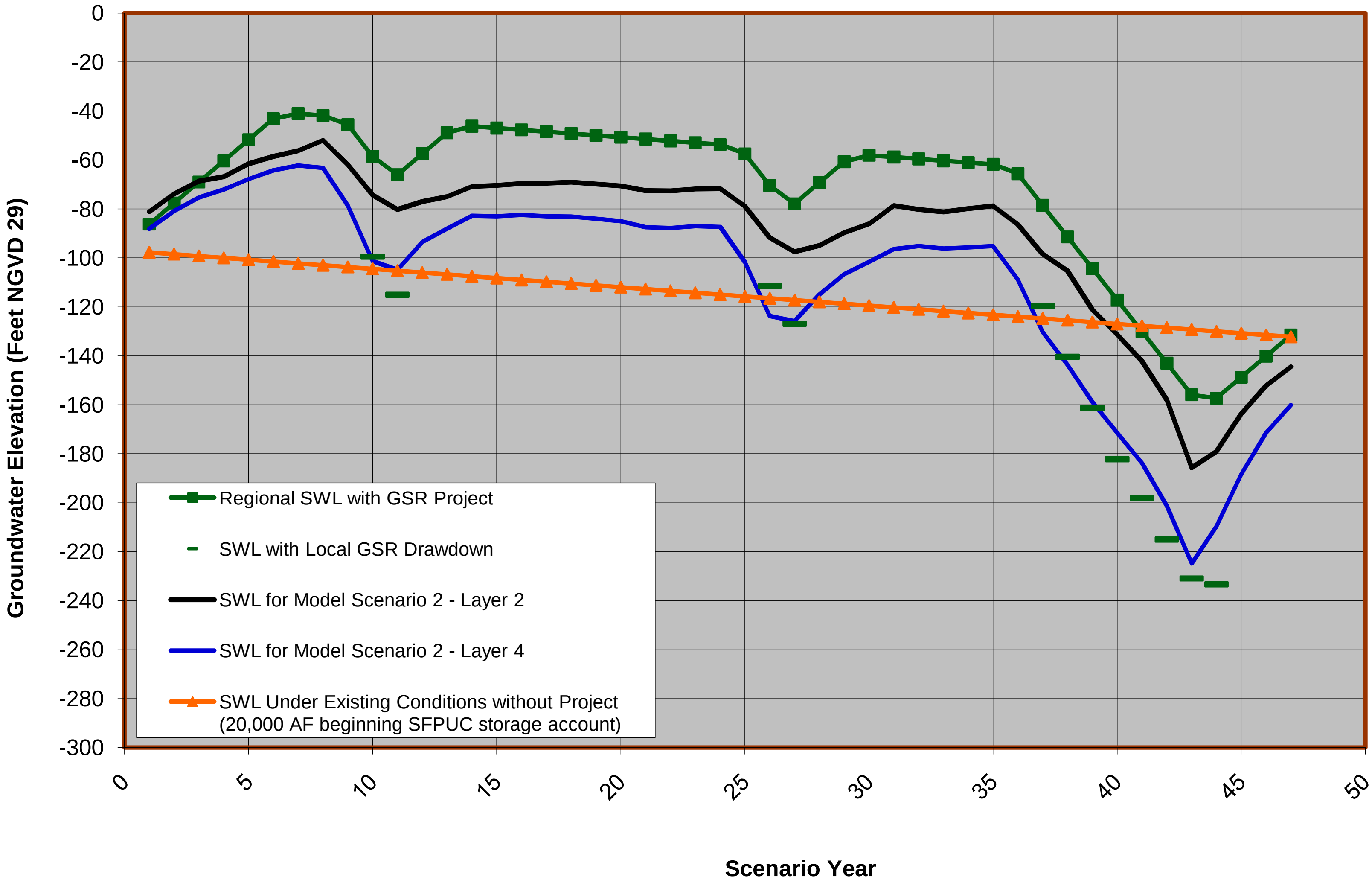


Figure 5. Estimated Static Water Levels at California Golf Club Well 8 for GSR Project

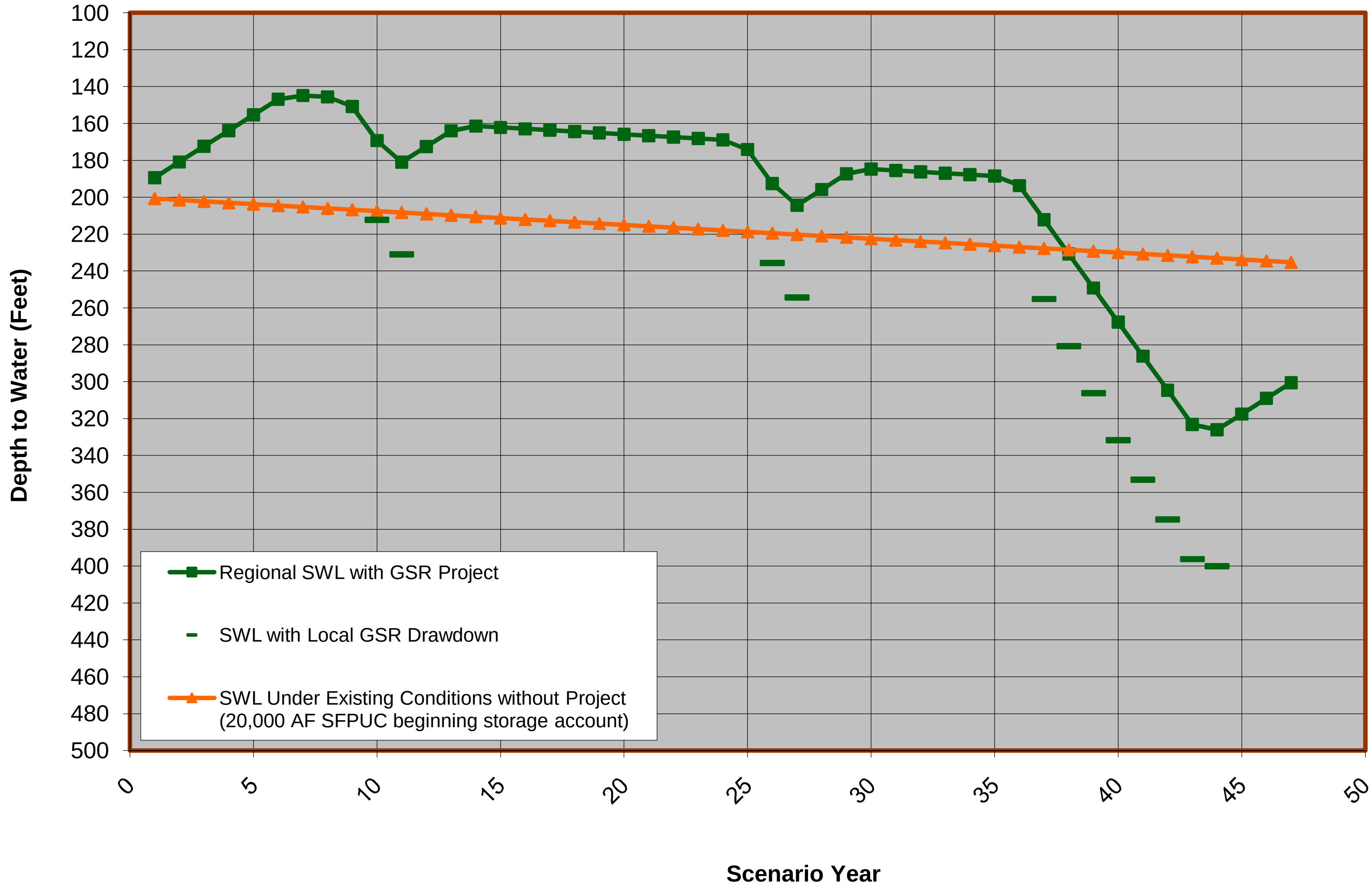


Figure 6. Estimated Groundwater Elevations at California Golf Club Well 8 for GSR Project (Scenario 2)

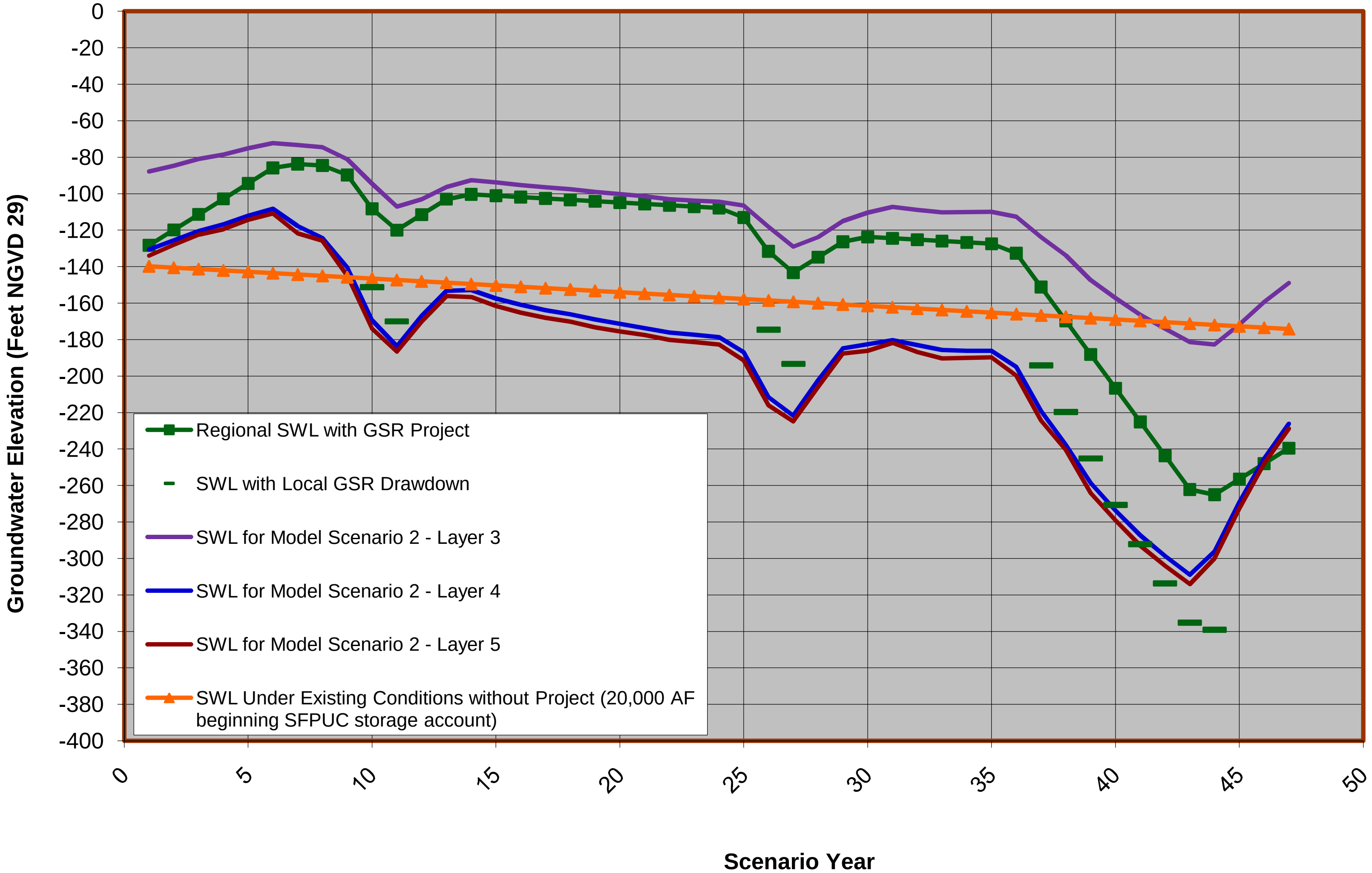


Figure 7. Estimated Static Water Levels at Lake Merced Golf Club Well 3 for GSR Project

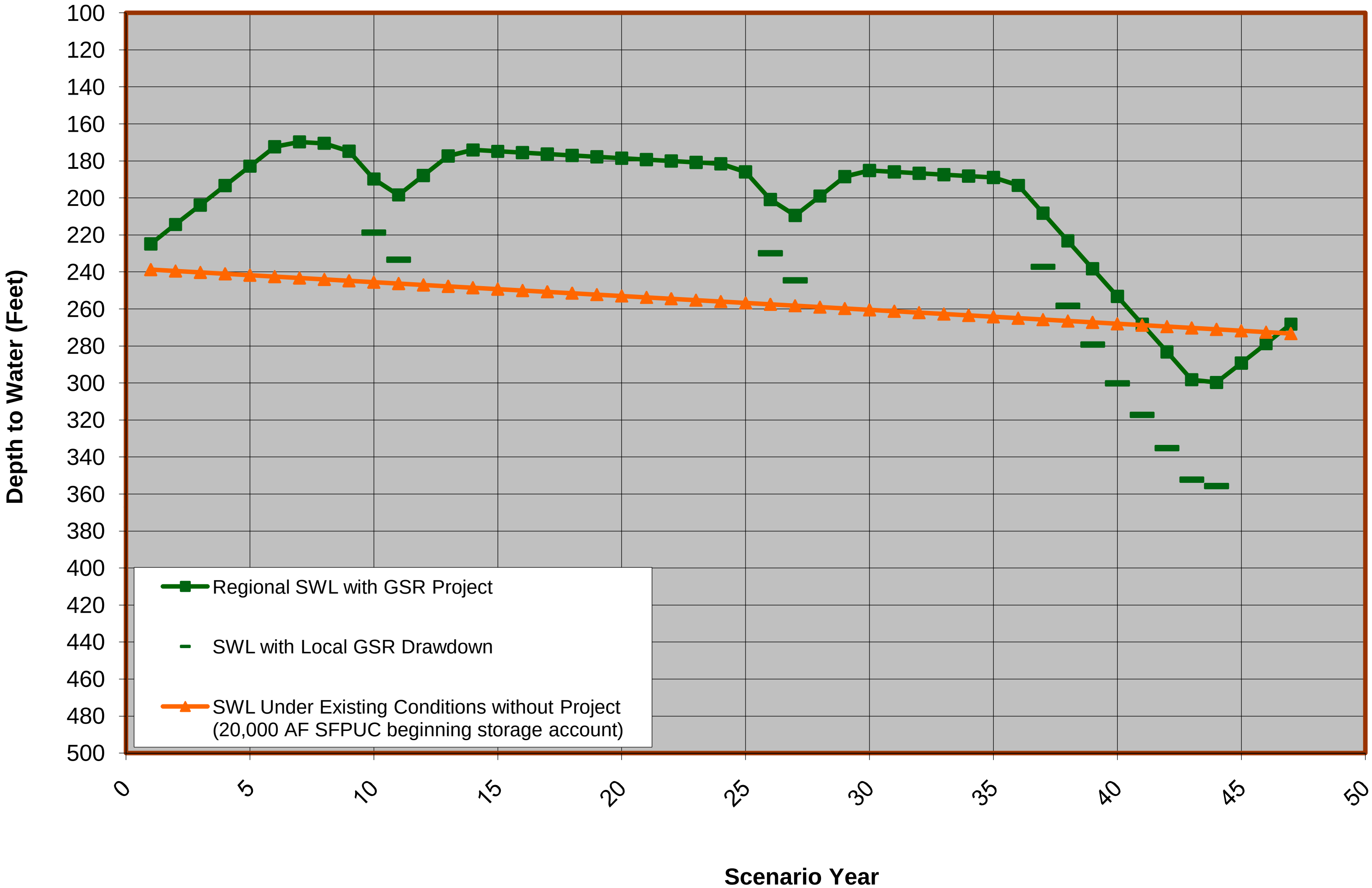


Figure 8. Estimated Groundwater Elevations at Lake Merced Golf Club Well 3 for GSR Project (Scenario 2)

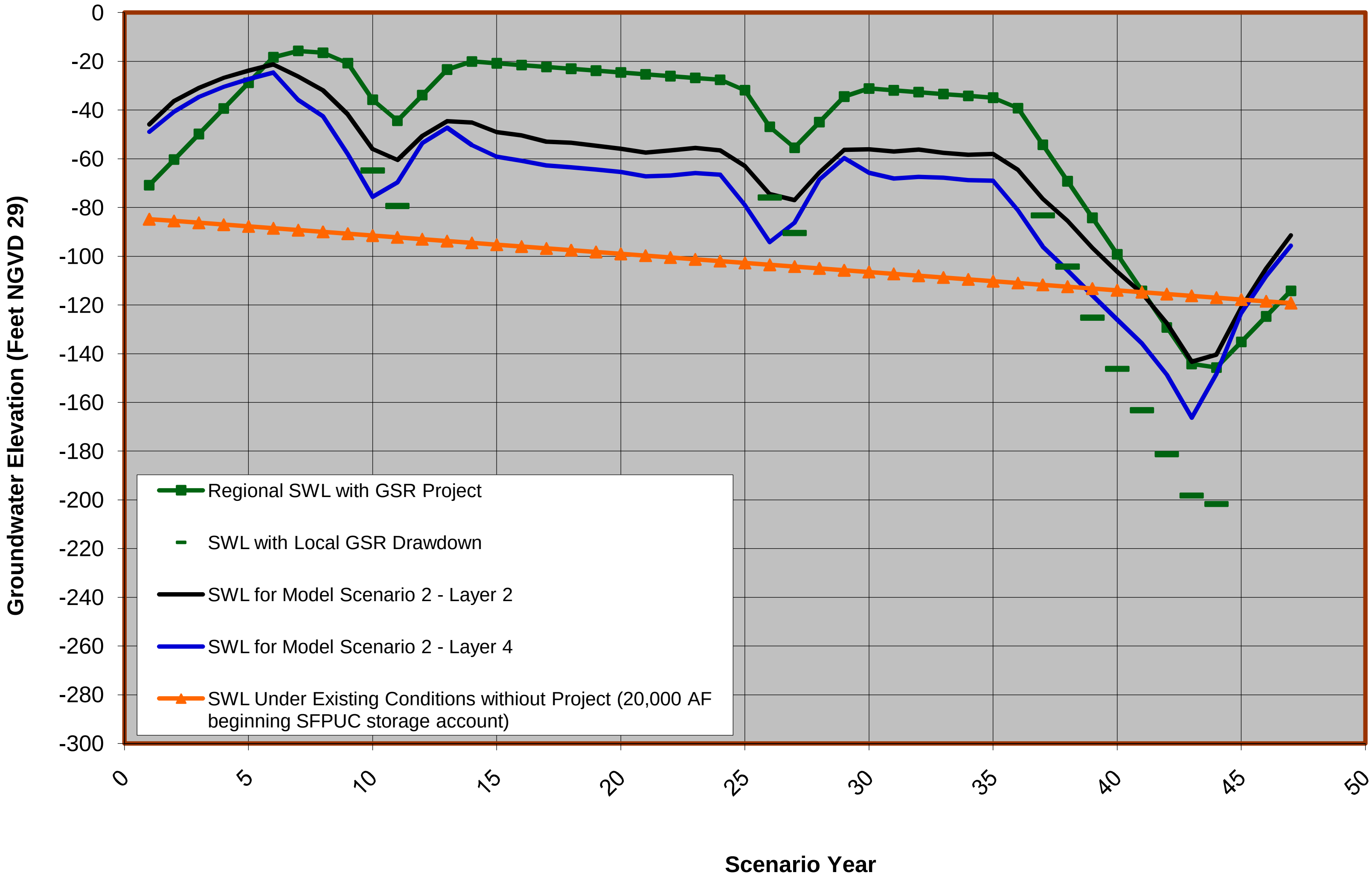


Figure 9. Estimated Static Water Levels at Olympic Golf Club Well 1 (#9) and Well 2 (#8) for GSR Project

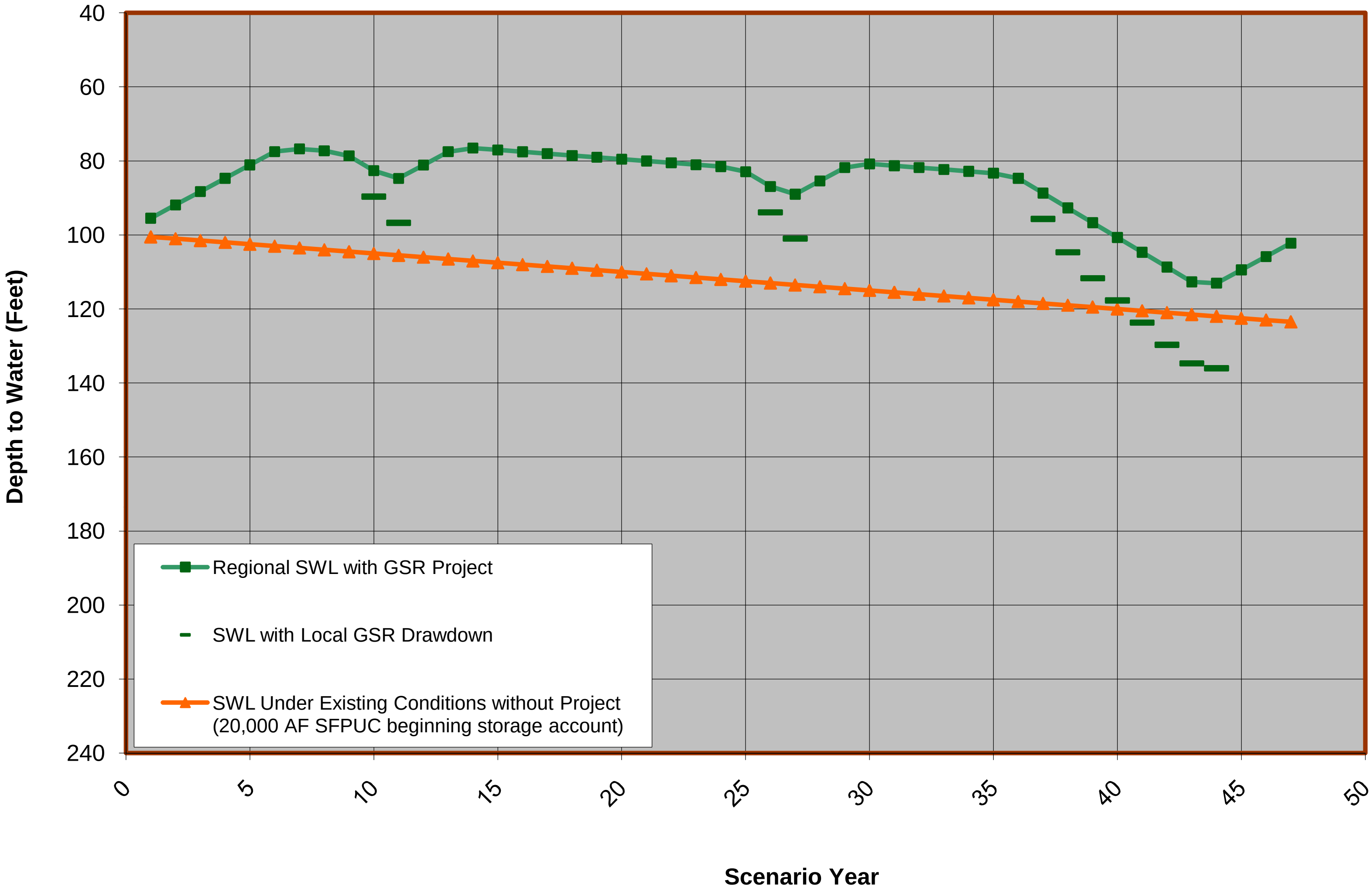
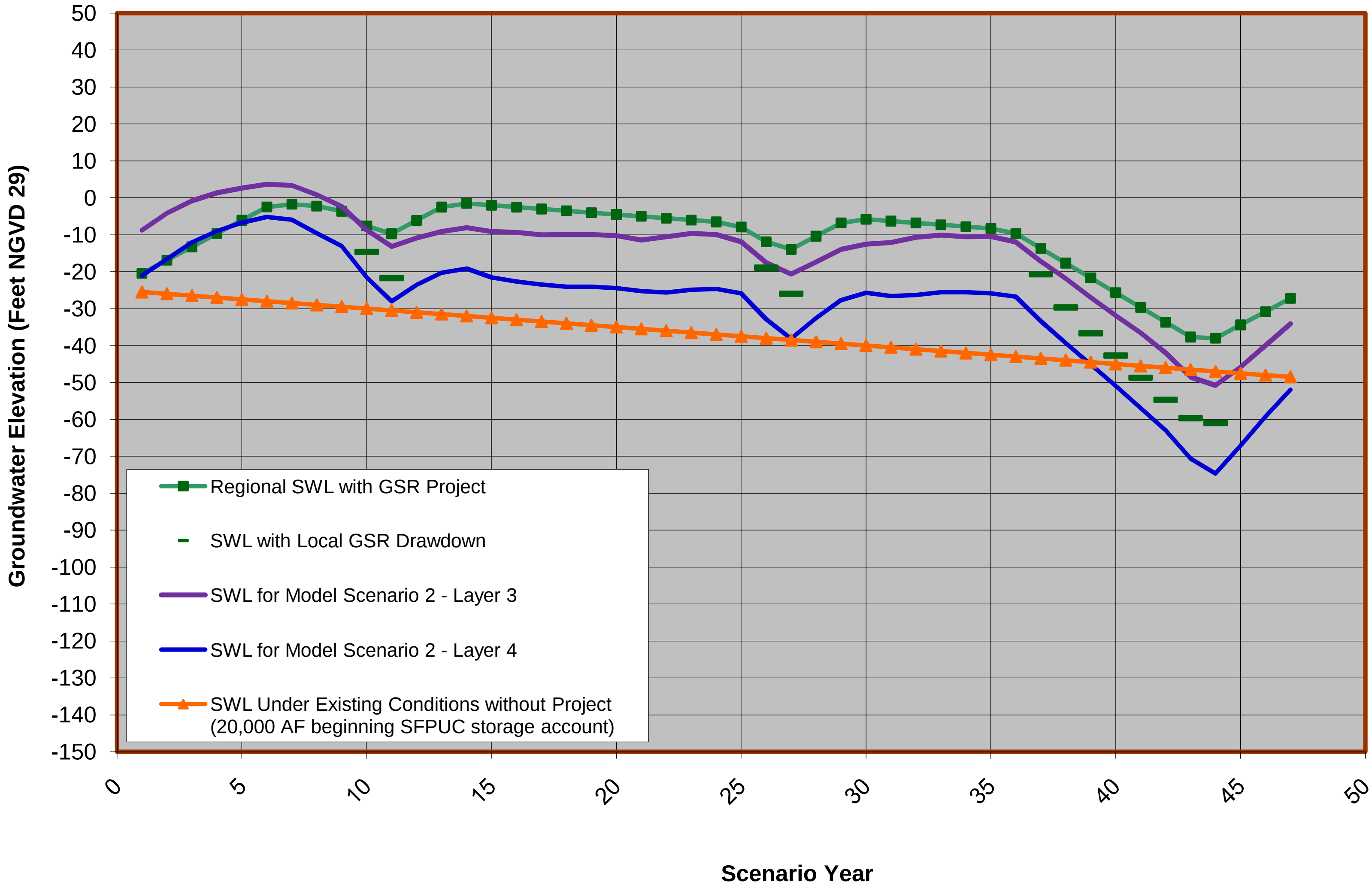
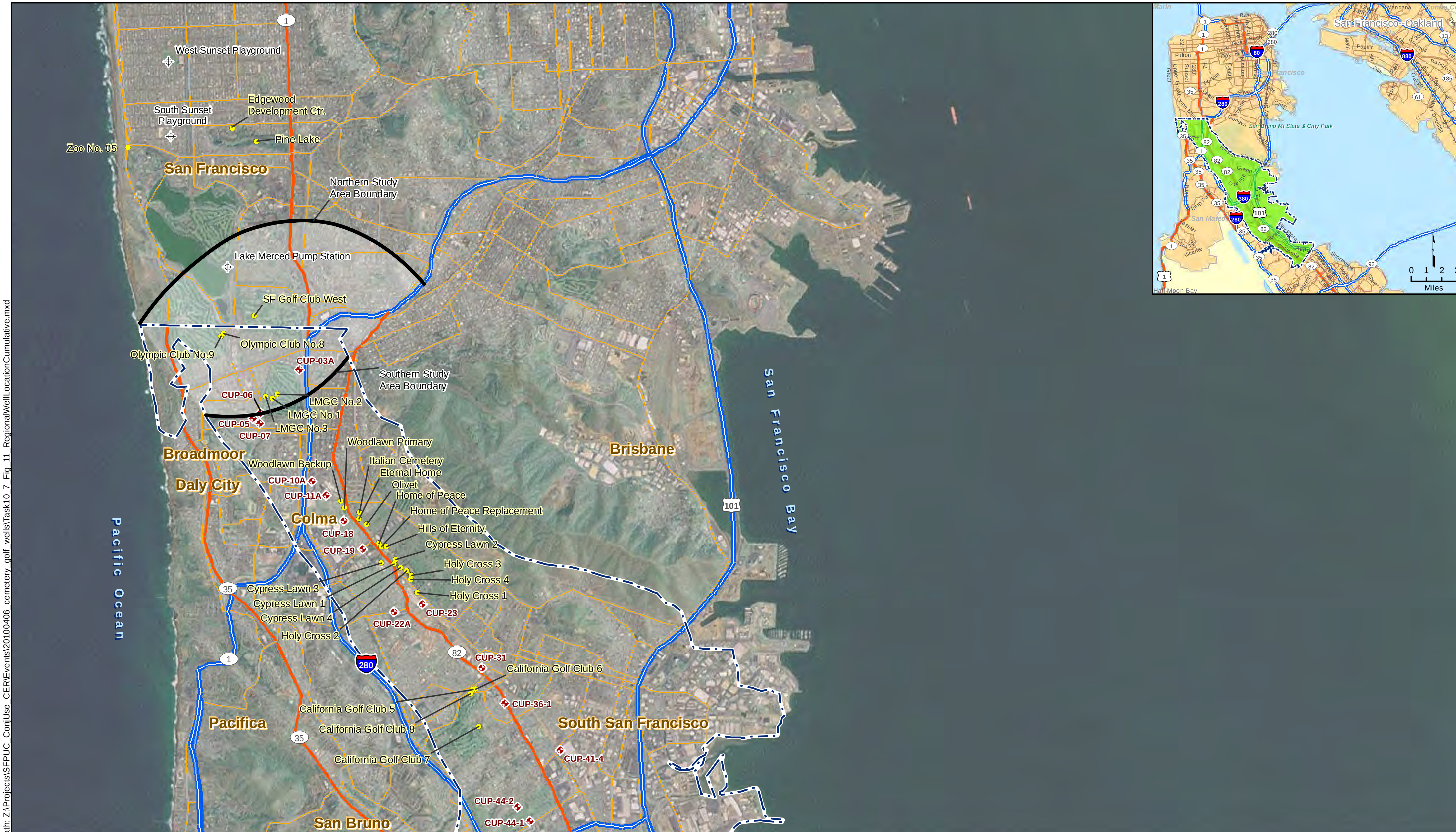


Figure 10. Estimated Groundwater Elevations at Olympic Club Well 1 (#9) for GSR Project (Scenario 2)





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Legend

- Study Area Boundary (based upon 1.5 mile radius)
- GSR Project Proposed Well
- Third Party Well
- South Westside Groundwater Basin
- SFGW Project Proposed Well

Scale: 0 — 2,500 — 5,000 Feet

1 " = 5,000 '

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REGIONAL WELL LOCATION MAP FOR CUMULATIVE PROJECT

FIGURE 11

DATE April 2012

APPENDICES

APPENDIX A

Table A-1. Colma Area Put Year Groundwater Level Rise Analysis

Well	Date	DTW (feet bgs)	Net Rise (feet)
Eternal Home	3/13/2001	261.4	
	2/4/2010	225	36
Hills of Eternity	6/27/2000	253	
	10/29/2007	214	39
Holy Cross 1	3/13/2001	236	
	3/8/2010	199.7	36
Holy Cross 2	3/13/2001	252.3	
	3/8/2010	204.73	48
Holy Cross 3	3/13/2001	264	
	3/8/2010	230.63	33
Italian	3/13/2001	294	
	1/22/2010	256.6	37

Logic/Data Analysis

In-lieu Recharge in Daly City/Cal Water areas from 2002 to 2009 = 18,147 AF

36 feet of rise/18,147 AF = 1 foot/500 AF

Amount of future Put in Daly City and Cal Water areas will be 4,300 AFY out of total Put of 6,180 AFY
(1,880 AFY will be in San Bruno)

4,300 AF per future Put Year/500 AF = **8.6 feet/year** (groundwater level rise per put year)

Assume 1 foot/500 AF relationship applies during take years as well

Amount of future CUP Take in Daly City and Cal Water areas will be 6,460 AF out of total Take of 8,100 AFY
(1,640 AFY of Take from wells CUP 41-4, CUP-44-1, CUP-44-2, and CUP-M-1 was discounted from Colma area)

6,460 AF per future Take Year/500 AF = **12.9 feet/year** (groundwater level decline per take year)

Table A-2. Colma Area Hold Year Groundwater Level Decline Analysis

Well	Date	DTW (feet bgs)	Net Decline (feet)	Years	Rate of Decline (feet/year)
Eternal Home	2/15/78	223			
	4/8/99	253	30	21	1.4
	3/13/01	261	38	23	1.7
Holy Cross 1	5/13/86	202			
	5/18/99	237	35	13	2.7
	3/13/01	236	34	15	2.3
Holy Cross 3	9/16/60	192			
	6/26/00	251	59	40	1.5
Hills of Eternity	5/15/85	226			
	7/8/99	238	12	14	0.9
	3/13/01	242	16	16	1.0

Logic/Data Analysis

Eternal Home Rate of Decline is about 1.5 feet/year
Two Holy Cross wells average Rate of Decline is about 2.0 feet/year
Hills of Eternity Rate of Decline is about 1.0 feet/year

Net average Rate of Decline for the three cemeteries from 1960 to 2001 is about 1.5 feet/year

Hydrofocus Historic Model Run Rate of Decline in Colma area is about 1 foot/year
Hydrofocus Future No-Project Model Run Rate of Decline in Colma area is 0.6 to 0.8 feet/year

KJ Model Scenario 1 (Future No Project) Rate of Decline n Colma area is about 0.75 feet/year

Future Hold Year Rate of Decline used in anlaysis = **0.75 feet/year**

Summary of Supplemental Water Deliveries
Program Inception to December 31, 2009
As of 2/3/10

		Cal Water Ccf	Daly City Ccf	San Bruno Ccf			
October-02	31		82,452.00				
November-02	30		105,213.90				
December-02	31		108,989.30				
January-03	31		112,624.33	31,426.47			
February-03	28	33,951.87	98,320.86	79,994.65			
March-03	31	37,589.57	108,346.26	88,565.51			
April-03	30	36,377.01	104,961.23	85,708.56			
May-03	31	37,589.57	108,180.48	88,565.51			
June-03	30	36,377.01	104,886.36	85,708.56			
July-03	31	37,589.57	108,140.37	88,565.51			
August-03	31	37,589.57	108,433.16	86,310.16			
September-03	30	36,377.01	104,414.44	85,708.56			
October-03	31	37,589.57	109,300.80	82,883.69			
November-03	30	18,188.50		10,533.42			
December-03	31						
January-04	31						
February-04	29						
March-04	31						
April-04	30	37,589.58	109,306.15	65,709.89			
May-04	31	36,377.01	112,934.49	88,565.51			
June-04	30	37,589.58	122,084.22	62,852.94			
July-04	31	36,377.01	126,266.04	88,565.51			
August-04	31	37,589.58	126,950.53	88,565.51			
September-04	30	37,589.58	123,144.39	85,708.56			
October-04	31	36,377.01	141,422.46	88,565.51			
November-04	30	37,589.58	116,322.19	85,708.56			
December-04	31	36,377.01	124,954.55	88,565.51			
January-05	31	37,589.58		88,565.51			
February-05	28	37,589.58	109,621.66	59,995.99			
March-05	31	33,951.88	124,495.99				
April-05	30	37,589.58	109,983.96				
May-05	31	36,377.01	124,504.01				
June-05	30	37,589.58	120,379.68				
July-05	31	36,377.01	124,852.94				
August-05	31	37,589.58	125,205.88				
September-05	30	37,589.58	121,474.60				
October-05	31	36,377.01	125,494.65				
November-05	30	37,589.58	122,058.82				
December-05	31	36,377.01	129,724.60				
January-06	31	37,589.58	124,906.42				
February-06	28	37,589.58	113,911.76				
March-06	31	33,951.88	125,987.97				
April-06	30	37,589.58	121,073.53				
May-06	31	36,377.01					
June-06	30	37,589.58					
July-06	31	36,377.01	138,706.50				
August-06	31	37,589.58	115,407.75				
September-06	30	37,589.58	112,946.52				
October-06	31	36,377.01	115,421.12				
November-06	30	37,589.58	120,008.02				
December-06	31	36,377.01	124,605.61				
January-07	31	37,589.58	124,139.04				
February-07			109,248.66				
March-07			109,724.60				
April-07			102,418.45				
No supplemental deliveries May 2007 - May 2009							
subtotal ccf		1,605,439	5,463,951	1,705,340	**Total**	**8,774,730**	**ccf**
subtotal AF		3,685	12,541	3,914	**Total**	**20,140**	**AF**
June-09			165,750.00				
July-09			121,665.78				
August-09			119,991.98				
September-09			109,283.42				
October-09			117,137.70				
November-09			100,427.81				
December-09			102,699.20				
subtotal ccf			836,956	**ccf**			
subtotal AF			1,921	**AF**			

Round to 20,000 AF

APPENDIX B

Regional Groundwater Storage and Recovery Project

To: Greg Bartow

From: Matt Holt, PE
Nick Johnson, PG

Date: 07/12/10

Subject: Estimated Drawdown at Third Party Wells

BACKGROUND AND OBJECTIVE

The Regional Groundwater Storage and Recovery Project in the South Westside Basin has been proposed to increase water supply reliability by balancing groundwater and surface water usage in wet and dry years. The proposed project includes installation of up to 16 Conjunctive Use wells to pump stored groundwater during dry years. The locations of primary and alternate Conjunctive Use wells are shown on Figure 1.

Groundwater extraction at Conjunctive Use wells will create localized cones of depression in water levels near each well. The purpose of this technical memorandum (TM) is to estimate potential groundwater level drawdown at representative Third Party wells resulting from operation of the Regional Groundwater Storage and Recovery Project.

METHODS AND ASSUMPTIONS

Water level drawdown at representative Third Party wells was estimated using a spreadsheet programmed to solve the Theis equation (Theis, 1935). The Theis equation estimates groundwater level drawdown at various distances from a pumping well based on an assumed rate and duration of pumping and estimated values of aquifer transmissivity and storage coefficient.

The Theis equation is a standard method for estimating time-varying drawdown. Its formulation assumes an idealized aquifer that is confined, homogenous, and isotropic, and has infinite areal extent. Although these conditions are rarely strictly met, the Theis equation generally provides informative results under a wide range of reasonably equivalent conditions. In the case of the South Westside Basin, the aquifer consists of multiple units that are unconfined at shallow depths and become increasingly confined with depth. Additionally, the basin is bounded by bedrock to the northeast and southwest. For each Conjunctive Use well evaluated, suitable aquifer parameter values were selected based on available aquifer tests generally representative of local conditions. Where unconfined or semi-confined conditions are present, the Theis equation may overestimate drawdown, and thus provide a conservative impact assessment. For these reasons, the Theis equation may be assumed to provide reasonable preliminary estimates of drawdown for the purpose of this analysis[1]. Furthermore, this approach is consistent with the drawdown estimates presented in the project's Conceptual Engineering Report (MWH, 2008). More accurate estimates may require site-specific aquifer testing and three-dimensional groundwater modeling.

The transmissivities and storage coefficients assumed for this evaluation are based on aquifer tests in Daly City and San Bruno performed and analyzed by Luhdorff and Scalmanini Consulting Engineers (LSCE) in 2003 (LSCE, 2004). The transmissivity, specific yield, and storativity estimated from the Daly City test were 16,400 gallons per day per foot (gpd/ft), 0.14, and $2.4x10^{-3}$, respectively. The transmissivity and storage coefficient estimated from the San Bruno test were 14,200 gpd/ft and $2.4x10^{-4}$, respectively.

For the analysis presented in this TM, the storage coefficient for Daly City was adjusted to $5.2x10^{-2}$ to reflect semi-confined conditions and the storage coefficient for San Bruno was adjusted to $5.2x10^{-3}$ to reflect leaky confined conditions. These adjusted storage coefficients were agreed upon during discussions between LSCE, Fugro, and MWH in February 2008. Daly City aquifer parameters were applied to wells in Daly City and Colma, while San Bruno aquifer parameters were applied to wells in South San Francisco, San Bruno, and Millbrae.

Based on Fugro's well inventory in the Task 8L Technical Memorandum, MWH estimated drawdown for nineteen "third party" wells at golf courses and cemeteries in the South Westside Basin that are known to use groundwater for irrigation. The representative Third Party wells are shown on Figure 1. Drawdown was estimated for all active wells at each golf course. Drawdown was estimated for a primary well at each cemetery, and a secondary backup well where applicable. The locations of the primary and secondary wells for Cypress Lawn Memorial Park were not provided to the project team. Consequently, primary and secondary well locations have been assumed for Cypress Lawn, based on the estimated locations of Cypress Lawn wells 4 and 3, respectively.

The drawdown at each Third Party well was estimated by considering the pumping rates of all Conjunctive Use wells within 1.5 miles. Primary and alternate configurations of the Regional Groundwater Storage and Recovery Project were evaluated because the project environmental impact report includes 16 primary Conjunctive Use wells and 3 alternate Conjunctive Use wells. The alternate configuration replaces primary wells CUP-3A, CUP-07, and CUP-44-1 with alternate wells CUP-20A, CUP-22, and CUP-36-2. Since the project is only expected to use up to 16 wells, the primary configuration and alternate configuration provide a collective analysis of all 19 wells. Drawdown was estimated for pumping durations of 1, 4, and 7.5 years. The 7.5-year duration represents the design drought assumed for this project.

[1] The accuracy of the drawdown estimates presented in this TM is limited by the assumed conditions and the available data and tools. The South Westside Basin is a complex system that cannot be fully modeled with the Theis spreadsheet tool. The Theis spreadsheet tool may not adequately reflect the three-dimensional and boundary effects of the groundwater system. If an accepted groundwater model of the South Westside Basin has been completed, its use should be considered for validating and improving the results of this analysis.

Existing and proposed wells that were considered as part of this analysis are listed in Table 1 along with their well screen intervals, the assumed Conjunctive Use well pumping rates, and the assumed aquifer parameters.

RESULTS

Table 2 lists the estimated drawdown for Third Party wells, after 1, 4, and 7.5 years of pumping from the primary configuration of Conjunctive Use wells. Table 3 lists the estimated drawdown for Third Party wells, after 1, 4, and 7.5 years of pumping from the alternate configuration of Conjunctive Use wells.

The Regional Groundwater Storage and Recovery Project will be operated with a "put before take" principle, meaning that the volume of extracted groundwater will not exceed the amount that was stored through in-lieu recharge. Regional groundwater levels will be higher at the start of any take cycle than they were prior to groundwater storage activities associated with this project. The drawdown estimates shown in Tables 2 and 3 will be relative to regional groundwater levels 1, 4, and 7.5 years after the take cycle begins.

Aquifer testing at the selected well sites is recommended to collect site-specific aquifer parameters. Anticipated drawdowns should be re-estimated after the exploratory drilling and aquifer testing activities are completed.

REFERENCES

LSCE, 2004. Update on the Conceptualization of the Lake-Aquifer System, Westside Ground Water Basin, San Francisco and San Mateo Counties. Prepared for San Francisco Public Utilities Commission.

MWH, 2008. Conceptual Engineering Report. Prepared for San Francisco Public Utilities Commission. November.

Theis, C.V., 1935. The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using groundwater storage, Am. Geophys. Union Trans., vol. 16, pp. 519-524.

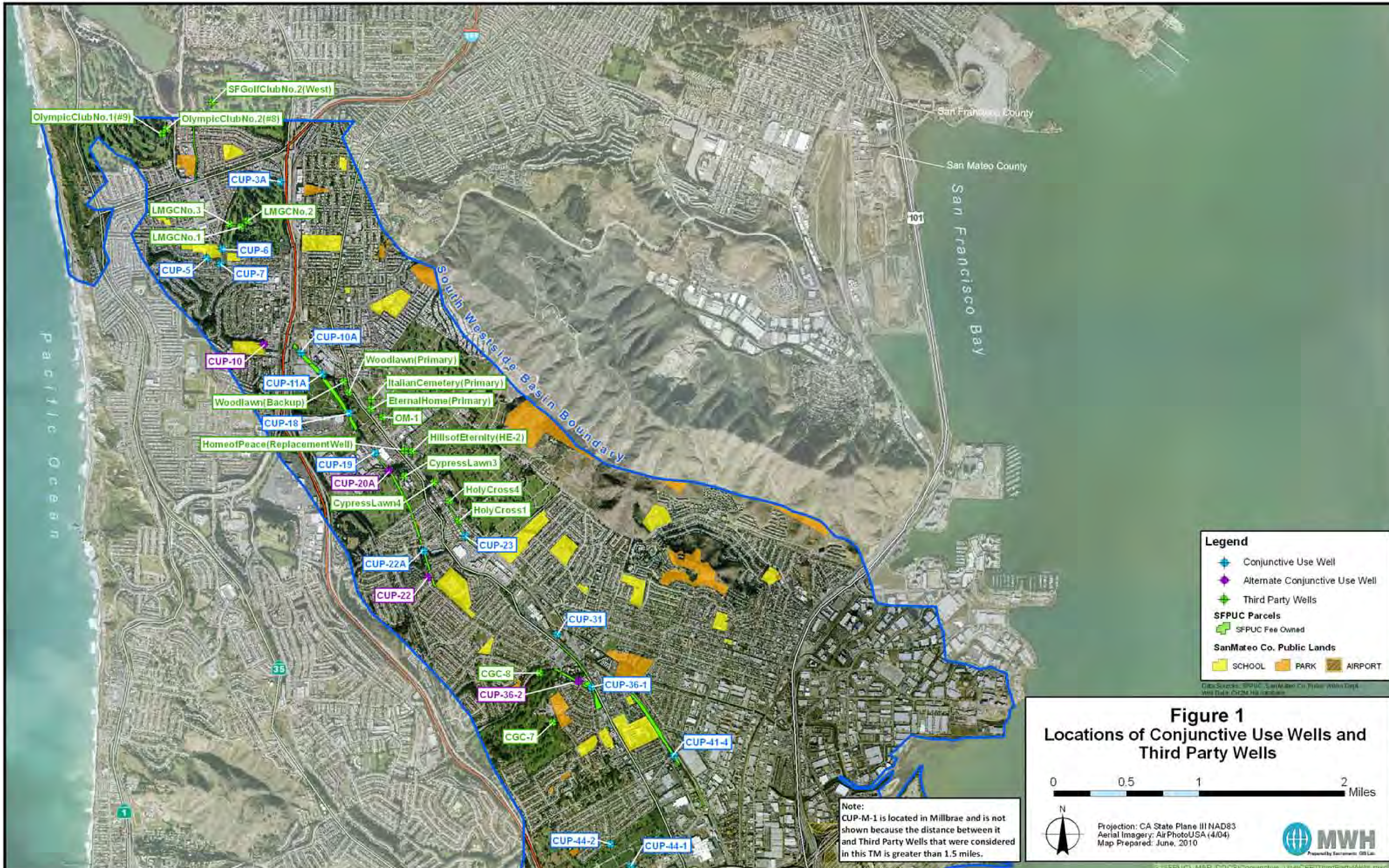


Figure 1
Locations of Conjunctive Use Wells and Third Party Wells

Table 1
Conjunctive Use Wells and Representative Third Party Wells

System or Owner	Well	Future Use of Well	Screen Interval (depth, ft)	Assumed Pump Rate (gpm)	Assumed Trans-missivity (gpd/ft)	Assumed Storage Coeff.
Conjunctive Use well	CUP-3A	Primary	410 to 625 (Proposed in CER)	400	16,400	5.0E-02
Conjunctive Use well	CUP-5	Primary	410 to 730 (Proposed in CER)	300	16,400	5.0E-02
Conjunctive Use well	CUP-6	Primary	420 to 730 (Proposed in CER)	300	16,400	5.0E-02
Conjunctive Use well	CUP-7	Primary	420 to 730 (Proposed in CER)	300	16,400	5.0E-02
Conjunctive Use well	CUP-10A	Primary	430 to 730 (Proposed in CER)	400	16,400	5.0E-02
Conjunctive Use well	CUP-11A	Primary	440 to 730 (Proposed in CER)	400	16,400	5.0E-02
Conjunctive Use well	CUP-18	Primary	430 to 640 (Proposed in CER)	400	16,400	5.0E-02
Conjunctive Use well	CUP-19	Primary	400 to 640 (Proposed in CER)	400	16,400	5.0E-02
Conjunctive Use well	CUP-22A	Primary	400 to 640 (Proposed in CER)	330	14,200	5.0E-03
Conjunctive Use well	CUP-23	Primary	400 to 640 (Proposed in CER)	330	14,200	5.0E-03
Conjunctive Use well	CUP-31	Primary	375 to 580 (Proposed in CER)	220	14,200	5.0E-03
Conjunctive Use well	CUP-36-1	Primary	395 to 580 (Proposed in CER)	220	14,200	5.0E-03
Conjunctive Use well	CUP-41	Primary	375 to 580 (Proposed)	220	14,200	5.0E-03
Conjunctive Use well	CUP-44-1	Primary	400 to 620 (Proposed in CER)	330	14,200	5.0E-03
Conjunctive Use well	CUP-44-2	Primary	410 to 620 (Proposed in CER)	330	14,200	5.0E-03
Conjunctive Use well	CUP-M-1	Primary	Not Identified in CER	160	14,200	5.0E-03
Conjunctive Use well	CUP-20A	Alternate	Not Identified in CER	400	16,400	5.0E-02
Conjunctive Use well	CUP-22	Alternate	Not Identified in CER	330	14,200	5.0E-03
Conjunctive Use well	CUP-36-2	Alternate	Not Identified in CER	220	14,200	5.0E-03

Table 1
Conjunctive Use Wells and Representative Third Party Wells

System or Owner	Well	Future Use of Well	Screen Interval (depth, ft)	Assumed Pump Rate (gpm)	Assumed Trans-missivity (gpd/ft)	Assumed Storage Coeff.
The Olympic Club	No. 1 (#9)	Active	Top of screen at 260	N/A	16,400	5.0E-02
The Olympic Club	No. 2 (#8)	Active	Top of screen at 200	N/A	16,400	5.0E-02
San Francisco Golf Club	No. 2 (West)	Active	Top of screen at 360	N/A	16,400	5.0E-02
Lake Merced Golf Club	LMGC No. 1	Active	Top of screen not reported	N/A	16,400	1.4E-01
Lake Merced Golf Club	LMGC No. 2	Active	Top of screen not reported	N/A	16,400	1.4E-01
Lake Merced Golf Club	LMGC No. 3	Active	Top of screen at 294	N/A	16,400	1.4E-01
Olivet Memorial Park	OM-1	Primary Well	Top of screen at 220	N/A	16,400	1.4E-01
Woodlawn Memorial Park	Primary Well	Primary Well	Top of screen at 275	N/A	16,400	1.4E-01
Woodlawn Memorial Park	Backup Well	Backup Well	Top of screen not reported	N/A	16,400	1.4E-01
Italian Cemetery	Primary Well	Primary Well	Top of screen at 300	N/A	16,400	1.4E-01
Eternal Home Cemetery	Primary Well	Primary Well	Top of screen at 280	N/A	16,400	1.4E-01
Salem Memorial Park, Home of Peace Cemetery, and Hills of Eternity Cemetery	Replacement Well	Primary Well	Not Constructed	N/A	16,400	5.0E-02
Salem Memorial Park, Home of Peace Cemetery, and Hills of Eternity Cemetery	HE-2	Secondary Well	Top of screen at 224	N/A	16,400	1.4E-01
Cypress Lawn Memorial Park	Cypress Lawn 3	Assumed Secondary Well	Top of screen at 191	N/A	16,400	1.4E-01
Cypress Lawn Memorial Park	Cypress Lawn 4	Assumed Primary Well	Top of screen at 330	N/A	16,400	5.0E-02
Holy Cross Cemetery	Holy Cross 1	Secondary Well	Top of screen at 368	N/A	16,400	5.0E-02
Holy Cross Cemetery	Holy Cross 4	Primary Well	Top of screen at 420	N/A	16,400	5.0E-02
California Golf Club of San Francisco	CGC-7	Secondary Well	Top of screen at 255	N/A	14,200	5.0E-03
California Golf Club of San Francisco	CGC-8	Primary Well	Top of screen at 320	N/A	14,200	5.0E-03

Table 2
Summary of Calculated Water Level Drawdowns in Third Party Wells, Primary Configuration of Conjunctive Use Wells

Owner	Well ID	Drawdown (ft) [1]			Number of Wells Used to Calculate Drawdown
		1 year	4 years	7.5 years	
The Olympic Club	No. 1 (#9)	7	17	23	4
The Olympic Club	No. 2 (#8)	7	17	23	4
San Francisco Golf Club	No. 2 (West)	7	17	22	4
Lake Merced Golf Club	LMGC No. 1	29	50	60	7
Lake Merced Golf Club	LMGC No. 2	27	47	58	7
Lake Merced Golf Club	LMGC No. 3	29	47	56	6
Olivet Memorial Park	OM-1	38	60	70	6
Woodlawn Memorial Park	Primary Well	45	73	87	9
Woodlawn Memorial Park	Backup Well	45	76	91	10
Italian Cemetery	Primary Well	40	68	81	9
Eternal Home Cemetery	Primary Well	41	65	76	7
Salem Memorial Park, Home of Peace Cemetery, and Hills of Eternity Cemetery	Replacement Well (Primary Well)	36	58	68	6
Salem Memorial Park, Home of Peace Cemetery, and Hills of Eternity Cemetery	HE-2 (Secondary Well)	34	56	66	6
Cypress Lawn Memorial Park	3 (Assumed Secondary)	35	56	66	6
Cypress Lawn Memorial Park	4 (Assumed Primary)	36	58	69	7
Holy Cross Cemetery	Holy Cross 1	43	64	75	7
Holy Cross Cemetery	Holy Cross 4	37	58	69	7
California Golf Club of San Francisco	CGC-7	41	63	73	7
California Golf Club of San Francisco	CGC-8	43	64	74	7

Table 3
Summary of Calculated Water Level Drawdowns in Third Party Wells, Alternate Configuration of Conjunctive Use Wells

Owner	Well ID	Drawdown (ft) [1]			Number of Wells Used to Calculate Drawdown
		1 year	4 years	7.5 years	
The Olympic Club	No. 1 (#9)	3	8	11	2
The Olympic Club	No. 2 (#8)	3	8	10	2
San Francisco Golf Club	No. 2 (West)	3	7	10	2
Lake Merced Golf Club	LMGC No. 1	17	31	39	5
Lake Merced Golf Club	LMGC No. 2	15	29	36	5
Lake Merced Golf Club	LMGC No. 3	17	29	35	4
Olivet Memorial Park	OM-1	50	80	93	8
Woodlawn Memorial Park	Primary Well	52	83	98	10
Woodlawn Memorial Park	Backup Well	51	85	100	10
Italian Cemetery	Primary Well	50	83	98	10
Eternal Home Cemetery	Primary Well	51	81	94	8
Salem Memorial Park, Home of Peace Cemetery, and Hills of Eternity Cemetery	Replacement Well (Primary Well)	54	82	96	8
Salem Memorial Park, Home of Peace Cemetery, and Hills of Eternity Cemetery	HE-2 (Secondary Well)	51	80	93	8
Cypress Lawn Memorial Park	3 (Assumed Secondary)	57	85	99	8
Cypress Lawn Memorial Park	4 (Assumed Primary)	52	82	96	9
Holy Cross Cemetery	Holy Cross 1	61	92	107	10
Holy Cross Cemetery	Holy Cross 4	52	81	95	9
California Golf Club of San Francisco	CGC-7	49	72	83	8
California Golf Club of San Francisco	CGC-8	53	77	88	8

APPENDIX C

Table C-1. Woodlawn Cemetery Primary Well Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	WL Well DTW (Feet)	WL Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	WL Well SWL (Feet bgs)	WL Well GWE (Feet NGVD 29)	WL Well Background DTW (Feet)	WL Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	209.2	-74.2	27,742				220.8	-85.8	-77.5	-84.9
2	put	200.6	-65.6	33,925				221.5	-86.5	-70.8	-77.9
3	put	192.0	-57.0	40,108				222.3	-87.3	-65.7	-72.2
4	put	183.4	-48.4	46,291				223.0	-88.0	-61.8	-68.4
5	put	174.8	-39.8	52,475				223.8	-88.8	-58.0	-64.4
6	put	166.2	-31.2	58,658				224.5	-89.5	-54.5	-60.9
7	Put/Hold	164.1	-29.1	60,500				225.3	-90.3	-51.9	-59.1
8	Hold	164.9	-29.9	60,500				226.0	-91.0	-51.8	-60.7
9	Hold/Take	168.6	-33.6	58,475				226.8	-91.8	-63.1	-89.1
10	take	181.5	-46.5	50,375	45	226.5	-91.5	227.5	-92.5	-77.3	-111.3
11	Take/Put	189.1	-54.1	45,858	54	243.1	-108.1	228.3	-93.3	-80.1	-101.0
12	put	180.5	-45.5	52,042				229.0	-94.0	-75.3	-89.6
13	put	171.9	-36.9	58,225				229.8	-94.8	-72.7	-84.2
14	Put/Hold	169.2	-34.2	60,430				230.5	-95.5	-68.6	-79.6
15	Hold	170.0	-35.0	60,430				231.3	-96.3	-67.9	-79.7
16	Hold	170.7	-35.7	60,430				232.0	-97.0	-67.0	-79.3
17	Hold	171.5	-36.5	60,430				232.8	-97.8	-67.3	-79.9
18	Hold	172.2	-37.2	60,430				233.5	-98.5	-67.1	-80.1
19	Hold	173.0	-38.0	60,430				234.3	-99.3	-67.8	-80.9
20	Hold	173.7	-38.7	60,430				235.0	-100.0	-68.7	-81.9
21	Hold	174.5	-39.5	60,430				235.8	-100.8	-71.1	-84.3
22	Hold	175.2	-40.2	60,430				236.5	-101.5	-70.7	-84.6
23	Hold	176.0	-41.0	60,430				237.3	-102.3	-70.2	-84.0
24	Hold	176.7	-41.7	60,430				238.0	-103.0	-70.4	-84.4
25	Hold/Take	180.5	-45.5	58,405				238.8	-103.8	-81.6	-111.8
26	take	193.4	-58.4	50,305	45	238.4	-103.4	239.5	-104.5	-96.1	-133.5
27	take/put	200.9	-65.9	45,788	54	254.9	-119.9	240.3	-105.3	-98.2	-121.7
28	put	192.3	-57.3	51,972				241.0	-106.0	-93.9	-110.6
29	put	183.7	-48.7	58,155				241.8	-106.8	-88.5	-102.6
30	Put/Hold	181.1	-46.1	60,360				242.5	-107.5	-85.0	-98.0
31	Hold	181.8	-46.8	60,360				243.3	-108.3	-80.2	-93.7
32	Hold	182.6	-47.6	60,360				244.0	-109.0	-78.5	-91.9
33	Hold	183.3	-48.3	60,360				244.8	-109.8	-78.8	-92.5
34	Hold	184.1	-49.1	60,360				245.5	-110.5	-78.5	-92.4
35	Hold	184.8	-49.8	60,360				246.3	-111.3	-77.9	-92.0
36	hold/take	188.6	-53.6	58,335				247.0	-112.0	-88.5	-118.8
37	take	201.5	-66.5	50,235	45	246.5	-111.5	247.8	-112.8	-102.2	-139.8
38	take	214.4	-79.4	42,135	54	268.4	-133.4	248.5	-113.5	-113.2	-153.4
39	take	227.3	-92.3	34,035	64	291.3	-156.3	249.3	-114.3	-126.4	-167.8
40	take	240.2	-105.2	25,935	73	313.2	-178.2	250.0	-115.0	-137.7	-180.4
41	take	253.1	-118.1	17,835	77	330.1	-195.1	250.8	-115.8	-149.2	-192.9
42	take	266.0	-131.0	9,735	81	347.0	-212.0	251.5	-116.5	-171.9	-211.8
43	take	278.9	-143.9	1,635	85	363.9	-228.9	252.3	-117.3	-198.9	-235.6
44	take/hold/put	280.4	-145.4	1,168	87	367.4	-232.4	253.0	-118.0	-182.3	-205.8
45	put	271.8	-136.8	7,352				253.8	-118.8	-164.6	-183.7
46	put	263.2	-128.2	13,535				254.5	-119.5	-152.5	-167.2
47	put	254.6	-119.6	19,718				255.3	-120.3	-144.2	-156.2

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area
2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area
3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; WL = Woodlawn; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-2. Italian Cemetery Well Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Date	Year Type	IT Well DTW (Feet)	IT Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	IT Well SWL (Feet bgs)	IT Well GWE (Feet NGVD 29)	IT Well Background DTW (Feet)	IT Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	245.8	-86.8	27,742				257.4	-98.4	-81.2	-88.2
2	put	237.2	-78.2	33,925				258.1	-99.1	-73.9	-80.9
3	put	228.6	-69.6	40,108				258.9	-99.9	-68.6	-75.3
4	put	220.0	-61.0	46,291				259.6	-100.6	-66.8	-72.1
5	put	211.4	-52.4	52,475				260.4	-101.4	-61.6	-67.8
6	put	202.8	-43.8	58,658				261.1	-102.1	-58.6	-64.3
7	Put/Hold	200.7	-41.7	60,500				261.9	-102.9	-56.2	-62.2
8	Hold	201.5	-42.5	60,500				262.6	-103.6	-52.0	-63.2
9	Hold/Take	205.2	-46.2	58,475				263.4	-104.4	-61.9	-78.7
10	take	218.1	-59.1	50,375	40	258.1	-99.1	264.1	-105.1	-74.3	-101.3
11	Take/Put	225.7	-66.7	45,858	50	275.7	-116.7	264.9	-105.9	-80.2	-104.9
12	put	217.1	-58.1	52,042				265.6	-106.6	-77.0	-93.5
13	put	208.5	-49.5	58,225				266.4	-107.4	-75.0	-88.0
14	Put/Hold	205.8	-46.8	60,430				267.1	-108.1	-70.8	-82.8
15	Hold	206.6	-47.6	60,430				267.9	-108.9	-70.4	-83.0
16	Hold	207.3	-48.3	60,430				268.6	-109.6	-69.7	-82.5
17	Hold	208.1	-49.1	60,430				269.4	-110.4	-69.5	-83.0
18	Hold	208.8	-49.8	60,430				270.1	-111.1	-69.1	-83.1
19	Hold	209.6	-50.6	60,430				270.9	-111.9	-69.9	-84.0
20	Hold	210.3	-51.3	60,430				271.6	-112.6	-70.6	-85.0
21	Hold	211.1	-52.1	60,430				272.4	-113.4	-72.6	-87.4
22	Hold	211.8	-52.8	60,430				273.1	-114.1	-72.6	-87.8
23	Hold	212.6	-53.6	60,430				273.9	-114.9	-71.8	-87.1
24	Hold	213.3	-54.3	60,430				274.6	-115.6	-71.7	-87.4
25	Hold/Take	217.1	-58.1	58,405				275.4	-116.4	-78.9	-101.6
26	take	230.0	-71.0	50,305	40	270.0	-111.0	276.1	-117.1	-91.7	-123.8
27	take/put	237.5	-78.5	45,788	50	287.5	-128.5	276.9	-117.9	-97.5	-125.9
28	put	228.9	-69.9	51,972				277.6	-118.6	-95.0	-115.0
29	put	220.3	-61.3	58,155				278.4	-119.4	-89.7	-106.7
30	Put/Hold	217.7	-58.7	60,360				279.1	-120.1	-86.2	-101.6
31	Hold	218.4	-59.4	60,360				279.9	-120.9	-78.7	-96.4
32	Hold	219.2	-60.2	60,360				280.6	-121.6	-80.3	-95.2
33	Hold	219.9	-60.9	60,360				281.4	-122.4	-81.2	-96.1
34	Hold	220.7	-61.7	60,360				282.1	-123.1	-79.9	-95.7
35	Hold	221.4	-62.4	60,360				282.9	-123.9	-78.8	-95.2
36	hold/take	225.2	-66.2	58,335				283.6	-124.6	-86.4	-108.9
37	take	238.1	-79.1	50,235	40	278.1	-119.1	284.4	-125.4	-98.6	-130.3
38	take	251.0	-92.0	42,135	50	301.0	-142.0	285.1	-126.1	-105.3	-143.6
39	take	263.9	-104.9	34,035	59	322.9	-163.9	285.9	-126.9	-121.2	-158.9
40	take	276.8	-117.8	25,935	68	344.8	-185.8	286.6	-127.6	-131.3	-171.4
41	take	289.7	-130.7	17,835	72	361.7	-202.7	287.4	-128.4	-142.3	-183.9
42	take	302.6	-143.6	9,735	77	379.6	-220.6	288.1	-129.1	-158.1	-201.4
43	take	315.5	-156.5	1,635	80	395.5	-236.5	288.9	-129.9	-185.8	-224.8
44	take/hold/put	317.0	-158.0	1,168	81.5	398.5	-239.5	289.6	-130.6	-179.1	-209.7
45	put	308.4	-149.4	7,352				290.4	-131.4	-163.8	-188.4
46	put	299.8	-140.8	13,535				291.1	-132.1	-152.1	-171.4
47	put	291.2	-132.2	19,718				291.9	-132.9	-144.4	-160.1

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area
2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area
3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; IT = Italian; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-3. Olivet Cemetery Well Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	OV Well DTW (Feet)	OV Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	OV Well SWL (Feet bgs)	OV Well GWE (Feet NGVD 29)	OV Well Background DTW (Feet)	OV Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	220.2	-78.2	27,742				231.8	-89.8	-81.6	-91.8
2	put	211.6	-69.6	33,925				232.5	-90.5	-74.2	-84.8
3	put	203.0	-61.0	40,108				233.3	-91.3	-68.8	-79.3
4	put	194.4	-52.4	46,291				234.0	-92.0	-67.2	-76.0
5	put	185.8	-43.8	52,475				234.8	-92.8	-62.9	-72.1
6	put	177.2	-35.2	58,658				235.5	-93.5	-60.4	-68.5
7	Put/Hold	175.1	-33.1	60,500				236.3	-94.3	-58.3	-65.9
8	Hold	175.9	-33.9	60,500				237.0	-95.0	-49.7	-67.7
9	Hold/Take	179.6	-37.6	58,475				237.8	-95.8	-60.2	-80.7
10	take	192.5	-50.5	50,375	38	230.5	-88.5	238.5	-96.5	-69.5	-105.7
11	Take/Put	200.1	-58.1	45,858	46	246.1	-104.1	239.3	-97.3	-75.7	-112.9
12	put	191.5	-49.5	52,042				240.0	-98.0	-74.7	-100.2
13	put	182.9	-40.9	58,225				240.8	-98.8	-73.4	-94.0
14	Put/Hold	180.2	-38.2	60,430				241.5	-99.5	-69.5	-87.7
15	Hold	181.0	-39.0	60,430				242.3	-100.3	-69.2	-87.8
16	Hold	181.7	-39.7	60,430				243.0	-101.0	-68.7	-87.1
17	Hold	182.5	-40.5	60,430				243.8	-101.8	-68.1	-87.7
18	Hold	183.2	-41.2	60,430				244.5	-102.5	-67.3	-88.0
19	Hold	184.0	-42.0	60,430				245.3	-103.3	-68.1	-88.9
20	Hold	184.7	-42.7	60,430				246.0	-104.0	-68.5	-89.9
21	Hold	185.5	-43.5	60,430				246.8	-104.8	-69.7	-92.5
22	Hold	186.2	-44.2	60,430				247.5	-105.5	-70.3	-93.0
23	Hold	187.0	-45.0	60,430				248.3	-106.3	-69.4	-92.2
24	Hold	187.7	-45.7	60,430				249.0	-107.0	-69.0	-92.6
25	Hold/Take	191.5	-49.5	58,405				249.8	-107.8	-73.9	-105.0
26	take	204.4	-62.4	50,305	38	242.4	-100.4	250.5	-108.5	-83.9	-129.4
27	take/put	211.9	-69.9	45,788	46	257.9	-115.9	251.3	-109.3	-90.9	-134.8
28	put	203.3	-61.3	51,972				252.0	-110.0	-90.6	-122.7
29	put	194.7	-52.7	58,155				252.8	-110.8	-85.9	-113.6
30	Put/Hold	192.1	-50.1	60,360				253.5	-111.5	-82.7	-107.7
31	Hold	192.8	-50.8	60,360				254.3	-112.3	-72.7	-102.4
32	Hold	193.6	-51.6	60,360				255.0	-113.0	-77.8	-100.6
33	Hold	194.3	-52.3	60,360				255.8	-113.8	-79.2	-101.7
34	Hold	195.1	-53.1	60,360				256.5	-114.5	-77.0	-101.3
35	Hold	195.8	-53.8	60,360				257.3	-115.3	-75.3	-100.8
36	hold/take	199.6	-57.6	58,335				258.0	-116.0	-81.8	-112.4
37	take	212.5	-70.5	50,235	38	250.5	-108.5	258.8	-116.8	-91.4	-136.2
38	take	225.4	-83.4	42,135	46	271.4	-129.4	259.5	-117.5	-92.9	-151.2
39	take	238.3	-96.3	34,035	53	291.3	-149.3	260.3	-118.3	-110.8	-166.5
40	take	251.2	-109.2	25,935	60	311.2	-169.2	261.0	-119.0	-118.9	-179.4
41	take	264.1	-122.1	17,835	63	327.1	-185.1	261.8	-119.8	-128.5	-192.0
42	take	277.0	-135.0	9,735	66	343.0	-201.0	262.5	-120.5	-139.5	-208.2
43	take	289.9	-147.9	1,635	69	358.9	-216.9	263.3	-121.3	-157.9	-229.8
44	take/hold/put	291.4	-149.4	1,168	70	361.4	-219.4	264.0	-122.0	-158.9	-217.2
45	put	282.8	-140.8	7,352				264.8	-122.8	-150.6	-196.8
46	put	274.2	-132.2	13,535				265.5	-123.5	-141.7	-178.6
47	put	265.6	-123.6	19,718				266.3	-124.3	-136.2	-166.3

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area
2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area
3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; OV = Olivet; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-4. Home of Peace Cemetery Well Groundwater Levels for GSR Project (Scenario 2)

Date	Year Type	HP Well DTW (Feet)	HP Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	HP Well SWL (Feet bgs)	HP Well GWE (Feet NGVD 29)	HP Well Background DTW (Feet)	HP Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 3 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 5 GWE (Feet NGVD 29)
1	put	229.2	-108.2	27,742				240.8	-119.8	-85.7	-98.5	-118.7
2	put	220.6	-99.6	33,925				241.5	-120.5	-79.3	-91.4	-111.2
3	put	212.0	-91.0	40,108				242.3	-121.3	-74.3	-85.9	-106.0
4	put	203.4	-82.4	46,291				243.0	-122.0	-71.7	-83.0	-103.2
5	put	194.8	-73.8	52,475				243.8	-122.8	-68.1	-79.2	-99.6
6	put	186.2	-65.2	58,658				244.5	-123.5	-64.9	-75.7	-96.5
7	Put/Hold	184.1	-63.1	60,500				245.3	-124.3	-62.0	-72.6	-107.0
8	Hold	184.9	-63.9	60,500				246.0	-125.0	-61.0	-74.7	-124.7
9	Hold/Take	188.6	-67.6	58,475				246.8	-125.8	-68.8	-85.3	-148.3
10	take	201.5	-80.5	50,375	36	237.5	-116.5	247.5	-126.5	-86.0	-113.1	-196.7
11	Take/Put	209.1	-88.1	45,858	43	252.1	-131.1	248.3	-127.3	-94.3	-125.3	-214.0
12	put	200.5	-79.5	52,042				249.0	-128.0	-87.3	-111.2	-170.1
13	put	191.9	-70.9	58,225				249.8	-128.8	-83.6	-103.8	-145.8
14	Put/Hold	189.2	-68.2	60,430				250.5	-129.5	-78.3	-96.2	-141.3
15	Hold	190.0	-69.0	60,430				251.3	-130.3	-78.0	-96.2	-154.1
16	Hold	190.7	-69.7	60,430				252.0	-131.0	-77.0	-95.5	-159.7
17	Hold	191.5	-70.5	60,430				252.8	-131.8	-77.2	-96.3	-163.4
18	Hold	192.2	-71.2	60,430				253.5	-132.5	-77.0	-96.6	-165.3
19	Hold	193.0	-72.0	60,430				254.3	-133.3	-77.6	-97.7	-167.6
20	Hold	193.7	-72.7	60,430				255.0	-134.0	-78.4	-98.7	-169.4
21	Hold	194.5	-73.5	60,430				255.8	-134.8	-80.6	-101.4	-171.9
22	Hold	195.2	-74.2	60,430				256.5	-135.5	-81.0	-102.1	-173.3
23	Hold	196.0	-75.0	60,430				257.3	-136.3	-80.1	-101.2	-173.6
24	Hold	196.7	-75.7	60,430				258.0	-137.0	-80.1	-101.6	-174.6
25	Hold/Take	200.5	-79.5	58,405				258.8	-137.8	-87.2	-111.5	-189.0
26	take	213.4	-92.4	50,305	36	249.4	-128.4	259.5	-138.5	-104.8	-138.6	-232.5
27	take/put	220.9	-99.9	45,788	43	263.9	-142.9	260.3	-139.3	-112.2	-148.5	-245.3
28	put	212.3	-91.3	51,972				261.0	-140.0	-106.1	-135.3	-200.1
29	put	203.7	-82.7	58,155				261.8	-140.8	-99.8	-124.8	-172.2
30	Put/Hold	201.1	-80.1	60,360				262.5	-141.5	-95.1	-117.7	-167.0
31	Hold	201.8	-80.8	60,360				263.3	-142.3	-89.1	-111.5	-173.3
32	Hold	202.6	-81.6	60,360				264.0	-143.0	-88.8	-109.9	-177.7
33	Hold	203.3	-82.3	60,360				264.8	-143.8	-89.6	-111.5	-181.7
34	Hold	204.1	-83.1	60,360				265.5	-144.5	-88.7	-110.9	-182.3
35	Hold	204.8	-83.8	60,360				266.3	-145.3	-87.9	-110.2	-182.1
36	hold/take	208.6	-87.6	58,335				267.0	-146.0	-94.9	-119.3	-196.3
37	take	221.5	-100.5	50,235	36	257.5	-136.5	267.8	-146.8	-111.5	-145.7	-239.3
38	take	234.4	-113.4	42,135	43	277.4	-156.4	268.5	-147.5	-121.9	-162.2	-265.6
39	take	247.3	-126.3	34,035	50	297.3	-176.3	269.3	-148.3	-136.2	-178.6	-287.4
40	take	260.2	-139.2	25,935	58	318.2	-197.2	270.0	-149.0	-146.7	-192.0	-303.1
41	take	273.1	-152.1	17,835	61	334.1	-213.1	270.8	-149.8	-157.4	-204.9	-316.5
42	take	286.0	-165.0	9,735	64	350.0	-229.0	271.5	-150.5	-170.0	-219.6	-328.0
43	take	298.9	-177.9	1,635	67	365.9	-244.9	272.3	-151.3	-189.2	-238.9	-338.0
44	ake/hold/pu	300.4	-179.4	1,168	68	368.4	-247.4	273.0	-152.0	-186.2	-229.6	-309.0
45	put	291.8	-170.8	7,352				273.8	-152.8	-172.6	-210.1	-260.8
46	put	283.2	-162.2	13,535				274.5	-153.5	-158.8	-190.0	-227.3
47	put	274.6	-153.6	19,718				275.3	-154.3	-149.8	-176.4	-205.2

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area

2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area

3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area

4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; HP = Home of Peace; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-5. Hills of Eternity Cemetery Well Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	HE Well DTW (Feet)	HE Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	HE Well SWL (Feet bgs)	HE Well GWE (Feet NGVD)	HE Well Background DTW (Feet)	HE Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 1 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	195.2	-71.2	27,742				206.8	-82.8	-60.7	-69.2	-100.7
2	put	186.6	-62.6	33,925				207.5	-83.5	-56.2	-64.0	-93.5
3	put	178.0	-54.0	40,108				208.3	-84.3	-52.8	-59.8	-87.9
4	put	169.4	-45.4	46,291				209.0	-85.0	-50.0	-57.8	-85.2
5	put	160.8	-36.8	52,475				209.8	-85.8	-47.5	-54.6	-81.2
6	put	152.2	-28.2	58,658				210.5	-86.5	-44.7	-52.1	-77.8
7	Put/Hold	150.1	-26.1	60,500				211.3	-87.3	-41.6	-49.6	-74.8
8	Hold	150.9	-26.9	60,500				212.0	-88.0	-40.2	-45.4	-76.0
9	Hold/Take	154.6	-30.6	58,475				212.8	-88.8	-39.5	-49.4	-89.8
10	take	167.5	-43.5	50,375	34	201.5	-77.5	213.5	-89.5	-42.5	-55.8	-118.5
11	Take/Put	175.1	-51.1	45,858	41	216.1	-92.1	214.3	-90.3	-45.9	-60.7	-128.8
12	put	166.5	-42.5	52,042				215.0	-91.0	-47.1	-60.1	-114.5
13	put	157.9	-33.9	58,225				215.8	-91.8	-49.2	-59.9	-106.7
14	Put/Hold	155.2	-31.2	60,430				216.5	-92.5	-47.5	-57.3	-98.7
15	Hold	156.0	-32.0	60,430				217.3	-93.3	-46.2	-56.7	-98.7
16	Hold	156.7	-32.7	60,430				218.0	-94.0	-44.4	-55.7	-98.2
17	Hold	157.5	-33.5	60,430				218.8	-94.8	-43.4	-55.0	-98.9
18	Hold	158.2	-34.2	60,430				219.5	-95.5	-42.9	-54.4	-99.2
19	Hold	159.0	-35.0	60,430				220.3	-96.3	-42.6	-54.4	-100.4
20	Hold	159.7	-35.7	60,430				221.0	-97.0	-43.1	-54.9	-101.4
21	Hold	160.5	-36.5	60,430				221.8	-97.8	-46.1	-56.7	-103.9
22	Hold	161.2	-37.2	60,430				222.5	-98.5	-45.0	-56.7	-104.8
23	Hold	162.0	-38.0	60,430				223.3	-99.3	-43.8	-55.7	-103.9
24	Hold	162.7	-38.7	60,430				224.0	-100.0	-43.3	-55.3	-104.3
25	Hold/Take	166.5	-42.5	58,405				224.8	-100.8	-46.9	-58.8	-116.5
26	take	179.4	-55.4	50,305	34	213.4	-89.4	225.5	-101.5	-52.0	-66.5	-144.3
27	take/put	186.9	-62.9	45,788	41	227.9	-103.9	226.3	-102.3	-55.7	-71.8	-152.6
28	put	178.3	-54.3	51,972				227.0	-103.0	-58.0	-72.2	-139.0
29	put	169.7	-45.7	58,155				227.8	-103.8	-57.7	-69.9	-128.0
30	Put/Hold	167.1	-43.1	60,360				228.5	-104.5	-58.0	-68.2	-120.4
31	Hold	167.8	-43.8	60,360				229.3	-105.3	-55.1	-62.9	-113.5
32	Hold	168.6	-44.6	60,360				230.0	-106.0	-53.1	-64.1	-112.7
33	Hold	169.3	-45.3	60,360				230.8	-106.8	-52.3	-64.2	-114.4
34	Hold	170.1	-46.1	60,360				231.5	-107.5	-51.4	-63.0	-113.7
35	Hold	170.8	-46.8	60,360				232.3	-108.3	-51.3	-62.2	-112.8
36	hold/take	174.6	-50.6	58,335				233.0	-109.0	-53.5	-65.8	-124.6
37	take	187.5	-63.5	50,235	34	221.5	-97.5	233.8	-109.8	-57.6	-72.5	-151.8
38	take	200.4	-76.4	42,135	41	241.4	-117.4	234.5	-110.5	-63.2	-76.3	-167.9
39	take	213.3	-89.3	34,035	48	261.3	-137.3	235.3	-111.3	-71.2	-87.6	-185.4
40	take	226.2	-102.2	25,935	56	282.2	-158.2	236.0	-112.0	-77.5	-94.1	-198.9
41	take	239.1	-115.1	17,835	59	298.1	-174.1	236.8	-112.8	-84.0	-101.3	-211.9
42	take	252.0	-128.0	9,735	62	314.0	-190.0	237.5	-113.5	-92.8	-109.6	-226.3
43	take	264.9	-140.9	1,635	65	329.9	-205.9	238.3	-114.3	-102.3	-121.2	-244.8
44	take/hold/put	266.4	-142.4	1,168	66	332.4	-208.4	239.0	-115.0	-108.0	-124.7	-233.2
45	put	257.8	-133.8	7,352				239.8	-115.8	-110.0	-121.9	-213.8
46	put	249.2	-125.2	13,535				240.5	-116.5	-108.1	-117.5	-193.2
47	put	240.6	-116.6	19,718				241.3	-117.3	-106.0	-114.3	-179.3

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area
2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area
3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; HE = Hills of Eternity: GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-6. Cypress Lawn Cemetery Well 3 Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	CL3 Well DTW (Feet)	CL3 Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	CL3 Well SWL (Feet bgs)	CL3 Well GWE (Feet NGVD 29)	CL3 Well Background DTW (Feet)	CL3 Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	245.2	-95.2	27,742				256.8	-106.8	-59.2	-109.6
2	put	236.6	-86.6	33,925				257.5	-107.5	-55.4	-102.4
3	put	228.0	-78.0	40,108				258.3	-108.3	-51.9	-96.8
4	put	219.4	-69.4	46,291				259.0	-109.0	-50.2	-94.6
5	put	210.8	-60.8	52,475				259.8	-109.8	-47.7	-90.5
6	put	202.2	-52.2	58,658				260.5	-110.5	-45.4	-87.3
7	Put/Hold	200.1	-50.1	60,500				261.3	-111.3	-43.0	-84.3
8	Hold	200.9	-50.9	60,500				262.0	-112.0	-40.4	-84.8
9	Hold/Take	204.6	-54.6	58,475				262.8	-112.8	-41.6	-97.4
10	take	217.5	-67.5	50,375	35	252.5	-102.5	263.5	-113.5	-45.5	-128.6
11	Take/Put	225.1	-75.1	45,858	46	271.1	-121.1	264.3	-114.3	-49.0	-144.1
12	put	216.5	-66.5	52,042				265.0	-115.0	-48.5	-128.9
13	put	207.9	-57.9	58,225				265.8	-115.8	-48.9	-119.6
14	Put/Hold	205.2	-55.2	60,430				266.5	-116.5	-47.2	-110.2
15	Hold	206.0	-56.0	60,430				267.3	-117.3	-46.6	-110.5
16	Hold	206.7	-56.7	60,430				268.0	-118.0	-45.5	-110.2
17	Hold	207.5	-57.5	60,430				268.8	-118.8	-44.7	-111.2
18	Hold	208.2	-58.2	60,430				269.5	-119.5	-44.1	-111.5
19	Hold	209.0	-59.0	60,430				270.3	-120.3	-43.8	-112.9
20	Hold	209.7	-59.7	60,430				271.0	-121.0	-44.1	-114.1
21	Hold	210.5	-60.5	60,430				271.8	-121.8	-46.0	-116.5
22	Hold	211.2	-61.2	60,430				272.5	-122.5	-45.8	-117.6
23	Hold	212.0	-62.0	60,430				273.3	-123.3	-44.7	-116.8
24	Hold	212.7	-62.7	60,430				274.0	-124.0	-44.3	-117.3
25	Hold/Take	216.5	-66.5	58,405				274.8	-124.8	-46.9	-126.7
26	take	229.4	-79.4	50,305	35	264.4	-114.4	275.5	-125.5	-52.7	-156.8
27	take/put	236.9	-86.9	45,788	46	282.9	-132.9	276.3	-126.3	-56.8	-170.0
28	put	228.3	-78.3	51,972				277.0	-127.0	-57.4	-155.4
29	put	219.7	-69.7	58,155				277.8	-127.8	-56.3	-142.5
30	Put/Hold	217.1	-67.1	60,360				278.5	-128.5	-55.6	-133.6
31	Hold	217.8	-67.8	60,360				279.3	-129.3	-52.6	-125.2
32	Hold	218.6	-68.6	60,360				280.0	-130.0	-52.4	-125.8
33	Hold	219.3	-69.3	60,360				280.8	-130.8	-52.0	-128.2
34	Hold	220.1	-70.1	60,360				281.5	-131.5	-51.3	-127.1
35	Hold	220.8	-70.8	60,360				282.3	-132.3	-51.0	-125.9
36	hold/take	224.6	-74.6	58,335				283.0	-133.0	-53.2	-135.5
37	take	237.5	-87.5	50,235	35	272.5	-122.5	283.8	-133.8	-57.9	-164.9
38	take	250.4	-100.4	42,135	46	296.4	-146.4	284.5	-134.5	-61.7	-181.5
39	take	263.3	-113.3	34,035	52	315.3	-165.3	285.3	-135.3	-69.8	-201.4
40	take	276.2	-126.2	25,935	56	332.2	-182.2	286.0	-136.0	-75.0	-215.3
41	take	289.1	-139.1	17,835	60	349.1	-199.1	286.8	-136.8	-80.6	-228.9
42	take	302.0	-152.0	9,735	63	365.0	-215.0	287.5	-137.5	-87.2	-241.9
43	take	314.9	-164.9	1,635	65	379.9	-229.9	288.3	-138.3	-95.4	-257.8
44	take/hold/put	316.4	-166.4	1,168	66	382.4	-232.4	289.0	-139.0	-99.5	-249.3
45	put	307.8	-157.8	7,352				289.8	-139.8	-99.2	-230.3
46	put	299.2	-149.2	13,535				290.5	-140.5	-97.2	-207.7
47	put	290.6	-140.6	19,718				291.3	-141.3	-95.6	-192.2

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area
2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area
3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; CL = Cypress Lawn; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-7. Cypress Lawn Cemetery Well 4 Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	CL4 Well DTW (Feet)	CL4 Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	CL4 Well SWL (Feet bgs)	CL4 Well GWE (Feet NGVD 29)	CL4 Well Background DTW (Feet)	CL4 Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 3 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 5 GWE (Feet NGVD 29)
1	put	188.2	-96.2	27,742				199.8	-107.8	-87.2	-109.6	-123.3
2	put	179.6	-87.6	33,925				200.5	-108.5	-81.4	-102.4	-115.7
3	put	171.0	-79.0	40,108				201.3	-109.3	-76.7	-96.8	-110.3
4	put	162.4	-70.4	46,291				202.0	-110.0	-74.6	-94.6	-107.9
5	put	153.8	-61.8	52,475				202.8	-110.8	-71.1	-90.5	-103.9
6	put	145.2	-53.2	58,658				203.5	-111.5	-68.2	-87.3	-100.9
7	Put/Hold	143.1	-51.1	60,500				204.3	-112.3	-65.2	-84.3	-109.4
8	Hold	143.9	-51.9	60,500				205.0	-113.0	-64.0	-84.8	-123.1
9	Hold/Take	147.6	-55.6	58,475				205.8	-113.8	-71.9	-97.4	-145.2
10	take	160.5	-68.5	50,375	36	196.5	-104.5	206.5	-114.5	-90.3	-128.6	-189.7
11	Take/Put	168.1	-76.1	45,858	47	215.1	-123.1	207.3	-115.3	-99.6	-144.1	-209.8
12	put	159.5	-67.5	52,042				208.0	-116.0	-92.0	-128.9	-172.4
13	put	150.9	-58.9	58,225				208.8	-116.8	-87.4	-119.6	-149.8
14	Put/Hold	148.2	-56.2	60,430				209.5	-117.5	-81.6	-110.2	-143.6
15	Hold	149.0	-57.0	60,430				210.3	-118.3	-81.3	-110.5	-155.1
16	Hold	149.7	-57.7	60,430				211.0	-119.0	-80.5	-110.2	-160.3
17	Hold	150.5	-58.5	60,430				211.8	-119.8	-80.6	-111.2	-163.7
18	Hold	151.2	-59.2	60,430				212.5	-120.5	-80.5	-111.5	-165.5
19	Hold	152.0	-60.0	60,430				213.3	-121.3	-81.1	-112.9	-168.0
20	Hold	152.7	-60.7	60,430				214.0	-122.0	-81.9	-114.1	-169.9
21	Hold	153.5	-61.5	60,430				214.8	-122.8	-83.8	-116.5	-172.0
22	Hold	154.2	-62.2	60,430				215.5	-123.5	-84.5	-117.6	-173.8
23	Hold	155.0	-63.0	60,430				216.3	-124.3	-83.7	-116.8	-174.1
24	Hold	155.7	-63.7	60,430				217.0	-125.0	-83.8	-117.3	-175.1
25	Hold/Take	159.5	-67.5	58,405				217.8	-125.8	-90.5	-126.7	-186.5
26	take	172.4	-80.4	50,305	36	208.4	-116.4	218.5	-126.5	-109.1	-156.8	-226.2
27	take/put	179.9	-87.9	45,788	47	226.9	-134.9	219.3	-127.3	-117.6	-170.0	-242.3
28	put	171.3	-79.3	51,972				220.0	-128.0	-110.9	-155.4	-203.6
29	put	162.7	-70.7	58,155				220.8	-128.8	-103.8	-142.5	-176.8
30	Put/Hold	160.1	-68.1	60,360				221.5	-129.5	-98.5	-133.6	-169.9
31	Hold	160.8	-68.8	60,360				222.3	-130.3	-92.2	-125.2	-172.8
32	Hold	161.6	-69.6	60,360				223.0	-131.0	-92.3	-125.8	-178.7
33	Hold	162.3	-70.3	60,360				223.8	-131.8	-93.4	-128.2	-182.9
34	Hold	163.1	-71.1	60,360				224.5	-132.5	-92.4	-127.1	-183.0
35	Hold	163.8	-71.8	60,360				225.3	-133.3	-91.5	-125.9	-182.4
36	hold/take	167.6	-75.6	58,335				226.0	-134.0	-98.2	-135.5	-194.4
37	take	180.5	-88.5	50,235	36	216.5	-124.5	226.8	-134.8	-116.0	-164.9	-233.7
38	take	193.4	-101.4	42,135	47	240.4	-148.4	227.5	-135.5	-126.7	-181.5	-257.2
39	take	206.3	-114.3	34,035	53	259.3	-167.3	228.3	-136.3	-141.2	-201.4	-281.0
40	take	219.2	-127.2	25,935	58	277.2	-185.2	229.0	-137.0	-151.6	-215.3	-296.6
41	take	232.1	-140.1	17,835	62	294.1	-202.1	229.8	-137.8	-162.0	-228.9	-310.3
42	take	245.0	-153.0	9,735	65	310.0	-218.0	230.5	-138.5	-172.7	-241.9	-321.5
43	take	257.9	-165.9	1,635	68	325.9	-233.9	231.3	-139.3	-187.2	-257.8	-331.5
44	take/hold/put	259.4	-167.4	1,168	69	328.4	-236.4	232.0	-140.0	-184.8	-249.3	-309.6
45	put	250.8	-158.8	7,352				232.8	-140.8	-173.7	-230.3	-265.9
46	put	242.2	-150.2	13,535				233.5	-141.5	-159.9	-207.7	-233.2
47	put	233.6	-141.6	19,718				234.3	-142.3	-150.5	-192.2	-211.5

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area

2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area

3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area

4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; CL = Cypress Lawn; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-8. Holy Cross Cemetery Well 1 Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	HC1 Well DTW (Feet)	HC1 Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	HC1 Well SWL (Feet bgs)	HC1 Well GWE (Feet NGVD 29)	HC1 Well Background DTW (Feet)	HC1 Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 3 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 5 GWE (Feet NGVD 29)
1	put	189.2	-95.2	27,742				200.8	-106.8	-83.4	-113.1	-125.1
2	put	180.6	-86.6	33,925				201.5	-107.5	-79.0	-106.9	-118.1
3	put	172.0	-78.0	40,108				202.3	-108.3	-75.0	-101.6	-112.8
4	put	163.4	-69.4	46,291				203.0	-109.0	-72.6	-99.1	-110.3
5	put	154.8	-60.8	52,475				203.8	-109.8	-69.4	-95.2	-106.1
6	put	146.2	-52.2	58,658				204.5	-110.5	-66.5	-91.8	-102.9
7	Put/Hold	144.1	-50.1	60,500				205.3	-111.3	-63.8	-89.7	-109.9
8	Hold	144.9	-50.9	60,500				206.0	-112.0	-64.7	-92.6	-121.3
9	Hold/Take	148.6	-54.6	58,475				206.8	-112.8	-75.3	-111.6	-139.1
10	take	161.5	-67.5	50,375	43	204.5	-110.5	207.5	-113.5	-93.8	-144.3	-178.5
11	Take/Put	169.1	-75.1	45,858	50	219.1	-125.1	208.3	-114.3	-100.2	-155.6	-200.7
12	put	160.5	-66.5	52,042				209.0	-115.0	-92.4	-139.4	-170.8
13	put	151.9	-57.9	58,225				209.8	-115.8	-86.8	-128.3	-150.8
14	Put/Hold	149.2	-55.2	60,430				210.5	-116.5	-81.2	-118.8	-144.4
15	Hold	150.0	-56.0	60,430				211.3	-117.3	-80.7	-119.5	-153.6
16	Hold	150.7	-56.7	60,430				212.0	-118.0	-80.2	-119.9	-158.1
17	Hold	151.5	-57.5	60,430				212.8	-118.8	-80.4	-121.1	-161.3
18	Hold	152.2	-58.2	60,430				213.5	-119.5	-80.6	-121.8	-163.1
19	Hold	153.0	-59.0	60,430				214.3	-120.3	-81.3	-123.5	-165.6
20	Hold	153.7	-59.7	60,430				215.0	-121.0	-82.1	-124.9	-167.6
21	Hold	154.5	-60.5	60,430				215.8	-121.8	-83.9	-127.4	-169.8
22	Hold	155.2	-61.2	60,430				216.5	-122.5	-84.8	-128.8	-171.7
23	Hold	156.0	-62.0	60,430				217.3	-123.3	-84.4	-128.4	-172.1
24	Hold	156.7	-62.7	60,430				218.0	-124.0	-84.7	-129.1	-173.2
25	Hold/Take	160.5	-66.5	58,405				218.8	-124.8	-94.8	-144.8	-181.3
26	take	173.4	-79.4	50,305	43	216.4	-122.4	219.5	-125.5	-113.2	-175.7	-216.2
27	take/put	180.9	-86.9	45,788	50	230.9	-136.9	220.3	-126.3	-118.3	-184.0	-234.3
28	put	172.3	-78.3	51,972				221.0	-127.0	-110.9	-167.9	-203.0
29	put	163.7	-69.7	58,155				221.8	-127.8	-103.6	-153.4	-178.9
30	Put/Hold	161.1	-67.1	60,360				222.5	-128.5	-98.1	-143.9	-171.6
31	Hold	161.8	-67.8	60,360				223.3	-129.3	-93.7	-137.0	-172.4
32	Hold	162.6	-68.6	60,360				224.0	-130.0	-92.3	-136.9	-177.4
33	Hold	163.3	-69.3	60,360				224.8	-130.8	-93.1	-139.3	-181.2
34	Hold	164.1	-70.1	60,360				225.5	-131.5	-92.6	-138.7	-181.3
35	Hold	164.8	-70.8	60,360				226.3	-132.3	-92.2	-137.9	-180.8
36	hold/take	168.6	-74.6	58,335				227.0	-133.0	-101.8	-153.3	-189.4
37	take	181.5	-87.5	50,235	43	224.5	-130.5	227.8	-133.8	-119.6	-183.7	-223.9
38	take	194.4	-100.4	42,135	50	244.4	-150.4	228.5	-134.5	-132.2	-202.9	-246.1
39	take	207.3	-113.3	34,035	57	264.3	-170.3	229.3	-135.3	-144.9	-222.7	-269.5
40	take	220.2	-126.2	25,935	64	284.2	-190.2	230.0	-136.0	-155.5	-237.5	-285.0
41	take	233.1	-139.1	17,835	68	301.1	-207.1	230.8	-136.8	-165.2	-251.1	-298.9
42	take	246.0	-152.0	9,735	70	316.0	-222.0	231.5	-137.5	-175.0	-263.8	-310.2
43	take	258.9	-164.9	1,635	73	331.9	-237.9	232.3	-138.3	-186.2	-277.3	-320.4
44	take/hold/put	260.4	-166.4	1,168	75	335.4	-241.4	233.0	-139.0	-179.0	-261.3	-305.4
45	put	251.8	-157.8	7,352				233.8	-139.8	-169.3	-241.5	-267.4
46	put	243.2	-149.2	13,535				234.5	-140.5	-156.5	-218.1	-236.9
47	put	234.6	-140.6	19,718				235.3	-141.3	-146.5	-200.9	-215.9

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area

2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area

3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area

4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; HC = Holy Cross; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-9. Holy Cross Cemetery Well 4 Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	HC4 Well DTW (Feet)	HC4 Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	HC4 Well SWL (Feet bgs)	HC4 Well GWE (Feet NGVD 29)	HC4 Well Background DTW (Feet)	HC4 Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 5 GWE (Feet NGVD 29)
1	put	210.2	-96.2	27,742				220.3	-106.3	-115.0	-126.9
2	put	201.6	-87.6	33,925				221.0	-107.0	-108.0	-119.3
3	put	193.0	-79.0	40,108				221.8	-107.8	-102.5	-113.9
4	put	184.4	-70.4	46,291				222.5	-108.5	-100.4	-111.7
5	put	175.8	-61.8	52,475				223.3	-109.3	-96.2	-107.4
6	put	167.2	-53.2	58,658				224.0	-110.0	-93.1	-104.4
7	Put/Hold	165.1	-51.1	60,500				224.8	-110.8	-90.8	-111.7
8	Hold	165.9	-51.9	60,500				225.5	-111.5	-91.3	-121.7
9	Hold/Take	169.6	-55.6	58,475				226.3	-112.3	-108.7	-141.8
10	take	182.5	-68.5	50,375	37	219.5	-105.5	227.0	-113.0	-141.1	-182.1
11	Take/Put	190.1	-76.1	45,858	44	234.1	-120.1	227.8	-113.8	-155.1	-204.2
12	put	181.5	-67.5	52,042				228.5	-114.5	-139.4	-173.2
13	put	172.9	-58.9	58,225				229.3	-115.3	-128.7	-152.5
14	Put/Hold	170.2	-56.2	60,430				230.0	-116.0	-118.9	-145.9
15	Hold	171.0	-57.0	60,430				230.8	-116.8	-119.5	-155.7
16	Hold	171.7	-57.7	60,430				231.5	-117.5	-119.9	-160.5
17	Hold	172.5	-58.5	60,430				232.3	-118.3	-121.0	-163.6
18	Hold	173.2	-59.2	60,430				233.0	-119.0	-121.4	-165.3
19	Hold	174.0	-60.0	60,430				233.8	-119.8	-123.2	-168.0
20	Hold	174.7	-60.7	60,430				234.5	-120.5	-124.5	-169.8
21	Hold	175.5	-61.5	60,430				235.3	-121.3	-126.7	-171.8
22	Hold	176.2	-62.2	60,430				236.0	-122.0	-128.1	-173.8
23	Hold	177.0	-63.0	60,430				236.8	-122.8	-127.7	-174.2
24	Hold	177.7	-63.7	60,430				237.5	-123.5	-128.2	-175.2
25	Hold/Take	181.5	-67.5	58,405				238.3	-124.3	-140.8	-183.8
26	take	194.4	-80.4	50,305	37	231.4	-117.4	239.0	-125.0	-171.6	-219.4
27	take/put	201.9	-87.9	45,788	44	245.9	-131.9	239.8	-125.8	-183.1	-237.8
28	put	193.3	-79.3	51,972				240.5	-126.5	-167.7	-205.3
29	put	184.7	-70.7	58,155				241.3	-127.3	-153.1	-180.3
30	Put/Hold	182.1	-68.1	60,360				242.0	-128.0	-143.4	-172.7
31	Hold	182.8	-68.8	60,360				242.8	-128.8	-134.7	-172.6
32	Hold	183.6	-69.6	60,360				243.5	-129.5	-136.3	-179.3
33	Hold	184.3	-70.3	60,360				244.3	-130.3	-139.1	-183.6
34	Hold	185.1	-71.1	60,360				245.0	-131.0	-138.0	-183.3
35	Hold	185.8	-71.8	60,360				245.8	-131.8	-136.7	-182.5
36	hold/take	189.6	-75.6	58,335				246.5	-132.5	-149.7	-192.1
37	take	202.5	-88.5	50,235	37	239.5	-125.5	247.3	-133.3	-180.0	-227.5
38	take	215.4	-101.4	42,135	44	259.4	-145.4	248.0	-134.0	-197.1	-248.4
39	take	228.3	-114.3	34,035	51	279.3	-165.3	248.8	-134.8	-218.6	-273.5
40	take	241.2	-127.2	25,935	58	299.2	-185.2	249.5	-135.5	-233.2	-288.9
41	take	254.1	-140.1	17,835	61	315.1	-201.1	250.3	-136.3	-246.9	-303.0
42	take	267.0	-153.0	9,735	65	332.0	-218.0	251.0	-137.0	-259.3	-314.0
43	take	279.9	-165.9	1,635	68	347.9	-233.9	251.8	-137.8	-273.2	-323.9
44	take/hold/put	281.4	-167.4	1,168	69	350.4	-236.4	252.5	-138.5	-261.0	-308.4
45	put	272.8	-158.8	7,352				253.3	-139.3	-241.6	-269.2
46	put	264.2	-150.2	13,535				254.0	-140.0	-217.9	-237.9
47	put	255.6	-141.6	19,718				254.8	-140.8	-201.1	-216.7

Assumptions:

1) Put Rate of 5.52 MGD results in 8.6 feet/year increase in groundwater levels in Colma area
2) Take Rate of 7.23 MGD results in 12.9 feet/year decrease in groundwater levels in Colma area
3) Hold Year results in 0.75 feet/year decrease in groundwater levels in Colma area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; HC = Holy Cross; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-10. California Golf Club Well 7 Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	CGC Well DTW (Feet)	CGC Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	CGC Well SWL (Feet bgs)	CGC Well GWE (Feet NGVD 29)	CGC Well Background DTW (Feet)	CGC Well Background GWE (Feet NGVD 29)	GW Model SC 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 3 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	189.4	-111.4	27,742				200.8	-122.8	-45.1	-87.9	-130.7
2	put	180.9	-102.9	33,925				201.5	-123.5	-43.3	-84.6	-125.6
3	put	172.4	-94.4	40,108				202.3	-124.3	-41.3	-81.0	-120.4
4	put	163.9	-85.9	46,291				203.0	-125.0	-39.7	-78.5	-116.8
5	put	155.4	-77.4	52,475				203.8	-125.8	-37.7	-75.1	-112.1
6	put	146.9	-68.9	58,658				204.5	-126.5	-35.8	-72.3	-108.3
7	Put/Hold	144.8	-66.8	60,500				205.3	-127.3	-34.9	-73.3	-117.7
8	Hold	145.6	-67.6	60,500				206.0	-128.0	-34.0	-74.5	-124.3
9	Hold/Take	150.8	-72.8	58,475				206.8	-128.8	-35.1	-81.1	-140.5
10	take	169.3	-91.3	50,375	41	210.3	-132.3	207.5	-129.5	-37.9	-94.6	-169.5
11	Take/Put	181.0	-103.0	45,858	52	233.0	-155.0	208.3	-130.3	-41.7	-107.1	-183.7
12	put	172.5	-94.5	52,042				209.0	-131.0	-41.5	-103.0	-166.9
13	put	164.0	-86.0	58,225				209.8	-131.8	-39.6	-96.3	-153.2
14	Put/Hold	161.4	-83.4	60,430				210.5	-132.5	-38.2	-92.7	-152.8
15	Hold	162.2	-84.2	60,430				211.3	-133.3	-38.1	-93.9	-157.5
16	Hold	162.9	-84.9	60,430				212.0	-134.0	-38.1	-95.3	-160.9
17	Hold	163.7	-85.7	60,430				212.8	-134.8	-38.0	-96.5	-163.9
18	Hold	164.4	-86.4	60,430				213.5	-135.5	-38.0	-97.5	-166.1
19	Hold	165.2	-87.2	60,430				214.3	-136.3	-38.1	-99.0	-169.0
20	Hold	165.9	-87.9	60,430				215.0	-137.0	-38.3	-100.3	-171.4
21	Hold	166.7	-88.7	60,430				215.8	-137.8	-38.6	-101.5	-173.7
22	Hold	167.4	-89.4	60,430				216.5	-138.5	-39.2	-103.1	-176.1
23	Hold	168.2	-90.2	60,430				217.3	-139.3	-39.2	-103.8	-177.3
24	Hold	168.9	-90.9	60,430				218.0	-140.0	-39.3	-104.4	-178.6
25	Hold/Take	174.1	-96.1	58,405				218.8	-140.8	-39.7	-106.5	-186.9
26	take	192.6	-114.6	50,305	41	233.6	-155.6	219.5	-141.5	-42.9	-118.1	-211.5
27	take/put	204.3	-126.3	45,788	52	256.3	-178.3	220.3	-142.3	-47.0	-129.0	-221.7
28	put	195.8	-117.8	51,972				221.0	-143.0	-47.0	-123.8	-202.5
29	put	187.3	-109.3	58,155				221.8	-143.8	-45.1	-115.0	-184.8
30	Put/Hold	184.7	-106.7	60,360				222.5	-144.5	-43.7	-110.4	-182.5
31	Hold	185.5	-107.5	60,360				223.3	-145.3	-42.6	-107.3	-180.4
32	Hold	186.2	-108.2	60,360				224.0	-146.0	-43.0	-108.9	-183.1
33	Hold	187.0	-109.0	60,360				224.8	-146.8	-43.1	-110.2	-185.8
34	Hold	187.7	-109.7	60,360				225.5	-147.5	-42.9	-110.1	-186.1
35	Hold	188.5	-110.5	60,360				226.3	-148.3	-42.9	-109.9	-186.2
36	hold/take	193.7	-115.7	58,335				227.0	-149.0	-43.5	-112.6	-194.9
37	take	212.2	-134.2	50,235	41	253.2	-175.2	227.8	-149.8	-46.4	-123.9	-219.1
38	take	230.7	-152.7	42,135	52	282.7	-204.7	228.5	-150.5	-49.9	-133.9	-237.7
39	take	249.2	-171.2	34,035	58	307.2	-229.2	229.3	-151.3	-55.3	-147.5	-258.6
40	take	267.7	-189.7	25,935	62	329.7	-251.7	230.0	-152.0	-59.6	-157.3	-273.7
41	take	286.2	-208.2	17,835	66	352.2	-274.2	230.8	-152.8	-63.8	-166.4	-287.3
42	take	304.7	-226.7	9,735	69	373.7	-295.7	231.5	-153.5	-67.7	-174.0	-298.7
43	take	323.2	-245.2	1,635	71	394.2	-316.2	232.3	-154.3	-71.8	-181.4	-309.0
44	take/hold/put	326.0	-248.0	1,168	73	399.0	-321.0	233.0	-155.0	-74.8	-182.7	-296.3
45	put	317.5	-239.5	7,352				233.8	-155.8	-73.8	-171.8	-269.2
46	put	309.0	-231.0	13,535				234.5	-156.5	-71.6	-159.4	-245.3
47	put	300.5	-222.5	19,718				235.3	-157.3	-69.5	-148.9	-226.2

Assumptions:

1) Put Rate of 5.52 MGD results in 8.5 feet/year increase in groundwater levels in CGC area

2) Take Rate of 7.23 MGD results in 18.5 feet/year decrease in groundwater levels in CGC area

3) Hold Year results in 0.75 feet/year decrease in groundwater levels in CGC area

4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; CGC = California Golf Club; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-11 . Olympic Golf Club Well 2 (#8) Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	Oly2 Well DTW (Feet)	Oly2 Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	Oly2 Well SWL (Feet bgs)	Oly2 Well GWE (Feet NGVD 29)	Oly2 Well Background DTW (Feet)	Oly2 Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 2 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 5 GWE (Feet NGVD 29)
1	put	95.5	-20.5	27,742				100.5	-25.5	5.3	-21.1	-57.4
2	put	91.9	-16.9	33,925				101.0	-26.0	10.8	-16.5	-52.2
3	put	88.3	-13.3	40,108				101.5	-26.5	11.5	-12.0	-48.5
4	put	84.7	-9.7	46,291				102.0	-27.0	12.5	-9.0	-46.1
5	put	81.1	-6.1	52,475				102.5	-27.5	12.5	-6.7	-44.4
6	put	77.5	-2.5	58,658				103.0	-28.0	13.1	-5.2	-43.0
7	Put/Hold	76.8	-1.8	60,500				103.5	-28.5	13.5	-5.9	-62.8
8	Hold	77.3	-2.3	60,500				104.0	-29.0	12.1	-9.6	-81.3
9	Hold/Take	78.6	-3.6	58,475				104.5	-29.5	9.9	-13.1	-98.5
10	take	82.6	-7.6	50,375	7	89.6	-14.6	105.0	-30.0	6.3	-21.6	-137.6
11	Take/Put	84.7	-9.7	45,858	12	96.7	-21.7	105.5	-30.5	4.0	-28.0	-143.6
12	put	81.1	-6.1	52,042				106.0	-31.0	3.8	-23.6	-96.1
13	put	77.5	-2.5	58,225				106.5	-31.5	3.7	-20.3	-74.1
14	Put/Hold	76.5	-1.5	60,430				107.0	-32.0	4.8	-19.2	-81.6
15	Hold	77.0	-2.0	60,430				107.5	-32.5	4.8	-21.5	-95.9
16	Hold	77.5	-2.5	60,430				108.0	-33.0	6.4	-22.7	-102.2
17	Hold	78.0	-3.0	60,430				108.5	-33.5	5.1	-23.5	-105.0
18	Hold	78.5	-3.5	60,430				109.0	-34.0	6.4	-24.1	-106.5
19	Hold	79.0	-4.0	60,430				109.5	-34.5	6.1	-24.1	-107.3
20	Hold	79.5	-4.5	60,430				110.0	-35.0	5.7	-24.5	-108.1
21	Hold	80.0	-5.0	60,430				110.5	-35.5	3.9	-25.3	-109.1
22	Hold	80.5	-5.5	60,430				111.0	-36.0	7.1	-25.6	-109.8
23	Hold	81.0	-6.0	60,430				111.5	-36.5	7.8	-24.9	-110.0
24	Hold	81.5	-6.5	60,430				112.0	-37.0	6.6	-24.7	-110.2
25	Hold/Take	82.9	-7.9	58,405				112.5	-37.5	4.1	-25.9	-119.0
26	take	86.9	-11.9	50,305	7	93.9	-18.9	113.0	-38.0	0.4	-32.8	-154.2
27	take/put	89.0	-14.0	45,788	12	101.0	-26.0	113.5	-38.5	0.3	-38.1	-157.6
28	put	85.4	-10.4	51,972				114.0	-39.0	0.4	-32.5	-108.7
29	put	81.8	-6.8	58,155				114.5	-39.5	2.0	-27.8	-85.4
30	Put/Hold	80.8	-5.8	60,360				115.0	-40.0	2.3	-25.7	-92.0
31	Hold	81.3	-6.3	60,360				115.5	-40.5	4.9	-26.6	-104.8
32	Hold	81.8	-6.8	60,360				116.0	-41.0	8.0	-26.3	-109.4
33	Hold	82.3	-7.3	60,360				116.5	-41.5	7.1	-25.6	-111.6
34	Hold	82.8	-7.8	60,360				117.0	-42.0	5.9	-25.6	-112.6
35	Hold	83.3	-8.3	60,360				117.5	-42.5	7.2	-25.9	-113.0
36	hold/take	84.7	-9.7	58,335				118.0	-43.0	5.2	-26.8	-121.7
37	take	88.7	-13.7	50,235	7	95.7	-20.7	118.5	-43.5	1.9	-33.4	-156.5
38	take	92.7	-17.7	42,135	12	104.7	-29.7	119.0	-44.0	-1.0	-39.3	-175.8
39	take	96.7	-21.7	34,035	15	111.7	-36.7	119.5	-44.5	-5.4	-45.2	-187.8
40	take	100.7	-25.7	25,935	17	117.7	-42.7	120.0	-45.0	-8.7	-50.9	-196.5
41	take	104.7	-29.7	17,835	19	123.7	-48.7	120.5	-45.5	-11.3	-56.9	-203.3
42	take	108.7	-33.7	9,735	21	129.7	-54.7	121.0	-46.0	-16.1	-63.0	-209.4
43	take	112.7	-37.7	1,635	22	134.7	-59.7	121.5	-46.5	-21.0	-70.6	-214.8
44	take/hold/put	113.0	-38.0	1,168	23	136.0	-61.0	122.0	-47.0	-21.4	-74.6	-183.9
45	put	109.4	-34.4	7,352				122.5	-47.5	-20.1	-67.1	-136.2
46	put	105.8	-30.8	13,535				123.0	-48.0	-17.0	-59.3	-111.7
47	put	102.2	-27.2	19,718				123.5	-48.5	-12.8	-52.0	-97.2

Assumptions:

1) Put Rate of 5.52 MGD results in 3.6 feet/year increase in groundwater levels in Olympic Club area
2) Take Rate of 7.23 MGD results in 4.0 feet/year decrease in groundwater levels in the Olympic Club area
3) Hold Year results in 0.5 feet/year decrease in groundwater levels in the Olympic Club area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; Oly = Olympic Club; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-12. San Francisco Golf Club Well 2 Groundwater Levels for GSR Project (Scenario 2)

Future Scenario Year	Year Type	SFGC2 Well DTW (Feet)	SFCG2 Well GWE (Feet NGVD 29)	SFPUC Storage Account	GSR Local Drawdown (Feet)	SFGC2 Well SWL (Feet bgs)	SFGC2 Well GWE (Feet NGVD 29)	SFGC2 Well Background DTW (Feet)	SFGC2 Well Background GWE (Feet NGVD 29)	GW Model Sc 2-Lay 3 GWE (Feet NGVD 29)	GW Model Sc 2-Lay 4 GWE (Feet NGVD 29)
1	put	155.5	-16.5	27,742				160.5	-21.5	-9.1	-23.6
2	put	151.9	-12.9	33,925				161.0	-22.0	-4.2	-18.6
3	put	148.3	-9.3	40,108				161.5	-22.5	-0.7	-14.0
4	put	144.7	-5.7	46,291				162.0	-23.0	1.3	-11.0
5	put	141.1	-2.1	52,475				162.5	-23.5	3.3	-7.4
6	put	137.5	1.5	58,658				163.0	-24.0	3.4	-7.3
7	Put/Hold	136.8	2.2	60,500				163.5	-24.5	3.0	-8.5
8	Hold	137.3	1.7	60,500				164.0	-25.0	1.4	-10.6
9	Hold/Take	138.6	0.4	58,475				164.5	-25.5	-3.2	-15.9
10	take	142.6	-3.6	50,375	7	149.6	-10.6	165.0	-26.0	-9.9	-24.9
11	Take/Put	144.7	-5.7	45,858	11	155.7	-16.7	165.5	-26.5	-13.8	-31.0
12	put	141.1	-2.1	52,042				166.0	-27.0	-11.5	-26.2
13	put	137.5	1.5	58,225				166.5	-27.5	-9.7	-22.9
14	Put/Hold	136.5	2.5	60,430				167.0	-28.0	-9.1	-22.5
15	Hold	137.0	2.0	60,430				167.5	-28.5	-9.7	-24.3
16	Hold	137.5	1.5	60,430				168.0	-29.0	-9.9	-25.5
17	Hold	138.0	1.0	60,430				168.5	-29.5	-10.5	-26.3
18	Hold	138.5	0.5	60,430				169.0	-30.0	-10.2	-26.6
19	Hold	139.0	0.0	60,430				169.5	-30.5	-10.3	-26.9
20	Hold	139.5	-0.5	60,430				170.0	-31.0	-10.6	-27.2
21	Hold	140.0	-1.0	60,430				170.5	-31.5	-11.0	-26.6
22	Hold	140.5	-1.5	60,430				171.0	-32.0	-10.0	-26.8
23	Hold	141.0	-2.0	60,430				171.5	-32.5	-9.9	-27.5
24	Hold	141.5	-2.5	60,430				172.0	-33.0	-10.2	-27.3
25	Hold/Take	142.9	-3.9	58,405				172.5	-33.5	-12.7	-29.0
26	take	146.9	-7.9	50,305	7	153.9	-14.9	173.0	-34.0	-17.8	-35.0
27	take/put	149.0	-10.0	45,788	11	160.0	-21.0	173.5	-34.5	-21.4	-41.4
28	put	145.4	-6.4	51,972				174.0	-35.0	-18.0	-35.6
29	put	141.8	-2.8	58,155				174.5	-35.5	-13.4	-28.8
30	Put/Hold	140.8	-1.8	60,360				175.0	-36.0	-12.0	-26.8
31	Hold	141.3	-2.3	60,360				175.5	-36.5	-11.5	-27.7
32	Hold	141.8	-2.8	60,360				176.0	-37.0	-11.1	-29.3
33	Hold	142.3	-3.3	60,360				176.5	-37.5	-10.3	-28.4
34	Hold	142.8	-3.8	60,360				177.0	-38.0	-9.9	-26.8
35	Hold	143.3	-4.3	60,360				177.5	-38.5	-9.8	-27.1
36	hold/take	144.7	-5.7	58,335				178.0	-39.0	-12.8	-30.1
37	take	148.7	-9.7	50,235	7	155.7	-16.7	178.5	-39.5	-18.3	-37.1
38	take	152.7	-13.7	42,135	11	163.7	-24.7	179.0	-40.0	-22.2	-41.6
39	take	156.7	-17.7	34,035	15	171.7	-32.7	179.5	-40.5	-28.4	-49.3
40	take	160.7	-21.7	25,935	17	177.7	-38.7	180.0	-41.0	-33.3	-55.0
41	take	164.7	-25.7	17,835	19	183.7	-44.7	180.5	-41.5	-38.2	-61.4
42	take	168.7	-29.7	9,735	20	188.7	-49.7	181.0	-42.0	-43.7	-67.6
43	take	172.7	-33.7	1,635	22	194.7	-55.7	181.5	-42.5	-49.6	-74.1
44	take/hold/put	173.0	-34.0	1,168	22	195.0	-56.0	182.0	-43.0	-51.9	-78.8
45	put	169.4	-30.4	7,352				182.5	-43.5	-46.6	-70.5
46	put	165.8	-26.8	13,535				183.0	-44.0	-40.2	-62.0
47	put	162.2	-23.2	19,718				183.5	-44.5	-34.1	-54.5

Assumptions:

1) Put Rate of 5.52 MGD results in 3.6 feet/year increase in groundwater levels in San Francisco Golf Club area
2) Take Rate of 7.23 MGD results in 4.0 feet/year decrease in groundwater levels in the San Francisco Golf Club area
3) Hold Year results in 0.5 feet/year decrease in groundwater levels in the San Francisco Golf Club area
4) Exact Put amounts are derived from SFPUC (D. Cameron) spreadsheet for resequenced hydrology years.

Notes: DTW = depth to water; SFGC = San Francisco Golf Club; GWE = groundwater elevation; Sc = Model Scenario; Lay = Model Layer

Table C-13. SFPUC Storage Account and Colma Cemetery Water Level Changes for Third Party Well Interference Analysis.

Scenario Year	Put Months	Hold Months	Take Months	Put Storage Chanage	Take Storage Change	Net Storage Change	Put WL Change	Hold WL Change	Take WL Change	Net WL Change	Cum Storage Change
0	3	0	0	1,559	0	1,559	-2.17	0.00	0.00	-2.17	21,559
1	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	27,742
2	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	33,925
3	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	40,108
4	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	46,291
5	12	0	0	6,184	0	6,184	-8.60	0.00	0.00	-8.60	52,475
6	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	58,658
7	4	8	0	1,842	0	1,842	-2.56	0.50	0.00	-2.06	60,500
8	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,500
9	0	9	3	0	-2,025	-2,025	0.00	0.56	3.23	3.79	58,475
10	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	50,375
11	3	0	9	1,558	-6,075	-4,517	-2.17	0.00	9.68	7.51	45,858
12	12	0	0	6,184	0	6,184	-8.60	0.00	0.00	-8.60	52,042
13	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	58,225
14	5	7	0	2,205	0	2,205	-3.07	0.44	0.00	-2.63	60,430
15	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
16	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
17	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
18	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
19	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
20	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
21	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
22	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
23	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
24	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
25	0	9	3	0	-2,025	-2,025	0.00	0.56	3.23	3.79	58,405
26	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	50,305
27	3	0	9	1,558	-6,075	-4,517	-2.17	0.00	9.68	7.51	45,788
28	12	0	0	6,184	0	6,184	-8.60	0.00	0.00	-8.60	51,972
29	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	58,155
30	5	7	0	2,205	0	2,205	-3.07	0.44	0.00	-2.63	60,360
31	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
32	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
33	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
34	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
35	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
36	0	9	3	0	-2,025	-2,025	0.00	0.56	3.23	3.79	58,335
37	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	50,235
38	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	42,135
39	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	34,035
40	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	25,935
41	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	17,835
42	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	9,735
43	0	0	12	0	-8,100	-8,100	0.00	0.00	12.90	12.90	1,635
44	3	6	3	1,558	-2,025	-467	-2.17	0.38	3.23	1.43	1,168
45	12	0	0	6,184	0	6,184	-8.60	0.00	0.00	-8.60	7,352
46	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	13,535
47	12	0	0	6,183	0	6,183	-8.60	0.00	0.00	-8.60	19,718
Totals	182	247	138	92,868	-93,150	-282	-129.2	15.4	148.4	34.6	

Assumptions: Put Year Water Level Rise = 8.6 feet; Take Year Water Level Decline = 12.9 feet; Hold Year Water Level Decline = 0.75 feet. It is assumed that method of calculating Put/Take Year WL changes includes background decline component.

Table C-14. SFPUC Storage Account and California Golf Club Water Level Changes for Third Party Well Interference Analysis.

Scenario Year	Put Months	Hold Months	Take Months	Put Storage Chanage	Take Storage Change	Net Storage Change	Put WL Change	Hold WL Change	Take WL Change	Net WL Change	Cum Storage Change
0	3	0	0	1,559	0	1,559	-2.14	0.00	0.00	-2.14	21,559
1	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	27,742
2	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	33,925
3	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	40,108
4	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	46,291
5	12	0	0	6,184	0	6,184	-8.50	0.00	0.00	-8.50	52,475
6	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	58,658
7	4	8	0	1,842	0	1,842	-2.53	0.50	0.00	-2.03	60,500
8	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,500
9	0	9	3	0	-2,025	-2,025	0.00	0.56	4.63	5.19	58,475
10	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	50,375
11	3	0	9	1,558	-6,075	-4,517	-2.14	0.00	13.88	11.73	45,858
12	12	0	0	6,184	0	6,184	-8.50	0.00	0.00	-8.50	52,042
13	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	58,225
14	5	7	0	2,205	0	2,205	-3.03	0.44	0.00	-2.59	60,430
15	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
16	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
17	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
18	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
19	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
20	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
21	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
22	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
23	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
24	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
25	0	9	3	0	-2,025	-2,025	0.00	0.56	4.63	5.19	58,405
26	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	50,305
27	3	0	9	1,558	-6,075	-4,517	-2.14	0.00	13.88	11.73	45,788
28	12	0	0	6,184	0	6,184	-8.50	0.00	0.00	-8.50	51,972
29	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	58,155
30	5	7	0	2,205	0	2,205	-3.03	0.44	0.00	-2.59	60,360
31	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
32	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
33	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
34	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
35	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
36	0	9	3	0	-2,025	-2,025	0.00	0.56	4.63	5.19	58,335
37	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	50,235
38	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	42,135
39	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	34,035
40	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	25,935
41	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	17,835
42	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	9,735
43	0	0	12	0	-8,100	-8,100	0.00	0.00	18.50	18.50	1,635
44	3	6	3	1,558	-2,025	-467	-2.14	0.38	4.63	2.86	1,168
45	12	0	0	6,184	0	6,184	-8.50	0.00	0.00	-8.50	7,352
46	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	13,535
47	12	0	0	6,183	0	6,183	-8.50	0.00	0.00	-8.50	19,718
Totals	182	247	138	92,868	-93,150	-282	-127.7	15.4	212.8	100.5	

Assumptions: Put Year Water Level Rise = 8.5 feet; Take Year Water Level Decline = 18.5 feet; Hold Year Water Level Decline = 0.75 feet. It is assumed that method of calculating Put/Take Year WL changes includes background decline component.

Table C-15. SFPUC Storage Account and Lake Merced Golf Club Water Level Changes for Third Party Well Interference Analysis.

Scenario Year	Put Months	Hold Months	Take Months	Put Storage Chanage	Take Storage Change	Net Storage Change	Put WL Change	Hold WL Change	Take WL Change	Net WL Change	Cum Storage Change
0	3	0	0	1,559	0	1,559	-2.65	0.00	0.00	-2.65	21,559
1	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	27,742
2	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	33,925
3	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	40,108
4	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	46,291
5	12	0	0	6,184	0	6,184	-10.50	0.00	0.00	-10.50	52,475
6	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	58,658
7	4	8	0	1,842	0	1,842	-3.13	0.50	0.00	-2.63	60,500
8	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,500
9	0	9	3	0	-2,025	-2,025	0.00	0.56	3.75	4.31	58,475
10	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	50,375
11	3	0	9	1,558	-6,075	-4,517	-2.65	0.00	11.25	8.60	45,858
12	12	0	0	6,184	0	6,184	-10.50	0.00	0.00	-10.50	52,042
13	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	58,225
14	5	7	0	2,205	0	2,205	-3.74	0.44	0.00	-3.31	60,430
15	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
16	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
17	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
18	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
19	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
20	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
21	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
22	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
23	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
24	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,430
25	0	9	3	0	-2,025	-2,025	0.00	0.56	3.75	4.31	58,405
26	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	50,305
27	3	0	9	1,558	-6,075	-4,517	-2.65	0.00	11.25	8.60	45,788
28	12	0	0	6,184	0	6,184	-10.50	0.00	0.00	-10.50	51,972
29	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	58,155
30	5	7	0	2,205	0	2,205	-3.74	0.44	0.00	-3.31	60,360
31	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
32	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
33	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
34	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
35	0	12	0	0	0	0	0.00	0.75	0.00	0.75	60,360
36	0	9	3	0	-2,025	-2,025	0.00	0.56	3.75	4.31	58,335
37	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	50,235
38	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	42,135
39	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	34,035
40	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	25,935
41	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	17,835
42	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	9,735
43	0	0	12	0	-8,100	-8,100	0.00	0.00	15.00	15.00	1,635
44	3	6	3	1,558	-2,025	-467	-2.65	0.38	3.75	1.48	1,168
45	12	0	0	6,184	0	6,184	-10.50	0.00	0.00	-10.50	7,352
46	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	13,535
47	12	0	0	6,183	0	6,183	-10.50	0.00	0.00	-10.50	19,718
Totals	182	247	138	92,868	-93,150	-282	-157.7	15.4	172.5	30.2	

Assumptions: Put Year Water Level Rise = 10.5 feet; Take Year Water Level Decline = 15.0 feet; Hold Year Water Level Decline = 0.75 feet. It is assumed that method of calculating Put/Take Year WL changes includes background decline component.

Table C-16. SFPUC Storage Account and Olympic Club Well Water Level Changes for Third Party Well Interference Analysis (based upon 2002-2005 data only)

Scenario Year	Put Months	Hold Months	Take Months	Put Storage Chanage	Take Storage Change	Net Storage Change	Put WL Change	Hold WL Change	Take WL Change	Net WL Change	Cum Storage Change
0	3	0	0	1,559	0	1,559	-0.91	0.00	0.00	-0.91	21,559
1	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	27,742
2	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	33,925
3	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	40,108
4	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	46,291
5	12	0	0	6,184	0	6,184	-3.60	0.00	0.00	-3.60	52,475
6	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	58,658
7	4	8	0	1,842	0	1,842	-1.07	0.33	0.00	-0.74	60,500
8	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,500
9	0	9	3	0	-2,025	-2,025	0.00	0.38	1.00	1.38	58,475
10	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	50,375
11	3	0	9	1,558	-6,075	-4,517	-0.91	0.00	3.00	2.09	45,858
12	12	0	0	6,184	0	6,184	-3.60	0.00	0.00	-3.60	52,042
13	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	58,225
14	5	7	0	2,205	0	2,205	-1.28	0.29	0.00	-0.99	60,430
15	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
16	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
17	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
18	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
19	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
20	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
21	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
22	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
23	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
24	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,430
25	0	9	3	0	-2,025	-2,025	0.00	0.38	1.00	1.38	58,405
26	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	50,305
27	3	0	9	1,558	-6,075	-4,517	-0.91	0.00	3.00	2.09	45,788
28	12	0	0	6,184	0	6,184	-3.60	0.00	0.00	-3.60	51,972
29	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	58,155
30	5	7	0	2,205	0	2,205	-1.28	0.29	0.00	-0.99	60,360
31	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,360
32	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,360
33	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,360
34	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,360
35	0	12	0	0	0	0	0.00	0.50	0.00	0.50	60,360
36	0	9	3	0	-2,025	-2,025	0.00	0.38	1.00	1.38	58,335
37	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	50,235
38	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	42,135
39	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	34,035
40	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	25,935
41	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	17,835
42	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	9,735
43	0	0	12	0	-8,100	-8,100	0.00	0.00	4.00	4.00	1,635
44	3	6	3	1,558	-2,025	-467	-0.91	0.25	1.00	0.34	1,168
45	12	0	0	6,184	0	6,184	-3.60	0.00	0.00	-3.60	7,352
46	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	13,535
47	12	0	0	6,183	0	6,183	-3.60	0.00	0.00	-3.60	19,718
Totals	182	247	138	92,868	-93,150	-282	-54.1	10.3	46.0	2.2	

Assumptions: Put Year Water Level Rise = 3.6 feet; Take Year Water Level Decline = 4.0 feet; Hold Year Water Level Decline = 0.5 feet. It is assumed that method of calculating Put/Take Year WL changes includes background decline component.

Figure C-1. Estimated Static Water Levels at Woodlawn Cemetery Primary Well for GSR Project

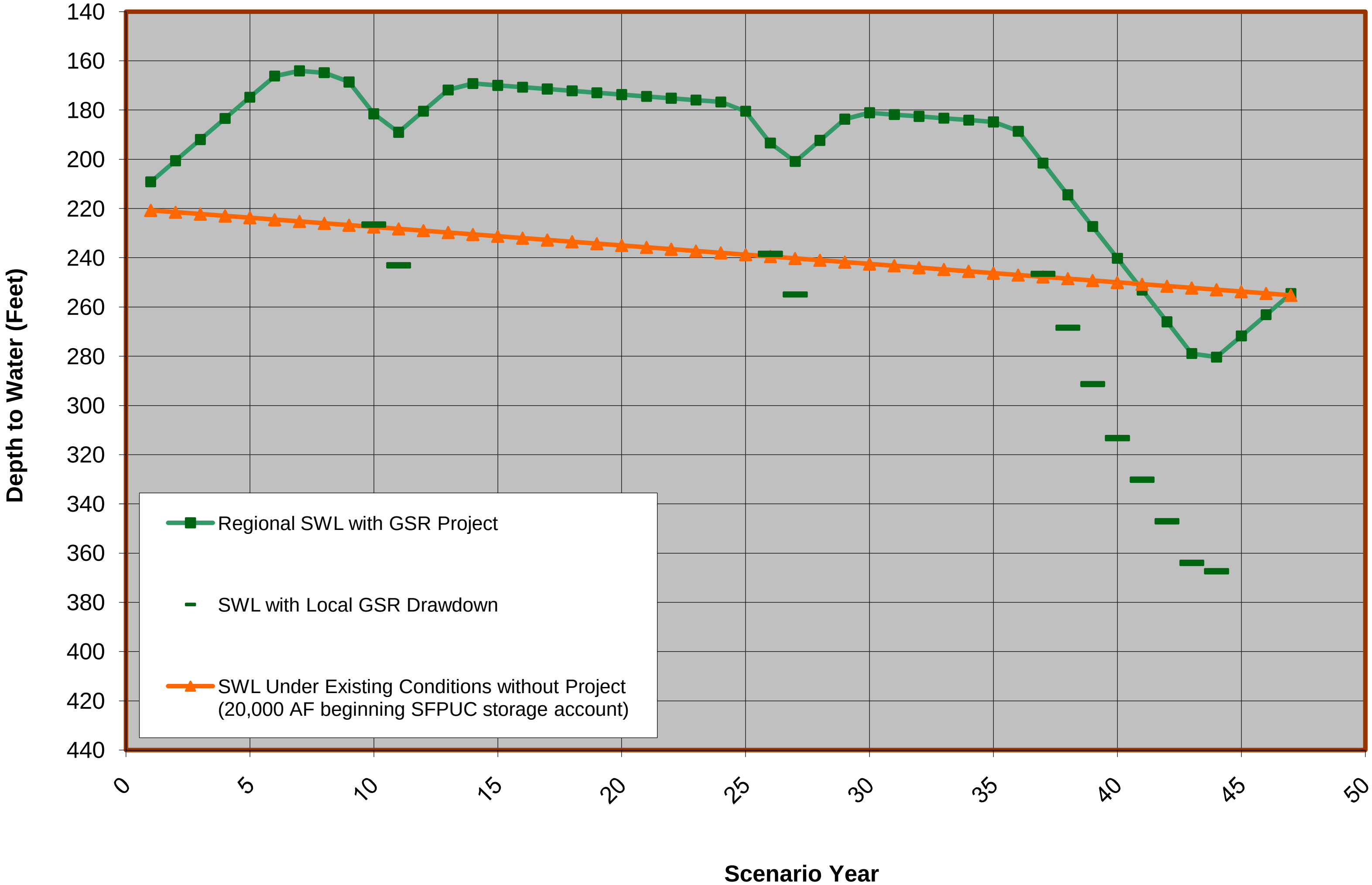


Figure C-2. Estimated Groundwater Elevations at Woodlawn Cemetery Primary Well for GSR Project (Scenario 2)

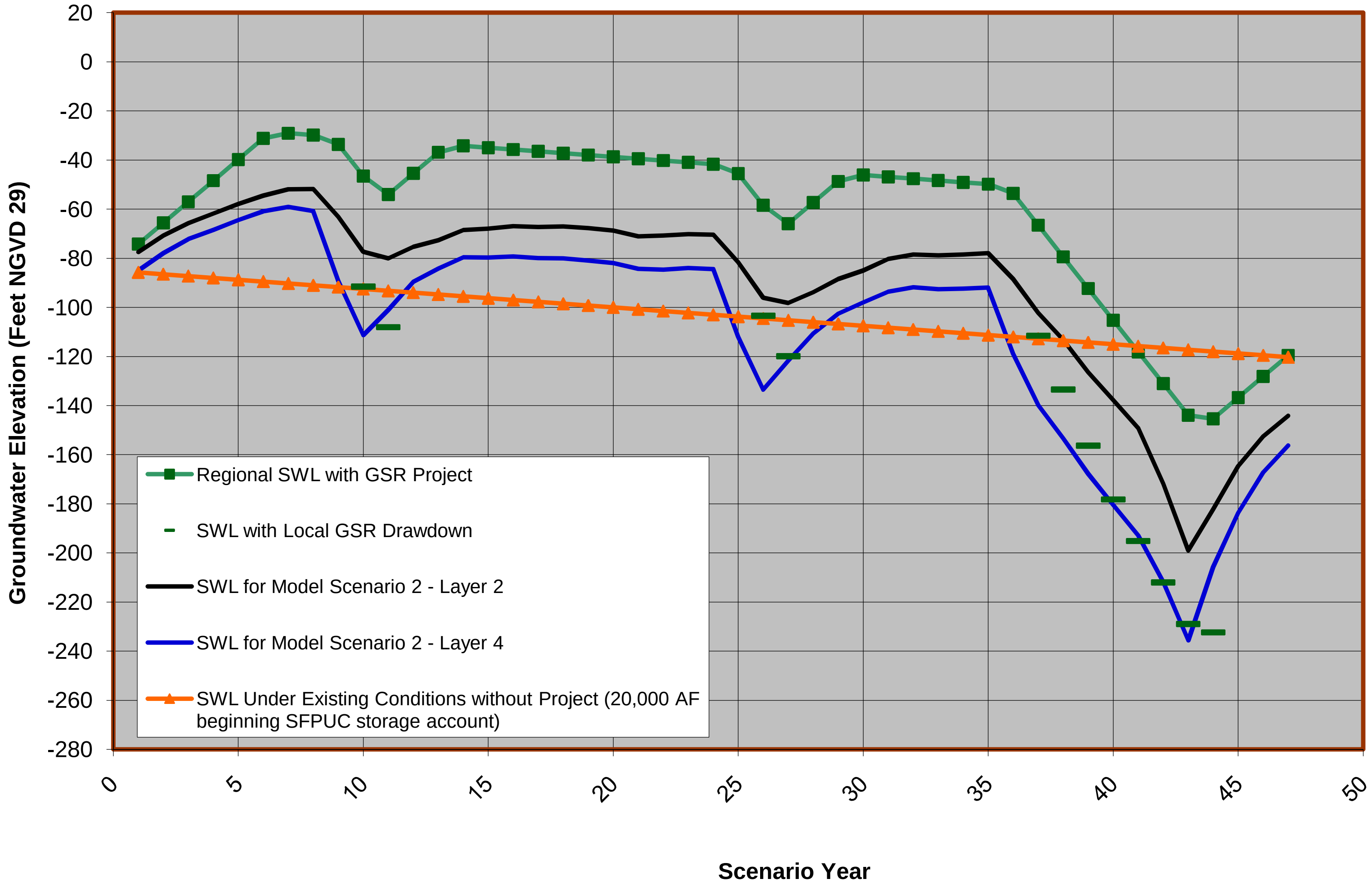


Figure C-3. Estimated Static Water Levels at Italian Cemetery Well for GSR Project

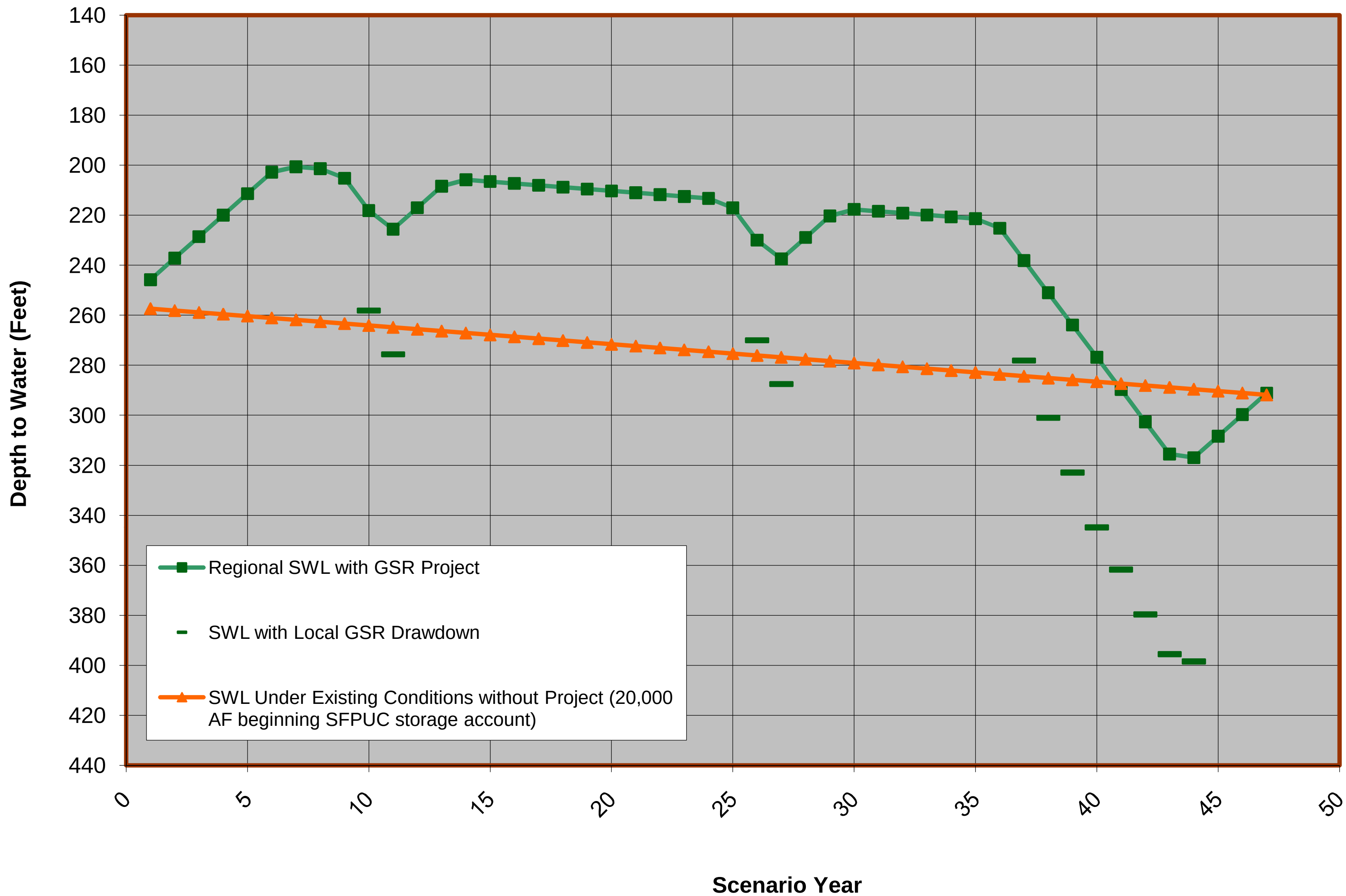


Figure C-4. Estimated Groundwater Elevations at Italian Cemetery Well for GSR Project (Scenario 2)

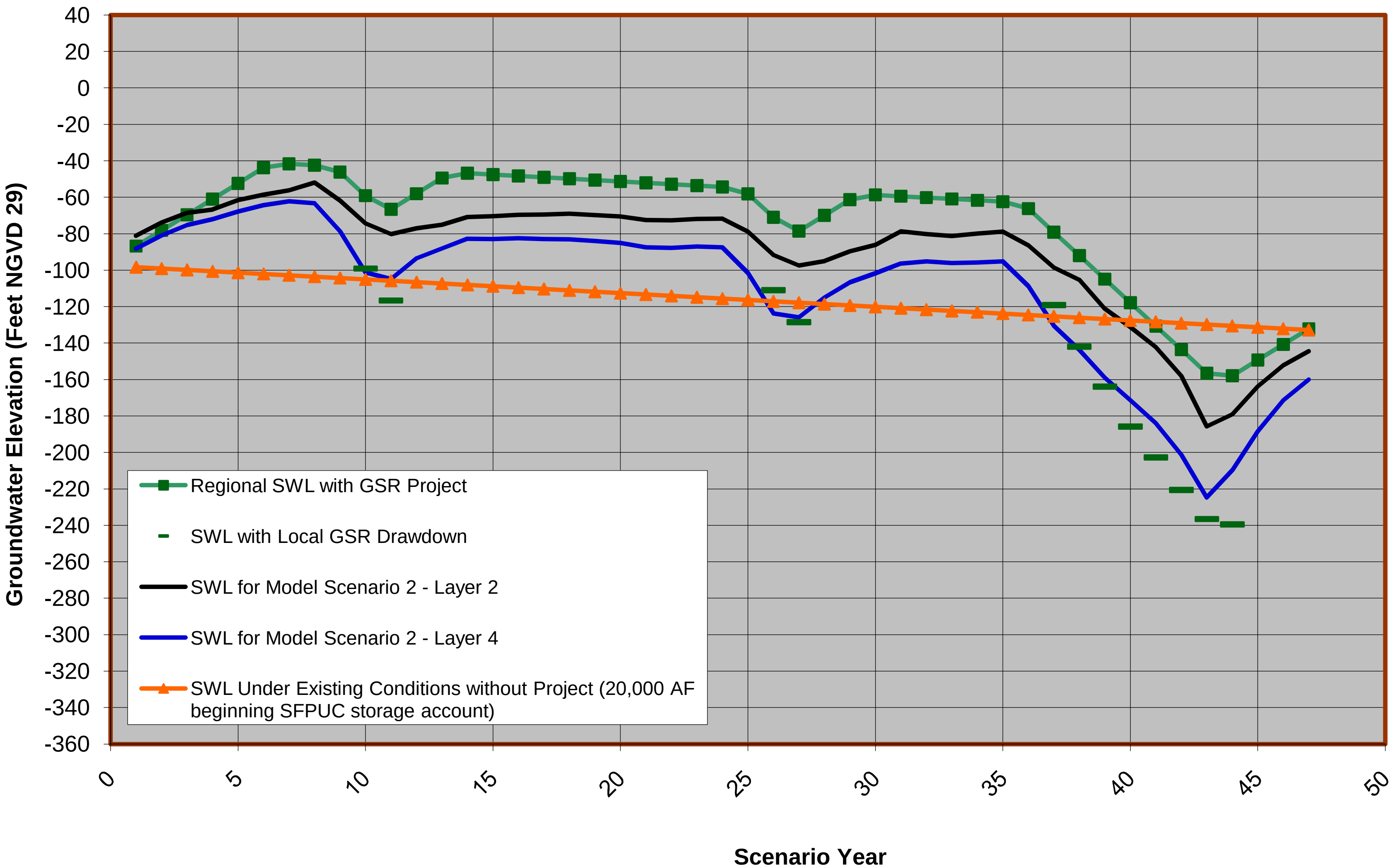


Figure C-5. Estimated Static Water Levels at Olivet Cemetery Well for GSR Project

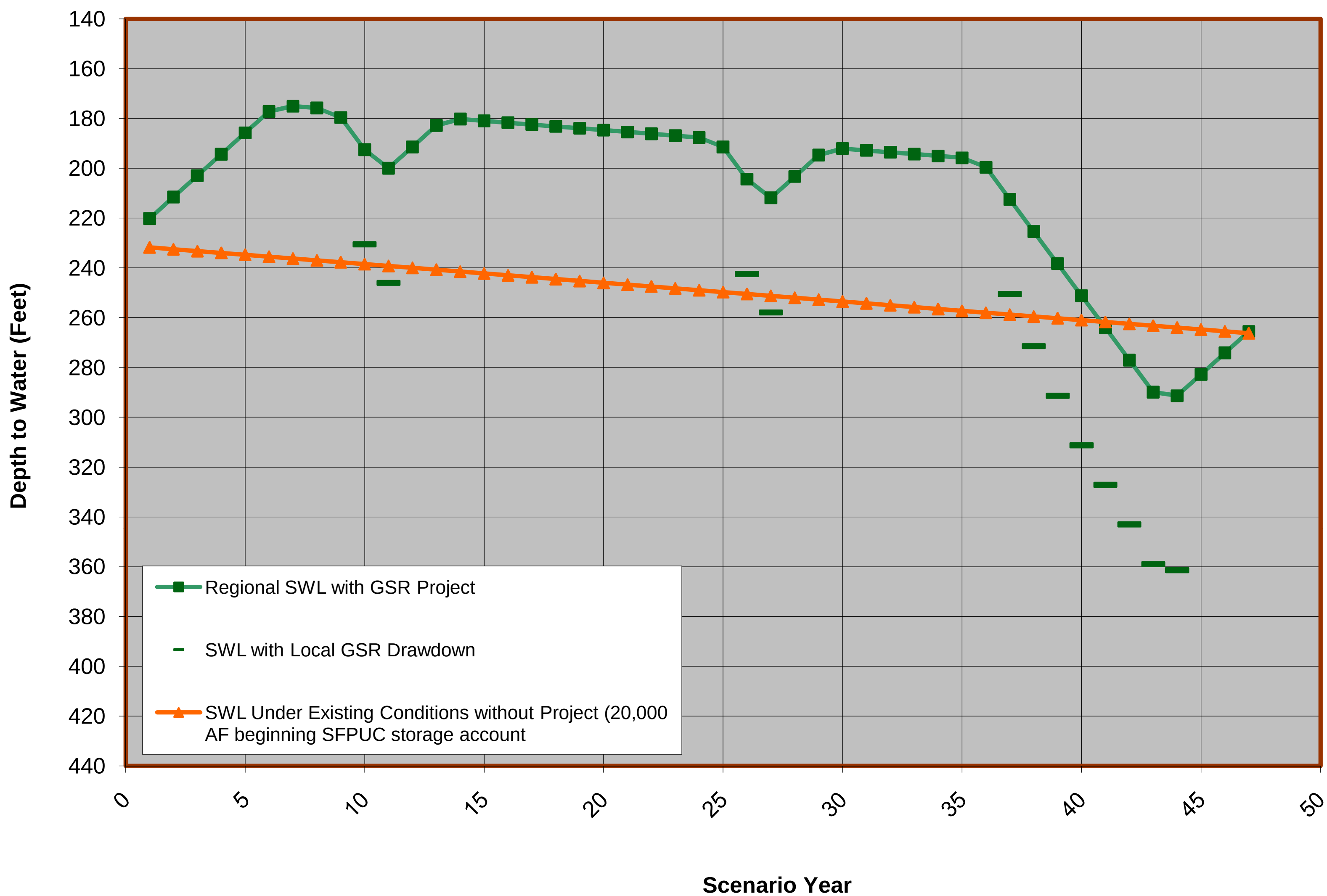


Figure C-6. Estimated Groundwater Elevations at Olivet Cemetery Well for GSR Project (Scenario 2)

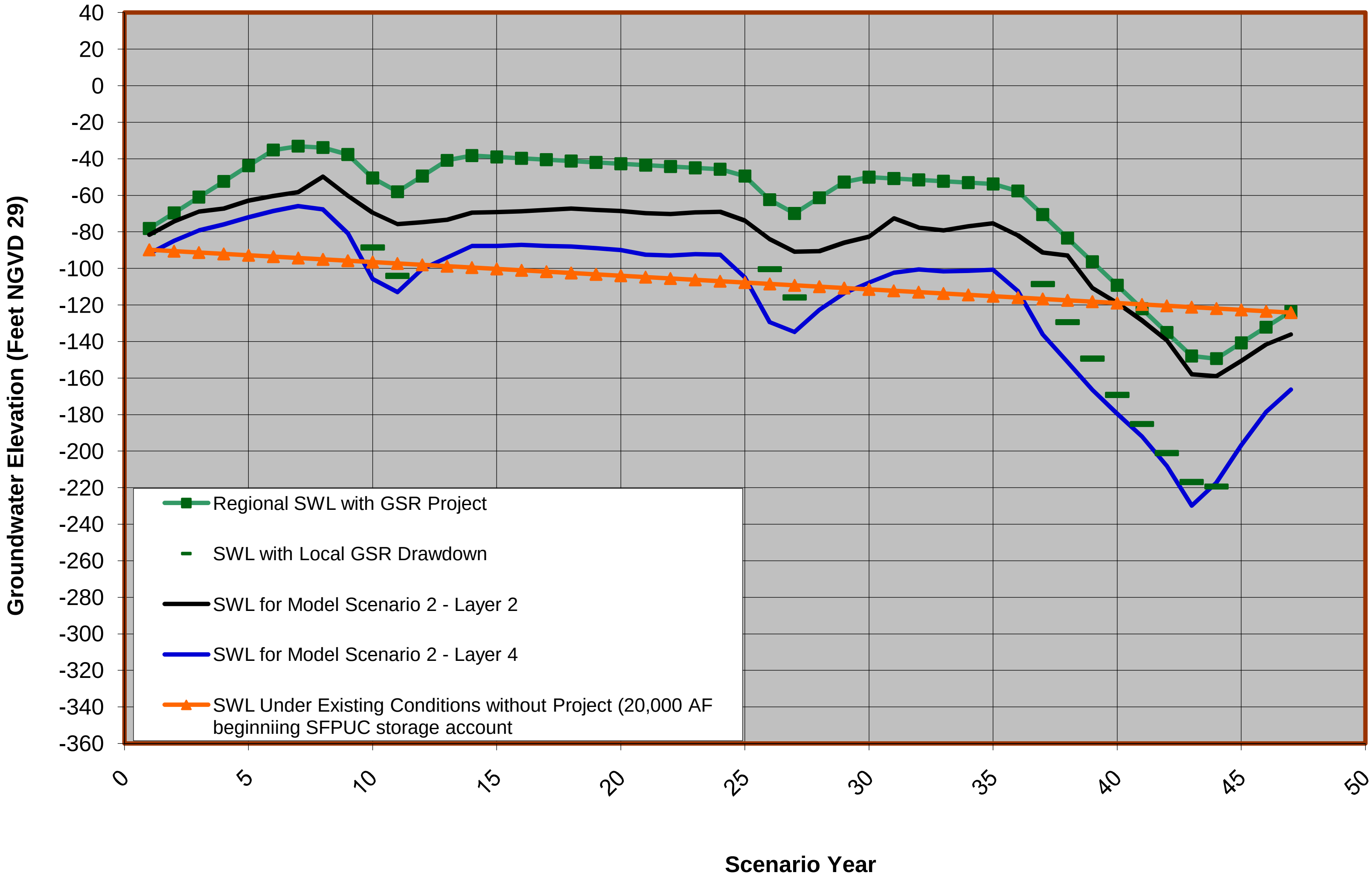


Figure C-7. Estimated Static Water Levels at Home of Peace Cemetery Well for GSR Project

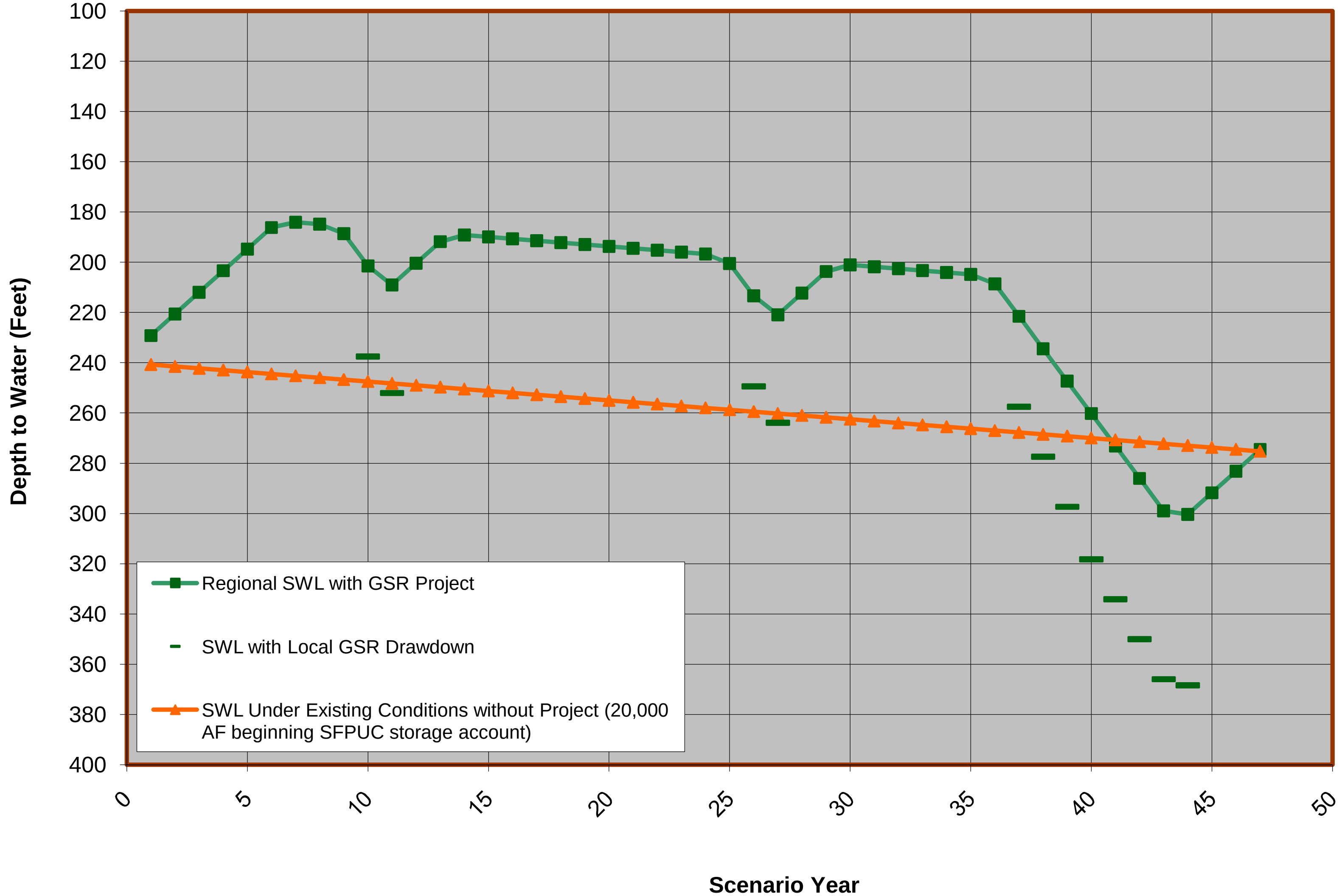


Figure C-8. Estimated Groundwater Elevations at Home of Peace Cemetery Well for GSR Project (Scenario 2)

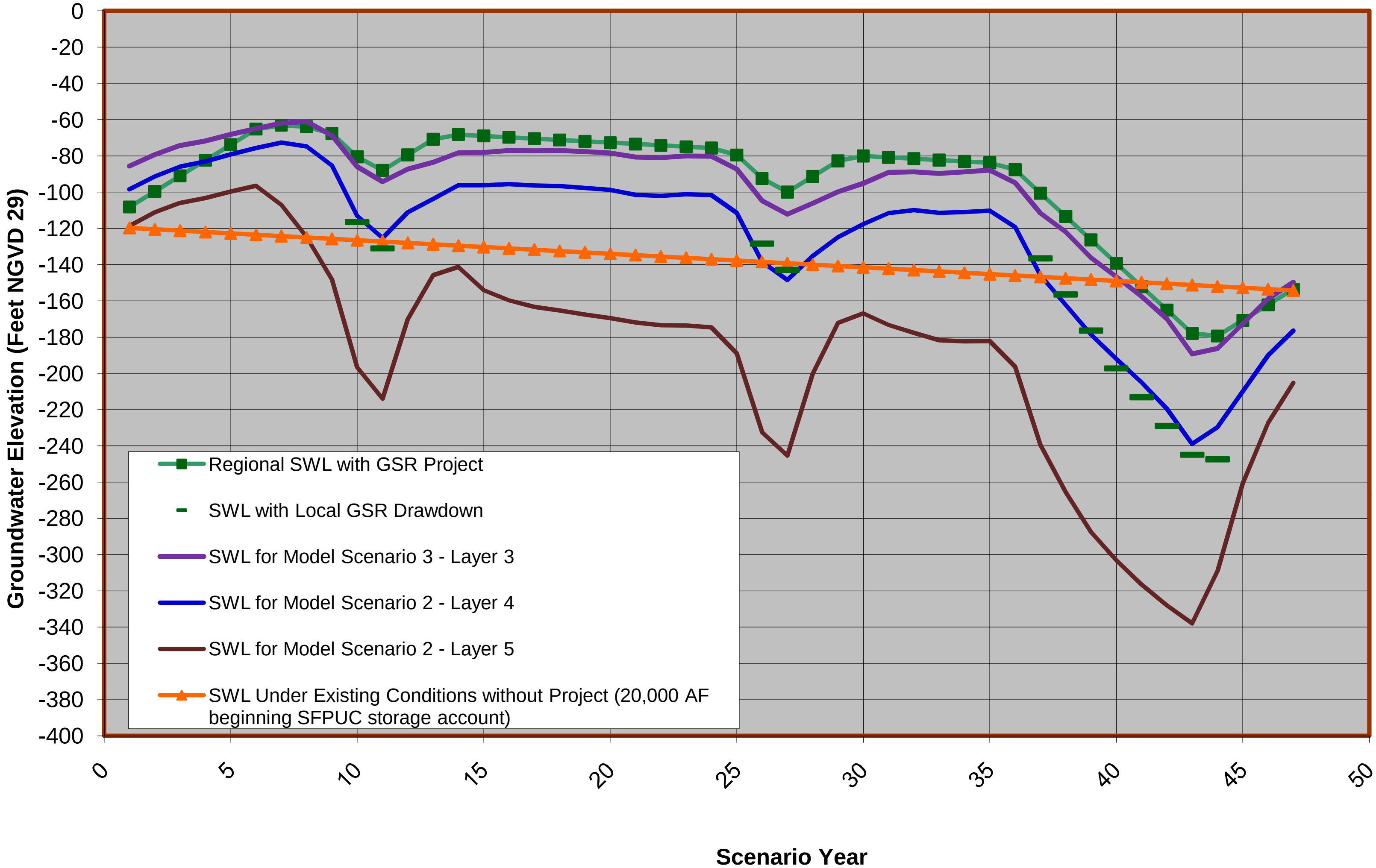


Figure C-9. Estimated Static Water Levels at Hills of Eternity Cemetery Well for GSR Project

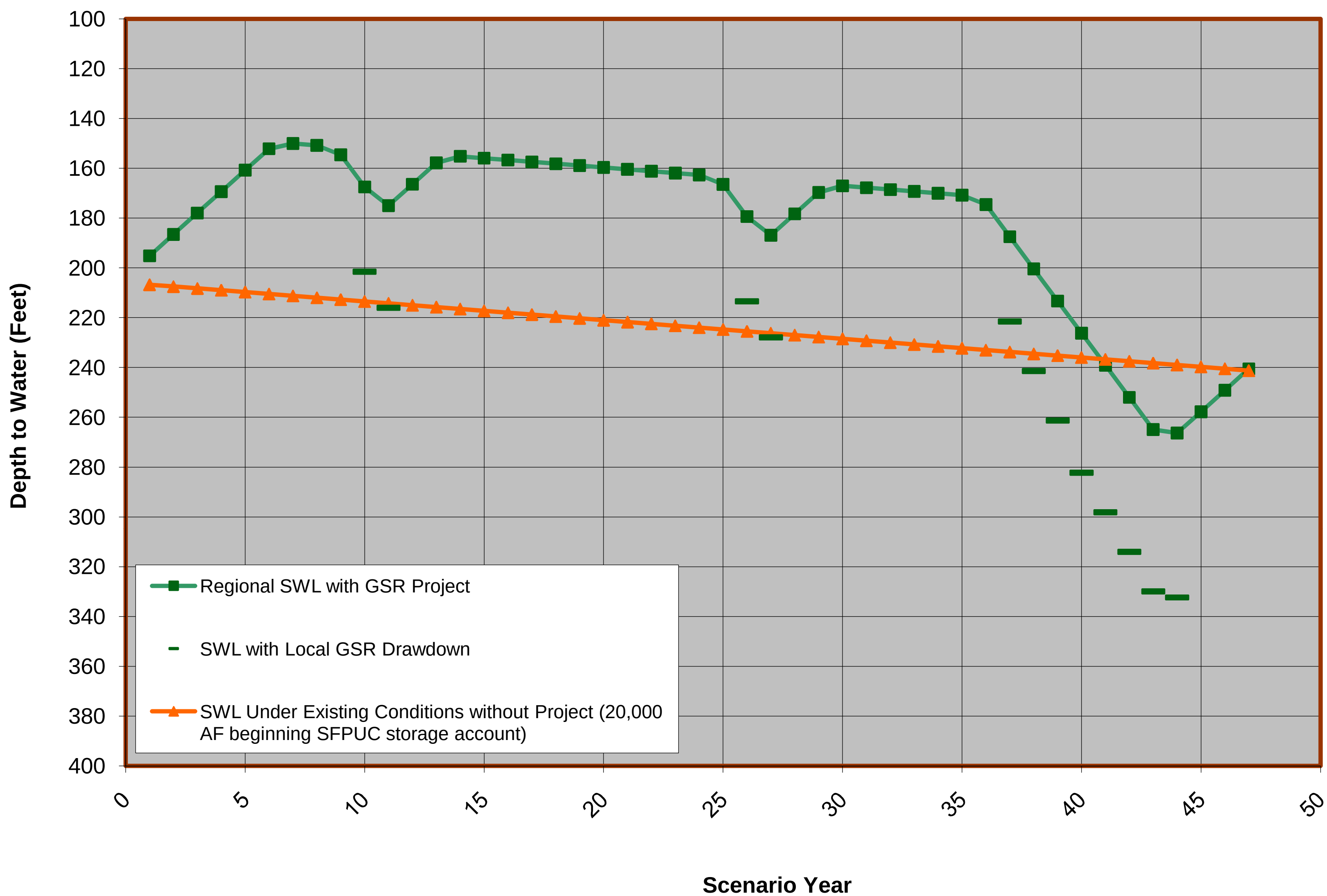


Figure C-10. Estimated Groundwater Elevations at Hills of Eternity Cemetery Well for GSR Project (Scenario 2)

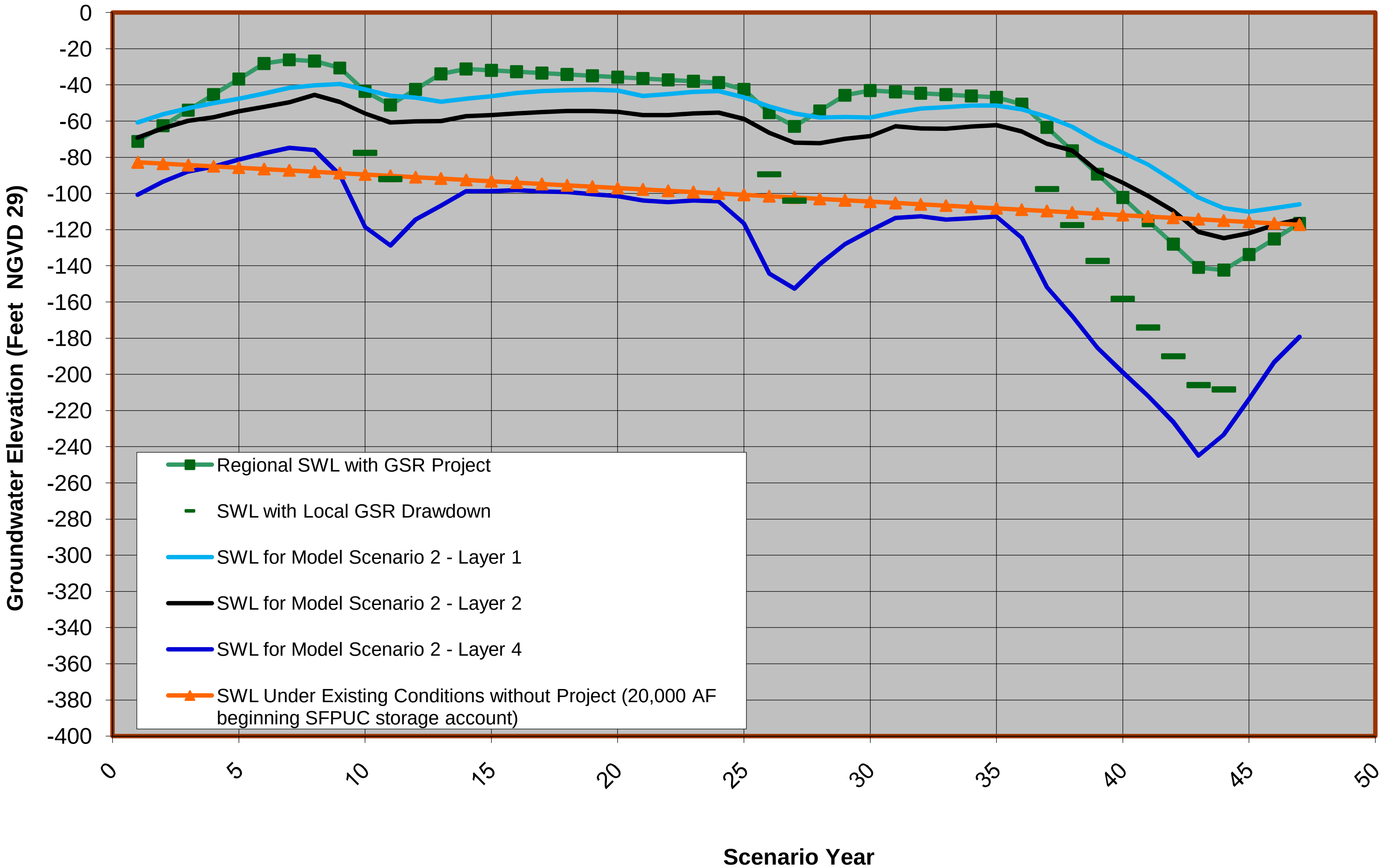


Figure C-11. Estimated Static Water Levels at Cypress Lawn Cemetery Well 3 for GSR Project

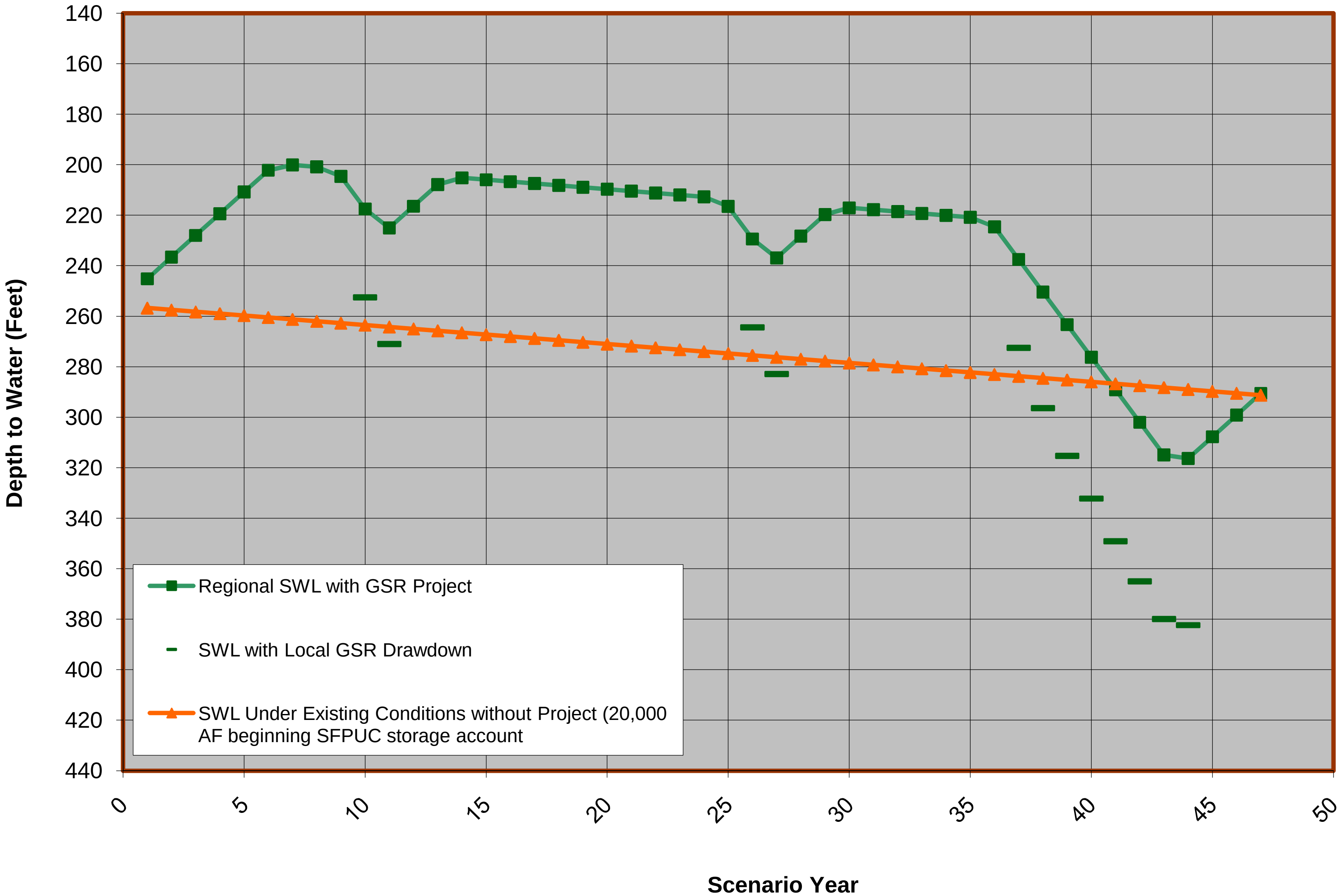


Figure C-12. Estimated Groundwater Elevations at Cypress Lawn Cemetery Well 3 for GSR Project (Scenario 2)

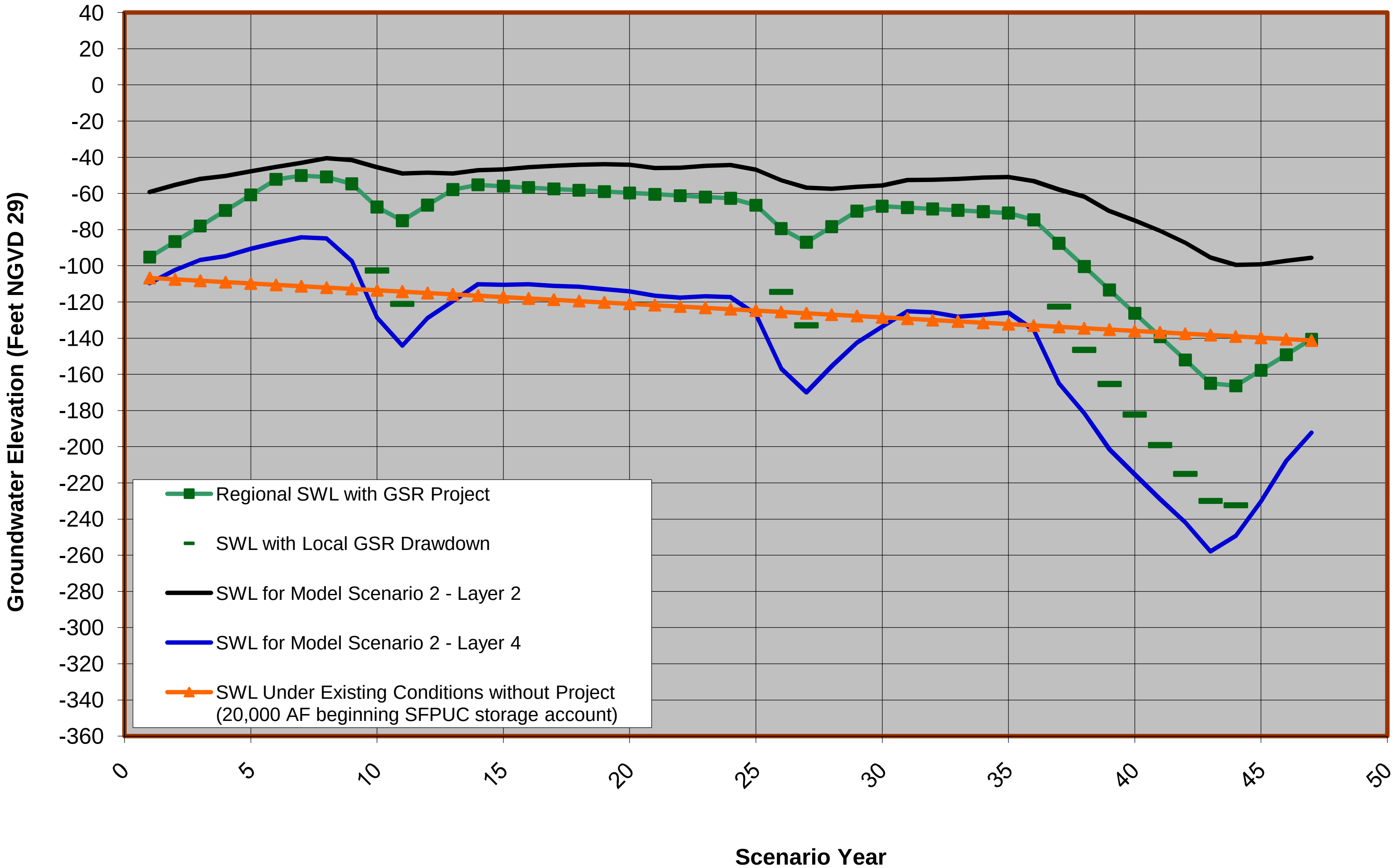


Figure C-13. Estimated Static Water Levels at Cypress Lawn Cemetery Well 4 for GSR Project

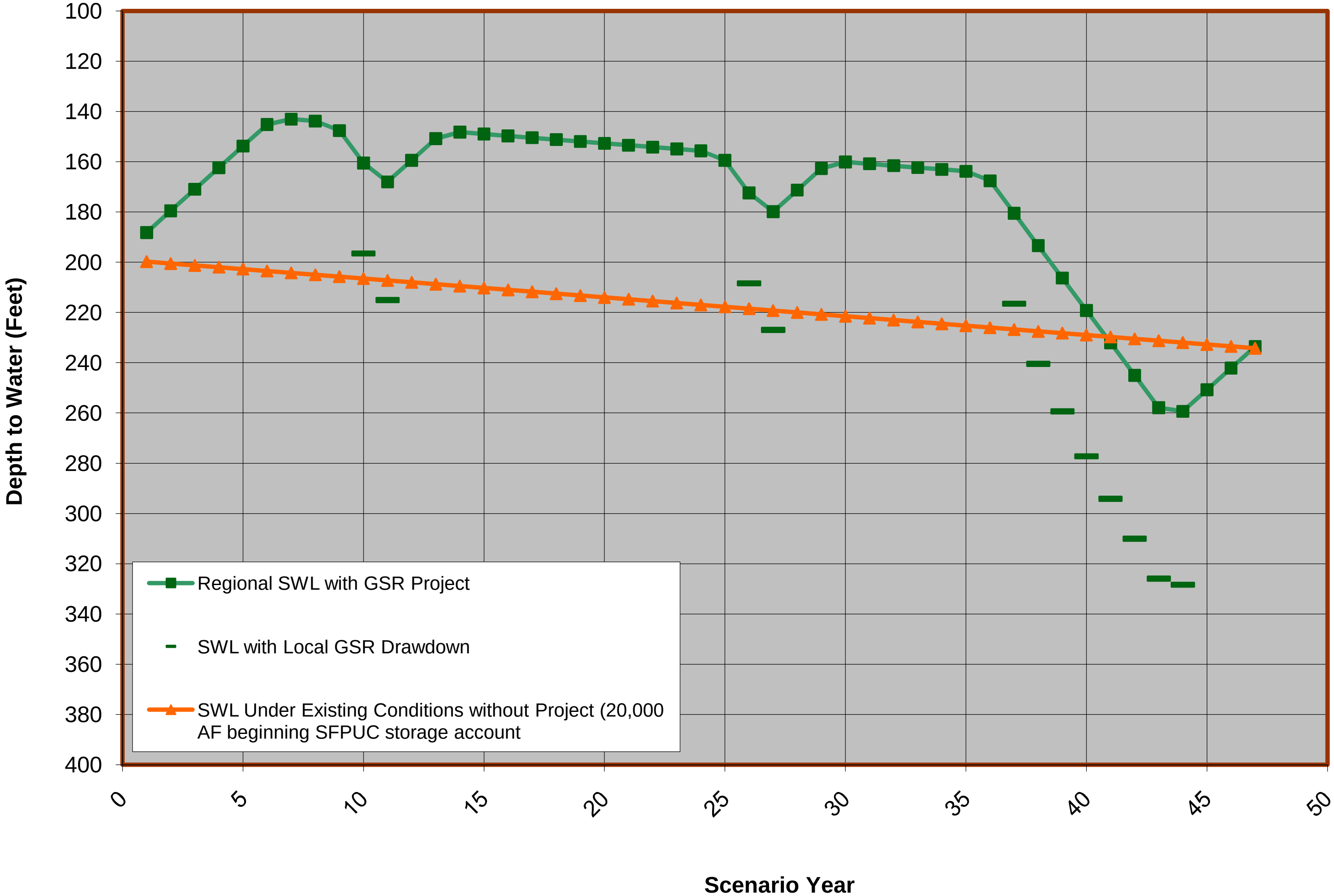


Figure C-14. Estimated Groundwater Elevations at Cypress Lawn Cemetery Well 4 for GSR Project (Scenario 2)

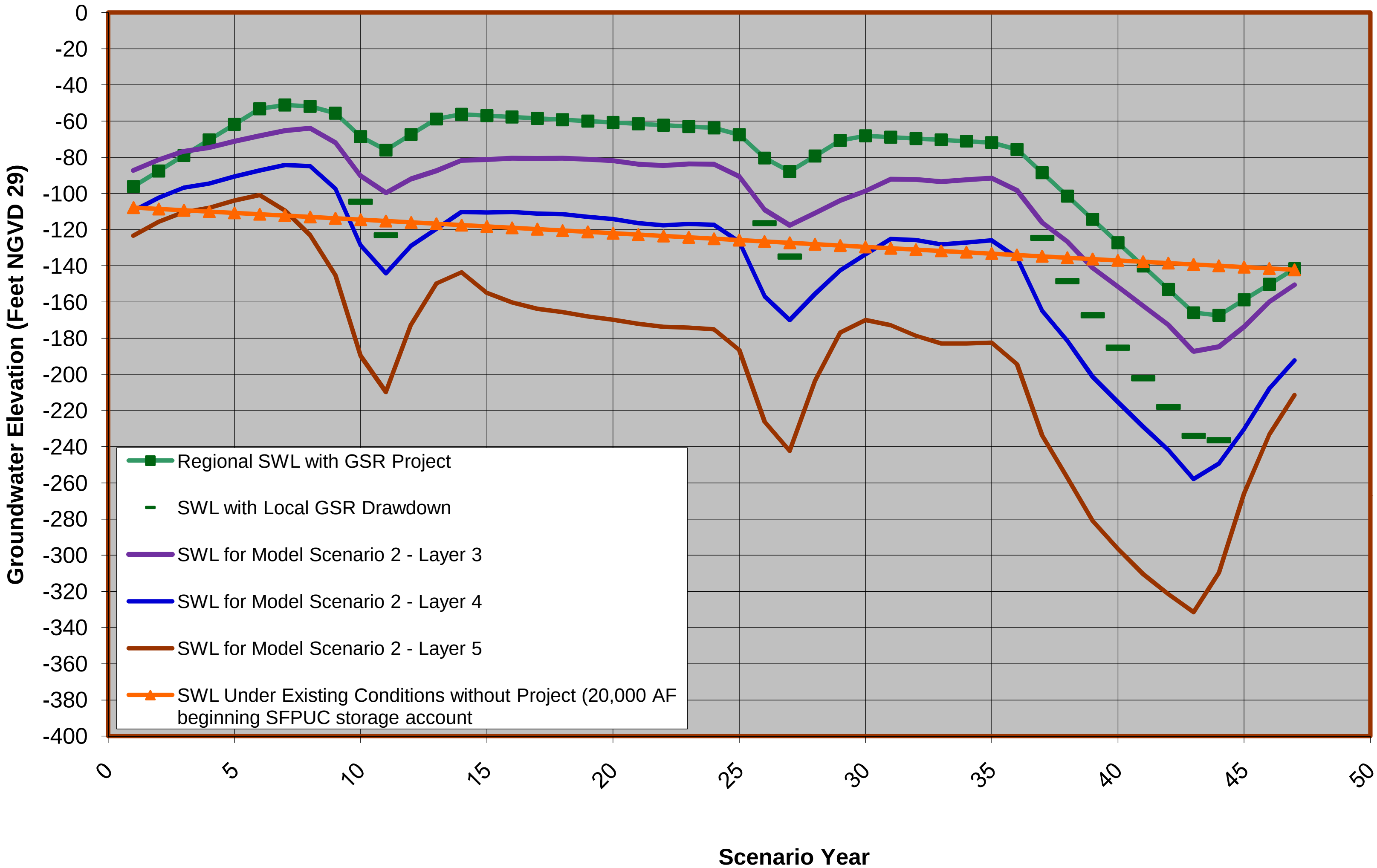


Figure C-15. Estimated Static Water Levels at Holy Cross Cemetery Well 1 for GSR Project

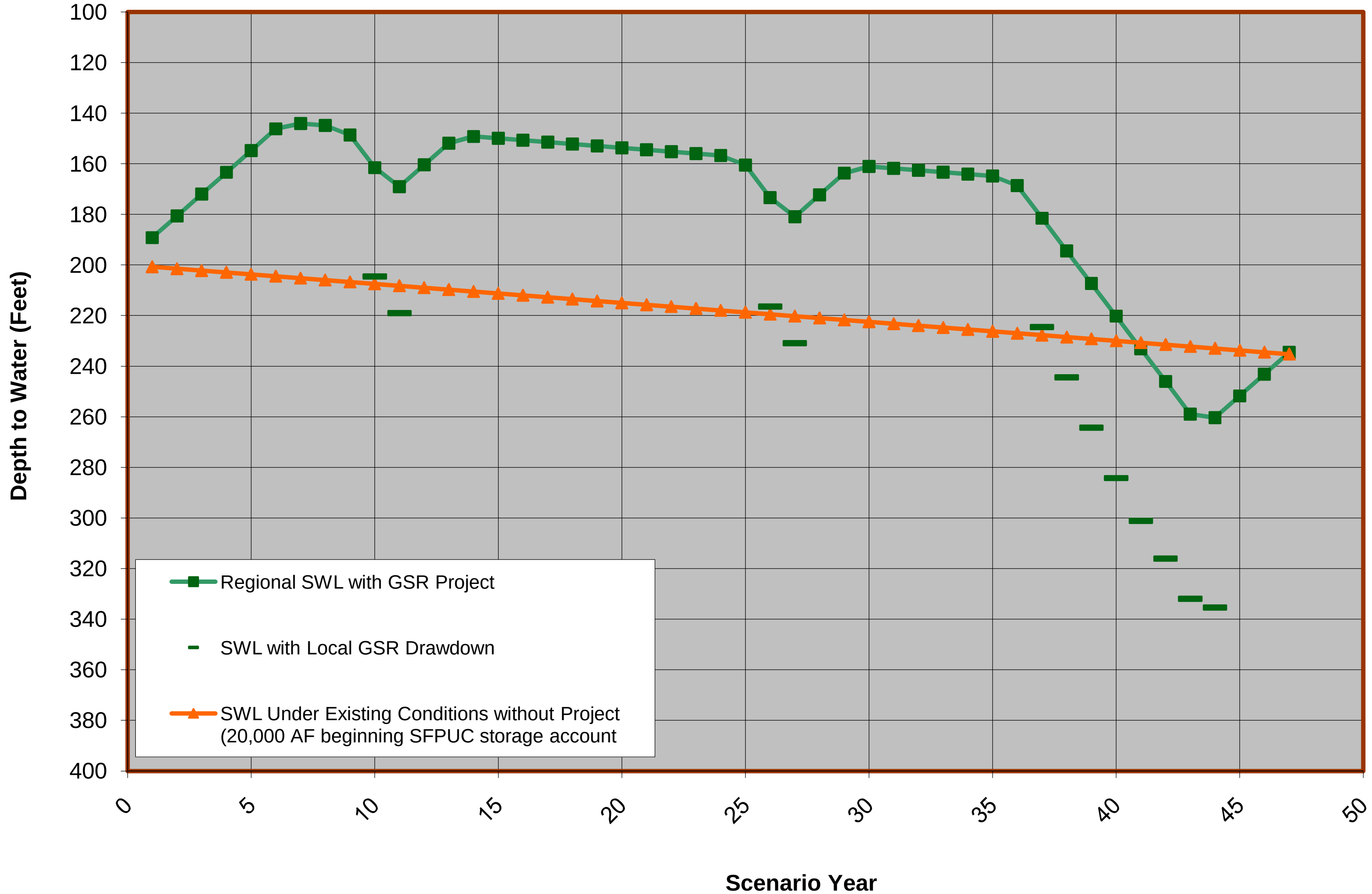


Figure C-16. Estimated Groundwater Elevations at Holy Cross Cemetery Well 1 for GSR Project (Scenario 2)

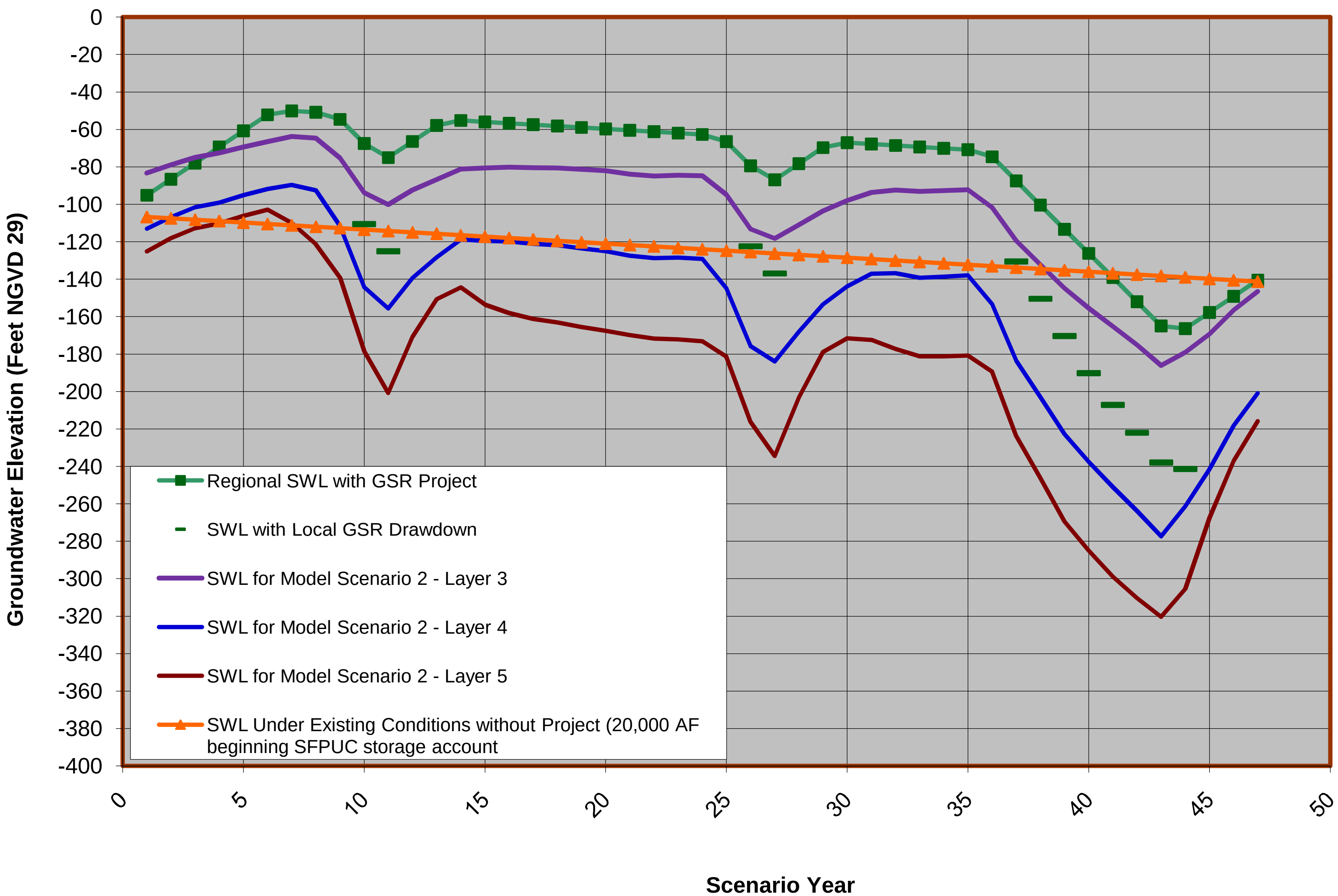


Figure C-17. Estimated Static Water Levels at Holy Cross Cemetery Well 4 for GSR Project

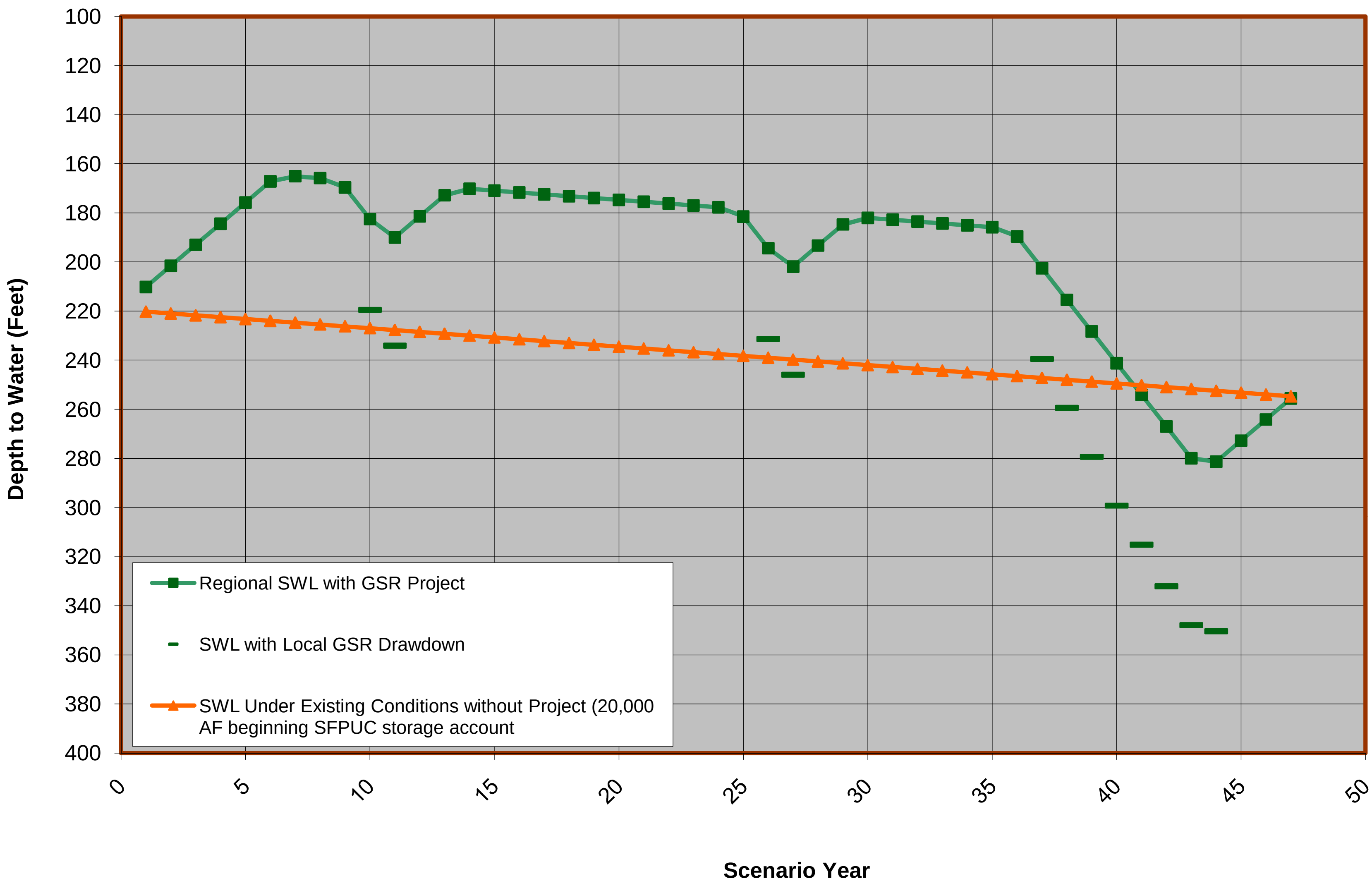


Figure C-18. Estimated Groundwater Elevations at Holy Cross Cemetery Well 4 for GSR Project (Scenario 2)

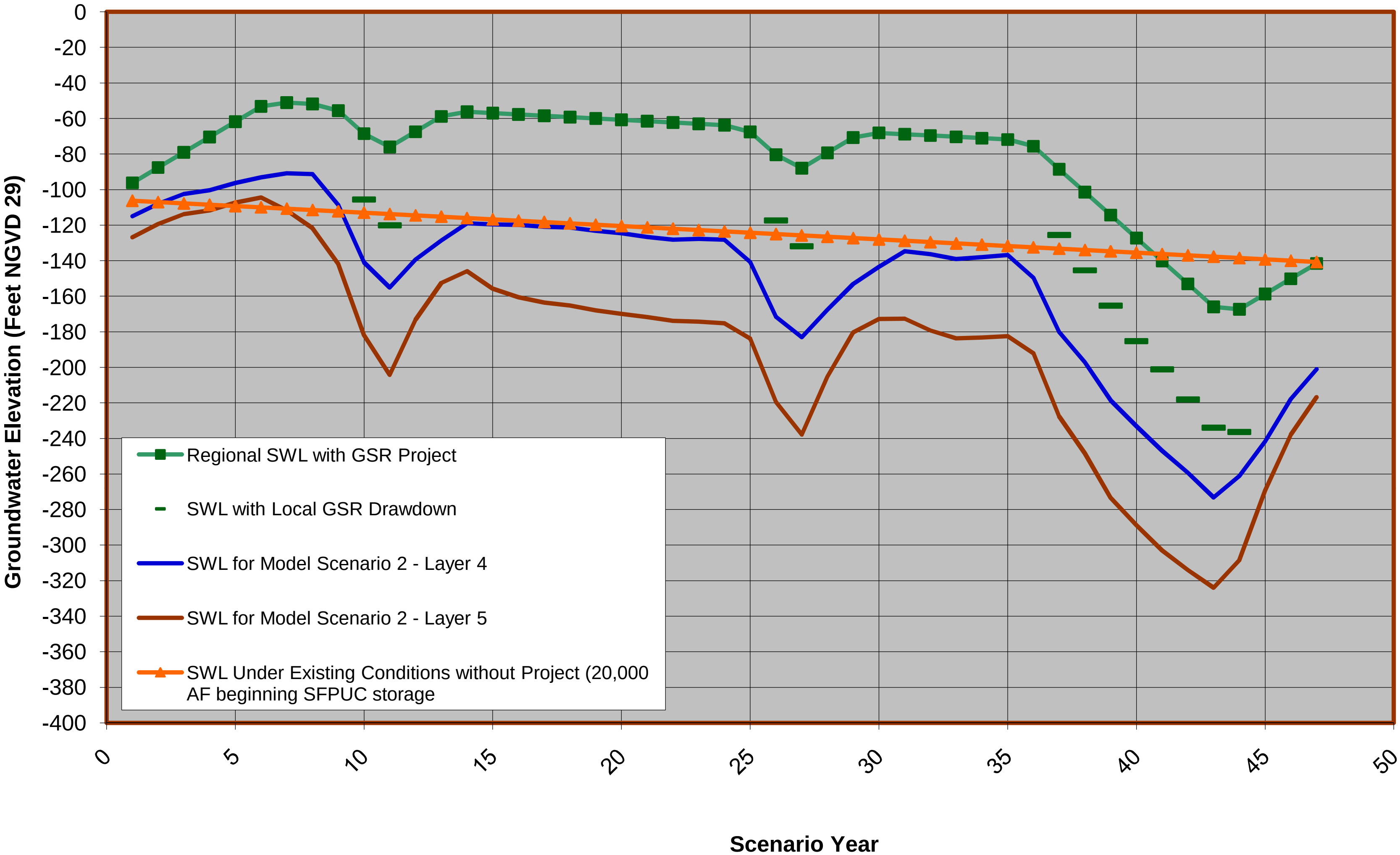


Figure C-19. Estimated Static Water Levels at California Golf Club Well 7 for GSR Project

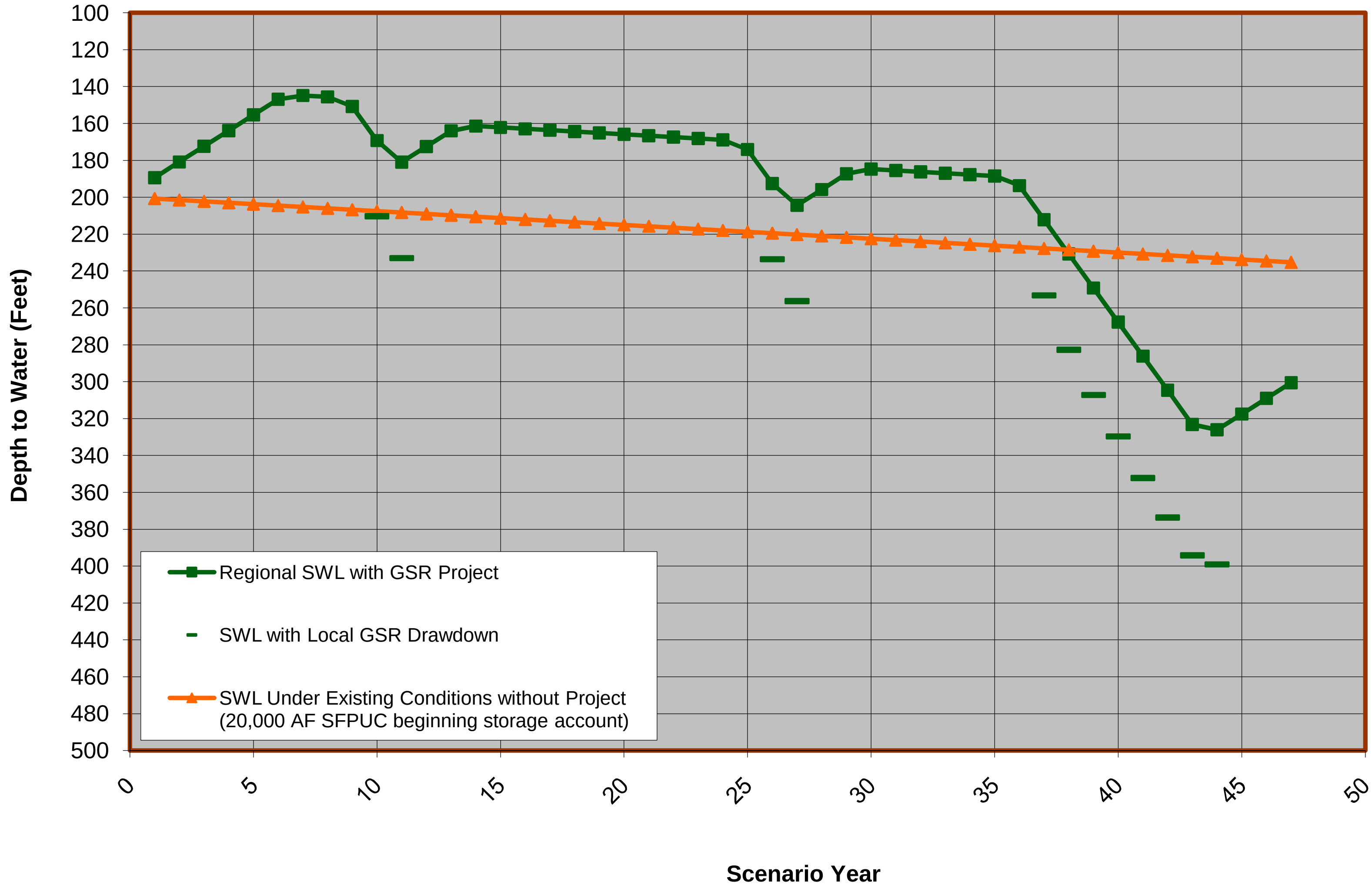


Figure C-20. Estimated Groundwater Elevations at California Golf Club Well 7 for GSR Project

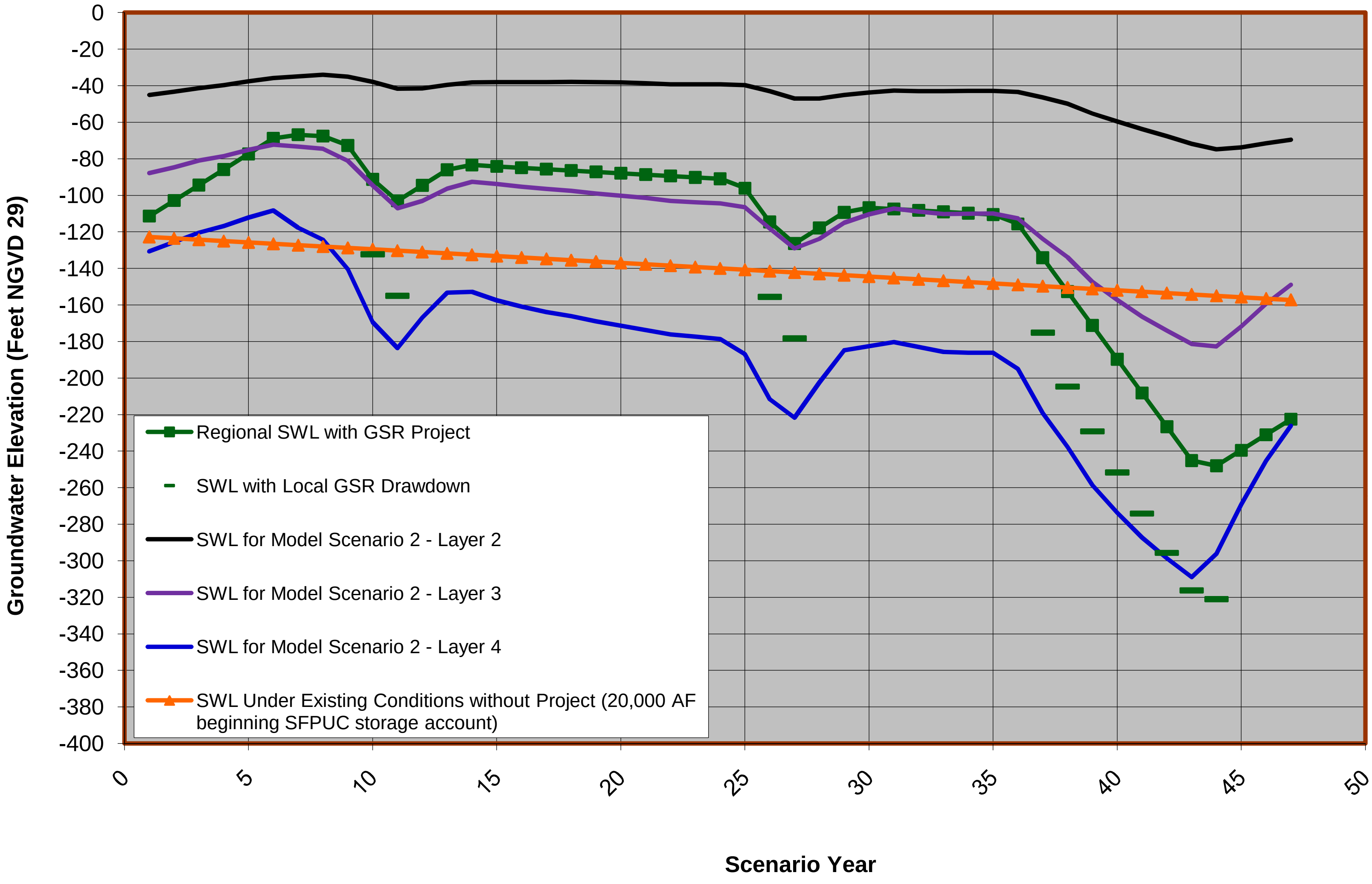


Figure C-21. Estimated Groundwater Elevations at Olympic Club Well No. 2 (#8) for GSR Project (Scenario 2)

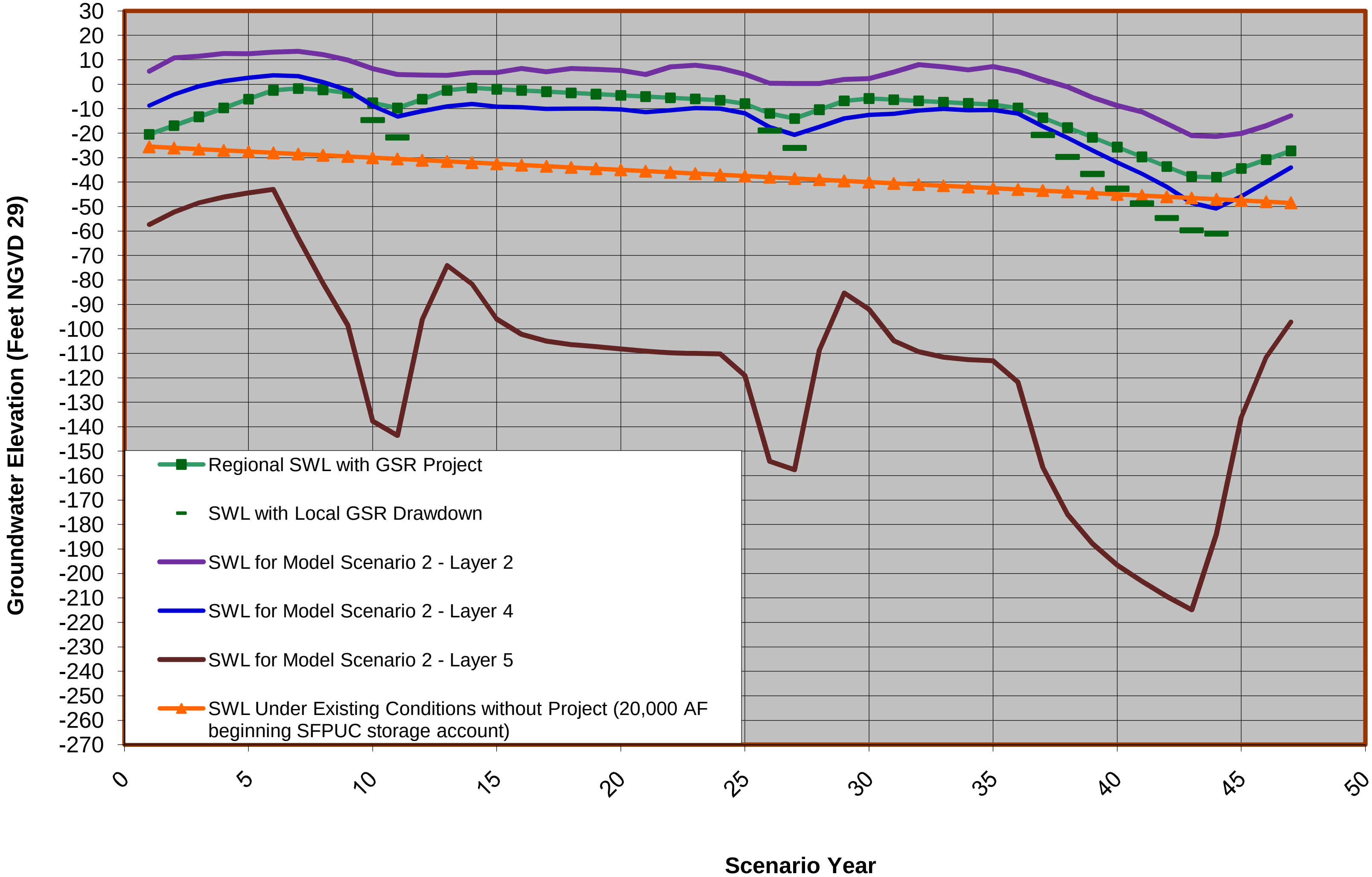


Figure C-22. Estimated Static Water Levels at San Francisco Golf Club Well 2 for GSR Project

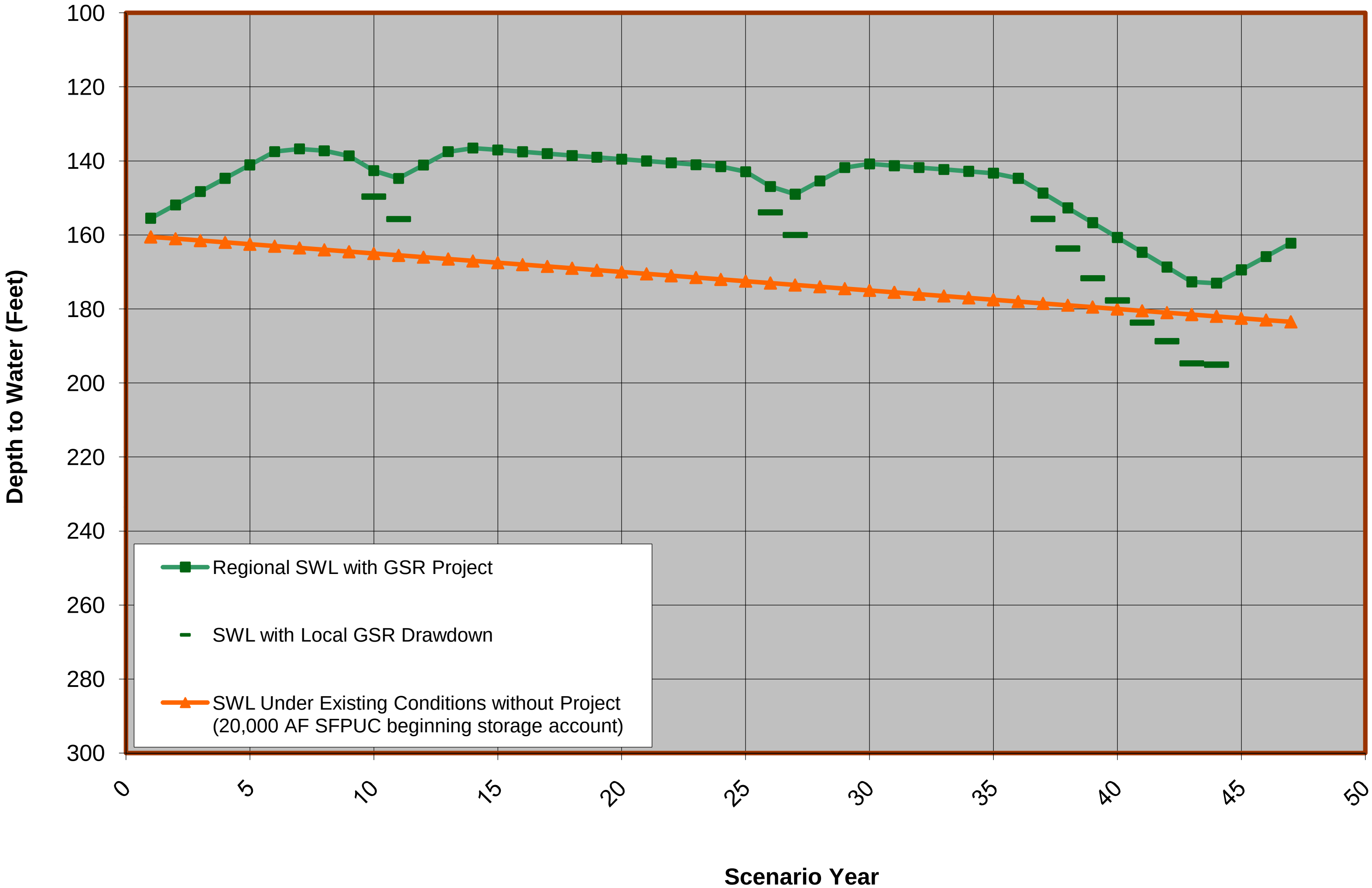
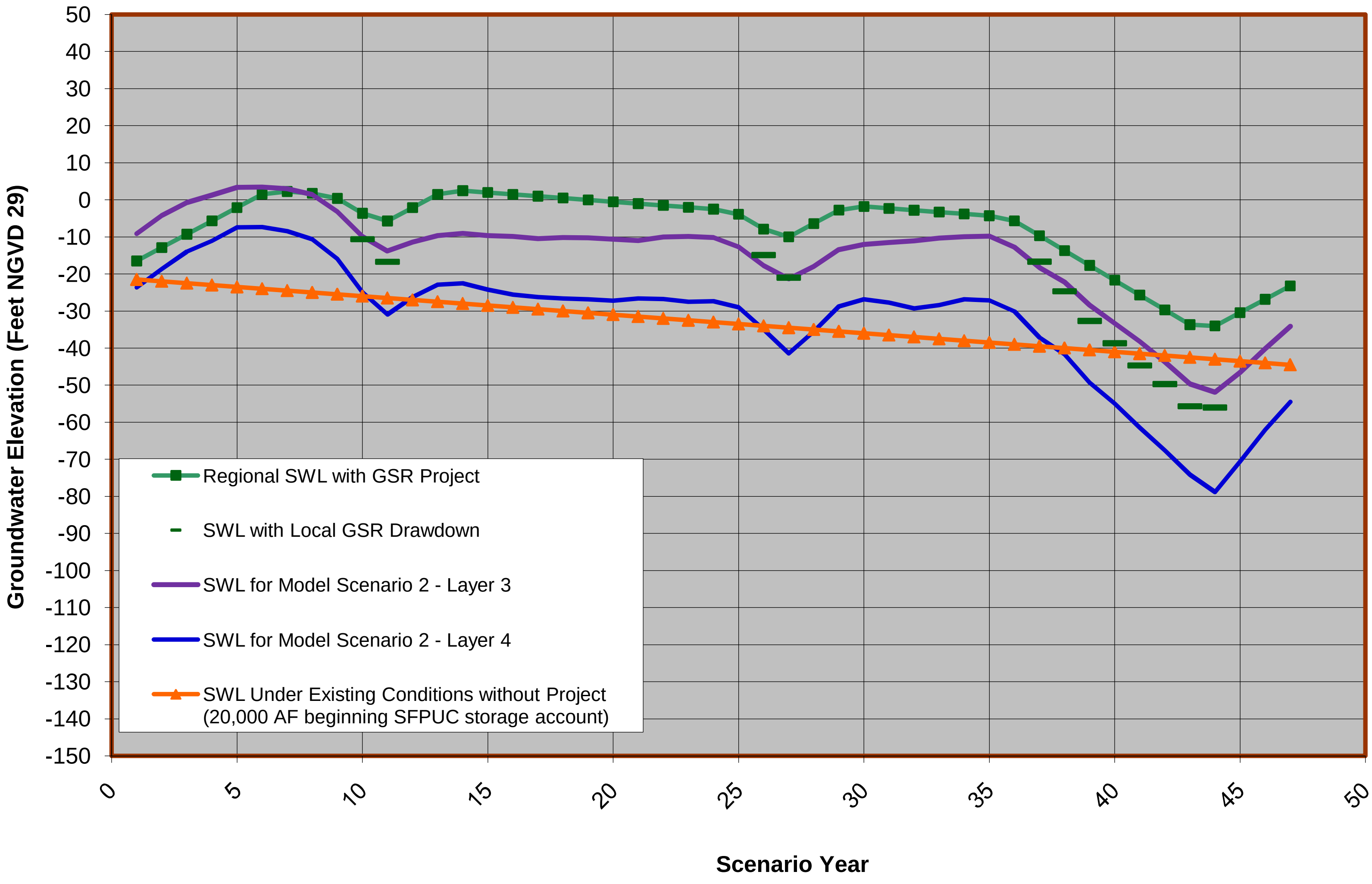


Figure C-23. Estimated Groundwater Elevations at San Francisco Club Well 2 for GSR Project (Scenario 2)



APPENDIX D

Form: Vta.(comp 11/93)
COMPUTATIONS

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Checked By: ______ Date: ______ Sheet No. ___ of ___
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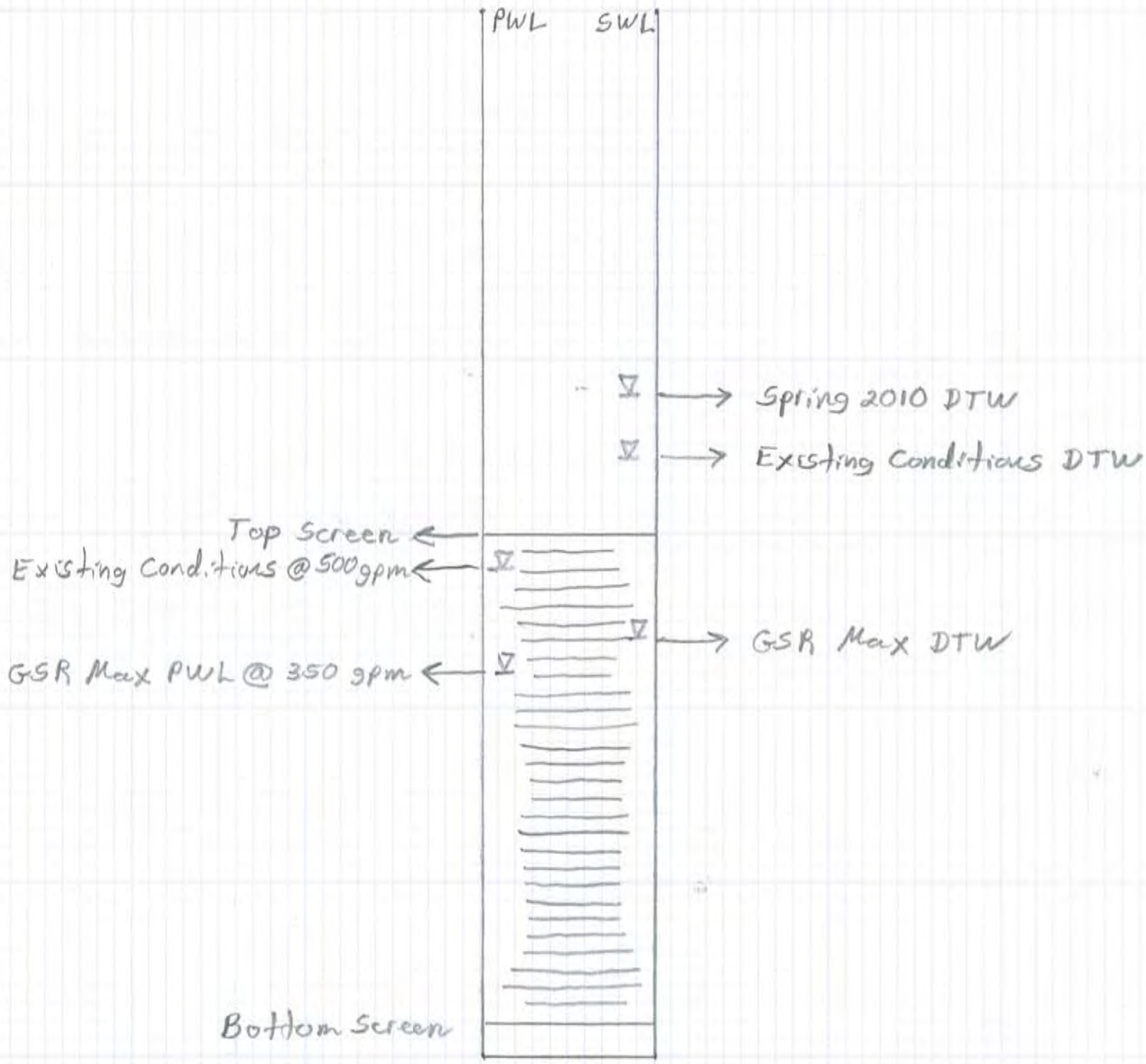
Intermediate Depth to Top Screen

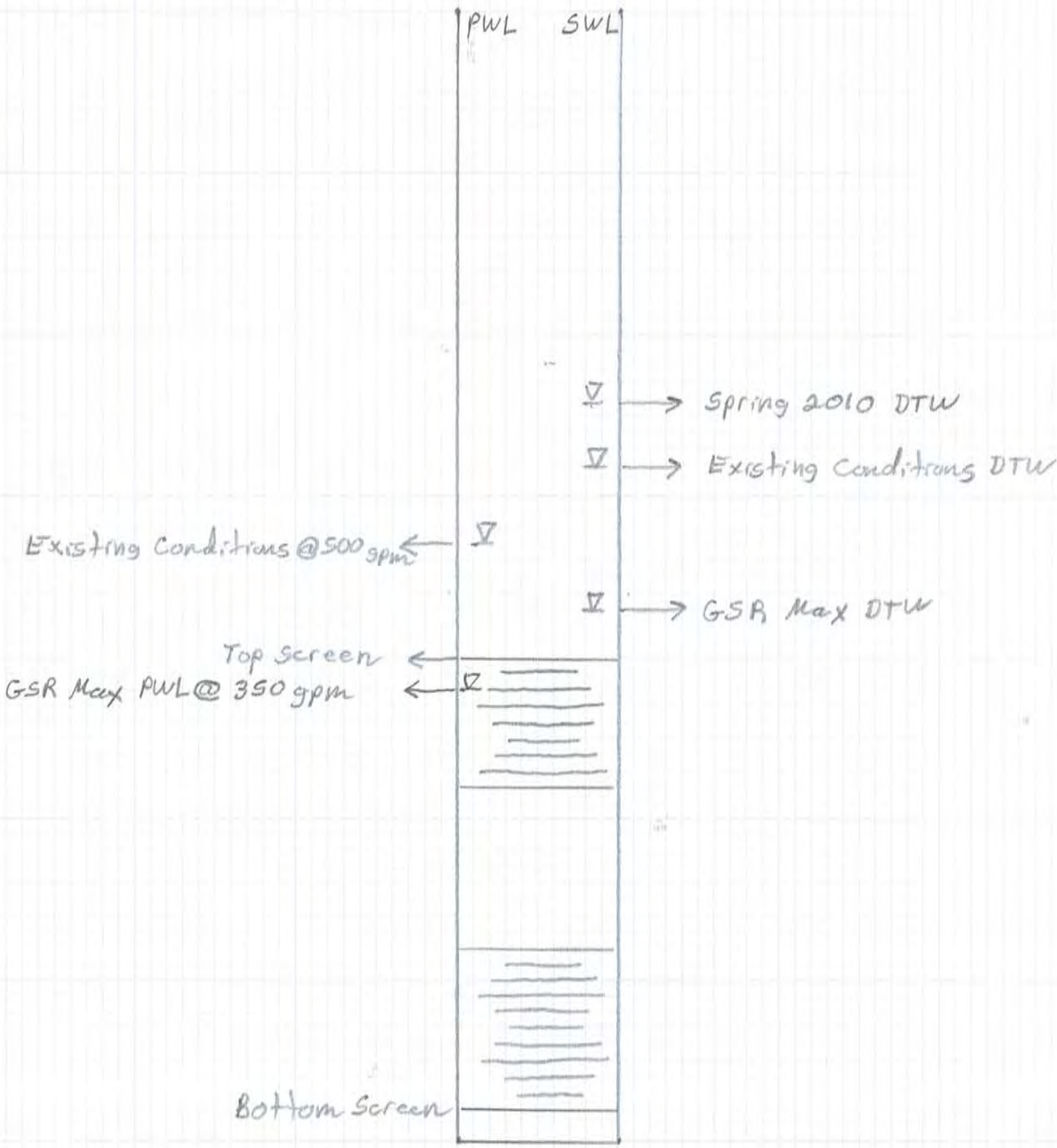


Note: Schematic - Not to Scale

Form: Vta.(comp 11/93)
COMPUTATIONS

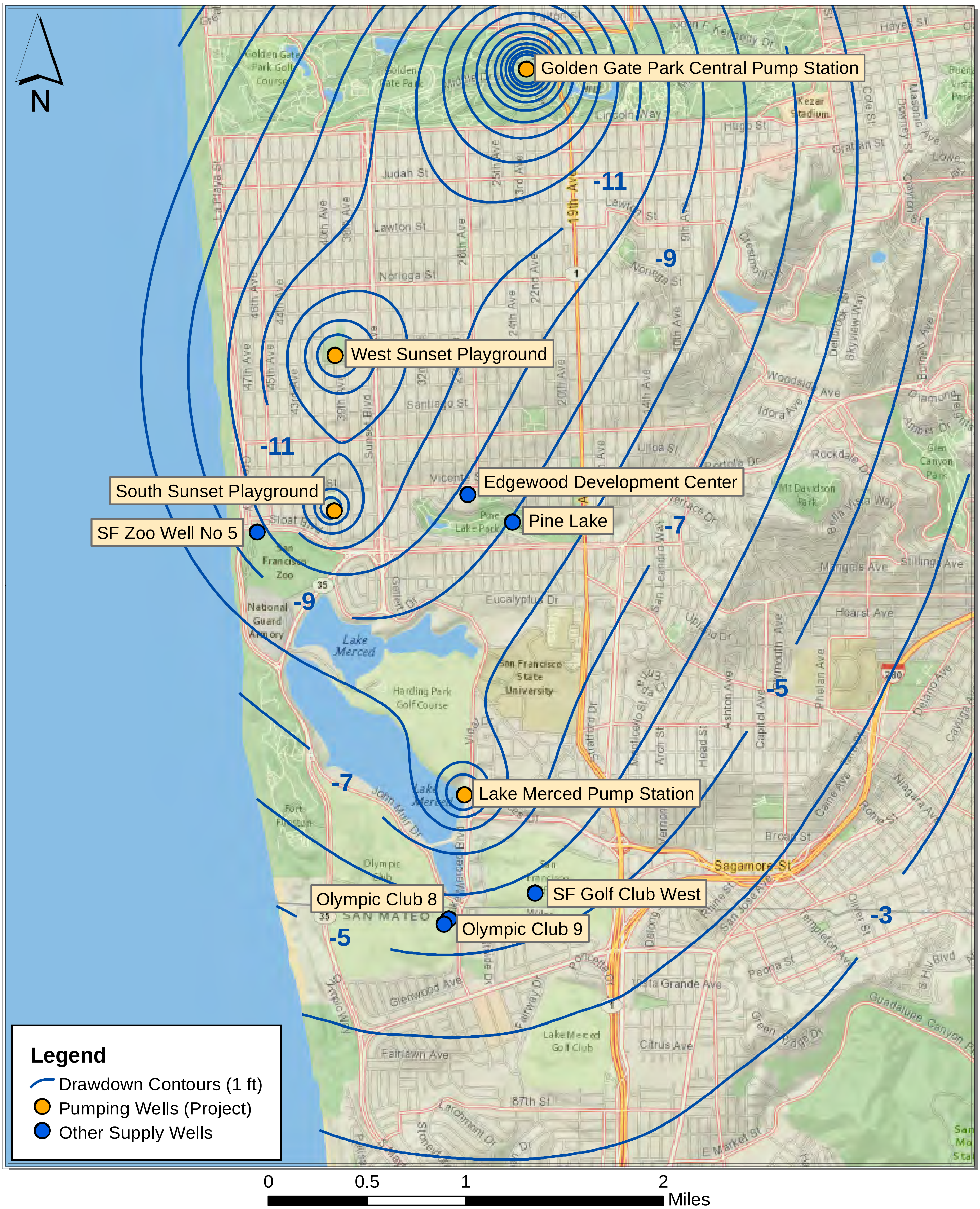
Job No.: ______ By: ______ Date: ______
Checked By: ______ Date: ______ Sheet No. ___ of ___
Subject: Typical Third Party Well
Deep Depth to Top Screen

FUGRO



Note: Schematic - Not to Scale

APPENDIX E



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LUHDORFF & SCALMANINI
CONSULTING ENGINEERS

Figure No
Drawdown Following 1 Year of Pumping
Scenario A Four Project Wells Pumping

X:\2010 Job Files\10-077\Task 10 8a\GIS\Figure 2 ScenarioB_dd.mxd

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Figure No

Drawdown Following 1 Year of Pumping

Scenario B Six Project Wells Pumping

APPENDIX F

Appendix F-1
Third Party Well Construction Details

WELL	GROUND ELEVATION (ft NGVD)	TOP OF SAND PACK (ft bgs)	TOP OF SCREEN (ft bgs)
Elk Glen Well	172	60	170
SF Zoo Well No. 5	32	130	160
Pine Lake [1]	83	48	98
Edgewood Development Center [1]	158	30 (liner)	120 (liner)
Olympic Club 8	61	50	200
Olympic Club 9	78	230	260
SF Golf Club West	148	50	360
City of Daly City Westlake (DC2)	110	255	340
Lake Merced Golf Club No. 1			
Lake Merced Golf Club No. 2			
Lake Merced Golf Club No. 3		50	294

<u>NOTES</u>:

1 - Information obtained by Jeff Gilman, SFPUC Water Enterprise. Well also known as Stern Grove W-2.

Table F-2
Third Party Well Pump Data [1]

WELL	Pump Make	Pump Model	Stages	Current or Design Capacity (gpm)	Other Information
SF Zoo Well No. 5	Goulds	12DHLC	4	1,160	Current capacity as observed in 2009 using Magmeter: 1,160 gpm (multiple observations).
Pine Lake	Flowserve	8MEL	10	250	Current capacity as observed in 2010.
Edgewood Development Center	Grundfos	25S50	26	25	Grundfos pump was noted in 1993 inspection for Groundwater Master Plan. Current pump is Goulds; assume to have similar head-capacity relationship for analysis of interference effects.
Olympic Club 8	Byron Jackson	11MQH	4	1,000	260 ft Column; Pump Intake at 270 ft.
Olympic Club 9	Byron Jackson	10GH	6	700	240 ft Column; Pump Intake at 248-250 ft.
SF Golf Club West	Byron Jackson	10MQH	9	700	345 ft Shaft and Oil Tubes on Work Order.
City of Daly City Westlake (DC2)	Byron Jackson	10MQL	9	500	Pump setting depth at 415 ft.
Lake Merced Golf Club No. 1	Not Available				
Lake Merced Golf Club No. 2	Not Available				
Lake Merced Golf Club No. 3	Not Available				

NOTES:

1 - Pump data obtained from SFPUC records and information requests to well owners. Contacts and site visits to Pine Lake and Edgewood Development Center by Jeff Gilman, SFPUC Water Enterprise.

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Appendix I

Energy Use Calculations

CALCULATIONS FOR GSR ENERGY USE IMPACTS
12/6/11

Project Impacts in 2018

WATER SUPPLY SOURCE	**Average Daily Production (mgd)**					
	GSR Project				Baseline	Change
	Put-year 32%	Take-year 23%	Hold-year 45%	weighted average		
Partner Agencies (PA)						
Groundwater wells	1.38	6.90	6.90	5.13	6.84	(1.71)
SFPUC						
Regional Water System (RWS)	5.52	(7.23)	-	0.10	-	0.10
GSR Groundwater wells	0.04	7.23	0.04	1.69	-	1.69
Total	**6.94**	**6.90**	**6.94**	**6.93**	**6.84**	**0.09**

WATER SUPPLY SOURCE	**Average Annual Energy Consumption (kW-hrs) (rounded to nearest million kWh)**					
	GSR Project				Baseline	Change
	Put-year 32%	Take-year 23%	Hold-year 45%	weighted average		
Partner Agencies (PA)						
Groundwater wells	3,000,000	16,000,000	16,000,000	12,000,000	16,000,000	(4,000,000)
SFPUC						
Regional Water System (RWS)	1,000,000	(1,000,000)	-	0	-	-
GSR Groundwater wells	0	17,000,000	0	4,000,000	-	4,000,000
Total	**4,000,000**	**32,000,000**	**16,000,000**	**16,000,000**	**16,000,000**	**-**
Percent Increase/Decrease						**0.0%**

Energy Data		***Units***	***Source of Data***
RWS Progam Environmental Impact Report (PEIR) Energy Consumption (2002)	44,000,000	kW-hr	PEIR (SF Planning Dept. 2008) was used because it was the base year used in the PEIR, and the only year with easily available energy use data for the Regional Water System
RWS Average Daily Production (2002)	275	Mgal/d	5/10/11 email from Antonia Sivyer per David Cameron
RWS Annual Water Production (2002)	100,375	Mgal	Average daily production X 365 days
RWS PEIR Unit-Energy Consumption (2002)	438	kW-hr/Mgal	2002 Energy consumption / 2002 Water Production
RWS Average Daily Production (2009)	219	Mgal/d	12/1/11 email from David Cameron (FY 2009 is 7/1/09 to 6/30/10)
RWS Baseline Energy Consumption (2009)	34,976,000	kW-hr	Average daily production x PEIR Unit-Energy Consumption x 365 days
RWS Average Daily Production (2018)	265	Mgal/d	Water System Improvement Proram (WSIP) Phased Variant from PEIR (SF Planning Dept. 2008)
RWS Future Energy Consumption (2030)	47,500,000	kW-hr	PEIR (SF Planning Dept. 2008)
RWS Average Daily Production (2030)	300	Mgal/d	PEIR (SF Planning Dept. 2008)
RWS Annual Water Production (2030)	109,500	Mgal	Average daily production X 365 days
RWS Future Unit-Energy Consumption (2030)	434	kW-hr/Mgal	2030 Energy consumption / 2030 Water Production
GSR Groundwater Energy Use (take year)	17,065,115	kW-hr	12-2-11 SFPUC GSR Groundwater Wells estimated KWh usage
GSR Groundwater Daily Production	7.23	Mgal/d	Project Description
GSR Groundwater Annual Water Production	2,639	Mgal	Average daily production X 365 days
GSR Unit-Energy Consumption	6,467	kW-hr/Mgal	GSR Energy consumption / GSR Water Production
GSR Groundwater Energy Use (put and hold year)	373,827	kW-hr	12-2-11 SFPUC GSR Groundwater Wells estimated KWh usage
PA Groundwater Unit-Energy Consumption	6,467	kW-hr/Mgal	Estimated to be the same as GSR
% of Put years in hydro sequence	32%		Table 10.1-9 in Kennedy/Jenks TM 10.1 Groundwater Modeling Analysis 2012
% of Take years in hydro sequence	23%		Table 10.1-9 in Kennedy/Jenks TM 10.1 Groundwater Modeling Analysis 2012
% of Hold years in hydro sequence	45%		Table 10.1-9 in Kennedy/Jenks TM 10.1 Groundwater Modeling Analysis 2012
	100%		

Appendix J

Vegetation Change Analysis Methodology

APPENDIX J- LAKE MERCED VEGETATION CHANGE ANALYSIS METHODOLOGY

Building upon prior studies, ESA updated a Geographic Information System (GIS) vegetation layer created by Nomad Ecology in 2010[1]. Using ArcGIS, ESA overlaid the 2010 vegetation data on high resolution 2010 aerials and then ground-truthed the resulting imagery in the field in May 2012. In general, the 2010 data correlated well with aerial signatures of the various vegetation types on the 2010 aerial photo and conditions on the ground. All discrepancies were mapped in the field and the 2010 vegetation layer was updated using the annotated field maps and aerial interpretation comparing the 2008 and 2010 aerials. To reduce the complexity of modeling vegetation change in response to water level management, many of the distinct vegetation types mapped by Nomad Ecology (Nomad 2011) were combined with similar types. Table J-1 presents the results of the vegetation mapping update, along with results from 2002 and 2010, for comparative purposes. See Figure 5.14-1 (Lake Merced 2012 Vegetation Types) in Section 5.14, Biological Resources for the updated Lake Merced vegetation map.

A GIS database was constructed using Light Detection and Ranging (LIDAR) (Foxgrover and Barnard 2012) surface topographic data, and bathymetric data supplied by the San Francisco Public Utilities Commission (SFPUC) (Sea Survey/Entrix 1987). The two data sets differ substantially in precision and vertical control, such that the bathymetric data were adjusted by hand to conform more closely with the greater vertical precision of the LIDAR data[2] as well as current aerial photos (USGS 2011). For example, in many cases, overlays of vegetation mapping and the bathymetric data resulted in the appearance of certain species or vegetation types occurring in much deeper water than field observations would support.

A set action of "action rules" was developed to predict the response of different vegetation types to changing inundation levels. Action rules were drawn from previous modeling efforts specific to Lake Merced (Stillwater Sciences 2009; EDAW 2004) and the Lower Crystal Springs Reservoir (ESA 2009), available literature on vegetation tolerance to inundation, and field observations. The action rules (see Table J-1 [Vegetation Model Action Rules]) are based on the following general principles:

1 The 2010 GIS vegetation layer was created by Nomad (Nomad 2011) using heads up digitizing on a 2008 aerial photo base and then verifying the results in the field.

2 The original bathymetric data created by Sea Survey and Entrix in 1987 was digitized from a scanned image and adjusted to "fit" a 2001 orthophoto background by Talavera & Richardson in 2001. Upon comparing the bathymetric data with April, 2011 aerial imagery it was clear that the data did not fit within the confines of lake as shown in the current aerial imagery. ESA adjusted the bathymetry again to fit the current imagery. The accuracy of the bathymetric data affects the amount of vegetation impacted with decreasing water surface elevation, which may be overestimated or underestimated.

TABLE J-1
Vegetation Model Action Rules

Class/Vegetation Type	Remove:	Add:	Replacer Status	Conflict Rule for Adding:
Class 1[(a)]				
Bulrush wetland	< -5	0 to -5	Primary Replacer	In areas of replacement overlap, the adjacent replacer wins. In areas where both replacers are adjacent, bulrush wins. In areas of no replacer adjacency, bulrush wins.
Cattail	< -3	0 to -3	Secondary Replacer	
Knotweed wetland	< -2	0 to -2	Secondary Replacer	
Class 2[(a)]				
Arroyo willow	< 0	1 to 0	Primary Replacer	In areas of replacement overlap, the adjacent replacer wins. In areas where both replacers are adjacent, willow wins. In areas where no adjacency, willow wins.
Rush meadow	< -1	1 to 0	Secondary Replacer	
Giant vetch	< -1	n/a	n/a	
Class 3[(a)(b)]				
Coastal scrub	< 1	n/a	n/a	
Dune scrub	< 1	n/a	n/a	
Oak woodland	< 1	n/a	n/a	
Non-native forest	< 1	n/a	n/a	
Non-native herbaceous	< 1	n/a	n/a	
Annual grassland	< 1	n/a	n/a	
Perennial grassland	< 1	n/a	n/a	

Source: ESA 2012

Notes:

Seasonal variation is 1 foot higher than average in wet season and 1 foot less than average in dry season.
Elevations are relative to modeled water surface elevation.

(a) **Class 1 - Tolerant:** Can survive permanent inundation at depths equal to or less than 5 feet below average annual WSE.
Class 2 - Moderately Intolerant: Survives inundation up to three months during dormant season.
Class 3 - Intolerant: This class is generally unable to survive inundation for more than two consecutive weeks.

(b) Upland vegetation types would not replace others as WSE rises.

The lower limit of both woody and herbaceous upland vegetation is determined by the maximum water surface elevation (WSE). The lower limit of upland vegetation is determined by inundation frequency and duration, a principal that also is applied in the federal method for determining the boundary between wetlands and non-wetlands for jurisdictional purposes. Observations of current conditions at Lake Merced, coupled with previous mapping and descriptions (SFRPD 2006; May and Associates 2009; Nomad 2011) indicate that the lower limit of upland woody vegetation is above the maximum WSE, which restricts upland plant species lacking adaptation to prolonged inundation or soil saturation. Upland woody vegetation will occur, but not persist, at the mean water level, and will be replaced by opportunistic wetland vegetation dominated by bulrush and knotweed. The lower limits of upland herbaceous communities also extend down to the maximum WSE, and would be replaced by wetlands if the water level rises.

The upper and lower limits of wetland vegetation depend on depth of inundation and inundation tolerance. For example, most herbaceous wetlands fringing Lake Merced occur no higher than 1 foot above the projected existing conditions mean WSE of 5.7 feet and at assumed depths no greater than 2 feet below WSE. The wetland species that make up these communities do not require year-round inundation. In contrast, bulrush wetlands require at least nine months inundation or soil saturation, readily tolerate permanent inundation, and are found at elevations no more than 1 foot above the seasonal high water elevation, and no greater than 5 feet lower than mean WSE.

Vegetation was categorized into three classes associated with water inundation tolerance. Inundation tolerance is largely a function of seasonal fluctuations in lake levels. Monthly water levels increase up to 1 foot above the annual average during winter (February through May), declining to 1 foot below average annual water level towards the end of the growing season (August through November) (Stillwater 2009). Class 1 includes vegetation types that are extremely tolerant and can survive permanent inundation. Class 2 vegetation is somewhat tolerant and can survive partial inundation due to seasonal variations. Class 3 vegetation is intolerant and cannot survive seasonal inundation. ESA developed action rules based on this classification that determined how vegetation would die or establish as WSE rises.

Replacement criteria not only took elevation relative to WSE into account but also adjacency of vegetation types. Overlapping depth tolerance among different wetland types requires complex rules for resolving conflicts when two wetland types have the potential to occupy the same elevation zone. For the purposes of the analysis, therefore, these conflicts were resolved by creating action rules that restrict the amount of overlap. The action rules also govern interactions between vegetation types for projected WSE that would cause the loss of one type and its replacement by one or more other type. For example, bulrush and knotweed have a somewhat overlapping tolerance to inundation. Priority rules for replacement instruct the GIS-based analysis to replace a "drowned" vegetation type with bulrush or knotweed (the most aggressive "replacer" types) based on the elevation of the replaced vegetation and its proximity to the nearest replacer type.

The GIS-based analysis was conducted to estimate vegetation response to changes in lake levels over time using the newly updated vegetation data, topography, bathymetry, slope, output from the water level models, and the action rules for vegetation change. For the purposes of the vegetation change analysis, the initial baseline estimates for existing vegetation acreage are those which would occur at a mean annual WSE of 6 feet City Datum. This is slightly higher than the baseline WSE of 5.7 feet used for the Kennedy Jenks hydrologic modeling but was necessary in order to correspond to the topographic data, which was created at 1 foot elevation intervals. The 2012 vegetation mapping update was based on a April 2011 aerial photo, at which time, according to historic WSE data (SFPUC 2011) Lake Merced WSE was at about 7 feet City Datum. The acreages given for the 6-foot WSE were obtained by running the receding WSE model on the 2012 vegetation data. In addition, the analysis only included vegetation at or below 13 feet City Datum, since this is the maximum possible lake water level due to the existing spillway height and therefore, elevation, at which vegetation change would be expected due to changes in WSE. Therefore, for the upland vegetation types and for arroyo willow riparian scrub, acreage located above the 13 foot elevation, as mapped in Figure 15.4-1 (Lake Merced 2012 Vegetation Types), would remain unchanged.

To determine impacts to vegetation associated with water surface elevation change it is necessary to have an accurate topographical representation of the area. For elevation above the surface of Lake Merced, ESA obtained a high resolution LIDAR derived digital elevation model (DEM) to provide accurate elevation data. Past Lake Merced inundation studies used 1 foot photogrametically created elevation contour data derived from flights of the area in 1996. The LIDAR derived elevation data were used in place of the photogrammetry data because they are considerably more current (2010) and determined to be a better representation of current conditions[3]. From the DEM, ESA created 1 foot elevation contour polygons so that areas could be calculated for each elevation range. For bathymetric topography ESA used contour data provided by the SFPUC. These contours were originally created from depth soundings of the lakes in 1987; the data was subsequently adjusted in 2001 to fit current aerial photos of that time. Visual analysis of the contour data compared to current aerial photos (2011) revealed inconsistencies along the shoreline. It was therefore necessary to modify the bathymetric data to match the aerial photos and surface DEM to create an accurate topographical representation. The adjusted bathymetric data was converted to a Triangular Irregular Network (TIN) which in turn was used to produce 1 foot contour polygons by interpolating elevation gaps in the original contour data. The 1 foot bathymetric elevation contours and the 1 foot DEM derived surface elevation contours were then combined to create a complete elevation dataset of the area. This finished elevation dataset was intersected with the vegetation data to determine distribution of vegetation by elevation ranges.

Two different approaches were used to determine impacts to vegetation associated with increasing and decreasing WSE under the proposed project. For impacts associated with water surface increase, a GIS approach similar to past inundation studies was used. As described above, action rules were established for each vegetation type dictating how vegetation would respond to increasing water surface elevation. Once the action rules were established for a relative water surface elevation, they were applied to every 1 foot contour up to the 13 foot spillway elevation. The resulting vegetation statistics were used to determine impacts to vegetation types due to increase in water surface elevation.

For decreasing water levels, a statistical approach was used to determine vegetation response. Unlike water rising scenarios in which parameters can be applied to current vegetation, the majority of land associated with decreasing water levels is currently inundated and free of vegetation (except for certain wetland species). For this approach ESA analyzed the proportions of vegetation at each elevation contour relative to the current water surface level and applied the statistics to lower water surface elevation. This approach keeps the vegetation distribution the same for each elevation range relative to the WSE, but due to differences in area for each elevation range the vegetation area totals are different for each modeled WSE. For example, if the contour range of 0 to 1 foot is currently inhabited with 60 percent bulrush wetland and 40 percent knotweed wetlands, that proportion (60 percent and 40 percent) would be assigned to the -1 to 0 foot contour range modeling a water surface decrease of 1 foot.

3 LIDAR tends to be superior when there is dense vegetative cover. ESA compared aerial photos where the historic WSE was known with the LIDAR and the photogrammetry derived elevation data and the LIDAR was a better match relative to the shoreline, which represents the WSE.

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Appendix K

Lake Merced Water Quality Data and Graphs

APPENDIX K

LAKE MERCED WATER QUALITY DATA AND GRAPHS

REGIONAL GROUNDWATER STORAGE AND RECOVERY PROJECT

April 2013

INTRODUCTION

This Appendix includes the following information:

- A list of abbreviations used in the water quality data or graphs;
- *Lake Merced Water Quality Data* includes a tabulation of historic Lake Merced water quality data; and
- *Lake Merced Water Quality Graphs* includes graphs of Lake Merced water quality at various lake levels over time.

The information in this appendix has been prepared by ESA.

ABBREVIATIONS USED IN THIS APPENDIX

The following is a list of abbreviations used in this Appendix:

Alk = alkalinity

Br = bromide

°C = degrees Centigrade

Cl^- = chloride

Cond = electrical conductivity

DO = dissolved oxygen

Fe = iron

Fl^- = fluoride

Ft = feet

Hard = hardness

mg/L = milligrams per liter

mmho/cm = micromhos per centimeter

Mn = manganese

MPN = most probable number

MTBE = methyl tertiary-butyl ether

mv = millivolts

NH3-N = ammonium

NO3-N = nitrate as nitrogen

No./m^3 = number per cubic meter

No./mL = number per milliliter

ntu = nephelometric turbidity unit

ORP = oxidation reduction potential

Orth P = orthophosphate

Pb = lead

SO4 = sulfate

TDS = total dissolved solids

Temp = temperature

TKN = total kjeldahl nitrogen

TOC = total organic carbon

Tot P = total phosphate

Turb = turbidity

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WATER QUALITY DATA

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	22.7	22.1	13.7	15.5	18.3	19.6	13.2		18.4	12.5	14.8	20.6	19.3	11.8	13.2	22.4	19.8	11.6	15.1	17.2
5	20.9	22.1	13.7	15.5	18.3	18.9	13.1		18.2	12.3	14.5	20.3	18.7	11.6	13.0	21.5	18.5	11.2	14.9	16.7
10	17.9	21.6	13.7	14.2	18.2	18.8	12.9		18.2	12.2	14.4	20.2	18.6	11.6	12.2	18.9	17.6	11.1	13.7	16.2
14									18.2	12.2				11.6			17.2			
15	17.8	21.4	13.7	12.9	18.0	18.8	12.7				14.4	19.8	18.5		12.1	18.4		11.0	13.3	16.1
16	17.8	21.1		12.9											12.1				13.2	16.1
17																				
17.4																				
17.5																				
18			13.7								14.4									
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	21.0		13.2	15.1	17.5	19.3	12.8		17.8	11.5	15.1	19.94	18.3	11.1	12.7	22.1	18.3	10.8	13.9	16.5
5	19.9		13.2	14.9	17.4	18.7	12.7		17.8	11.5	14.6	19.8	17.9	10.9	12.4	20.5	17.5	10.6	13.8	16.3
9																	17.3			
10	17.7		13.2	13.9	17.3	18.6	12.5		17.8	11.3	14.5	19.7	17.8	10.9	12.0	18.4		10.4	13.3	16.0
11																			13.3	16.0
12				13.5																
13											14.5									
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	########	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	19.4	17.2	15.8	12.3	17.4	20.4	19.1	13.2	19.9	19.5	16.5	12.8	12.5	17.2	21.1	18.3	18.9	17.0	13.7	13.1
5	19.2	17.2	15.8	12.0	17.4	19.7	18.9	12.4	19.8	19.5	16.4	12.0	12.3	17.1	21.1	18.2	18.5	16.1	13.7	13.1
10	19.1	17.2	15.8	11.9	17.4	18.9	18.8	12.3	19.7	19.4	16.3	11.9	12.1	16.9	21.1	18.2	17.8	16.1	13.7	13.1
14																				
15	18.4	17.2	15.7	11.9	17.3	18.5	18.8	12.3	19.5	19.2	16.3	11.7	11.9	16.8	19.4	18.2	17.3	16.0	13.7	13.0
16	18.4				17.0			12.3								18.2				
17							18.8		19.3	19.1	16.3		11.9				17.2			
17.4																				
17.5																				
18												11.7		16.7				16.0	13.7	12.9
18.8																				
19															19.1					
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	########	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	18.7	16.4	15.2	11.8	17.0	19.9	18.4	12.6	19.2	19.2	16.2	12.2	12.5	16.9	20.9	17.7	18.5	n/a	13.0	12.7
5	18.6	16.4	15.1	11.5	17.0	19.2	18.3	11.8	19.1	19.1	16.0	11.0	12.0	16.7	20.7	17.7	18.1	n/a	12.9	12.6
9																				
10	18.0	16.4	15.1	11.3	17.0	18.3	18.2	11.7	18.8	18.8	15.9	10.8	11.8	16.3	20.0	17.5	17.4	n/a	12.9	12.5
11					17.0	18.1														
12				11.3			18.2		18.7		15.8							n/a		
13								11.7		18.7		11.3	11.6		19.3	17.5	17.1		12.9	
13.8																				
14														16.2						12.3
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

Depth	23-Jan-06 Temp	01-Mar-06 Temp	26-Apr-06 Temp	14-Jun-06 Temp	24-Aug-06 Temp	25-Oct-06 Temp	20-Dec-06 Temp	29-Mar-07 Temp	26-Jun-07 Temp	20-Aug-07 Temp	27-Dec-07 Temp	28-Mar-08 Temp	10-Jun-08 Temp	24-Sep-08 Temp	4-Dec-08 Temp	24-Mar-09 Temp	4-Jun-09 Temp	22-Sep-09 Temp	15-Dec-09 Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	12.3	13.1	16.1	20.2	18.5	17.0	10.9	16.5	19.4	22.1	10.1	14.7	20.4	19.9	14.4	14.4	19.1	19.6	10.9
5	11.9	12.9	16.0	19.6	18.5	17.0	10.8	14.1	19.3	20.0	10.2	14.5	19.3	18.9	13.9	14.2	18.5	19.3	10.4
10	11.9	12.9	15.9	18.5	18.5	17.0	10.8	13.9	18.8	18.8	10.1	14.3	17.3	18.2	13.9	13.4	16.8	19.2	10.3
14																			
15	11.8	12.7	15.8	18.2	18.5	16.9	10.8	13.7	18.6	18.5	9.9	14.3	17.2	18.0	13.8	13.4	16.5	18.6	10.3
16																			
17																			
17.4														17.8					
17.5															13.8				
18	11.8					16.8				18.4									
18.8													17.1						10.4
19		12.6	14.7	17.5	18.5		10.8	13.5	17.2		9.9								
19.3																		18.5	
19.9																	16.4		
20												13.6				13.3			
20.6												13.5							

Lake Merced
North East

Depth	23-Jan-06 Temp	01-Mar-06 Temp	26-Apr-06 Temp	14-Jun-06 Temp	24-Aug-06 Temp	25-Oct-06 Temp	20-Dec-06 Temp	29-Mar-07 Temp	26-Jun-07 Temp	20-Aug-07 Temp	27-Dec-07 Temp	28-Mar-08 Temp	10-Jun-08 Temp	24-Sep-08 Temp	4-Dec-08 Temp	24-Mar-09 Temp	4-Jun-09 Temp	22-Sep-09 Temp	15-Dec-09 Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	11.6	12.8	16.1	19.5	18.1	16.7	10.2	15.4	19.4	20.7	9.29	14.8	20.1	19.3	13.6	14.0	18.1	19.3	10.4
5	11.2	12.5	16.0	18.8	18.1	16.7	10.2	14.3	19.3	20.1	9.29	14.6	19.0	18.9	13.3	13.5	17.3	19.2	9.9
9																			
10	11.2	12.3	16.0	18.1	18.0	16.6	10.1	14.2	19.0	18.7	9.17	14.4	17.3	18.0	13.2	13.3	16.8	19.1	9.9
11																			
12																			
13	11.2					16.6							17.1	17.8					
13.8																		18.6	
14		12.2		18.0	18.0					18.2									
14.1															13.2				
14.7																13.3			9.9
15			15.9				10.1	13.9	18.7		9.21	14.2					**16.3**		
15.8												14.2							

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	20.5	21.9	13.6	15.1	17.9	19.5	12.6	17.7	18.0	12.2	14.8	19.9	18.7	11.6	12.7	21.1	19.6	11.3	14.3	16.1
5	18.8	21.9	13.6		17.9	18.6	12.3	17.5	18.0	12.2	14.4	19.8	18.3	11.5	12.2	20.5	18.5	10.6	14.2	16.0
6				14.1																
10	17.3	21.2	13.6		17.9	18.6	12.3	17.3	18.0	12.2	14.1	19.8	18.2	11.5	12.0	18.5	17.6	10.6	13.5	15.9
12				14.0																
15	17.0	20.8	13.6		17.6	18.6	12.3	16.8	18.0	12.0	13.9	18.3	18.1	11.5	11.8	17.8	17.1	10.6	13.3	15.2
16	17.0	20.7												11.5		17.8	17.0	10.7		
17	17.0									12.0									13.3	
18				13.3	17.6				18.0			18.3	18.2		11.8					15.1
18.2																				
18.9																				
19				13.3			12.2													
20								16.5			14.0									
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	20.8	21.8	13.5	15.6	18.5	19.6	12.8	18.2	18.5	12.2	14.5	20.3	19.0	11.7	13.2	21.6	19.5	11.5	14.7	16.4
5	20.5	21.6	13.5	15.1	18.5	18.7	12.7	17.9	18.4	12.2	14.2	20.3	18.6	11.6	12.8	20.8	19.0	10.9	14.5	16.4
10	17.9	21.1	13.5		18.4	18.7	12.6	17.8	18.4	12.2	14.1	19.7	18.6	11.5	12.6	18.9	17.8	10.9	13.3	15.4
12				14.9																
15	17.2	20.8	13.5		17.7	18.7	12.5	17.1	18.3	12.1	13.9	19.1	18.6	11.5	11.9	17.8	17.1	10.9	13.2	15.4
16	17.1	20.8															17.1	11.1		
17														11.5						
18				13.8	17.6				18.3	12.1		18.2			11.8	17.7			13.1	15.6
19							12.5	16.8					18.5							
19.2																				
20											14.0									
20.4																				
21																				
21.5																				
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	########	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	18.6	17.3	15.6	12.1	16.6	19.3	18.5	12.8	19.1	19.0	16.1	12.5	12.1	15.8	20.5	18.2	18.3	16.5	13.5	13.0
5	18.5	17.3	15.6	12.1	16.6	19.2	18.5	12.3	19.1	19.0	16.1	11.8	11.7	15.6	20.5	18.2	18.3	16.0	13.5	13.0
6																				
10	18.5	17.2	15.5	12.0	16.4	18.4	18.4	12.2	18.9	18.8	16.0	11.7	11.5	15.5	19.7	18.2	18.0	15.8	13.5	13.0
12																				
15	18.5	17.0	15.5	11.8	16.1	18.1	18.4	12.2	18.0	18.8	16.0	11.7	11.4	15.4	19.0	18.2	17.1	15.7	13.5	13.0
16	18.5	17.0		11.8																
17			15.6			18.1					16.0	11.8	11.3							
18					16.0					18.7							16.9		13.4	
18.2																				
18.9																				
19							18.4	12.2	17.8											12.9
20														15.4	18.5	18.1		15.6		
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	########	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**	**Temp**
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	19.1	17.3	15.6	11.9	17.2	20.1	18.8	13.1	19.6	19.6	16.3	12.4	12.1	16.0	20.5	18.5	18.7	16.6	13.6	13.1
5	19.1	17.3	15.6	11.9	17.2	20.0	18.7	12.2	19.5	19.6	16.3	11.7	11.6	15.6	20.5	18.5	18.3	16.2	13.6	13.1
10	18.9	17.3	15.6	11.8	17.2	19.3	18.6	12.2	18.9	19.4	16.2	11.6	11.5	15.5	20.3	18.5	17.3	16.1	13.6	13.1
12																				
15	18.9	17.2	15.6	11.8	16.8	18.4	18.5	12.2	18.1	18.8	16.2	11.6	11.4	15.5	19.0	18.1	16.9	16.0	13.6	13.0
16		17.2																		
17	18.8		15.6			18.1					16.1		11.4							
18					16.1															
19				11.8			18.5			18.7		11.6						16.0		
19.2																				
20								12.2	17.8					15.5	18.6	18.1	16.9		13.6	12.9
20.4																				
21														15.5						
21.5																				
22																				
22.8																				
23.2																				

Lake Merced South - Pistol Range

Depth	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	11.7	12.7	15.3	19.1	18.5	16.9	11.0	14.5	18.6	20.3	10.1	13.82	18.8	19.5	13.82	13.6	18.1	19.2	10.5
5	11.6	12.6	15.3	19.0	18.5	16.9	11.0	14.0	18.6	19.9	9.8	13.7	18.1	19.1	13.71	12.8	17.5	19.1	10.4
6																12.8			
10	11.6	12.6	15.2	18.9	18.4	16.9	11.0	13.9	18.4	18.8	9.8	13.57	17.3	18.1	13.68		16.7	19.0	10.4
12																			
15	11.5	12.5	15.1	18.3	18.4	16.9	10.9	13.8	18.4	18.4	9.7	13.56	16.7	17.9	13.61	12.7	16.3	18.6	10.3
16																			
17																			
18	11.5																		
18.2																			10.4
18.9																		18.4	
19						16.8									13.6				
20		12.5	15.1	18.0	18.4		10.9	13.6	18.1	18.1	9.7	13.45	16.5			12.7	16.3		
20.1														17.8					
20.6																12.7			
20.8																	16.3		
21				18.0				13.6		18.1	9.7								
21.5												13.45							
22									18.0										

Lake Merced South - Pump Station

Depth	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp	Temp
Ft	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C	°C
Surf	11.9	12.5	15.7	19.5	18.6	16.9	10.9	14.5	19.2	20.9	10.0	13.9	19.5	19.2	14.0	13.6	18.7	19.6	10.6
5	11.8	12.4	15.6	19.3	18.6	16.9	10.9	13.9	19.0	20.6	9.9	13.9	18.2	19.1	13.9	12.8	18.0	19.6	10.4
10	11.8	12.3	15.6	18.5	18.6	16.9	10.9	13.7	18.3	18.9	9.8	13.9	17.6	18.2	13.9	12.8	16.8	19.0	10.4
12																			
15	11.8	12.3	15.6	18.1	18.6	16.7	10.9	13.6	18.3	18.6	9.8	13.9	16.5	18.0	13.8	12.8	16.3	18.7	10.4
16																			
17																			
18						16.7													
19																			
19.2																		18.5	
20	11.7	12.3	15.3	18.0			10.9	13.6	18.2	18.3	9.8	13.9	16.4	17.8		12.8	16.3		
20.4																			10.4
21		12.3		18.0	18.5					18.3	9.8		16.5	17.8	13.8				
21.5																	16.3		
22			15.3				10.9	13.6	18.1										
22.8																12.8			
23.2												13.9							

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.79	9.07	8.42	8.50	8.79	8.75	8.49		8.37	8.29	8.31	8.73	8.36	8.51	8.45	9.02	8.68	8.08	8.72	8.32	8.75
5	8.67	8.96	8.33	8.49	8.77	8.59	8.47		8.27	8.24	8.34	8.72	8.33	8.47	8.37	9.03	8.46	7.95	8.68	8.27	8.69
10	8.12	8.59	8.27	8.05	8.73	8.40	8.36		8.26	8.19	8.36	8.72	8.34	8.47	8.12	8.02	7.99	7.90	8.38	7.98	8.67
14									8.21	8.17				8.37			7.76				
15	8.00	8.42	8.29	7.73	8.22	8.21	8.23				8.37	8.15	8.24		7.92	7.94		7.85	8.07	7.88	8.26
16	7.96	8.24		7.73											7.91				8.07	7.84	8.24
17																					
17.4																					
17.5																					
18			8.29								8.04										
18.8																					
19																					
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.37		7.96	8.00	8.16	8.31	8.35		8.12	8.18	8.26	8.19	7.89	8.48	8.28	8.74	8.12	7.96	8.36	7.97	8.39
5	8.14		7.95	7.91	8.12	8.16	8.33		8.11	8.18	8.25	8.22	7.88	8.44	8.16	8.50	7.69	7.90	8.26	7.90	8.35
9																	7.61				
10	7.81		7.93	7.61	8.03	8.13	8.24		8.07	8.13	8.25	8.12	7.86	8.43	7.88	7.80		7.82	7.97	7.74	7.84
11																			7.96	7.66	
12				7.52																	
13											7.99										
13.8																					
14																					
14.1																					
14.7																					
15																					
15.8																					

Lake Merced
North

	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06
Depth	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.08	8.29	8.23	8.47	8.51	7.81	7.47	8.26	8.42	7.79	8.17	8.53	8.69	8.28	8.29	8.51	8.10	7.89	8.17	8.07	8.26
5	8.07	8.26	8.13	8.46	8.42	7.75	7.39	8.24	8.39	7.75	8.15	8.52	8.68	8.26	8.27	8.45	8.04	7.88	8.10	8.03	8.24
10	8.07	8.26	8.10	8.47	7.99	7.71	7.35	8.21	8.38	7.76	8.13	8.49	8.66	8.23	8.26	8.08	8.23	7.87	8.08	8.04	8.23
14																					
15	8.08	8.24	8.08	8.31	7.76	7.68	7.34	8.07	8.07	7.73	8.10	8.44	8.64	7.59	8.25	7.78	8.41	7.91	8.05	8.04	8.18
16				7.94			7.33								8.25						
17						7.68		8.03	7.65	7.73		8.44				7.7					
17.4																					
17.5																					
18											8.08		8.62				8.63	7.95	7.80	8.03	
18.8																					
19														7.51							8.04
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06
Depth	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.03	8.20	7.99	7.91	8.19	7.70	7.41	8.39	8.16	7.65	8.11	8.40	8.81	8.00	8.22	8.25	n/a	7.80	8.11	7.91	8.29
5	8.04	8.12	7.95	7.85	8.03	7.63	7.31	8.35	8.14	7.64	8.06	8.44	8.78	7.94	8.21	8.15	n/a	7.81	7.92	7.86	8.22
9																					
10	8.05	8.10	7.80	7.85	7.55	7.57	7.29	8.15	7.98	7.63	8.03	8.43	8.60	7.55	8.17	7.72	n/a	7.86	7.79	7.85	8.03
11				7.87	7.53																
12			7.80			7.60		8.09		7.61							n/a				
13							7.29		7.73		8.00	8.36		7.46	8.13	7.65		7.95		7.84	
13.8																					
14													8.52						7.67		7.92
14.1																					
14.7																					
15																					
15.8																					

Lake Merced
North

	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.37	8.89	8.15	8.37	8.40	8.96	8.66	9.09	7.75	8.36	8.83	8.79	7.97	8.30	8.66	8.84	8.20
5	8.31	8.75	8.13	8.36	8.31	8.77	8.62	8.72	7.75	8.32	8.67	8.39	7.92	8.30	8.62	8.84	8.13
10	8.25	8.20	8.11	8.34	8.30	8.34	8.26	8.44	7.72	8.31	8.09	8.13	7.90	8.21	8.30	8.91	8.07
14																	
15	8.04	8.10	8.08	8.31	8.30	8.22	8.03	8.08	7.64	8.32	7.99	8.02	7.86	8.19	8.19	8.99	8.07
16																	
17																	
17.4												7.77					
17.5													7.85	7.85			
18				8.10				7.96									
18.8											7.72						8.03
19	7.84	7.97	8.03		8.29	8.00	7.66		7.64								
19.3																8.94	
19.9															8.15		
20										8.12				8.17			
20.6										8.18							

Lake Merced
North East

	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.08	8.35	8.05	8.23	8.13	8.87	8.36	8.83	7.49	8.15	8.59	8.55	7.66	8.26	8.44	8.62	8.09
5	8.08	7.97	8.02	8.24	8.07	8.61	8.28	8.69	7.48	8.16	8.38	8.44	7.60	8.27	8.28	8.64	8.05
9																	
10	8.06	7.88	7.93	8.24	8.05	8.20	7.99	8.01	7.42	8.10	7.72	7.82	7.60	8.25	8.23	8.59	8.09
11																	
12																	
13				8.23							7.71	7.63					
13.8																8.64	
14		7.88	7.91					8.00									
14.1													7.57				
14.7														8.35			8.06
15	7.95				8.06	7.98	7.72		7.43	8.01					7.92		
15.8										8.01							

Lake Merced
South - Pistol
Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.70	8.72	8.03	8.16	8.44	8.41	8.21	8.63	8.17	8.29	8.25	8.54	8.39	8.19	8.14	8.61	8.44	8.17	8.52	8.03	8.30
5	8.41	8.67	8.03		8.42	8.22	8.16	8.63	8.13	8.33	8.46	8.47	8.18	8.16	8.10	8.60	8.39	8.16	8.49	8.03	8.26
6				8.02																	
10	8.02	7.91	8.03		8.41	8.16	8.11	8.58	8.12	8.31	8.53	8.20	8.11	8.15	8.05	8.01	7.96	8.11	8.35	8.03	8.24
12				7.97																	
15	7.66	7.77	8.00		7.78	8.00	8.09	8.32	8.12	8.18	8.49	7.56	8.22	8.14	7.94	7.61	7.53	8.06	8.18	7.93	8.24
16	7.66	7.78												8.08		7.55	7.48	7.60			8.09
17	7.72									8.17									8.01		
18				7.74	7.73				8.11			7.62	7.70		7.82					7.44	
18.2																					
18.9																					
19				7.75			8.06														
20								8.14			8.10										
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced
South - Pump
Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.70	8.62	7.99	8.29	8.70	8.46	8.28	8.70	8.53	8.33	8.29	8.66	8.33	8.17	8.19	8.63	8.40	8.18	8.55	8.04	8.41
5	8.68	8.40	7.96	8.26	8.63	8.38	8.27	8.69	8.40	8.34	8.24	8.65	8.25	8.14	8.14	8.60	8.36	8.15	8.49	8.04	8.37
10	8.22	7.85	7.94		8.57	8.33	8.20	8.68	8.37	8.28	8.24	7.86	8.30	8.13	8.03	8.17	8.10	8.14	8.08	7.89	8.36
12				8.16																	
15	7.92	7.73	7.93		7.85	8.32	8.18	8.46	8.37	8.19	8.18	7.52	8.48	8.13	7.89	7.66	7.52	8.10	7.92	7.91	8.36
16	7.87	7.76															7.42	7.50			
17														8.10							8.35
18				7.68	7.68				8.34	8.14		7.50			7.71	7.61			7.85	7.42	
19							8.13	8.29					7.93								
19.2																					
20											7.84										
20.4																					
21																					
21.5																					
22																					
22.8																					
23.2																					

Lake Merced
South - Pistol
Range

Depth	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06
Depth	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.23	8.08	7.92	8.03	8.27	7.49	7.66	8.54	8.15	7.70	7.87	8.31	8.81	8.53	7.97	8.34	6.89	7.77	7.97	8.03	8.23
5	8.21	8.06	7.91	8.01	8.21	7.48	7.63	8.51	8.08	7.69	7.83	8.21	8.78	8.50	7.95	8.32	6.85	7.77	7.95	8.01	8.21
6																					
10	8.16	7.94	7.90	7.92	7.74	7.44	7.63	8.40	8.01	7.68	7.82	8.13	8.73	7.95	7.92	8.18	6.79	7.79	7.94	7.98	8.20
12																					
15	8.14	7.94	7.84	7.71	7.47	7.44	7.62	7.90	7.84	7.67	7.82	8.19	8.73	7.53	7.88	7.68	6.78	7.81	7.92	7.95	8.19
16	8.11		7.82																		
17		7.96			7.42					7.63	7.79	8.12									
18				7.57					7.75							7.54		7.81		7.93	
18.2																					
18.9																					
19						7.47	7.61	7.76											7.75		
20													8.67	7.40	7.75		6.83				8.18
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced
South - Pump
Station

Depth	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06
Depth	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH	pH
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.24	8.16	7.89	8.19	8.34	7.58	7.52	8.61	8.37	7.62	7.90	8.24	8.84	8.53	8.09	8.44	8.19	7.86	8.09	8.03	8.22
5	8.22	8.15	7.86	8.18	8.32	7.48	7.47	8.60	8.36	7.61	7.88	8.17	8.81	8.49	8.07	8.24	8.15	7.84	8.03	8.00	8.19
10	8.24	8.15	7.86	8.18	8.15	7.36	7.46	8.29	8.13	7.58	7.87	8.12	8.79	8.42	7.99	7.81	8.14	7.84	8.01	7.98	8.17
12																					
15	8.24	8.14	7.87	8.00	7.74	7.31	7.46	8.02	7.66	7.52	7.85	7.93	8.77	7.49	7.78	7.58	6.83	7.86	7.91	7.97	8.16
16	8.19																				
17		8.14			7.45					7.52		7.93									
18				7.61																	
19			7.83			7.31			7.56		7.84						6.90				
19.2																					
20							7.43	7.91					8.75	7.41	7.84	7.49		7.89	7.82	7.95	8.13
20.4																					
21													8.74								8.12
21.5																					
22																					
22.8																					
23.2																					

Lake Merced South - Pistol Range

	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.19	8.53	7.97	8.20	8.26	8.67	8.24	8.60	7.91	8.14	8.32	8.70	7.85	8.07	8.40	8.56	8.01
5	8.15	8.49	7.94	8.18	8.17	8.66	8.20	8.48	7.85	8.13	8.24	8.64	7.83	8.08	8.36	8.54	7.97
6																	
10	8.10	8.32	7.90	8.16	8.06	8.53	8.05	8.17	7.84	8.12	8.10	8.03	7.82	8.04	8.18	8.54	7.94
12																	
15	8.06	7.90	7.88	8.13	8.04	8.27	7.99	7.88	7.83	8.13	8.02	7.90	7.81	8.04	8.03	8.29	7.90
16																	
17																	
18																	
18.2																	7.85
18.9																8.37	
19				7.96									7.80				
20	7.90	7.79	7.83		8.08	8.20	7.62	7.59	7.78	8.13	7.49			8.03	8.05		
20.1												7.53					
20.6														7.58			
20.8															7.95		
21		7.78				8.20		7.59	7.69								
21.5										8.17							
22							7.60										

Lake Merced South - Pump Station

	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**	**pH**
Ft	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units	pH units
Surf	8.49	8.57	8.06	8.19	8.23	8.60	8.33	8.66	7.84	8.13	8.39	8.63	7.86	8.43	8.49	8.57	8.06
5	8.44	8.52	8.04	8.16	8.18	8.57	8.27	8.64	7.84	8.13	8.28	8.60	7.82	8.43	8.49	8.56	8.05
10	8.42	8.05	8.04	8.09	8.10	8.38	7.94	8.15	7.78	8.14	8.19	7.93	7.79	8.44	8.20	8.15	8.05
12																	
15	8.35	7.93	8.01	7.87	8.04	8.11	7.80	7.92	7.79	8.14	7.70	7.88	7.78	8.52	7.99	8.10	8.05
16																	
17																	
18				7.89													
19																	
19.2																8.16	
20	8.11	7.81			8.04	8.07	7.72	7.77	7.79	8.17	7.65	7.81		8.61	7.90		
20.4																	8.05
21		7.77	7.86					7.71	7.83		7.49	7.56	7.74				
21.5															7.89		
22	8.02				8.05	8.11	7.70										
22.8														8.57			
23.2										8.19							

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	742	842	888	864	728	774	726		793	851	711	729	755	780	738	808	861	811	757	755
5	744	844	902	883	728	757	726		795	850	712	734	760	781	736	807	866	812	757	757
10	754	855	917	974	728	761	727		795	862	714	737	762	781	740	826	874	814	760	766
14									796	864				778			881			
15	758	871	919	1020	737	764	729				724	753	764		743	834		812	763	769
16	757	882		1070											742				766	769
17																				
17.4																				
17.5																				
18			949								716									
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	716		818	736	706	762	689		784	822	664	724	749	745	686	787	832	753	693	722
5	718		821	741	706	763	689		784	824	667	728	756	745	687	792	835	753	695	724
9																	843			
10	720		822	742	706	763	690		784	834	670	731	764	746	689	803		754	697	727
11																			697	726
12				747																
13											684									
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	755	802	820	753	747	778	674	633	717	342	752	717	673	676	703	745	794	781	806	678
5	757	803	821	753	748	779	638	647	717	613	755	717	675	676	703	746	795	730	806	680
10	759	803	821	754	748	787	639	642	717	613	759	718	677	675	703	745	799	734	807	681
14																				
15	769	804	822	754	752	792	640	644	718	620	760	724	679	675	704	745	801	734	806	682
16	769				759			646								745				
17							640		724	627	760		679				806			
17.4																				
17.5																				
18												723		675				732	807	692
18.8																				
19															716					
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond	Cond
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	740	775	785	696	711	754	650	640	709	613	750	716	667	666	702	742	794	n/a	795	664
5	741	775	786	697	712	756	651	644	709	612	750	724	668	665	702	742	796	n/a	795	668
9																				
10	748	776	787	697	712	761	651	645	712	614	750	731	672	665	703	743	800	n/a	795	672
11					712	765														
12				697			651		714		752							n/a		
13								646		609		726	670		710	744	806		796	
13.8																				
14														667						683
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	658	700	634	666	717	733	596	563	724	717	731	696	713	774	809	751	774	692	697
5	660	699	634	669	717	733	593	565	726	724	731	696	718	786	810	751	774	697	697
10	661	699	635	675	718	734	594	567	734	732	731	697	730	790	810	752	780	704	698
14																			
15	662	698	638	677	718	735	594	569	738	736	732	697	731	792	811	753	781	717	698
16																			
17																			
17.4														798					
17.5															811				
18	662					744				740									
18.8													736						698
19		699	656	696	720		593	576	753		732								
19.3																		726	
19.9																	782		
20												702				753			
20.6												703							

Lake Merced
North East

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	649	690	646	678	725	739	598	565	735	730	724.3	697	726	780	796	738	770	692	679
5	651	690	645	678	726	740	600	568	738	732	724.5	696	731	782	796	738	773	695	679
9																			
10	652	692	645	679	727	740	597	569	743	740	724.9	697	738	792	796	739	773	703	678
11																			
12																			
13	652					740							744	799					
13.8																		718	
14		696		682	727					749									
14.1															796				
14.7																739			679
15			647				597	573	749		726.8	697					777		
15.8												697							

Lake Merced
South - Pistol
Range

Depth	15-May-97 Cond	10-Sep-97 Cond	3-Dec-97 Cond	16-Mar-98 Cond	8-Jul-98 Cond	23-Sep-98 Cond	17-Mar-99 Cond	21-Jun-99 Cond	15-Sep-99 Cond	8-Dec-99 Cond	21-Mar-00 Cond	21-Jun-00 Cond	9-Aug-00 Cond	19-Dec-00 Cond	7-Mar-01 Cond	20-Jun-01 Cond	1-Oct-01 Cond	18-Dec-01 Cond	5-Mar-02 Cond	30-Apr-02 Cond
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	490	573	639	590	547	585	560	565	597	635	557	580	599	620	600	673	707	667	639	648
5	492	573	664		547	585	558	565	597	643	563	584	603	620	600	673	707	667	626	649
6				603																
10	492	576	674		547	585	558	565	597	646	562	588	605	619	599	671	710	668	627	650
12				613																
15	494	578	689		550	584	555	567	597	650	562	598	606	619	600	674	713	668	629	652
16	494	580												619		675	714	665		
17	494									650									630	
18				621	552				596			599	605		601					660
18.2																				
18.9																				
19				629			557													
20								568			560									
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

Depth	15-May-97 Cond	10-Sep-97 Cond	3-Dec-97 Cond	16-Mar-98 Cond	8-Jul-98 Cond	23-Sep-98 Cond	17-Mar-99 Cond	21-Jun-99 Cond	15-Sep-99 Cond	8-Dec-99 Cond	21-Mar-00 Cond	21-Jun-00 Cond	9-Aug-00 Cond	19-Dec-00 Cond	7-Mar-01 Cond	20-Jun-01 Cond	1-Oct-01 Cond	18-Dec-01 Cond	5-Mar-02 Cond	30-Apr-02 Cond
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	490	574	594	555	544	585	561	565	595	637	588	579	598	619	601	674	708	668	639	646
5	490	575	595	554	545	584	561	565	597	639	587	580	601	620	601	673	707	666	639	647
10	492	577	594		546	585	561	566	597	642	587	595	600	620	601	671	709	666	641	648
12				560																
15	493	578	594		548	585	561	566	597	646	588	591	605	620	601	674	712	666	641	649
16	493	579															715	673		
17														620						
18				563	552				597	647		668			602	678			643	651
19							561	567					601							
19.2																				
20											599									
20.4																				
21																				
21.5																				
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	659	683	630	602	594	622	437	434	411	454	538	490	532	517	533	535	616	522	625	536
5	659	684	632	602	594	624	522	455	461	455	538	490	532	517	533	536	592	524	624	537
6																				
10	660	684	645	602	595	627	522	441	463	452	538	466	535	516	534	537	593	528	625	538
12																				
15	660	684	646	603	596	628	522	441	465	454	539	461	535	517	534	538	595	526	626	539
16	659	684		603																
17			647			629					540	453	536							
18					597					450							601		627	
18.2																				
18.9																				
19							522	440	470											540
20														517	538	539		528		
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	659	684	620	598	592	621	436	431	469	525	538	449	532	515	533	536	611	546	619	537
5	659	684	621	598	593	622	437	444	467	525	538	443	531	515	533	536	612	529	620	538
10	660	684	621	598	593	623	436	453	466	527	538	444	531	515	533	537	613	535	620	539
12																				
15	660	685	621	598	594	624	438	451	468	529	539	443	532	515	532	540	614	533	621	540
16		685																		
17	660		621			627					539		533							
18					595															
19				598			438			532		444						533		
19.2																				
20								450	468					515	534	527	616		621	541
20.4																				
21														515						
21.5																				
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	529	569	542	562	600	564	520	473	610	611	612	597.6	623	662	685.2	656	682	611	610
5	530	569	542	562	600	564	524	474	613	613	613	597.4	623	663	685.4	655	681	613	610
6																			
10	531	569	542	562	609	564	525	474	615	613	613	597.3	623	669	685.3	656	682	614	610
12																			
15	532	569	543	563	607	564	528	479	616	614	614	597.2	622	670	685.5	656	683	620	610
16																			
17																			
18	533																		
18.2																			610
18.9																		625	
19						566									685.3				
20		567	544	564	609		522	481	618	616	614	597.2	624			656	683		
20.1														702					
20.6																652			
20.8																	683		
21				564				482		617	613								
21.5												597							
22									619										

Lake Merced
South - Pump
Station

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**	**Cond**
Ft	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm	mmho/cm
Surf	531	569	538	562	594	566	498	475	610	612	613	597	624	662	684	656	682	610	611
5	531	569	539	562	595	566	500	476	612	611	613	598	623	662	684	655	681	610	610
10	532	568	539	564	595	566	500	476	615	614	613	597	623	669	685	655	683	618	611
12																			
15	533	568	540	563	596	568	502	479	616	614	613	597	625	670	685	656	684	618	610
16																			
17																			
18						570													
19																			
19.2																		623	
20	533	567	541	564			501	481	617	614	614	597	625	670		655	684		
20.4																			611
21		566		564	598					615	613		625	684	686				
21.5																	685		
22			542				500	481	621										
22.8																656			
23.2												598							

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf			569	518	466	495	465		508	544	455	466	484	499	472	517	551	519	485	483
5			578	530	466	484	465		509	544	456	470	486	500	471	517	554	520	485	484
10			587	584	466	487	465		509	551	457	471	488	500	474	529	560	521	486	490
14									509	553				498			564			
15			588	612	472	489	466				463	482	489		475	534		520	488	492
16				642											475				490	492
17																				
17.4																				
17.5																				
18			608								459									
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf			524	442	452	488	441		502	526	426	464	479	477	439	503	533	482	444	462
5			525	445	452	488	441		502	527	427	466	484	477	440	507	534	482	445	463
9																	539			
10			526	445	452	488	442		502	533	429	468	489	478	441	514		482	446	465
11																			446	464
12				448																
13											438									
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	483	514	525	482	478	498	431	405	459	219	482	459	431	432	450	477	508	500	516	434	421
5	485	514	525	482	479	499	408	414	459	393	483	459	432	432	450	477	509	467	516	435	422
10	486	514	525	482	479	504	409	411	459	392	485	459	433	432	450	477	511	470	516	436	423
14																					
15	492	514	526	483	481	507	410	412	460	397	486	463	435	432	451	477	513	469	516	436	423
16	492				485			414								477					
17							410		463	401	487		435				516				
17.4																					
17.5																					
18												462		432				469	516	443	424
18.8																					
19															458						
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	474	496	502	446	455	483	416	409	454	392		458	426	426	449	475	508	n/a	509	425	415
5	474	496	503	446	456	484	417	412	454	392		463	427	426	449	475	509	n/a	509	427	416
9																					
10	479	497	504	446	456	487	417	413	455	393		468	429	426	450	475	512	n/a	509	430	417
11					456	490															
12				446			417		457									n/a			
13								413		390		465	429		454	476	516		509		418
13.8																					
14														427						437	
14.1																					
14.7																					
15																					
15.8																					

Lake Merced
North

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	448	406	426	459	469	382	360	463	459	468	446	456	495	518	481	495	443	446
5	448	406	428	459	469	380	362	465	463	468	446	460	503	518	481	495	446	446
10	448	406	432	459	470	380	363	470	468	468	446	467	505	518	481	499	451	447
14																		
15	447	409	433	459	470	380	364	472	470	468	446	468	507	519	482	500	459	447
16																		
17																		
17.4													511					
17.5														519				
18					476				473									
18.8												471						447
19	448	420	445	461		379	369	482		468								
19.3																	465	
19.9																501		
20											449				482			
20.6											450							

Lake Merced
North East

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	442	413	434	464	473	383	362	470	467	464	446	465	499	510	472	493	443	434
5	442	413	434	465	474	384	363	472	468	464	446	468	501	510	472	495	445	434
9																		
10	443	413	434	465	473	382	364	476	474	464	446	472	507	510	473	495	450	434
11																		
12																		
13					474							476	511					
13.8																	459	
14	445		436	465					479									
14.1														510				
14.7															473			434
15		414				382	366	479		465	446					497		
15.8											446							

Lake Merced
South - Pistol
Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf			409	354	350	375	358	361	382	406	357	371	383	397	384	431	452	427	409	415
5			425		350	374	358	361	382	412	360	374	386	397	384	431	452	427	400	415
6				362																
10			431		350	374	357	362	382	413	360	377	387	396	384	430	454	427	401	416
12				368																
15			441		352	374	355	363	382	416	360	383	388	396	384	432	456	427	402	417
16														396		432	457	425		
17										416									403	
18				373	353				381			384	388		384					422
18.2																				
18.9																				
19				377			356													
20								363			358									
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf			380	333	348	374	359	362	381	408	376	370	383	396	385	431	453	427	409	414
5			381	332	349	374	359	362	382	409	376	371	384	397	384	431	453	426	409	414
10			380		349	374	359	362	382	411	376	381	384	397	384	429	454	426	410	415
12				336																
15			380		351	374	359	362	382	414	376	377	387	397	385	431	456	426	410	416
16																	458	431		
17														397						
18				338	353				382	414		427			385	434			412	417
19							359	363					385							
19.2																				
20											383									
20.4																				
21																				
21.5																				
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	422	437	403	385	380	398	280	278	265	291	344	314	340	331	341	342	394	334	400	343	338
5	422	438	405	385	380	399	334	291	295	291	344	313	340	331	341	343	379	335	400	344	339
6																					
10	422	438	413	385	381	401	334	282	296	289	345	298	343	330	342	344	380	338	400	345	340
12																					
15	422	438	413	386	381	402	334	282	297	290	345	295	343	331	342	344	381	336	401	345	341
16	422	438		386																	
17			414			402					346	290	343								
18					382					288							384		401		341
18.2																					
18.9																					
19							334	282	301											346	
20														331	344	345		338			
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced
South - Pump
Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS	TDS
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	422	438	397	383	379	397	279	276	300	336	344	287	340	330	341	342	391	350	396	344	340
5	422	438	397	383	379	398	279	284	299	336	344	284	340	330	341	343	392	339	397	344	340
10	422	438	397	383	379	398	279	290	298	337	344	284	340	330	341	344	393	342	397	345	341
12																					
15	422	438	397	383	380	399	280	289	300	339	345	284	341	330	341	346	393	341	397	346	341
16		438																			
17	422		398			401					345		341								
18					381																
19				383			280			340		284						341			
19.2																					
20								288	299					330	342	342	394		397	346	341
20.4																					
21														330							
21.5																					
22																					
22.8																					
23.2																					

Lake Merced South - Pistol Range

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	364	347	360	384	361	333	303	391	391	392	382	399	423	439	420	436	391	390
5	364	347	359	384	361	335	304	392	392	393	382	399	424	439	419	436	392	390
6																		
10	364	347	360	389	361	336	304	393	392	393	382	399	428	439	420	437	393	390
12																		
15	364	347	361	389	361	338	307	394	393	393	382	398	429	439	420	437	397	390
16																		
17																		
18																		
18.2																		391
18.9																	400	
19					362									439				
20	363	348	361	390		334	308	396	394	393	382	399			420	437		
20.1													449					
20.6															418			
20.8																437		
21			361				309		394	392								
21.5											382							
22								396										

Lake Merced South - Pump Station

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**	**TDS**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	364	345	359	380	362	319	304	391	391	392	382	399	424	438	420	436	390	391
5	364	345	359	381	362	320	305	392	391	392	382	399	424	438	419	436	390	391
10	364	345	361	381	362	321	305	393	393	392	382	399	428	438	419	437	396	391
12																		
15	364	345	361	381	364	321	307	394	393	393	382	400	429	438	420	437	396	391
16																		
17																		
18					365													
19																		
19.2																	398	
20	363	346	361			321	308	395	393	393	382	400	429		419	438		
20.4																		391
21	362		361	383					394	393		400	438	439				
21.5																438		
22		347				320	308	398										
22.8															420			
23.2											383							

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	14.5	10.2	6.7	9.6	9.3	8.6	9.1		7.6	7.9	7.7	10.8	7.3	7.9	9.9	13.1	13.0	9.4	10.6	11.0	10.8
5	10.0	9.8	5.2	9.5	9.1	6.4	9.0		6.2	7.1	7.3	9.2	6.4	7.5	9.0	12.5	8.8	8.0	10.3	10.2	9.3
10	2.0	2.4	4.7	4.9	8.5	4.2	7.6		6.2	6.6	7.1	8.9	5.9	7.3	6.4	0.4	3.1	8.2	6.3	4.4	8.2
14									5.7	6.6				4.4			0.7				
15	0.5	0.2	4.7	0.37	3.4	1.1	6.2				6.7	1.0	4.6		3.8	0.6		8.6	1.5	2.5	1.2
16	0.2	0.2		0.27											3.9				0.6	1.2	1.1
17																					
17.4																					
17.5																					
18			4.5								0.1										
18.8																					
19																					
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	11.5		5.9	8.0	6.9	7.6	9.5		6.8	9.5	8.7	7.6	6.0	9.7	9.5	11.1	8.1	9.6	8.8	9.1	10.0
5	9.1		5.7	7.3	6.5	6.1	9.3		6.6	9.0	8.1	7.3	5.2	9.3	8.5	7.0	2.7	9.3	8.2	8.1	9.1
9																	1.2				
10	3.0		5.4	3.2	5.6	5.7	8.5		6.1	8.1	7.2	5.9	4.7	9.0	6.4	0.4		8.9	3.6	5.5	3.2
11																			3.3	2.0	
12				0.86																	
13											0.1										
13.8																					
14																					
14.1																					
14.7																					
15																					
15.8																					

Lake Merced
North

	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06
Depth	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	6.3	6.6	9.6	9.7	10.8	6.7	8.7	5.8	9.4	8.1	8.2	7.9	7.0	7.1	11.3	8.6	7.4	8.5	8.1	8.1	8.5
5	6.1	6.3	8.4	9.4	9.4	5.7	5.9	5.4	9.0	6.4	7.6	7.8	6.8	7.0	10.5	6.6	7.0	7.8	7.5	7.8	8.0
10	5.9	6.2	8.0	9.2	3.2	5.1	4.1	5.1	8.9	6.6	6.9	7.6	6.8	6.8	6.5	6.1	6.8	7.5	7.5	7.8	7.5
14																					
15	5.8	5.8	7.4	7.2	0.3	4.7	3.5	2.4	5.2	5.9	5.3	6.9	6.6	0.2	2.6	5.9	6.9	6.9	7.6	7.3	5.0
16				3.8			3.5														
17						4.6		0.9	0.2	5.7		6.8									
17.4																					
17.5																					
18											4.1		6.5					3.5	7.5		
18.8																					
19														0.2						4.9	0.3
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06
Depth	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**	**DO**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	8.5	8.7	10.1	7.4	9.6	7.4	9.1	7.6	8.3	8.1	9.5	9.1	8.0	6.6	9.9		7.8	9.4	7.9	9.6	7.9
5	8.4	7.6	9.6	6.9	7.7	6.5	5.9	7.2	7.9	7.7	7.6	9.3	7.8	5.9	8.7		7.6	7.5	7.3	9.2	8.0
9																					
10	7.7	7.5	7.7	6.6	1.4	5.4	4.1	4.7	5.7	7.6	5.6	9.1	6.4	1.2	3.1		7.3	5.6	6.9	6.6	7.7
11				6.7	0.8																
12			6.7			5.7		3.4		5.8											
13							4.1		0.2		0.3	8.2		0.2					6.7		
13.8																					
14													4.9					3.3		3.8	
14.1																					
14.7																					
15																					5.6
15.8																					

Lake Merced
North

	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth Ft	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L
Surf	12.3	6.5	5.5	8.2	9.8	10.2	17.9	8.2	8.9	17.9	13.4	5.9	9.3	13.5	10.5	8.9
5	10.5	6.4	5.3	8.0	8.1	9.4	9.4	8.1	8.5	14.1	6.1	4.9	9.2	12.5	6.5	7.7
10	3.7	6.1	5.1	7.9	5.8	4.8	6.6	7.7	8.3	4.4	2.5	4.5	7.3	6.6	1.3	7.1
14																
15	2.2	6.0	5.1	7.9	4.8	2.5	2.7	6.2	8.0	3.2	0.1	3.7	7.0	4.9	0.3	6.8
16																
17																
17.4											0.1					
17.5												3.7	3.7			
18			0.8				0.5									
18.8										0.9						6.7
19	0.3	5.7		7.7	1.1	0.5		6.3								
19.3															0.3	
19.9														2.4		
20									0.6				5.5			
20.6									0.4							

Lake Merced
North East

	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth Ft	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L	**DO** mg/L
Surf	8.9	7.5	6.5	7.0	10.5	9.6	14.0	6.37	8.7	14.3	12.7	4.9	8.6	11.5	9.7	9.8
5	4.8	7.1	6.5	6.9	8.0	8.2	10.9	6.20	8.8	10.4	10.6	4.0	8.2	9.1	7.2	8.9
9																
10	3.3	6.0	6.5	6.7	5.7	5.2	3.9	5.38	7.9	2.8	1.8	4.0	6.7	8.1	1.0	8.9
11																
12																
13			6.4							0.7	0.1					
13.8															0.4	
14	1.1	4.8					0.3									
14.1												3.9				
14.7													0.8			6.0
15				6.6	1.4	1.6		0.58	6.5					3.0		
15.8									6.2							

Lake Merced
South - Pistol

Depth	15-May-97 DO	10-Sep-97 DO	3-Dec-97 DO	16-Mar-98 DO	8-Jul-98 DO	23-Sep-98 DO	17-Mar-99 DO	21-Jun-99 DO	15-Sep-99 DO	8-Dec-99 DO	21-Mar-00 DO	21-Jun-00 DO	9-Aug-00 DO	19-Dec-00 DO	7-Mar-01 DO	20-Jun-01 DO	1-Oct-01 DO	18-Dec-01 DO	5-Mar-02 DO	30-Apr-02 DO	18-Jun-02 DO
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	12.4	8.5	7.4	8.6	8.7	7.9	8.9	8.0	6.6	9.8	9.2	9.4	7.9	7.4	9.0	9.5	11.2	9.5	9.8	9.9	8.0
5	9.2	7.9	7.3		8.5	6.6	8.6	7.9	6.4	9.7	8.8	8.2	6.2	7.3	8.5	9.3	10.4	9.2	9.7	9.8	7.7
6				7.9																	
10	6.7	1.6	7.3		8.4	6.1	8.3	7.5	6.2	9.5	8.4	6.0	5.6	7.2	8.1	5.2	6.5	8.7	8.7	9.3	7.5
12				7.5																	
15	3.5	0.2	6.6		4.6	4.9	8.2	5.9	6.2	8.5	7.7	0.1	5.5	7.0	7.2	1.3	1.9	8.3	6.7	8.3	7.0
16	3.3	0.2												6.8		1.2	1.4	0.4			1.7
17	3.4									8.7									1.6		
18				5.5	4.5				6.3			0.1	***0.05***		6.2					0.2	
18.2																					
18.9																					
19				5.4			8.1														
20								4.7			0.2										
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced
South -

Depth	15-May-97 DO	10-Sep-97 DO	3-Dec-97 DO	16-Mar-98 DO	8-Jul-98 DO	23-Sep-98 DO	17-Mar-99 DO	21-Jun-99 DO	15-Sep-99 DO	8-Dec-99 DO	21-Mar-00 DO	21-Jun-00 DO	9-Aug-00 DO	19-Dec-00 DO	7-Mar-01 DO	20-Jun-01 DO	1-Oct-01 DO	18-Dec-01 DO	5-Mar-02 DO	30-Apr-02 DO	18-Jun-02 DO
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	12.2	7.6	6.8	9.2	10.1	8.0	9.5	8.3	9.0	10.2	8.8	10.5	8.9	6.8	9.2	9.7	10.7	10.1	10.0	9.8	8.7
5	12.1	5.0	6.6	9.2	9.7	7.4	9.4	8.2	7.7	9.8	8.6	10.0	7.7	6.7	8.8	9.3	10.2	9.7	9.9	9.8	8.6
10	7.8	1.9	6.3		9.1	7.0	8.9	7.9	7.6	9.6	8.4	3.3	7.4	6.6	8.2	6.3	7.7	9.6	6.0	8.1	8.2
12				8.7																	
15	5.5	0.2	6.2		4.9	6.9	8.8	6.6	7.7	8.9	7.8	0.1	7.1	6.3	6.5	1.6	2.0	9.2	3.0	7.9	8.0
16	4.5	0.2															1.1	0.6			
17														6.1							7.5
18				4.4	3.2				7.4	8.7		0.1			4.6	0.7			0.5	0.1	
19							8.3	5.2					0.1								
19.2																					
20											0.1										
20.4																					
21																					
21.5																					
22																					
22.8																					
23.2																					

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
South - Pistol

Depth (Ft)	23-Aug-02 DO (mg/L)	23-Oct-02 DO (mg/L)	11-Feb-03 DO (mg/L)	14-May-03 DO (mg/L)	15-Jul-03 DO (mg/L)	30-Sep-03 DO (mg/L)	2-Dec-03 DO (mg/L)	27-May-04 DO (mg/L)	29-Aug-04 DO (mg/L)	27-Oct-04 DO (mg/L)	9-Dec-04 DO (mg/L)	9-Feb-05 DO (mg/L)	18-Apr-05 DO (mg/L)	23-Jun-05 DO (mg/L)	28-Sep-05 DO (mg/L)	31-Oct-05 DO (mg/L)	29-Nov-05 DO (mg/L)	29-Dec-05 DO (mg/L)	23-Jan-06 DO (mg/L)	01-Mar-06 DO (mg/L)	26-Apr-06 DO (mg/L)
0	8.0	6.5	10.1	8.5	9.8	6.7	9.1	8.3	7.5	7.4	8.1	9.5	8.0	8.1	9.9	8.6	8.3	8.9	9.1	8.8	8.1
5	7.8	6.2	10.0	8.4	9.1	6.7	8.4	8.0	6.9	7.1	7.3	8.8	7.9	8.1	9.6	8.1	8.3	8.7	8.9	8.8	7.9
6																					
10	7.4	5.2	10.0	7.7	5.5	6.3	8.1	7.5	6.4	6.7	6.8	8.2	7.6	5.3	8.6	7.0	8.2	8.7	8.7	8.8	7.7
12																					
15	6.7	4.9	9.6	5.9	2.6	6.2	7.9	3.2	4.9	6.5	6.5	8.6	7.6	2.2	4.2	6.6	8.2	8.6	8.6	8.7	7.4
16	5.8		9.3																		
17		3.2			2.0					3.8	3.7	7.8									
18				4.5					3.5										8.6		
18.2																					
18.9																					
19						5.8	7.8	0.3										7.4			
20													7.2							8.6	5.9
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced
South -

Depth (Ft)	23-Aug-02 DO (mg/L)	23-Oct-02 DO (mg/L)	11-Feb-03 DO (mg/L)	14-May-03 DO (mg/L)	15-Jul-03 DO (mg/L)	30-Sep-03 DO (mg/L)	2-Dec-03 DO (mg/L)	27-May-04 DO (mg/L)	29-Aug-04 DO (mg/L)	27-Oct-04 DO (mg/L)	9-Dec-04 DO (mg/L)	9-Feb-05 DO (mg/L)	18-Apr-05 DO (mg/L)	23-Jun-05 DO (mg/L)	28-Sep-05 DO (mg/L)	31-Oct-05 DO (mg/L)	29-Nov-05 DO (mg/L)	29-Dec-05 DO (mg/L)	23-Jan-06 DO (mg/L)	01-Mar-06 DO (mg/L)	26-Apr-06 DO (mg/L)
Surf	7.9	7.3	9.4	9.5	9.9	7.6	9.0	8.8	9.6	6.5	7.9	9.5	8.1	8.3	10.5	8.8	8.5	9.0	9.2	8.8	9.7
5	7.6	7.2	9.2	9.4	9.4	6.5	8.0	8.6	9.3	6.1	7.5	9.0	7.9	8.1	8.6	8.2	8.2	8.7	8.8	8.6	9.5
10	7.7	7.2	9.1	9.3	8.0	4.8	7.7	6.6	7.2	5.5	6.5	9.0	7.8	7.7	6.0	7.2	8.1	8.5	8.6	8.4	9.4
12																					
15	7.6	7.1	9.2	7.8	4.6	3.9	7.6	4.4	3.0	3.6	6.1	7.0	7.8	1.9	2.6	5.0	8.1	7.8	8.7	8.3	8.9
16	7.0																				
17		6.9			1.2					3.5		6.9									
18				4.7																	
19			8.5			3.9			0.3		5.3										
19.2																					
20							7.0	2.0					7.6					7.6	8.7	8.0	7.3
20.4																					
21													7.6							7.9	
21.5																					
22																					6.4
22.8																					
23.2																					

Lake Merced
South - Pistol

Depth	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	9.4	6.5	7.1	8.4	9.1	8.4	11.5	10.9	8.9	11.5	11.9	7.1	10.0	10.5	9.8	9.8
5	9.1	6.2	7.0	8.4	8.9	7.7	10.1	10.2	9.0	10.9	10.9	6.7	9.9	9.9	8.0	9.5
6																
10	8.2	5.9	7.0	7.7	8.8	6.8	8.0	10.1	8.6	10.2	4.5	6.6	9.2	8.0	6.7	9.3
12																
15	5.0	5.9	6.7	7.4	8.5	6.7	5.2	10.0	8.5	9.5	3.0	6.4	9.1	6.6	0.3	8.7
16																
17																
18																
18.2																7.8
18.9															0.4	
19			4.1									6.3				
20	3.6	5.9		4.4	7.2	3.2	1.5	9.7	8.2	0.6			8.3	6.5		
20.1											0.2					
20.6													2.8			
20.8														0.7		
21	3.3				6.9		1.4	9.3								
21.5									7.9							
22						1.9										

Lake Merced
South -

Depth	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO	DO
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	9.7	6.2	6.6	7.8	8.6	8.9	11.8	10.9	9.2	11.7	11.2	8.4	10.2	10.9	11.0	9.22
5	9.4	6.0	6.4	7.6	8.5	8.0	11.5	10.9	9.3	11.0	10.6	8.0	9.7	10.8	9.8	9.12
10	5.9	6.0	5.5	7.3	6.7	6.0	7.4	10.2	9.3	10.3	3.7	7.7	9.6	7.8	2.3	8.86
12																
15	4.7	5.9	0.7	7.2	6.2	4.5	5.3	10.0	9.2	6.3	3.3	7.6	9.5	5.2	0.3	8.65
16																
17																
18			0.5													
19																
19.2															0.4	
20	3.3			7.2	6.1	3.7	3.4	9.9	9.2	5.4	2.6		9.4	3.6		
20.4																8.59
21	2.4	4.0					3.2	9.9		0.5	0.2	7.2				
21.5														0.4		
22				7.1	5.7	2.1										
22.8													0.5			
23.2									9.0							

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	295	186	305	274	290	264	395		352	328	191	202	269	302	366	166	232	319	261	215
5	302	173	305	262	286	251	394		353	328	178	192	271	293	366	159	233	318	253	205
10	319	138	305	231	280	232	393		352	329	168	168	269	276	364	47	236	315	234	176
14									353	330				240			231			
15	328	9	305	206	271	202	393				141	128	267		359	25		308	188	136
16	329	13		205											354				94	40
17																				
17.4																				
17.5																				
18			309								54									
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	338		281	262	315	299	423		344	278	186	346	253	296	351	169	223	272	268	218
5	347		276	253	315	297	424		343	265	166	341	252	284	349	143	223	264	264	203
9																	214			
10	361		271	244	315	297	426		343	236	110	335	249	265	343	44		246	241	168
11																			207	62
12				237																
13											-48									
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	457	451	528	547	540	470	498	473	437	299	373	330	328	323	173	378	265	427	319	298	228
5	455	451	528	547	540	471	498	474	436	294	372	330	323	309	169	378	258	419	316	297	229
10	451	450	527	547	538	473	498	475	435	287	371	331	313	304	151	377	248	391	309	296	229
14																					
15	443	446	525	544	537	471	497	475	429	268	370	332	303	298	102	376	233	367	297	293	229
16	332				530			475								373					
17							497		409	69	368		293				219				
17.4																					
17.5																					
18												334		290				338	281	295	228
18.8																					
19															-3						
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	416	438	529	542	538	469	494	474	442	205	339	276	319	275	147	374	264	n/a	289	239	216
5	376	433	529	541	538	469	493	475	441	186	333	269	313	259	132	374	257	n/a	276	228	211
9																					
10	323	397	529	540	537	468	491	474	442	143	325	256	304	244	71	374	236	n/a	255	214	202
11					535	448															
12				533			485		441		314							n/a			
13								471		55		213	290		-21	374	218		227		184
13.8																					
14														198						190	
14.1																					
14.7																					
15																					
15.8																					

Lake Merced
North

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	285	213	278	315	369	356	230	185	304	296	278	280	227	447	324	305	255	381
5	285	209	259	314	368	359	231	175	296	294	269	274	191	448	322	298	226	382
10	285	203	232	313	367	358	242	139	295	293	260	240	152	448	322	274	140	382
14																		
15	285	186	208	309	364	355	242	76	269	288	242	211	88	448	319	255	89	381
16																		
17																		
17.4													-4					
17.5														448				
18					368				268									
18.8												93						381
19	287	130	161	305		350	239	-31		287								
19.3																	79	
19.9																199		
20											77				317			
20.6											58							

Lake Merced
North East

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**	**ORP**
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	268	244	328	310	379	360	204	243	295	251	316	276	263	515	273	333	292	347
5	268	238	328	308	378	361	204	234	277	239	312	260	249	518	263	331	260	343
9																		
10	267	232	323	303	377	360	210	227	251	202	294	187	136	519	248	323	186	331
11																		
12																		
13					376							31	10					
13.8																	133	
14	266		318	296					74									
14.1														521				
14.7															199			318
15		215				357	203	220		103	278					319		
15.8											260							

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	311	276	233	292	286	287	404	349	340	301	225	174	184	429	431	216	262	280	266	224
5	325	276	228		282	287	403	347	340	294	207	148	175	429	432	215	264	276	259	211
6				291																
10	336	290	214		275	283	402	344	339	288	196	119	164	429	431	219	274	266	248	200
12				289																
15	346	287	197		273	274	400	343	339	283	181	-56	136	429	431	217	284	254	221	183
16	346	288												431		206	283	175		
17	344									277									139	
18				287	265				339			-57	56		430					61
18.2																				
18.9																				
19				287			398													
20								346			172									
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	303	242	269	297	289	287	366	313	336	316	176	203	198	421	410	225	243	264	268	232
5	305	241	264	299	286	284	361	309	337	313	173	193	190	421	411	226	243	262	263	225
10	318	244	258		278	265	350	298	337	312	159	159	170	421	411	227	246	256	249	212
12				285																
15	326	241	257		273	252	337	280	336	311	140	105	132	418	412	231	255	239	214	181
16	324	246															259	138		
17														418						
18				286	269				335	309		30			411	228			114	66
19							320	258					29							
19.2																				
20											63									
20.4																				
21																				
21.5																				
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	348	453	526	547	542	482	502	431	414	318	341	315	319	321	221	355	284	309	315	318	235
5	336	453	523	547	542	481	497	431	407	314	338	316	312	310	214	353	277	307	312	316	232
6																					
10	315	453	518	547	541	481	486	430	385	305	322	315	305	291	203	349	267	302	306	315	228
12																					
15	286	451	507	544	537	477	466	430	358	298	315	313	293	275	190	344	255	295	298	313	223
16	208	445		540																	
17			423			467					311	316	252								
18					526					232							210		289		212
18.2																					
18.9																					
19							430	429	159											313	
20														258	157	341		278			
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced
South - Pump
Station

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP	ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	414	449	518	543	533	468	506	402	445	260	341	338	335	321	260	376	279	349	323	318	231
5	401	449	516	543	532	466	506	401	445	251	342	338	332	312	254	377	275	345	322	318	231
10	374	448	513	542	529	464	506	400	446	236	342	339	325	303	238	378	263	321	318	318	230
12																					
15	334	445	505	537	524	457	503	398	446	207	344	340	317	297	222	383	251	294	312	318	230
16		438																			
17	260		491			447					345		295								
18					510																
19				530			502			155		340						278			
19.2																					
20								398	446					293	193	386	237		301	318	229
20.4																					
21														290							
21.5																					
22																					
22.8																					
23.2																					

Lake Merced South - Pistol Range

Depth	01-Mar-06 ORP	26-Apr-06 ORP	14-Jun-06 ORP	24-Aug-06 ORP	25-Oct-06 ORP	20-Dec-06 ORP	29-Mar-07 ORP	26-Jun-07 ORP	20-Aug-07 ORP	27-Dec-07 ORP	28-Mar-08 ORP	10-Jun-08 ORP	24-Sep-08 ORP	4-Dec-08 ORP	24-Mar-09 ORP	4-Jun-09 ORP	22-Sep-09 ORP	15-Dec-09 ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	276	303	417	254	428	343	357	356	364	304	356	283	240	472	350	322	337	374
5	276	301	416	250	428	346	356	358	360	305	352	277	230	472	346	315	316	374
6																		
10	275	299	412	243	428	350	361	361	357	303	345	255	214	471	342	305	296	372
12																		
15	274	294	411	235	428	349	373	364	343	299	337	234	152	470	338	298	254	368
16																		
17																		
18																		
18.2																		366
18.9																	237	
19					430									468				
20	272	290	409	220		344	370	372	317	296	324	128			328	273		
20.1													19					
20.6															326			
20.8																198		
21			404				368		290	295								
21.5											299							
22								373										

Lake Merced South - Pump Station

Depth	01-Mar-06 ORP	26-Apr-06 ORP	14-Jun-06 ORP	24-Aug-06 ORP	25-Oct-06 ORP	20-Dec-06 ORP	29-Mar-07 ORP	26-Jun-07 ORP	20-Aug-07 ORP	27-Dec-07 ORP	28-Mar-08 ORP	10-Jun-08 ORP	24-Sep-08 ORP	4-Dec-08 ORP	24-Mar-09 ORP	4-Jun-09 ORP	22-Sep-09 ORP	15-Dec-09 ORP
Ft	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV	mV
Surf	281	289	396	284	416	364	331	326	339	415	472	272	260	82	284	306	344	385
5	282	288	396	283	416	366	332	327	337	415	472	266	254	77	282	296	332	384
10	282	287	399	282	417	370	333	334	339	417	471	256	242	74	278	286	320	383
12																		
15	282	286	399	279	419	372	343	335	331	417	469	243	217	73	263	265	301	380
16																		
17																		
18					419													
19																		
19.2																	294	
20	281	288	399			371	344	336	314	416	464	217	185		244	241		
20.4																		377
21	281		398	277					292	414		91	35	70				
21.5																195		
22		287				369	339	335										
22.8															170			
23.2											455							

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	10.0	25	28	10	32.6		20.0		32.0	26.1	19.0	28.8	28.2	26.7	21.1	30.3	27.0	3.7	11.0	31.9
5	10.0	24	25	11	31.1		20.5		32.0	25.0	19.0	27.3	25.0	26.6	21.6	34.8	30.0	3.2	9.2	33.7
10	7.4	26	29	11	25.6		20.8		33.0	24.6	19.1	28.0	28.5	27.6	23.7	32.0	30.0	3.9	13.6	33.3
14									30.0	27.9				27.8			30.0			
15	7.4	28	24	13	28.5		22.1					28.2	28.7		21.9	21.8		4.6	13.4	23.9
16																				
17																				
17.4																				
17.5																				
18											20.0									
18.8																				
19																				
19.3																				
20																				
20.6																				

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	8.2		7.0	6.7	19.4		32.3		23.0	24.1	25.4	22.7	21.7	36.4	33.1	30.0	20.0	3.9	16.1	24.1
5	7.5		5.2	8.3	20.3		29.6		22.0	26.6	25.4	27.4	20.4	32.8	32.7	30.0	21.0	3.0	17.2	24.1
9																	20.0			
10	8.1		7.1	10	18.3		31.1		23.0	24.9		26.1	48.7	32.3	32.9	33.3		3.5	17.0	24.9
12																				
13											32.6									
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	23.0	23.0	14.9	20.4	22.0	32.5	24.3	29.6	1.6	14.0	11.0	3.4	3.7	1.2	8.2	11.3	11.0	13.6	10.0	9.4
5	23.0	28.0	4.5	18.5	25.1	34.7	22.1	28.2	1.9	14.0	13.0	3.5	4.1	1.4	8.6	11.0	12.0	13.5	12.0	7.7
10	23.0	23.0	9.7	22.4	25.0	32.6	22.9	25.8	1.2	13.0	13.0	5.6	3.9	1.6	8.3	11.9	11.0	13.5	11.0	8.4
14																				
15	16.0	25.0	19.6	21.8	24.0	28.1	25.5	24.8	1.5	14.0	11.0	7.5	4.4	1.5	8.2	13.1	11.0	13.4	10.0	6.5
16																12.6				
17										14.0			5.0				8.0			
17.4																				
17.5																				
18												7.6		1.5				12.8	10.0	7.3
18.8																				
19															8.8					
19.3																				
20																				
20.6																				

Lake Merced
North East

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	29.0	20.0	19.0	19.6	17.0	23.4	28.1	29.8	12.2	14.0	11.0	6.1	8.2	7.6	10.8	15.1	12.0	12.6	9.5	10.0
5	26.0	19.0	16.3	20.7	16.8	21.2	31.4	24.7	11.3	15.0	11.0	6.6	4.6	9.1	11.0	16.0	12.0	13.6	10.0	8.5
9																				
10	25.0	21.0	25.8	20.2	17.4	20.6	22.7	18.4	10.5	15.0	11.0	5.5	8.7	9.5	9.2	16.8	12.0	12.6	9.0	6.5
12																				
13										14.0		5.5	4.8		10.3	15.5	11.0	11.0	10.0	
13.8																				
14														9.7						5.3
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

Depth	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09
	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	11.0	8.2	10.5	23.5	23.0	27.0	25.0	19.0	21.0	32.0	15.2	7.2	32.0			14.7	15.4
5	10.0	6.7	9.6	23.5	23.0	24.0	24.0	18.0	22.0	36.1	15.0	7.3	30.0			14	18.1
10	8.9	7.5	11.0	18.2	21.5	20.0	23.0	18.0	18.0	33.4	14.2	7.6	22.0			13.8	
14																	
15	11.0	6.8	11.0	14.9	22.2	21.0	21.0	21.0	18.0	36.1	14.5	7.5	25.0			14.7	
16																	
17																	
17.4																	
17.5																	
18	10.0					21.0				24.3							
18.8													20.0				
19		8.4	7.3	13.4	22.0		23.0	20.0	18.0		14.2						
19.3																	
20																15.2	
20.6												10.3					

Lake Merced
North East

Depth	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09
	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	11.0	13.0	2.1	20.8	18.0	23.0	17.0	17.0	21.0	27.0	8.2	9.2	22.0			**13.4**	19.3
5	11.0	13.0	1.9	20.5	18.0	23.0	16.0	18.0	21.0	28.0	8.8	10.0	23.0			**14.7**	18.4
9																	
10	11.0	13.0	1.9	17.2	18.0	25.0	16.0	17.0	19.0	26.0	8.6	9.5	22.0			**14**	
12																	
13	11.0					24.0							19.0				
13.8																	
14		12.0		14.4	20.0					27.0							
14.1																	
14.7																**14.8**	
15			2.0				17.0	16.0	19.0		8.7						
15.8												9.4					

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	20.0	32	22	8.4	13.2		12.1	16.1	25.0	23.9	20.6	16.6	19.1	10.7	9.4	14.0	13.0	2.2	9.0	13.0
5	20.0	28	22		12.3		12.0	17.1	23.0	27.1	17.0	15.4	19.1	11.8	10.9	14.4	13.0	2.7	8.8	12.5
6				9.9																
10	20.0	26	22		10.5		12.2	16.0	22.0	28.5	18.0	15.8	19.0	10.6	10.3	13.5	13.0	3.6	8.8	12.3
12				11																
15	18.0	25	24		9.7		11.3	16.3	22.0	28.6				12.0	13.1	16.5	13.0	3.0	8.8	13.6
16	18.0	28																		
17																				
18				11								12.1	16.8							
18.9																				
19																				
20											17.0									
20.6																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb	Turb
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	20.0	28	22	9.8	10.8		10.2	16.0	30.0	28.2	18.2	17.7	21.2	9.8	10.1	12.8	13.0	2.5	7.9	13.2
5	18.0	30	19	10	12.5		10.4	15.4	26.0	28.9	18.0	15.1	19.2	10.1	9.7	12.2	14.0	3.2	10.1	12.4
10	18.0	24	20		10.2		11.7	15.1	24.0	33.3	16.8	14.5	19.1	10.7	9.6	12.3	15.0	2.5	10.0	12.7
12				8.6																
15	17.0	26	19		9.1		11.8	16.3	25.0	31.6				11.9	10.1	14.4	13.0	3.0	10.3	13.0
16																				
17																				
18				12								15.3								
19													19.1							
19.2																				
20											17.1									
21																				
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	17.0	20.0	12.6	14.3	12.8	15.6	16.2	19.5	11.8	22.0	19.0	15.0	11.3	7.8	10.2	9.1	7.0	12.8	10.0	9.4
5	14.0	20.0	13.0	14.5	12.0	17.4	14.1	17.9	12.3	21.0	18.0	15.0	10.7	8.2	11.4	9.9	7.0	11.0	11.0	9.4
6																				
10	13.0	17.0	12.1	14.9	9.5	18.8	15.2	16.2	11.8	20.0	18.0	17.0	12.3	8.2	10.6	9.6	7.0	9.7	10.0	8.7
12																				
15	13.0	20.0	6.9	13.4	12.3	15.3	15.1	19.2	12.5	20.0	18.0	14.0	17.2	7.6	11.2	8.3	7.0	9.7	11.0	9.0
16																				
17												16.0	11.5							
18										18.0							7.0		11.0	
18.9																				
19																				10.0
20														9.2	9.1	8.3		9.6		
20.6																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**	**Turb**
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	13.0	22.0	8.0	15.0	11.2	16.3	14.4	17.3	11.4	20.0	18.0	14.0	2.5	8.1	10.2	10.4	7.0	10.7	11.0	11.0
5	12.0	16.0	7.6	14.6	9.8	17.5	18.2	19.5	11.3	20.0	18.0	12.0	11.4	7.5	11.0	11.1	7.0	10.4	10.0	9.6
10	12.0	17.0	8.0	13.7	11.0	17.1	11.9	18.6	11.1	23.0	18.0	13.0	12.7	7.8	9.7	11.7	7.8	9.9	10.0	8.6
12																				
15	12.0	17.0	7.3	13.3	10.8	18.0	13.3	15.7	12.7	17.0	19.0	12.0	10.4	7.6	11.1	9.5	7.5	8.8	10.0	9.2
16																				
17													12.3							
18																				
19										16.0		13.0						8.8		
19.2																				
20															10.1	10.2	7.5		9.6	9.2
21														7.6						
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

Depth	23-Jan-06 Turb	01-Mar-06 Turb	26-Apr-06 Turb	14-Jun-06 Turb	24-Aug-06 Turb	25-Oct-06 Turb	20-Dec-06 Turb	29-Mar-07 Turb	26-Jun-07 Turb	20-Aug-07 Turb	27-Dec-07 Turb	28-Mar-08 Turb	10-Jun-08 Turb	24-Sep-08 Turb	4-Dec-08 Turb	24-Mar-09 Turb	4-Jun-09 Turb
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	9.9	11.0	11.0	11.8	22.5	24.0	10.0	7.0	12.5	10.5	14.3	7.2	8.7			8.6	10.4
5	9.6	10.0	11.8	14.1	21.0	20.0	11.0	6.7	12.0	11.0	15.3	7.3	9.3			8.9	9.6
6																	
10	11.0	10.0	11.0	14.2	21.0	20.0	10.0	7.3	12.0		15.1	7.6	9.0			7.5	
12																	
15	11.0	11.0	10.5	13.8	23.0	18.0	11.0	7.0	11.0	11.0	14.1	7.5	9.2			7.8	
16																	
17																	
18	11.0																
18.9																	
19						22.0											
20		10.0	9.8		21.0		11.0						8.7				
20.6																8.5	
21				15.4				6.8			14.2						
21.5												10.3					
22									11.0								

Lake Merced
South - Pump
Station

Depth	23-Jan-06 Turb	01-Mar-06 Turb	26-Apr-06 Turb	14-Jun-06 Turb	24-Aug-06 Turb	25-Oct-06 Turb	20-Dec-06 Turb	29-Mar-07 Turb	26-Jun-07 Turb	20-Aug-07 Turb	27-Dec-07 Turb	28-Mar-08 Turb	10-Jun-08 Turb	24-Sep-08 Turb	4-Dec-08 Turb	24-Mar-09 Turb	4-Jun-09 Turb
Ft	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu	ntu
Surf	10.0	10.0	10.3	12.0	20.5	21.0	10.0	7.2	12.0	11.0	14.1	8.5	8.5			9.1	9.52
5	9.8	10.0	10.5	14.5	22.0	21.0	10.0	7.1	12.8	11.0	14.1	7.2	8.7			9.8	9.08
10	11.0	9.4	10.3	12.8	21.5	22.0	10.0	6.9	11.0	7.0	14.0	7.0	8.5			9.5	
12																	
15	11.0	9.1	11.5	11.8	21.0	17.0	11.0	6.7	11.0	9.5	14.2	7.2	9.0			10.3	
16																	
17																	
18						12.0											
19																	
19.2																	
20	11.0																
21		9.4		12.2	21.0					12.0	14.9		8.9				
22			11.4				11.0	6.8	10.0								
22.8																10.3	
23.2												7.2					

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	274	304	300	233	244		232		276	264	248	228	210	264	220	256	280	---	230	260
5	274	304	300	236	234		234		272	276	240	228	220	264	244	248	280	---	225	250
10	272	304	300	231	236		240		268	272	240	236	225	268	252	248	280	---	220	245
14									260	272				268			280			
15	272	304	300	240	242		236					236	220		244	248		---	235	245
16																				
17																				
17.4																				
17.5																				
18											240									
18.8																				
19																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	262		285	214	224		220		268	244	216	224	210	236	216	240	260	---	225	230
5	260		288	202	232		220		268	240	220	232	220	252	224	244	260	---	240	235
9																	264			
10	260		286	205	234		232		272	240		228	220	252	224	252		---	245	240
12																				
13											228									
13.8																				
14																				
14.1																				
15																				
15.8																				

Lake Merced
North

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	235	232	235	225	210	235	255	260	204	264	220	255	204	200	220	220	240	248	232	230	225
5	240	240	240	230	220	260	270	265	204	264	224	255	200	200	252	225	244	244	232	235	235
10	250	248	250	240	230	270	275	270	204	264	224	250	200	205	248	230	252	240	234	235	230
14																					
15	255	252	260	240	230	270	275	270	204	266	226	250	204	205	244	235	248	240	236	235	225
16																235					
17										266			204				244				
17.4																					
17.5																					
18												250		210				244	236	230	225
18.8																					
19															216						
20																					
20.6																					

Lake Merced
North East

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	255	256	255	230	230	270	280	280	208	262	226	235	204	195	236	240	244	240	234	215	215
5	250	256	255	230	225	270	280	285	208	264	226	235	204	190	240	225	244	240	234	215	215
9																					
10	250	256	260	235	225	270	280	285	210	266	228	235	208	190	244	200	248	240	236	225	210
12																					
13										266		235	208		244	235	256	240	238		210
13.8																					
14														185						235	
14.1																					
15																					
15.8																					

Lake Merced
North

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	210	194	195	240	228	224	230	250	248	244	208	220		
5	208	194	200	220	228	224	230	250	248	244	228	232		
10	206	194	200	205	232	224	225	248	244	244	208	240		
14														
15	204	195	205	225	228	212	225	248	244	248	208	240		
16														
17														
17.4														
17.5														
18					220				244					
18.8												240		
19	206	196	210	235		204	225	246		264				
20														
20.6											228			

Lake Merced
North East

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	180	196	200	215	228	220	235	248	256	252	212	244		
5	152	196	200	225	228	220	235	248	264	248	200	232		
9														
10	114	195	205	240	224	216	235	250	268	244	224	232		
12														
13					216							228		
13.8														
14	88		210	210					268					
14.1														
15		194				216	215	250		236				
15.8											220			

Lake Merced
South - Pistol
Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	172	190	204	162	170		170	176	180	196	188	180	160	188	184	180	196	---	190	190
5	172	190	198		170		168	172	178	180	184	172	165	180	172	184	196	---	190	190
6				155																
10	172	190	198		170		166	168	180	204	184	176	160	184	188	184	200	---	195	195
12				158																
15	172	190	197		170		166	176	180	184				196	180	188	200	---	195	195
16	172	190																		
17																				
18				161								172	170							
19																				
20											172									
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	172	192	196	155	166		166	168	178	200	178	176	170	196	176	196	204	---	200	200
5	172	190	198	160	166		170	180	186	184	184	180	175	188	184	188	204	---	200	190
10	172	190	200		170		170	176	182	180	176	180	160	200	184	192	208	---	195	180
12				158																
15	172	190	196		170		170	172	182	200				200	180	176	208	---	190	180
16																				
17																				
18				157								168								
19													165							
20											176									
21																				
22																				
23.2																				

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	200	208	190	190	170	195	155	150	132	170	150	160	152	150	170	150	176	160	162	155	170
5	205	208	190	190	170	190	150	155	132	170	150	165	152	135	164	175	172	160	162	155	170
6																					
10	215	208	200	185	175	180	150	160	132	168	150	170	148	125	156	170	164	170	160	158	168
12																					
15	220	208	200	185	175	190	145	165	132	168	150	170	144	135	158	165	168	168	160	158	166
16																					
17												170	136								
18										166							172		160		163
19																				162	
20														155	158	150		164			
21																					
21.5																					
22																					

Lake Merced
South - Pump
Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk	Alk
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	210	200	190	170	165	200	175	150	144	168	152	160	136	145	158	165	168	166	160	162	155
5	210	200	190	180	165	200	180	155	144	168	152	165	136	140	158	145	164	168	160	165	155
10	205	208	195	185	170	200	180	150	144	168	152	170	140	140	160	160	160	176	158	168	155
12																					
15	205	212	195	185	170	200	180	145	144	168	152	160	140	145	160	170	164	170	158	168	162
16																					
17													140								
18																					
19										168		155						160			
20															158	140	168		158	165	162
21														145							
22																					
23.2																					

Lake Merced
South - Pistol
Range

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	146	148	170	170	156	168	160	178	180	184	168	160		
5	146	150	165	165	164	168	160	178	180	184	156	164		
6														
10	148	146	160	160	172	168	160	178		182	152	168		
12														
15	148	144	155	170	164	160	160	178	192	182	156	172		
16														
17														
18														
19					156									
20	154	142		175		156						184		
21			150				160			186				
21.5											172			
22								178						

Lake Merced
South - Pump
Station

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**	**Alk**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	154	142	170	225	172	172	162	180	180	184	168	156		
5	152	140	145	210	160	168	162	180	180	184	160	172		
10	150	140	150	210	148	164	162	182	180	184	164	184		
12														
15	148	138	155	230	156	160	162	182	188	184	168	188		
16														
17														
18					164									
19														
20														
21	146		160	210					196	182		160		
22		142				152	162	182						
23.2											152			

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	272	290	277	231	240		240		266	280	256	248	270	252	232	260	276	---	245	250
5	272	290	280	227	244		240		276	272	252	244	260	256	252	264	280	---	260	250
10	272	290	280	229	244		246		270	260	248	244	245	268	260	272	284	---	250	255
14									260	256				268			284			
15	272	290	280	232	244		246					244	245		252	272		---	260	260
16																				
17																				
17.4																				
17.5																				
18											244									
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	268		272	218	235		228		240	252	220	244	255	240	236	272	280	---	260	260
5	268		273	214	245		250		256	280	232	236	245	260	240	272	284	---	250	260
9																	284			
10	268		273	212	255		252		274	280		240	265	256	244	272		---	250	265
12																				
13											228									
13.8																				
14																				
14.1																				
14.4																				
14.7																				
15																				
15.8																				

Lake Merced
North

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	260	260	285	265	240	255	265	250	236	262	256	255	240	245	252	220	240	244	248	240	220
5	260	264	280	255	255	250	245	255	238	264	256	255	232	230	244	225	244	240	248	245	215
10	255	264	280	250	250	280	225	250	242	265	258	255	228	220	220	230	248	240	248	240	235
14																					
15	255	268	275	250	250	280	225	240	244	264	258	255	224	220	220	235	252	244	246	235	235
16																235					
17										262			224				260				
17.4																					
17.5																					
18												255		220				256	244	220	210
18.8																					
19															220						
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	280	276	280	260	255	255	240	265	246	262	266	260	236	250	256	260	248	276	250	240	235
5	275	276	260	245	255	270	240	275	246	264	266	260	236	245	252	245	252	260	250	245	235
9																					
10	270	280	265	245	255	280	245	280	248	267	266	265	236	235	230	275	264	248	250	235	220
12																					
13										264		270	236		224	275	256	254	250		215
13.8																					
14														220						215	
14.1																					
14.4																					
14.7																					
15																					
15.8																					

Lake Merced
North

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	222	200	205	235	236	224	230	244	248	244	240	232	244	240	232	250	272	264
5	218	202	215	240	240	224	230	244	248	244	240	232	260	268	264	246	278	256
10	218	202	225	245	248	228	226	244	244	244	240	256	260	268	260	258	266	268
14																		
15	220	204	225	235	244	232	228	244	244	248	240	252		272	224	252	272	276
16																		
17																		
17.4													272					
17.5														280				
18					240				244									
18.8												244						284
19	220	204	220	230		236	232	244		264								
19.3																	276	
19.9																252		
20															228			
20.6											228							

Lake Merced
North East

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	218	206	215	230	236	236	235	246	246	248	220	260	252	256	232	256	274	264
5	220	206	220	235	236	236	235	246	246	240	232	264	260	208	228	250	270	256
9																		
10	222	206	230	240	232	232	235	244	246	244	236	260	256	272	224	256	272	256
12																		
13					228							232	256					
13.8																	274	
14	222		235	240					250									
14.1														252				
14.4																		
14.7															240			272
15		206				232	225	242		244						254		
15.8											244							

Lake Merced
South - Pistol
Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	172	185	185	157	185		176	168	188	196	184	180	200	200	200	212	228	---	200	205
5	170	186	182		185		174	188	188	204	188	172	195	188	188	212	228	---	200	205
6				156																
10	170	186	182		195		180	192	190	200	192	176	180	192	192	216	224	---	200	210
12				163																
15	170	186	182		195		176	192	188	180				208	200	216	220	---	200	210
16	170	186																		
17																				
18				158								172	200							
18.2																				
18.5																				
18.9																				
19																				
20											188									
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	172	186	182	156	185		176	184	184	192	192	180	185	204	196	216	220	---	215	210
5	170	186	182	161	185		176	180	186	204	188	184	195	188	192	208	220	---	210	210
10	170	186	184		185		180	168	184	192	184	180	185	184	200	208	224	---	210	210
12				154																
15	170	186	178		190		182	184	188	180				200	188	204	224	---	210	205
16																				
17																				
18				157								180								
19													200							
19.2																				
20											176									
20.4																				
20.9																				
21																				
21.5																				
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	205	224	200	195	210	205	175	170	162	168	175	175	164	160	174	220	176	176	178	167	170
5	210	224	200	180	190	205	160	170	162	168	175	175	164	160	170	195	180	176	178	172	175
6																					
10	215	220	205	180	180	210	150	175	162	168	174	175	160	160	168	170	188	184	178	170	180
12																					
15	215	216	205	180	170	210	145	175	162	168	174	170	160	165	166	190	180	190	180	170	175
16																					
17												170	160								
18										168							172		180		165
18.2																					
18.5																					
18.9																					
19																				172	
20														175	164	210		188			
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced
South - Pump
Station

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard	Hard
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	230	220	195	210	180	205	175	170	162	162	170	180	156	145	156	175	160	180	176	168	168
5	220	220	195	195	190	210	165	175	162	164	170	180	160	150	156	195	164	176	176	168	172
10	210	228	200	200	165	210	160	175	160	166	170	180	160	155	156	175	172	172	176	168	175
12																					
15	210	230	200	200	165	210	155	170	160	165	170	175	164	150	156	200	172	168	176	170	175
16																					
17													164								
18																					
19										164		170						196			
19.2																					
20															158	175	192		176	172	178
20.4																					
20.9																					
21														140							
21.5																					
22																					
22.8																					
23.2																					

Lake Merced
South - Pistol
Range

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	165	160	165	175	192	180	180	188	188	194	168	164	208	220	196	200	220	220
5	166	160	175	170	184	172	180	188	188	194	168	184	208	212	196	202	220	208
6																		
10	168	160	185	170	176	168	178	188		194	168	200	208	200	196	204	214	216
12																		
15	168	160	190	175	180	176	178	186	188	194	188	192	192	200	200	204	218	220
16																		
17																		
18																		
18.2																		208
18.5														196				
18.9																	218	
19					184													
20	168	160		190		180						200						
20.1													200					
20.6															188			
20.8																200		
21			165				180			192								
21.5											200							
22								186										

Lake Merced
South - Pump
Station

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**	**Hard**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	170	157	165	170	176	184	180	192	188	192	168	172	192	228	196	200	218	216
5	168	160	165	170	180	176	180	192	188	192	172	204	208		196	206	220	228
10	168	162	170	180	184	172	180	190	188	194	188	200	208	196	196	204	224	208
12																		
15	166	162	175	190	176	172	178	186	188	192	192	176	208	196	196	204	224	220
16																		
17																		
18					168													
19																		
19.2																	232	
20																		
20.4																		228
20.9														196				
21	162		170	180					188	190		200						
21.5																204		
22		162				168	178	184										
22.8															196			
23.2											180							

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	93	100	110	82	83	101	84		91	93	90	87	90	91	89	94	101	98	89	91
5	92	98	110	82	81	100	84		91	93	88	87	90	91	89	94	100	91	95	91
10	93	97	110	82	81	101	84		91	93	85	87	90	91	89	93	101	91	96	91
14									91	93				91			100			
15	94	97	100	82	81	100	84					87	90		89	93		92	96	91
16																				
17																				
17.4																				
17.5																				
18											85									
18.8																				
19																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	84		87	66	73	88	76		86	85	86	80	83	82	78	83	88	74	80	82
5	84		88	66	73	88	76		86	86	80	80	83	82	77	83	88	75	77	81
9																	87			
10	84		88	66	73	87	76		86	86		80	83	82	77	83		78	78	80
12																				
13											76									
14																				
14.1																				
15																				
15.8																				

Lake Merced
North

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	95	96	100	86	83	94	102	103	87	87	87	98	93	83	85	91	91	89	89	78
5	93	98	100	86	83	94	102	105	86	87	89	98	93	82	86	91	90	89	89	78
10	93	100	100	87	83	94	102	105	86	89	90	98	92	82	87	90	89	90	88	78
14																				
15	93	100	100	87	83	94	102	105	85	92	91	98	92	81	86	90	89	90	89	78
16																90				
17										93			91				89			
17.4																				
17.5																				
18												98		80				90	90	78
18.8																				
19															86					
20																				
20.6																				

Lake Merced
North East

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	83	86	86	74	70	88	96	104	88	88	85	100	86	75	83	85	87	86	90	74
5	82	88	86	74	70	87	96	106	88	88	84	100	86	75	83	84	87	86	90	74
9																				
10	82	88	86	74	70	87	96	106	88	88	84	100	86	76	82	83	88	86	89	73
12																				
13										88		100	86		82	83	88	86	89	
14														76						72
14.1																				
15																				
15.8																				

Lake Merced
North

Depth	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	84	84	78	83	84	86	95	83	91	90	96	100	100		
5	84	84	78	83	85	86	95	84	91	90	96	100	100		
10	84	84	78	83	86	87	95	86	90	89	94	100	100		
14															
15	83	84	78	82	86	87	96	87	89	89	93	100	100		
16															
17															
17.4															
17.5															
18	83					87				90					
18.8													100		
19		84	78	82	86		96	88	89		92				
20															
20.6												100			

Lake Merced
North East

Depth	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	90	82	75	80	82	93	92	86	90	90	91	100	100		
5	88	82	75	80	82	93	94	87	90	89	91	100	100		
9															
10	88	80	76	80	82	93	95	87	88	89	90	98	100		
12															
13	86					93							100		
14		80		80	82					88					
14.1															
15			76				95	87	87		90				
15.8												98			

Lake Merced South - Pistol Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	61	63	70	58	59	83	65	64	69	71	75	70	71	74	74	78	83	75	83	80
5	61	63	69		58	83	65	64	69	71	75	69	71	74	73	78	83	76	82	80
6				58																
10	60	63	69		58	83	65	64	69	71	75	69	71	74	73	78	83	77	83	82
12				58																
15	61	63	69		58	83	65	64	69	71				73	73	78	83	78	82	82
16	60	63																		
17																				
18				58								69	71							
19																				
20											77									
21																				
21.5																				
22																				

Lake Merced South - Pump Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	61	63	69	58	60	83	66	64	69	71	76	70	71	73	73	77	83	79	80	83
5	61	63	69	58	59	83	66	64	69	71	76	69	71	73	73	77	83	81	81	83
10	61	63	69		58	83	65	64	69	71	77	69	71	73	73	77	83	79	83	82
12				58																
15	61	63	69		58	83	66	64	69	71				73	73	77	83	80	82	82
16																				
17																				
18				58								69								
19													70							
20											72									
21																				
22																				
23.2																				

Lake Merced
South - Pistol
Range

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	83	88	78	73	68	75	80	75	56	67	68	84	67	65	71	72	72	72	78	68
5	83	88	78	73	68	75	80	75	56	66	67	84	67	65	71	73	72	72	78	66
6																				
10	82	88	78	72	68	76	80	76	57	65	65	85	67	64	71	74	72	73	77	65
12																				
15	82	88	78	72	68	76	80	76	58	63	65	85	67	64	71	72	72	73	77	66
16																				
17												85	67							
18										62							72		76	
19																				69
20														64	71	71		72		
21																				
21.5																				
22																				

Lake Merced
South -
Pump Station

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-	Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	82	87	76	73	68	76	78	74	61	65	63	82	63	65	71	72	73	73	77	73
5	82	84	76	73	68	76	78	74	60	65	63	82	63	65	71	72	73	73	77	72
10	81	84	75	73	68	77	78	75	60	65	64	84	64	65	71	71	73	73	77	72
12																				
15	81	82	75	73	68	77	78	75	59	64	65	84	64	65	70	71	73	72	76	82
16																				
17													64							
18																				
19										64		85						72		
20															70	72	73		76	84
21														65						
22																				
23.2																				

Lake Merced
South - Pistol
Range

Depth	23-Jan-06 Cl^-	01-Mar-06 Cl^-	26-Apr-06 Cl^-	14-Jun-06 Cl^-	24-Aug-06 Cl^-	25-Oct-06 Cl^-	20-Dec-06 Cl^-	29-Mar-07 Cl^-	26-Jun-07 Cl^-	20-Aug-07 Cl^-	27-Dec-07 Cl^-	28-Mar-08 Cl^-	10-Jun-08 Cl^-	24-Sep-08 Cl^-	4-Dec-08 Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	73	74	70	70	75	88	87	84	82	84	87	94	98		
5	73	74	70	70	75	88	88	84	82	84	87	94	97		
6															
10	73	74	70	71	75	88	88	83	82		88	94	96		
12															
15	73	74	70	71	75	90	88	83	81	83	88	94	98		
16															
17															
18	73														
19						90									
20		74	70		75		88						98		
21				71				82			88				
21.5												94			
22									81						

Lake Merced
South -
Pump Station

Depth	23-Jan-06 Cl^-	01-Mar-06 Cl^-	26-Apr-06 Cl^-	14-Jun-06 Cl^-	24-Aug-06 Cl^-	25-Oct-06 Cl^-	20-Dec-06 Cl^-	29-Mar-07 Cl^-	26-Jun-07 Cl^-	20-Aug-07 Cl^-	27-Dec-07 Cl^-	28-Mar-08 Cl^-	10-Jun-08 Cl^-	24-Sep-08 Cl^-	4-Dec-08 Cl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	74	74	70	71	75	90	89	83	81	83	86	93	98		
5	74	74	70	71	75	90	88	80	81	83	86	93	98		
10	73	74	70	72	74	90	88	76	81	83	86	94	96		
12															
15	73	74	72	72	74	90	88	76	80	83	86	94	98		
16															
17															
18						90									
19															
20	73														
21		74		72	74					83	86		98		
22			72				88	76	80						
23.2												94			

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.045	0.045	0.045	0.045	0.045	0.045	0.025		0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.05	0.005
5	0.045	0.045	0.045	0.045	0.045	0.045	0.025		0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.06	0.005
10	0.045	0.045	0.045	0.045	0.045	0.045	0.025		0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
14									0.025	0.025				0.005			0.005				
15	0.045	0.045	0.045	0.045	0.045	0.045	0.025					0.025	0.025		0.025	0.025		0.005	0.01	0.005	0.005
16																					
17																					
17.4																					
17.5																					
18											0.025										
18.8																					
19																					
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.045		0.16	0.045	0.045	0.045	0.025		0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
5	0.045		0.16	0.045	0.045	0.045	0.025		0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
9																	0.005				
10	0.045		0.16	0.045	0.045	0.045	0.025		0.025	0.025		0.025	0.025	0.005	0.025	0.025		0.005	0.01	0.005	0.005
11																					
12																					
13											0.025										
13.8																					
14																					
14.1																					
14.7																					
15																					
15.8																					

Lake Merced
North

Depth	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06
	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	0.34	0.02	***0.005***	1.42	1.10	0.86	0.32	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.11	***0.005***	***0.005***	***0.005***
5	***0.005***	1.06	0.02	***0.005***	1.48	1.10	0.90	0.50	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.42	***0.005***	***0.005***	***0.005***
10	***0.005***	0.48	***0.005***	***0.005***	1.54	1.20	0.90	0.66	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.24	***0.005***	0.02	***0.005***
14																						
15	***0.005***	0.46	***0.005***	***0.005***	1.48	1.20	0.78	0.48	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.14	***0.005***	0.09	***0.005***
16															***0.005***							
17									***0.005***			***0.005***				***0.005***						
17.4																						
17.5																						
18											***0.005***		***0.005***				***0.005***	***0.005***	***0.005***	***0.005***		
18.8																						
19														***0.005***							0.13	***0.005***
19.3																						
19.9																						
20																						
20.6																						

Lake Merced
North East

Depth	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06
	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	***0.005***	***0.005***	***0.005***	1.00	0.82	1.50	0.32	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.31	***0.005***	***0.005***	***0.005***
5	***0.005***	***0.005***	***0.005***	***0.005***	1.00	0.64	0.90	0.48	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.24	***0.005***	***0.005***	***0.005***
9																						
10	***0.005***	***0.005***	0.02	***0.005***	0.64	0.66	0.86	0.48	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
11																						
12																						
13									***0.005***		***0.005***	***0.005***		***0.005***	***0.005***	***0.005***	***0.005***	***0.005***		***0.005***		
13.8																						
14													***0.005***						0.48		***0.005***	
14.1																						
14.7																						
15																						***0.005***
15.8																						

Lake Merced
North

	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.05	***0.005***	***0.005***	***0.005***	0.93	***0.005***	***0.005***	***0.005***	0.07
5	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.03	***0.005***	***0.005***	***0.005***	1.10	***0.005***	***0.005***	***0.005***	0.08
10	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.05	***0.005***	***0.005***	***0.005***	0.96	***0.005***	***0.005***	***0.005***	0.07
14																
15	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.04	***0.005***	***0.005***		0.93	***0.005***	***0.005***	***0.005***	0.10
16																
17																
17.4											***0.005***					
17.5												0.96				
18			***0.005***				***0.005***									
18.8										***0.005***						0.12
19	***0.005***	***0.005***		***0.005***	***0.005***	***0.005***		0.04								
19.3															***0.005***	
19.9														***0.005***		
20													***0.005***			
20.6									***0.005***							

Lake Merced
North East

	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**	**NO_3-N**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	***0.005***	***0.005***	0.06	***0.005***	***0.005***	***0.005***	0.11	***0.005***	***0.005***	***0.005***	0.37	***0.005***	***0.005***	***0.005***	0.09
5	***0.005***	***0.005***	***0.005***	0.06	***0.005***	***0.005***	***0.005***	0.10	***0.005***	***0.005***	***0.005***	0.17	***0.005***	***0.005***	***0.005***	0.11
9																
10	***0.005***	***0.005***	***0.005***	0.05	***0.005***	***0.005***	***0.005***	0.12	***0.005***	***0.005***	0.02	0.63	***0.005***	***0.005***	***0.005***	0.12
11																
12																
13			***0.005***							***0.005***	0.01					
13.8															***0.005***	
14	***0.005***	***0.005***					***0.005***									
14.1												0.78				
14.7													***0.005***			0.12
15				0.05	***0.005***	***0.005***		0.10						***0.005***		
15.8									***0.005***							

Lake Merced South - Pistol Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.045	0.045	0.045	0.045	0.045	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
5	0.045	0.045	0.045		0.045	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
6				0.045																	
10	0.045	0.045	0.045		0.045	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
12				0.045																	
15	0.045	0.045	0.045		0.045	0.045	0.025	0.025	0.025	0.025				0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
16	0.045	0.045																			
17																					
18				0.045								0.025	0.025								
18.2																					
18.5																					
18.9																					
19																					
20											0.025										
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced South - Pump Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.045	0.045	0.045	0.045	0.045	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
5	0.045	0.045	0.045	0.045	0.045	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.01	0.01	0.005	0.005
10	0.045	0.045	0.045		0.045	0.045	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
12				0.045																	
15	0.045	0.045	0.045		0.045	0.045	0.025	0.025	0.025	0.025				0.005	0.025	0.025	0.005	0.005	0.01	0.005	0.005
16																					
17																					
18				0.045								0.025									
19													0.025								
19.2																					
20											0.025										
20.4																					
20.9																					
21																					
21.5																					
22																					
22.8																					
23.2																					

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
South - Pistol
Range

Depth	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06
Depth	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	0.04	0.02	***0.005***	0.05	0.54	0.14	0.05	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
5	***0.005***	0.06	***0.005***	***0.005***	0.20	0.55	0.15	0.09	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
6																						
10	***0.005***	0.04	0.01	***0.005***	0.35	0.52	0.08	0.11	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
12																						
15	***0.005***	0.23	***0.005***	***0.005***	0.40	0.49	0.07	0.32	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
16																						
17											***0.005***	***0.005***										
18									***0.005***							***0.005***		***0.005***		***0.005***		
18.2																						
18.5																						
18.9																						
19																			***0.005***			
20													***0.005***	***0.005***	***0.005***		***0.005***				***0.005***	***0.005***
20.1																						
20.6																						
20.8																						
21																						
21.5																						
22																						

Lake Merced
South - Pump
Station

Depth	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06
Depth	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	0.01	0.02	***0.005***	***0.005***	0.49	0.03	0.23	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
5	***0.005***	***0.005***	0.01	***0.005***	0.62	0.48	0.35	0.11	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
10	***0.005***	***0.005***	***0.005***	***0.005***	0.44	0.46	0.05	0.31	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
12																						
15	***0.005***	0.01	***0.005***	***0.005***	0.40	0.45	0.10	0.50	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***
16																						
17												***0.005***										
18																						
19									***0.005***		***0.005***						***0.005***					
19.2																						
20														***0.005***	***0.005***	***0.005***		***0.005***	***0.005***	***0.005***		
20.4																						
20.9																						
21													***0.005***								***0.005***	
21.5																						
22																						***0.005***
22.8																						
23.2																						

Lake Merced
South - Pistol
Range

	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.06	0.005	0.005	0.005	0.005
5	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.06	0.005	0.005	0.005	0.005
6																
10	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005	0.11	0.005	0.005	0.005	0.005
12																
15	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.08	0.21	0.005	0.005	0.005	0.005
16																
17																
18																
18.2																0.005
18.5												0.31				
18.9															0.005	
19			0.005													
20		0.005		0.005						0.005						
20.1											0.15					
20.6													0.005			
20.8														0.005		
21	0.005				0.01			0.005								
21.5									0.005							
22						0.005										

Lake Merced
South - Pump
Station

	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N	NO_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.03	0.005	0.005	0.005	0.005
5	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005		0.005	0.005	0.005	0.005
10	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.04	0.005	0.005	0.005	0.005
12																
15	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.06	0.005	0.005	0.005	0.005
16																
17																
18			0.005													
19																
19.2															0.005	
20																
20.4																0.005
20.9												0.14				
21	0.005	0.005					0.005	0.005		0.005						
21.5														0.005		
22				0.005	0.005	0.005										
22.8													0.005			
23.2									0.005							

Lake
Merced
North

Depth	15-May-97 TKN	10-Sep-97 TKN	3-Dec-97 TKN	16-Mar-98 TKN	8-Jul-98 TKN	23-Sep-98 TKN	17-Mar-99 TKN	21-Jun-99 TKN	15-Sep-99 TKN	8-Dec-99 TKN	21-Mar-00 TKN	21-Jun-00 TKN	9-Aug-00 TKN	19-Dec-00 TKN	7-Mar-01 TKN	20-Jun-01 TKN	1-Oct-01 TKN	18-Dec-01 TKN	5-Mar-02 TKN	30-Apr-02 TKN
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf														5.30	2.13	0.90	4.26	1.70	---	2.6
5															9.64	***0.25***	0.95	1.50	---	2.9
10															4.09	0.50	1.68	1.20	---	3.0
14														3.40			2.35			
15															2.58	5.80		1.40	---	1.9
16																				
17																				
17.4																				
17.5																				
18																				
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake
Merced
North East

Depth	15-May-97 TKN	10-Sep-97 TKN	3-Dec-97 TKN	16-Mar-98 TKN	8-Jul-98 TKN	23-Sep-98 TKN	17-Mar-99 TKN	21-Jun-99 TKN	15-Sep-99 TKN	8-Dec-99 TKN	21-Mar-00 TKN	21-Jun-00 TKN	9-Aug-00 TKN	19-Dec-00 TKN	7-Mar-01 TKN	20-Jun-01 TKN	1-Oct-01 TKN	18-Dec-01 TKN	5-Mar-02 TKN	30-Apr-02 TKN
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf														9.40	5.66	0.25	2.35	1.00	---	1.9
5															3.42	0.25	1.56	1.60	---	1.6
9																	3.08			
10														6.60	3.70	1.10		1.40	---	1.8
11																				
12																				
13																				
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake
Merced
North

Depth	18-Jun-02 TKN	23-Aug-02 TKN	23-Oct-02 TKN	11-Feb-03 TKN	14-May-03 TKN	15-Jul-03 TKN	30-Sep-03 TKN	2-Dec-03 TKN	27-May-04 TKN	29-Aug-04 TKN	27-Oct-04 TKN	9-Dec-04 TKN	9-Feb-05 TKN	18-Apr-05 TKN	23-Jun-05 TKN	17-Aug-05 TKN	28-Sep-05 TKN	31-Oct-05 TKN	29-Nov-05 TKN	29-Dec-05 TKN
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	23.0	10.0	2.2	1.5	8.0	4.1	11.30	5.7	10.2	6.4	6.3	4.1	4.7	5.2	1.13	7.90	1.85	3.50	6.6	NA
5	21.3	7.3	2.2	1.5	4.4	2.8	9.50	5.3	8.3	3.5	5.9	1.3	6.3	4.4	0.98	5.70	2.27	2.97	3.5	NA
10	9.0	7.8	2.4	1.6	2.9	2.0	5.50	4.4	8.1	9.1	11.4	0.6	6.9	3.8	0.84	3.80	2.07	4.48	4.5	NA
14																				
15	11.0	12.2	2.9	1.8	1.5	1.9	4.30	2.9	7.4	7.6	6.8	3.2	7.8	3.3	0.47	5.50	2.13	4.48	2.5	NA
16																3.00				
17										10.5			9.2				4.03			
17.4																				
17.5																				
18												1.1		2.4				5.88	2.8	NA
18.8																				
19															0.59					
19.3																				
19.9																				
20																				
20.6																				

Lake
Merced
North East

Depth	18-Jun-02 TKN	23-Aug-02 TKN	23-Oct-02 TKN	11-Feb-03 TKN	14-May-03 TKN	15-Jul-03 TKN	30-Sep-03 TKN	2-Dec-03 TKN	27-May-04 TKN	29-Aug-04 TKN	27-Oct-04 TKN	9-Dec-04 TKN	9-Feb-05 TKN	18-Apr-05 TKN	23-Jun-05 TKN	17-Aug-05 TKN	28-Sep-05 TKN	31-Oct-05 TKN	29-Nov-05 TKN	29-Dec-05 TKN
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	24.0	9.4	1.9	1.6	5.9	3.4	9.80	6.6	5.8	7.5	4.4	5.6	5.7	7.5	1.04	8.40	5.74	5.94	0.9	NA
5	10.2	6.2	2.0	1.6	4.2	2.3	3.20	5.2	1.5	18.0	13.3	3.4					3.72	7.00	6.0	NA
9																				
10	6.5	6.8	1.8	1.4	7.7	1.2	1.90	3.0	4.8	5.2	12.1	6.0	6.7	7.0	0.93	8.80	5.57	3.78	7.7	NA
11																				
12																				
13										6.3		3.5	9.9		0.71	5.3	2.80	4.59	2.8	
13.8																				
14														6.6						NA
14.1																				
14.7																				
15																				
15.8																				

Lake
Merced
North

Depth	23-Jan-06 TKN	01-Mar-06 TKN	26-Apr-06 TKN	14-Jun-06 TKN	24-Aug-06 TKN	25-Oct-06 TKN	20-Dec-06 TKN	29-Mar-07 TKN	26-Jun-07 TKN	20-Aug-07 TKN	27-Dec-07 TKN	28-Mar-08 TKN	10-Jun-08 TKN	24-Sep-08 TKN	4-Dec-08 TKN	24-Mar-09 TKN	4-Jun-09 TKN	22-Sep-09 TKN	15-Dec-09 TKN
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	3.42	1.13		1.82	3.96	4.60	2.53	1.74	2.33	2.70	2.2	0.78	2.49	2.9	4.0		3.22	3.95	1.26
5	1.51	1.15		1.86	2.86	2.62	2.65	1.81	2.73	1.50	2.1	0.93	2.69	2.8	2.6		3.16	3.95	1.32
10	2.52	0.99		1.92	4.56	2.81	2.72	1.68	2.35	1.50	2.6	0.52	2.27	2.7	2.9		2.72	6.92	2.49
14																			
15	3.36	0.99		1.85	3.19	5.94	2.62	1.27	2.41	2.20	1.8	0.56	2.18		2.3		2.91	7.48	2.58
16																			
17																			
17.4														2.1					
17.5															2.9				
18	4.54					2.42													
18.8													3.02						2.63
19		***0.45***		1.95	2.80		2.38	1.39	1.95		2.0								
19.3																		4.20	
19.9																	2.74		
20																			
20.6												1.0							

Lake
Merced
North East

Depth	23-Jan-06 TKN	01-Mar-06 TKN	26-Apr-06 TKN	14-Jun-06 TKN	24-Aug-06 TKN	25-Oct-06 TKN	20-Dec-06 TKN	29-Mar-07 TKN	26-Jun-07 TKN	20-Aug-07 TKN	27-Dec-07 TKN	28-Mar-08 TKN	10-Jun-08 TKN	24-Sep-08 TKN	4-Dec-08 TKN	24-Mar-09 TKN	4-Jun-09 TKN	22-Sep-09 TKN	15-Dec-09 TKN
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	1.06	0.45		2.25	3.56	4.62	2.02	2.1	1.57	1.50	1.4	0.36	1.79	2.6	2.7		2.97	3.92	2.91
5		0.45		1.37	3.18	3.86	2.10	1.7	2.00	2.00	1.6	0.36	2.55	2.4	2.5		2.44	4.00	0.98
9																			
10	2.02	0.45		1.43	3.05	5.85	3.40	1.7	1.89	1.60	1.6	0.57	2.07	2.4	2.2		2.32	3.42	2.55
11																			
12																			
13	1.57					4.66							1.54	2.4					
13.8																		4.06	
14		1.21		1.32	3.57					1.50									
14.1															2.7				
14.7																			2.94
15							2.21	1.2	1.99		1.5						2.27		
15.8												0.80							

Lake Merced South - Pistol Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0														3.60	7.45	***0.25***	2.91	0.97	---	1.3
5															5.36	***0.25***	0.73	1.00	---	1.3
6																				
10															5.99	0.40	1.62	1.10	---	1.4
12																				
15															4.93	1.50	1.23	0.98	---	1.3
16														2.00						
17																				
18																				
18.2																				
18.9																				
19																				
20																				
20.1																				
20.8																				
21																				
21.5																				
22																				

Lake Merced South - Pump Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf														5.70	7.62		3.59	0.97		1.4
5															6.61	1.00	5.10	1.10		1.3
10															3.70	1.50	5.43	1.20		1.3
12																				
15															2.30	0.25	8.46	1.10		1.5
16																				
17														3.40						
18																				
19																				
19.2																				
20																				
20.4																				
21																				
21.5																				
22																				
23.2																				

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced South - Pistol Range

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	7.9	15.0	1.9	1.1	13.8	3.3	9.10	2.6	12.0	12.7	6.4	6.5	7.9	7.5	1.16	3.70	1.88	6.16	1.8	NA
5	10.5	5.5	2.0	1.3	9.9	9.0	6.00	1.5	7.2	8.8	5.4	5.3	6.0	5.1	0.91	5.10	4.20	3.92	2.3	NA
6																				
10	9.7	8.8	1.9	1.3	7.3	1.9	1.80	2.6	5.8	6.2	4.8	2.7	7.1	4.5	0.64	6.50	2.18	6.27	2.4	NA
12																				
15	5.8	6.2	2.0	1.3	1.9	0.4	1.10	0.9	4.4	4.0	4.0	2.1	8.0	3.9	0.49	5.60	2.30	4.20	2.3	NA
16																				
17												0.60	12.8							
18										5.10							1.79		3.6	
18.2																				
18.9																				
19																				NA
20														2.6	0.30	3.20		5.82		
20.1																				
20.8																				
21																				
21.5																				
22																				

Lake Merced South - Pump Station

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN	TKN
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	8.7	10.9	1.8	1.1	9.4	3.3	5.80	1.7	8.5	11.7	7.3	4.2	5.6	5.5	1.05	5.10	2.52	3.71	2.7	NA
5	3.2	9.2	1.9	1.4	7.9	9.0	18.80	8.1	28.2	9.2	14.8	2.6	7.1	5.3	0.88	5.60	3.95	3.08	2.7	NA
10	10.9	9.9	1.8	1.2	5.2	1.9	8.50	3.2	11.8	18.6	6.5	2.3	7.7	4.5	0.69	8.40	2.55	2.41	1.4	NA
12																				
15	4.9	6.0	2.1	1.2	4.4	0.4	2.20	3.1	10.6	5.9	4.9	1.7	8.7	4.0	0.50	7.00	2.80	3.64	2.4	NA
16																				
17													9.7							
18																				
19										4.50		0.90						4.48		
19.2																				
20															0.29	6.60	3.30		9.7	NA
20.4																				
21														5.1						
21.5																				
22																				
23.2																				

Lake Merced South - Pistol Range

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.95	1.16		1.78	2.7	3.58	1.4	0.90	1.37	1.50	1.4	0.47	0.84	2.3	2.6		2.60	9.16	2.13
5	2.46	1.11		0.71	3.2	2.20	4.2	1.05	2.49	1.10	1.2	0.42	1.57	2.2	2.6		1.79	3.44	2.44
6																			
10	0.95	***0.45***		0.94	2.7	2.16	2.3	1.04	1.36	1.50	1.2	0.89	1.01	2.7	2.5		1.85	3.42	2.16
12																			
15		1.16		1.55	2.4	2.10	1.6	1.06	***0.25***	1.00	1.3	0.64	1.12	2.2	2.4		1.90	3.00	2.58
16																			
17																			
18	1.12																		
18.2																			2.41
18.9																		3.28	
19						2.16									2.3				
20		***0.45***			2.4		2.2						1.15						
20.1														2.1					
20.8																	1.85		
21				1.78				0.91			1.3								
21.5												0.45							
22									1.37										

Lake Merced South - Pump Station

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**	**TKN**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	1.18	0.45		0.95	3.58	3.6	2.28	0.94	1.22	1.10	1.5	0.81	1.12	2.6	2.0		3.11	3.42	2.32
5	1.34	1.23		1.72	2.30	3.4	2.50	1.09	1.60	1.20	1.1	0.33	0.95	2.7	2.5		2.10	3.81	2.10
10	1.09	0.45		2.27	3.43	2.3	2.67	1.06	1.56	1.30	1.4	0.76	1.04	2.4	2.6		1.88	3.81	2.02
12																			
15	2.52	0.92		2.14	2.90	2.3	4.21	1.16	1.40	1.20	1.2	0.82	2.21	2.2	2.4		1.88	3.08	2.49
16																			
17																			
18						2.0													
19																			
19.2																		3.00	
20	2.35																		
20.4																			2.16
21		***0.45***		1.37	5.33					1.60	1.3		1.51	1.9	2.3				
21.5																	1.90		
22							1.57	1.62	1.57										
23.2												0.17							

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02
Depth	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.05	0.05	0.05	0.03	0.02		0.11		0.04	0.05	0.03	0.025	0.025		0.05	0.05	0.05	0.12	0.06	0.06	0.11	0.04
5	0.05	0.05	0.05	0.02	0.05		0.14		0.01	0.05	0.03	0.025	0.025		0.04	0.07	0.03	0.09	0.06	0.08	0.07	0.06
10	0.05	0.05	0.05	0.02	0.03		0.17		0.07	0.05	0.03	0.025	0.025		0.04	0.05	0.09	0.10	0.03	0.03	0.06	0.05
14									0.02	0.05							0.05					
15	0.13	0.66	0.05	0.04	0.02		0.20					0.025	0.025		0.05	0.24		0.04	0.04	0.05	0.09	0.04
16																						
17																						
17.4																						
17.5																						
18											0.03											
18.8																						
19																						
19.3																						
19.9																						
20																						
20.6																						

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02
Depth	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.05		0.05	0.03	0.03		0.05		0.005	0.05	0.03	0.04	0.025		0.26	0.05	0.05	0.10	0.08	0.05	0.09	0.03
5	0.05		0.1	0.02	0.02		0.04		0.005	0.05	0.04	0.04	0.025		0.05	0.06	0.06	0.07	0.11	0.05	0.09	0.06
9																	0.05					
10	0.05		0.05	0.04	0.03		0.05		0.01	0.03		0.04	0.025		0.05	0.06		0.04	0.09	0.04	0.08	0.04
11																						
12																						
13											0.04											
13.8																						
14																						
14.1																						
14.7																						
15																						
15.8																						

Lake Merced
North

Depth	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06
	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.10	0.08	0.31	0.13	0.09	0.11	0.01	0.12	0.03	0.03	0.09	0.09	0.09	***0.005***	0.03	0.04	0.06	0.05	0.03	***0.005***	0.03	0.04	0.07
5	0.11	0.13	0.35	0.53	0.15	0.12	0.01	0.05	0.06	0.02	0.07	0.04	0.10	0.04	0.03	0.05	0.06	0.04	0.09	0.01	0.04	0.04	0.02
10	0.10	0.06	0.31	0.18	0.21	0.06	0.01	0.04	0.11	0.05	0.06	0.06	0.08	***0.005***	0.02	0.05	0.08	0.05	0.09	0.02	0.05	0.05	0.02
14																							
15	0.10	0.07	0.36	0.12	0.16	0.10	0.01	0.08	0.10	0.02	0.02	0.04	0.11	***0.005***	0.01	0.05	0.11	0.02	0.07	0.02	0.05	0.08	0.03
16														0.04									
17								0.08			0.04				0.03								
17.4																							
17.5																							
18										0.06		0.03				0.03	0.09	0.03	0.04				
18.8																							
19													0.11							0.02	0.04	0.10	0.03
19.3																							
19.9																							
20																							
20.6																							

Lake Merced
North East

Depth	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06
	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.05	0.03	0.22	0.08	0.19	0.10	0.005	0.03	0.03	0.03	0.03	0.04	0.11	0.01	0.01	0.02	0.05	0.06	0.02	0.03	0.15	0.07	0.13
5	0.07	0.03	0.19	0.08	0.16	0.08	0.005	0.03	0.05	0.01	0.08	0.05	0.15	0.15	0.04	0.04	0.08	0.03	0.03	0.02	0.15	0.07	0.02
9																							
10	0.06	0.07	0.29	0.12	0.09	0.09	0.005	0.28	0.03	0.02	0.06	0.03	0.10	0.06	0.04	0.05	0.07	0.03	0.06	0.03	0.13	0.06	0.12
11																							
12																							
13								0.05		0.04	0.07		0.10	0.06	0.03	0.05	0.07		0.05				
13.8																							
14												0.02						0.01		0.02		0.02	0.10
14.1																							
14.7																							
15																					0.15		
15.8																							

Lake Merced
North

	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.03	0.21	0.02	0.03	0.05	0.07	0.06	0.05	0.06	0.58	0.17	0.06	0.05	0.25
5	0.10	0.25	0.02	0.04	0.05	0.06	0.03	0.10	0.08	0.60	0.04	0.05	0.04	0.30
10	0.09	0.18	***0.005***	0.02	0.05	0.06	0.05	0.11	0.09	0.64	0.07	0.05	0.02	0.27
14														
15	0.08	0.22	0.04	0.02	0.06	0.10	0.03	0.06		0.70	0.03	0.05	0.09	0.35
16														
17														
17.4									0.18					
17.5										0.78	0.78			
18	0.04			0.09	0.05									
18.8								0.11						0.37
19		0.22	0.04			0.10								
19.3													0.75	
19.9												0.04		
20											0.03			
20.6							0.03							

Lake Merced
North East

	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.05	0.40	0.04	0.24	0.08	0.25	0.01	0.10	0.07	0.72	0.01	0.04	0.03	0.19
5	0.09	0.40	0.03	0.17	0.06	0.23	0.02	0.05	0.06	0.70	0.03	0.03	0.01	0.20
9														
10	0.09	0.42	0.03	0.03	0.09	0.24	0.10	0.05	0.21	0.76	0.13	0.04	0.02	0.23
11														
12														
13	0.05							0.03	0.25					
13.8													0.14	
14					0.04									
14.1										0.72				
14.7											0.02			0.22
15		0.37	0.03	0.05		0.29						0.03		
15.8							0.04							

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02
Depth	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.05	0.13	0.05	0.04	0.06		0.02	0.02	0.005	0.04	0.02	0.04	0.05		0.02	0.06	0.04	0.03	0.05	0.04	0.05	0.06
5	0.05	0.05	0.05		0.03		0.03	0.03	0.005	0.04	0.03	0.04	0.025		0.02	0.05	0.04	0.13	0.04	0.05	0.04	0.04
6				0.03																		
10	0.05	0.05	0.05		0.03		0.04	0.04	0.005	0.04	0.03	0.04	0.025		0.005	0.07	0.05	0.02	0.01	0.04	0.06	0.04
12				0.03																		
15	0.05	0.05	0.05		0.03		0.04	0.04	0.005	0.04					0.02	0.03	0.04	0.19	0.14	0.04	0.05	0.03
16	0.05	0.05																				
17																						
18				0.03								0.04	0.025									
18.2																						
18.9																						
19																						
20											0.04											
20.1																						
20.6																						
20.8																						
21																						
21.5																						
22																						

Lake Merced
South - Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02
Depth	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.05	0.05	0.05	0.03	0.03		0.005	0.005	0.01	0.05	0.03	0.01	0.025		0.03	0.11	0.05	0.05	0.06	0.03	0.03	0.04
5	0.05	0.05	0.05	0.03	0.04		0.04	0.04	0.02	0.07	0.03	0.07	0.025		0.03	0.05	0.05	0.12	0.05	0.04	0.09	0.03
10	0.05	0.12	0.05		0.04		0.01	0.01	0.02	0.05	0.03	0.06	0.025		0.06	0.03	0.04	0.04	0.05	0.11	0.05	0.04
12				0.07																		
15	0.05	0.05	0.05		0.03		0.01	0.01	0.01	0.04					0.03	0.03	0.05	0.12	0.04	0.04	0.04	0.03
16																						
17																						
18				0.07								0.005										
19													0.025									
19.2																						
20											0.04											
20.4																						
21																						
21.5																						
22																						
22.8																						
23.2																						

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
South - Pistol
Range

	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06
Depth	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.11	0.13	0.03	0.04	0.07	0.16	0.005	0.06	0.04	0.04	0.02	0.02	0.03	0.04	0.02	0.01	0.02	0.07	0.04	0.02	0.03	0.05	0.08
5	0.06	0.03	0.16	0.07	0.11	0.04	0.005	0.08	0.03	0.01	0.05	0.04	0.09	0.06	0.04	0.04	0.02	0.09	0.04	0.02	0.03	0.04	0.10
6																							
10	0.03	0.03	0.05	0.07	0.11	0.05	0.04	0.04	0.03	0.04	0.06	0.03	0.07	0.07	0.03	0.03	0.02	0.08	0.03	0.02	0.04	0.05	0.06
12																							
15	0.18	0.02	0.15	0.07	0.06	0.21	0.005	0.07	0.05	0.04	0.03	0.02	0.06	0.06	0.02	0.05	0.02	0.10	0.04	0.02	0.04	0.07	0.12
16																							
17										0.03	0.02												
18								0.04							0.02		0.02		0.04				
18.2																							
18.9																							
19																		0.06					
20												***0.005***	0.06	0.03		0.03				0.04	0.04		0.03
20.1																							
20.6																							
20.8																							
21																						0.02	
21.5																							
22																							

Lake Merced
South - Pump
Station

	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06
Depth	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N	NH_3-N
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.07	0.02	0.04	0.07	0.05	0.07	0.32	0.04	0.04	0.02	0.04	0.05	0.03	0.05	0.005	0.02	0.01	0.07	0.02	0.06	0.04	0.06	0.06
5	0.06	0.08	0.08	0.08	0.05	0.04	0.44	0.02	0.04	0.01	0.03	0.03	0.05	0.03	0.03	0.02	0.02	0.07	0.02	0.03	0.04	0.02	0.03
10	0.65	0.03	0.11	0.12	0.07	0.04	0.34	0.07	0.03	0.05	0.02	0.03	0.06	***0.005***	0.005	0.03	0.02	0.06	0.02	0.03	0.03	0.07	0.04
12																							
15	0.06	0.03	0.09	0.06	0.07	0.03	0.08	0.05	0.02	0.03	0.03	0.04	0.05	0.02	0.005	0.02	0.02	0.06	0.02	0.03	0.04	0.05	0.03
16																							
17											0.02												
18																							
19								0.05		0.04						0.02							
19.2																							
20													0.05	0.01	0.01		0.04	0.06	0.03				
20.4																							
21												0.01								0.06		0.02	0.08
21.5																							
22																					0.03		
22.8																							
23.2																							

Lake Merced
South - Pistol
Range

	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.08	0.09	0.02	0.03	0.04	0.19	***0.005***	0.01	0.09	0.06	0.01	0.03	0.04	0.07
5	0.10	0.07	0.01	0.03	0.04	0.15	0.01	0.11	0.09	0.08	0.01	0.03	0.04	0.09
6														
10	0.10	0.07	0.02	0.03		0.01	***0.005***	0.04	0.07	0.06	0.01	0.02	0.05	0.06
12														
15	0.11	0.09	0.02	0.04	0.03	0.05	0.01	0.09	0.12	0.07	0.01	0.03	0.04	0.07
16														
17														
18														
18.2														0.04
18.9													0.04	
19	0.12									0.06				
20		0.09			0.03			0.02						
20.1									0.18					
20.6											0.005			
20.8												0.02		
21			0.02			0.01								
21.5							0.04							
22				0.03										

Lake Merced
South - Pump
Station

	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**	**NH_3-N**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.12	0.07	0.02	0.03	0.02	0.03	***0.005***	0.08	0.09	0.04	0.01	0.04	0.05	0.08
5	0.09	0.07	0.02	0.04	0.03	0.13	***0.005***	0.11	0.08		0.005	0.04	0.06	0.08
10	0.09	0.06	0.02	0.03	0.02	0.01	0.03	0.05	0.08	0.04	0.05	0.02	0.05	0.06
12														
15	0.32	0.07	0.08	0.12	0.03	0.19	0.03	0.10	0.10	0.06	0.07	0.03	0.04	0.06
16														
17														
18	0.47													
19														
19.2													0.04	
20														
20.4														0.03
21					0.05	0.04		0.06		0.04				
21.5												0.01		
22		0.08	0.09	0.06										
22.8											0.12			
23.2							0.04							

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	*0.01*	0.12	0.07	*0.01*	0.12	0.03	*0.01*		0.08	0.05	*0.01*	0.04	0.05	0.02	*0.01*	*0.01*	0.03	0.03	*0.01*	0.08
5	*0.01*	0.13	0.07	*0.01*	0.13	0.03	*0.01*		0.08	0.05	*0.01*	0.03	0.08	0.04	*0.01*	0.03	0.03	0.05	*0.01*	0.10
10	*0.01*	0.14	0.09	*0.01*	0.12	0.03	*0.01*		0.08	0.06	*0.01*	0.04	0.05	0.03	0.03	0.04	0.03	0.04	*0.01*	0.07
14									0.09	0.05				0.03			0.05			
15	*0.01*	0.23	0.07	0.03	0.17	0.05	*0.01*					0.06	0.05		*0.01*	0.13		0.04	*0.01*	0.10
16																				
17																				
17.4																				
17.5																				
18											*0.01*									
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	*0.01*		0.06	*0.01*	0.19	*0.01*	0.03		0.06	0.05	*0.01*	0.09	0.08	0.03	*0.01*	0.03	***0.005***	0.05	*0.01*	0.06
5	*0.01*		0.05	*0.01*	0.17	0.04	0.04		0.06	0.05	*0.01*	0.09	0.08	0.03	*0.01*	0.05	0.04	0.04	*0.01*	0.06
9																	0.03			
10	*0.01*		0.05	*0.01*	0.18	0.03	0.04		0.06	0.05		0.09	0.07	0.02	*0.01*	0.07		0.03	*0.01*	0.08
11																				
12																				
13											*0.01*									
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.14	0.16	0.23	0.07	0.03	0.18	0.31	0.16	0.29	0.24	0.09	0.01	***0.005***	0.05	0.11	0.11	0.16	0.20	0.19	0.16	0.06
5	0.14	0.13	0.26	0.05	0.01	0.20	0.32	0.20	0.29	0.24	0.07	0.01	***0.005***	0.05	0.10	0.13	0.23	0.20	0.18	0.17	0.07
10	0.14	0.13	0.23	0.03	0.05	0.20	0.29	0.18	0.28	0.24	0.04	***0.005***	0.06	0.03	0.10	0.11	0.17	0.21	0.18	0.16	0.07
14																					
15	0.15	0.13	0.21	0.01	0.07	0.22	0.30	0.16	0.29	0.21	0.07	0.01	***0.005***	0.03	0.09	0.12	0.18	0.23	0.15	0.10	0.10
16																0.10					
17										0.25			***0.005***				0.20				
17.4																					
17.5																					
18												0.01		0.04				0.18	0.14	0.09	0.14
18.8																					
19															0.10						
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.14	0.13	0.18	0.05	0.03	0.19	0.33	0.18	0.23	0.12	0.14	0.05	0.03	0.04	0.10	0.16	0.15	0.14	0.10	0.05	0.12
5	0.13	0.10	0.18	0.04	0.03	0.19	0.32	0.18	0.28	0.20	0.18	0.03	0.02	0.03	0.35	0.16	0.18	0.14	0.09	0.06	0.09
9																					
10	0.15	0.10	0.18	0.02	0.03	0.21	0.35	0.16	0.21	0.16	0.22	0.08	0.05	0.03	0.13	0.15	0.15	0.14	0.10	0.04	0.08
11																					
12																					
13										0.20		0.05	0.02		0.21	0.14	0.13	0.16	0.08		0.04
13.8																					
14														0.10						0.03	
14.1																					
14.7																					
15																					
15.8																					

Lake Merced
North

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.08	0.11	0.26	0.12	0.28	0.15	0.08	0.13	0.13	0.11	0.06	0.16	0.20	0.39	0.18	0.26	0.30	0.19
5	0.18	0.12	0.30	0.13	0.28	0.13	0.08	0.13	0.16	0.10	0.06	0.24	0.26	0.40	0.18	0.26	0.30	0.22
10	0.16	0.12	0.28	0.18	0.31	0.15	0.07	0.14	0.14	0.14	0.18	0.24	0.25	0.36	0.17	0.28	0.30	0.27
14																		
15	0.19	0.14	0.28	0.18	0.34	0.15	0.09	0.16	0.15	0.12	0.09	0.26		0.31	0.16	0.26	0.36	0.21
16																		
17																		
17.4													0.29					
17.5														0.40				
18					0.30				0.21									
18.8												0.18						0.22
19	0.15	0.17	0.30	0.21		0.13	0.09	0.23		0.10								
19.3																	0.33	
19.9																0.21		
20															0.13			
20.6											0.08							

Lake Merced
North East

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.09	0.21	0.23	0.19	0.26	0.16	0.09	0.13	0.11	0.11	0.02	0.13	0.20	0.36	0.04	0.26	0.31	0.24
5	0.09	0.20	0.24	0.20	0.25	0.14	0.09	0.13	0.13	0.10	0.04	0.17	0.20	0.30	0.06	0.22	0.32	0.23
9																		
10	0.07	0.19	0.24	0.19	0.25	0.15	0.07	0.16	0.14	0.09	0.06	0.20	0.30	0.33	0.05	0.18	0.30	0.23
11																		
12																		
13					0.25							0.16	0.32					
13.8																	0.32	
14	0.07		0.24	0.15					0.17									
14.1														0.26				
14.7															0.06			0.22
15		0.19				0.14	0.08	0.18		0.09						0.12		
15.8											0.01							

Lake Merced
South - Pistol
Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.01***	0.02	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	0.02	***0.01***	***0.01***	***0.005***	0.03	***0.01***	0.09
5	***0.01***	0.03	***0.01***		***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	0.02	***0.01***	***0.01***	***0.005***	0.03	***0.01***	0.06
6				***0.01***																
10	***0.01***	0.05	***0.01***		***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	0.04	***0.01***	***0.01***	***0.005***	0.03	***0.01***	0.09
12				***0.01***																
15	***0.01***	0.08	***0.01***		***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***				0.03	***0.01***	0.03	***0.005***	0.03	***0.01***	0.06
16	***0.01***	0.08																		
17																				
18				***0.01***								***0.01***	***0.01***							
18.2																				
18.5																				
18.9																				
19																				
20											***0.01***									
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South -
Pump Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P	Orth P
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.01***	0.04	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	0.04	***0.01***	***0.01***	***0.005***	0.02	***0.01***	0.09
5	***0.01***	0.03	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	0.06	***0.01***	***0.01***	***0.005***	0.03	***0.01***	0.12
10	***0.01***	0.05	***0.01***		***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	0.04	***0.01***	***0.01***	***0.005***	0.03	***0.01***	0.07
12				***0.01***																
15	***0.01***	0.08	***0.01***		***0.01***	***0.01***	***0.01***	***0.01***	***0.01***	***0.01***				0.03	***0.01***	***0.01***	***0.005***	0.03	***0.01***	0.10
16																				
17																				
18				***0.01***								***0.01***								
19													***0.01***							
19.2																				
20											***0.01***									
20.4																				
20.9																				
21																				
21.5																				
22																				
22.8																				
23.2																				

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.08	0.09	0.15	0.11	0.10	0.04	0.15	0.10	0.12	0.06	0.08	0.11	0.03	0.10	0.11	0.07	0.13	0.10	0.09	0.11	0.07
5	0.11	0.09	0.13	0.06	0.06	0.11	0.15	0.12	0.12	0.05	0.10	0.08	0.03	0.09	0.08	0.09	0.11	0.10	0.07	0.11	0.05
6																					
10	0.10	0.06	0.18	0.01	0.03	0.10	0.12	0.10	0.13	0.07	0.09	0.11	0.02	0.09	0.08	0.12	0.10	0.09	0.04	0.13	0.04
12																					
15	0.12	0.06	0.21	0.01	0.03	0.10	0.16	0.11	0.15	0.07	0.05	0.06	0.02	0.10	0.11	0.10	0.12	0.07	0.05	0.10	0.03
16																					
17												0.08	0.01								
18										0.09							0.10		0.06		0.03
18.2																					
18.5																					
18.9																					
19																				0.11	
20														0.11	0.06	0.12		0.06			
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced
South -
Pump Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.11	0.10	0.17	0.02	0.07	0.06	0.13	0.09	0.13	0.09	0.13	0.02	0.04	0.07	0.12	0.12	0.08	0.02	0.08	0.10	0.03
5	0.11	0.08	0.18	0.01	0.02	0.13	0.14	0.10	0.13	0.04	0.10	0.03	0.02	0.11	0.11	0.14	0.09	0.05	0.06	0.09	0.06
10	0.12	0.10	0.15	0.02	0.01	0.10	0.09	0.09	0.14	0.06	0.09	0.14	0.03	0.10	0.11	0.11	0.09	0.05	0.04	0.11	0.06
12																					
15	0.08	0.09	0.20	0.01	0.01	0.08	0.13	0.14	0.14	0.14	0.11	0.05	0.04	0.12	0.09	0.13	0.14	0.04	0.05	0.10	0.06
16																					
17													0.05								
18																					
19										0.13		0.07						0.04			
19.2																					
20															0.11	0.12	0.07		0.02	0.08	0.07
20.4																					
20.9																					
21														0.10							
21.5																					
22																					
22.8																					
23.2																					

Lake Merced
South - Pistol
Range

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.07	0.03	0.08	0.07	0.17	0.05	0.03	0.04	0.02	0.01	0.04	0.03	0.10	0.20	0.09	0.18	0.09	0.07
5	0.08	0.03	0.09	0.08	0.17	0.05	0.03	0.01	0.02	0.01	0.02	0.03	0.09	0.21	0.09	0.16	0.12	0.08
6																		
10	0.11	0.05	0.07	0.06	0.18	0.04	0.03	0.03		***0.005***	0.03	0.03	0.05	0.24	0.12	0.19	0.09	0.08
12																		
15	0.02	0.07	0.11	0.08	0.20	0.05	0.01	0.04	0.01	***0.005***	0.04	0.03	0.10	0.16	0.11	0.15	0.03	0.09
16																		
17																		
18																		
18.2																		0.13
18.5														0.16				
18.9																	0.16	
19					0.16													
20	0.08	0.05		0.08		0.02						0.04						
20.1													0.11					
20.6															0.12			
20.8																0.18		
21			0.10				0.02			0.01								
21.5											0.05							
22								0.07										

Lake Merced
South -
Pump Station

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**	**Orth P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.02	0.03	0.07	0.06	0.20	0.01	***0.005***	0.06	0.04	***0.005***	***0.005***	0.04	0.08	0.19	0.08	0.13	0.10	0.07
5	0.01	0.04	0.09	0.08	0.18	0.03	0.01	0.04	0.04	0.04	***0.005***	0.05	0.08		0.08	0.17	0.11	0.05
10	0.005	0.06	0.09	0.07	0.20	0.05	***0.005***	0.05	0.04	***0.005***	0.01	0.04	0.09	0.23	0.07	0.14	0.12	0.06
12																		
15	0.06	0.11	0.10	0.08	0.16	0.01	***0.005***	0.07	0.04	***0.005***	0.01	0.07	0.10	0.17	0.07	0.16	0.16	0.06
16																		
17																		
18					0.16													
19																		
19.2																	0.210	
20																		
20.4																		0.05
20.9														0.18				
21	***0.005***		0.08	0.06					0.04	***0.005***		0.07						
21.5																0.20		
22		0.10				0.02	0.01	0.06										
22.8															0.08			
23.2											0.02							

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.09	0.30	***0.005***	0.09	0.21		0.17		0.28	0.32	0.17	0.29	0.29	0.26	0.20	0.50	0.31	0.18	0.16	0.20
5	0.11	0.31	0.01	0.08	0.22		0.17		0.26	0.31	0.17	0.29	0.30	0.26	0.22	0.40	0.32	0.18	0.18	0.22
10	0.11	0.33	***0.005***	0.10	0.22		0.16		0.32	0.29	0.14	0.29	0.29	0.26	0.22	0.39	0.34	0.19	0.17	0.20
14									0.31	0.32				0.25			0.35			
15	0.10	0.41	0.02	0.12	0.28		0.15					0.30	0.33		0.23	0.52		0.19	0.18	0.25
16																				
17																				
17.4																				
17.5																				
18											0.13									
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.06		***0.005***	0.07	0.19		0.19		0.22	0.27	0.22	0.30	0.32	0.25	0.25	0.34	0.36	0.16	0.10	0.19
5	0.07		***0.005***	0.08	0.19		0.19		0.24	0.27	0.24	0.29	0.30	0.27	0.24	0.41	0.30	0.18	0.16	0.19
9																	0.23			
10	0.07		***0.005***	0.08	0.23		0.20		0.23	0.30		0.32	0.44	0.20	0.24	0.45		0.13	0.17	0.19
11																				
12																				
13											0.15									
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.28	0.23	0.26	0.13	0.10	0.29	0.33	0.19	0.31	0.28	0.21	0.03	0.05	0.05	0.21	0.14	0.20		0.24	0.17
5	0.28	0.25	0.27	0.12	0.14	0.31	0.32	0.22	0.29	0.31	0.21	0.03	0.04	0.05	0.15	0.13	0.26	0.23	0.25	0.18
10	0.29	0.25	0.27	0.15	0.14	0.32	0.33	0.21	0.33	0.28	0.20	0.02	0.13	0.03	0.20	0.19	0.22		0.28	0.24
14																				
15	0.27	0.22	0.26	0.15	0.10	0.36	0.41	0.21	0.32	0.28	0.18	0.07	0.12	0.05	0.12	0.18	0.21	0.29	0.30	0.22
16																0.23				
17										0.29			0.05				0.26			
17.4																				
17.5																				
18												0.07		0.07				0.24	0.30	0.19
18.8																				
19															0.13					
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.23	0.19	0.21	0.14	0.10	0.24	0.36	0.21	0.26	0.20	0.24	0.09	0.07	0.09	0.48	0.28	0.20	0.26	0.15	0.24
5	0.18	0.23	0.20	0.13	0.11	0.35	0.34	0.22	0.28	0.20	0.24	0.09	0.07	0.08	0.41	0.21	0.18	0.23	0.21	0.21
9																				
10	0.22	0.27	0.20	0.13	0.14	0.34	0.38	0.19	0.22	0.20	0.26	0.11	0.08	0.11	0.20	0.24	0.18	0.29	0.15	0.16
11																				
12																				
13										0.21		0.09	0.02		0.24	0.24	0.15	0.27	0.16	
13.8																				
14														0.21						0.18
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.18	0.15	0.15	0.35	0.36	0.34	0.25	0.19	0.30	0.31	0.18	0.16	0.26	0.37	0.39	0.29	0.37	0.52	0.31
5	0.18	0.18	0.18	0.33	0.26	0.31	0.27	0.18	0.23	0.32	0.16	0.14	0.29	0.40	0.40	0.18	0.32	0.52	0.33
10	0.20	0.18	0.16	0.29	0.32	0.31	0.26	0.18	0.32	0.37	0.17	0.23	0.24	0.40	0.39	0.19	0.33	0.52	0.33
14																			
15	0.24	0.19	0.20	0.31	0.29	0.38	0.26	0.20	0.30	0.31	0.17	0.15	0.26		0.44	0.18	0.32	0.52	0.32
16																			
17																			
17.4														0.40					
17.5															0.40				
18	0.29					0.32				0.39									
18.8													0.24						0.30
19		0.16	0.26	0.30	0.29		0.25	0.19	0.29		0.15								
19.3																		0.50	
19.9																	0.29		
20																0.17			
20.6												0.16							

Lake Merced
North East

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.19	0.23	0.23	0.27	0.24	0.27	0.25	0.19	0.34	0.31	0.12	0.14	0.22	0.34	0.36	0.14	0.30	0.46	0.29
5	0.21	0.12	0.22	0.26	0.27	0.27	0.25	0.19	0.26	0.32	0.11	0.12	0.25	0.35	0.33	0.14	0.27	0.46	0.29
9																			
10	0.20	0.12	0.20	0.24	0.30	0.25	0.27	0.17	0.35	0.33	0.12	0.13	0.31	0.37	0.35	0.16	0.21	0.48	0.32
11																			
12																			
13	0.14					0.30							0.25	0.39					
13.8																		0.52	
14		0.18		0.24	0.30					0.28									
14.1															0.34				
14.7																0.16			0.28
15			0.23				0.24	0.15	0.30		0.12						0.19		
15.8												0.11							

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.08	0.25	0.03	0.05	0.08		0.07	0.18	0.16	0.25	0.19	0.18	0.20	0.13	0.14	0.22	0.19	0.10	0.11	0.15
5	0.07	0.22	0.03		0.10		0.07	0.18	0.18	0.28	0.16	0.17	0.19	0.15	0.14	0.24	0.15	0.15	0.11	0.09
6				0.06																
10	0.08	0.24	0.04		0.10		0.08	0.14	0.18	0.25	0.18	0.18	0.18	0.16	0.13	0.26	0.13	0.11	0.11	0.13
12				0.07																
15	0.08	0.28	0.03		0.07		0.08	0.11	0.16	0.21				0.17	0.13	0.28	0.18	0.27	0.11	0.10
16	0.08	0.28																		
17																				
18				0.08								0.18	0.18							
18.2																				
18.5																				
18.9																				
19																				
20											0.17									
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.08	0.25	0.02	0.05	0.07		0.07	0.17	0.17	0.18	0.20	0.18	0.16	0.16	0.13	0.24	0.19	0.13	0.11	0.11
5	0.07	***0.01***	0.02	0.05	0.13		0.08	0.18	0.17	0.16	0.19	0.18	0.18	0.19	0.13	0.24	0.19	0.12	0.10	0.12
10	0.06	0.24	0.04		0.09		0.07	0.15	0.14		0.18	0.18	0.18	0.16	0.14	0.25	0.19	0.09	0.12	0.12
12				0.05																
15	0.09	0.25	0.01		0.06		0.07	0.22	0.17					0.18	0.14	0.24	0.21	0.11	0.13	0.13
16																				
17																				
18				0.06								0.17								
19													0.18							
19.2																				
20											0.17									
20.4																				
20.9																				
21																				
21.5																				
22																				
22.8																				
23.2																				

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.13	0.15	0.18	0.13	0.10	0.18	0.18	0.10	0.18	0.17	0.21	0.11	0.27	0.10	0.21	0.16	0.16	0.18	0.09	0.18
5	0.13	0.18	0.18	0.11	0.07	0.13	0.16	0.14	0.20	0.14	0.24	0.14	0.07	0.11	0.20	0.17	0.15	0.23	0.14	0.17
6																				
10	0.13	0.15	0.21	0.11	0.07	0.11	0.13	0.15	0.20	0.18	0.20	0.13	0.18	0.14	0.22	0.18	0.14	0.20	0.08	0.16
12																				
15	0.13	0.15	0.25	0.12	0.07	0.19	0.16	0.16	0.18	0.17	0.16	0.13	0.13	0.13	0.22	0.17	0.23	0.21	0.14	0.15
16																				
17												0.17	0.37							
18										0.16							0.21		0.06	
18.2																				
18.5																				
18.9																				
19																				0.18
20														0.19	0.11	0.18		0.17		
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P	Tot P
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.11	0.15	0.20	0.13	0.12	0.08	0.18	0.20	0.18	0.23	0.20	0.12	0.06	0.07	0.15	0.17	0.10	0.18	0.09	0.17
5	0.12	0.16	0.21	0.11	0.07	0.13	0.16	0.17	0.23	0.13	0.24	0.08	0.15	0.16	0.22	0.15	0.11		0.13	0.19
10	0.14	0.17	0.19	0.12	0.06	0.17	0.15	0.17	0.24	0.15	0.24	0.15	0.07	0.15	0.20	0.13	0.15	0.11	0.10	0.19
12																				
15	0.12	0.16	0.25	0.12	0.06	0.20	0.19	0.17	0.24	0.26	0.23	0.16	0.10	0.17	0.24	0.13	0.20	0.11	0.08	0.10
16																				
17													0.10							
18																				
19										0.19		0.11						0.10		
19.2																				
20															0.14	0.18	0.22		0.09	0.12
20.4																				
20.9																				
21														0.18						
21.5																				
22																				
22.8																				
23.2																				

Lake Merced
South - Pistol
Range

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0	0.16	0.07	0.17	0.18	0.19	0.20	0.15	0.08	0.09	0.10	0.12	0.10	0.09	0.19	0.27	0.14	0.21	0.21	0.12
5	0.16	0.10	0.18	0.19	0.19	0.23	0.14	0.09	0.16	0.11	0.10	0.11	0.10	0.15	0.25	0.15	0.19	0.25	0.12
6																			
10	0.13	0.21	0.09	0.10	0.19	0.21	0.12	0.06	0.12		0.09	0.08	0.11	0.19	0.30	0.17	0.19	0.32	0.11
12																			
15	0.13	0.15	0.18	0.14	0.16	0.24	0.13	0.07	0.15	0.10	0.08	0.08	0.08	0.15	0.17	0.17	0.21	0.30	0.11
16																			
17																			
18	0.15																		
18.2																			0.13
18.5															0.28				
18.9																		0.19	
19						0.16													
20		0.08	0.17		0.17		0.16						0.09						
20.1														0.17					
20.6																0.12			
20.8																	0.19		
21				0.13				0.09			0.10								
21.5												0.07							
22									0.17										

Lake Merced
South - Pump
Station

	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**	**Tot P**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.13	0.14	0.20	0.21	0.23	0.22	0.17	0.13	0.14	0.13	0.08	0.05	0.09	0.21	0.24	0.09	0.21	0.40	0.15
5	0.13	0.10	0.12	0.16	0.24	0.18	0.23	0.09	0.16	0.15	0.15	0.06	0.08	0.16		0.08	0.18	0.28	0.16
10	0.07	0.16	0.23	0.20	0.26	0.20	0.11	0.10	0.13	0.15	0.08	0.06	0.10	0.19	0.23	0.1	0.14	0.29	0.14
12																			
15	0.07	0.14	0.21	0.18	0.19	0.21	0.10	0.07	0.13	0.15	0.12	0.07	0.10	0.25	0.25	0.12	0.16	0.29	0.13
16																			
17																			
18						0.21													
19																			
19.2																		0.28	
20	0.08																		
20.4																			0.12
20.9															0.22				
21		0.06		0.19	0.15					0.12	0.07		0.12						
21.5																	0.20		
22			0.20				0.19	0.06	0.12										
22.8																0.11			
23.2												0.05							

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.10	0.10	***0.05***	0.11	***0.05***	0.09	***0.05***		***0.05***	0.10	0.13	0.11	0.12	0.12	0.13	0.13	0.09	0.10	***0.05***	
5	0.10	0.10	***0.05***	0.11	***0.05***	0.10	***0.05***		***0.05***	***0.05***	0.12	0.11	0.12	0.12	0.12	0.13	0.10	0.10	***0.05***	
10	0.10	0.10	***0.05***	0.11	***0.05***	0.08	***0.05***		***0.05***	***0.05***	0.12	0.11	0.12	0.12	0.13	0.12	0.08	0.10	***0.05***	
14									***0.05***	***0.05***				0.12			0.10			
15	0.10	0.10	***0.05***	0.11	***0.05***	0.10	***0.05***					0.11	0.12		0.12	0.12		0.10	***0.05***	
16																				
17																				
17.4																				
17.5																				
18											0.13									
18.8																				
19																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.10		***0.05***	***0.05***	***0.05***	0.08	***0.05***		***0.05***	***0.05***	0.12	0.10	0.11	0.12	***0.05***	***0.05***	0.08	0.10	***0.05***	
5	0.10		***0.05***	***0.05***	***0.05***	0.08	***0.05***		***0.05***	***0.05***	0.12	0.10	0.11	0.12	0.10	***0.05***	0.08	0.10	***0.05***	
9																	0.08			
10	***0.05***		***0.05***	***0.05***	***0.05***	0.08	***0.05***		***0.05***	***0.05***		0.10	0.10	0.12	***0.05***	***0.05***		0.10	***0.05***	
11																				
12																				
13											0.12									
14																				
14.1																				
15																				
15.8																				

Lake Merced
North

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.25	0.16	0.16	0.02	0.04	0.14	0.30	0.24	0.32	0.27	0.25	0.18	0.38	0.21	0.36	0.42	0.26	0.23	0.30	0.31	0.15
5	0.25	0.20	0.22	0.18	0.07	0.16	0.30	0.21	0.30	0.27	0.29	0.19	0.38	0.23	0.36	0.37	0.26	0.26	0.30	0.34	0.15
10	0.12	0.20	0.17	0.17	0.12	0.15	0.35	0.27	0.30	0.27	0.32	0.53	0.38	0.23	0.39	0.42	0.27	0.24	0.31	0.31	0.16
14																					
15	0.18	0.18	0.17	0.17	0.09	0.16	0.32	0.26	0.30	0.25	0.26	0.31	0.39	0.24	0.37	0.42	0.27	0.28	0.30	0.31	0.20
16																0.37					
17										0.29			0.42				0.29				
17.4																					
17.5																					
18												0.18		0.24				0.26	0.30	0.30	0.19
18.8																					
19															0.43						
20																					
20.6																					

Lake Merced
North East

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.22	0.17	0.09	0.17	0.09	0.16	0.28	0.19	0.31	0.29	0.27	0.13	0.37	0.23	0.42	0.15	0.27	0.28	0.30	0.30	0.25
5	0.16	0.18	0.13	0.16	0.10	0.18	0.26	0.23	0.33	0.30	0.27	0.12	0.37	0.23	0.39	0.15	0.29	0.26	0.31	0.32	0.22
9																					
10	0.15	0.18	0.12	0.15	0.12	0.13	0.27	0.22	0.32	0.30	0.28	0.14	0.37	0.22	0.41	0.15	0.27	0.24	0.32	0.30	0.24
11																					
12																					
13										0.26		0.17	0.37		0.46	0.18	0.30	0.27	0.32		0.24
14														0.25						0.32	
14.1																					
15																					
15.8																					

Lake Merced
North

Depth	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.25	0.25	0.27	0.16	0.24	0.23	0.09	0.14	0.15	0.23	0.24	0.20		
5	0.29	0.22	0.30	0.17	0.25	0.23	0.11	0.17	0.14	0.23	0.23	0.19		
10	0.28	0.25	0.36	0.18	0.25	0.25	0.12	0.15	0.18	0.25	0.26	0.28		
14														
15	0.39	0.23	0.33	0.16	0.25	0.25	0.16	0.20	0.18	0.24	0.29	0.38		
16														
17														
17.4														
17.5														
18					0.28				0.18					
18.8												0.31		
19	0.28	0.25	0.32	0.17		0.24	0.18	0.20		0.26				
20														
20.6											0.25			

Lake Merced
North East

Depth	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.30	0.29	0.25	0.28	0.24	0.32	0.36	0.12	0.14	0.24	0.13	0.14		
5	0.33	0.27	0.24	0.28	0.27	0.32	0.32	0.16	0.14	0.27	0.14	0.23		
9														
10	0.33	0.27	0.30	0.27	0.21	0.32	0.28	0.15	0.16	0.25	0.19	0.30		
11														
12														
13					0.19							0.27		
14	0.36		0.30	0.28					0.16					
14.1														
15		0.28				0.32	0.38	0.18		0.22				
15.8											0.18			

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.40	0.40	0.40	0.36	0.3	0.27	0.28	0.33	0.33	0.33	0.30	0.38	0.30	0.31	0.26	0.29	0.27	0.30	0.23	NA
5	0.40	0.40	0.40		0.3	0.27	0.28	0.33	0.34	0.34	0.29	0.37	0.30	0.30	0.27	0.29	0.27	0.30	0.21	NA
6				0.36																
10	0.40	0.40	0.40		0.3	0.27	0.28	0.33	0.33	0.33	0.29	0.37	0.30	0.32	0.27	0.28	0.27	0.30	0.22	NA
12				0.36																
15	0.40	0.40	0.40		0.3	0.27	0.28	0.33	0.34	0.33				0.31	0.26	0.29	0.27	0.30	0.23	NA
16	0.40	0.40																		
17																				
18				0.36								0.37	0.30							
19																				
20											0.28									
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.40	0.40	0.40	0.36	0.3	0.26	0.28	0.33	0.33	0.33	0.29	0.39	0.30	0.31	0.28	0.28	0.26	0.30	0.22	
5	0.40	0.40	0.40	0.36	0.3	0.27	0.28	0.32	0.34	0.33	0.28	0.38	0.29	0.30	0.26	0.29	0.27	0.30	0.22	
10	0.40	0.40	0.40		0.3	0.27	0.28	0.33	0.34	0.33	0.29	0.38	0.29	0.30	0.26	0.30	0.27	0.30	0.22	
12				0.36																
15	0.40	0.40	0.40		0.3	0.27	0.29	0.32	0.33	0.33				0.31	0.26	0.29	0.27	0.30	0.23	
16																				
17																				
18				0.36								0.37								
19													0.30							
20											0.29									
21																				
22																				
23.2																				

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
South - Pistol
Range

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.47	0.32	0.27	0.51	0.39	0.23	0.52	0.47	0.54	0.55	0.50	0.66	0.46	0.47	0.57	0.40	0.36	0.47	0.52	0.51	0.42
5	0.45	0.33	0.31	0.44	0.37	0.25	0.53	0.47	0.55	0.45	0.52	0.66	0.47	0.47	0.54	0.40	0.37	0.47	0.53	0.48	0.40
6																					
10	0.36	0.32	0.28	0.46	0.37	0.27	0.55	0.47	0.53	0.46	0.52	0.59	0.46	0.47	0.57	0.42	0.37	0.48	0.55	0.46	0.42
12																					
15	0.37	0.32	0.35	0.47	0.34	0.29	0.52	0.50	0.53	0.46	0.52	0.57	0.46	0.46	0.56	0.47	0.39	0.47	0.55	0.52	0.41
16																					
17												0.58	0.52								
18										0.48							0.39		0.51		0.45
19																				0.47	
20														0.45	0.55	0.39		0.45			
21																					
21.5																					
22																					

Lake Merced
South - Pump
Station

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.27	0.36	0.33	0.49	0.36	0.25	0.55	0.47	0.53	0.46	0.52	0.35	0.46	0.46	0.68	0.41	0.39	0.51	0.41	0.37	0.48
5	0.27	0.34	0.32	0.48	0.35	0.28	0.55	0.49	0.54	0.48	0.52	0.35	0.47	0.47	0.60	0.40	0.40	0.48	0.43	0.34	0.50
10	0.37	0.34	0.35	0.48	0.37	0.25	0.54	0.49	0.53	0.46	0.50	0.37	0.48	0.50	0.60	0.40	0.43	0.49	0.43	0.37	0.50
12																					
15	0.36	0.33	0.35	0.49	0.35	0.30	0.57	0.47	0.51	0.48	0.49	0.35	0.50	0.49	0.62	0.37	0.41	0.48	0.43	0.38	0.51
16																					
17													0.43								
18																					
19										0.50		0.36						0.45			
20															0.61	0.38	0.41		0.45	0.38	0.49
21														0.49							
22																					
23.2																					

Lake Merced South - Pistol Range

Depth	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.39	0.44	0.31	0.32	0.38	0.34	0.39	0.35	0.45	0.41	0.25	0.34		
5	0.57	0.43	0.33	0.34	0.41	0.37	0.39	0.37	0.44	0.41	0.33	0.33		
6														
10	0.48	0.41	0.33	0.33	0.37	0.36	0.39	0.37		0.44	0.30	0.34		
12														
15	0.48	0.43	0.32	0.35	0.43	0.38	0.40	0.41	0.45	0.43	0.25	0.36		
16														
17														
18														
19					0.42									
20	0.40	0.42		0.32		0.39						0.34		
21			0.35				0.41			0.42				
21.5											0.26			
22								0.41						

Lake Merced South - Pump Station

Depth	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-	Fl^-
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.36	0.43	0.32	0.32	0.42	0.38	0.46	0.46	0.44	0.44	0.28	0.35		
5	0.43	0.44	0.33	0.34	0.43	0.40	0.46	0.42	0.47	0.45	0.27	0.38		
10	0.40	0.47	0.30	0.33	0.42	0.39	0.45	0.41	0.47	0.48	0.33	0.37		
12														
15	0.39	0.45	0.36	0.35	0.42	0.41	0.45	0.39	0.46	0.46	0.27	0.36		
16														
17														
18					0.48									
19														
20														
21	0.51		0.38	0.32					0.45	0.44		0.36		
22		0.44				0.38	0.44	0.39						
23.2											0.27			

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	9.5	9.1	10.2	7.7	9.7		7.7		9.6	8.7	7.3	8.7	8.2	20.8	6.9	7.9	12.1	5.8	7.9	7.5
5	9.8	9.3	15.4	8.2	9.7		8.0		9.9	13.2	7.2	9.9	8.1	17.1	6.9	7.4	12.8	5.9	8.3	6.8
10	9.2	9.2	12.3	8.4	9.4		8.2		9.6	8.8	7.3	9.2	8.3	23.9	7.1	7.8	14.5	5.9	9.1	6.7
14									9.5	7.4				24.4			12.8			
15	9.0	9.3	15.1	8.0	9.7		8.2					8.9	8.0		6.9	7.3		5.8	8.5	6.1
16																				
17																				
17.4																				
17.5																				
18											7.2									
18.8																				
19																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	7.9		7.0	6.6	8.4		7.4		7.9	15.6	6.6	8.2	7.1	19.6	6.1	9.6	***5.0***	4.4	7.0	5.3
5	7.7		7.9	6.7	8.2		7.3		8.5	4.8	6.7	8.0	9.3	35.6	6.7	8.6	***5.0***	4.5	7.6	5.5
9																	***5.0***			
10	7.3		7.3	6.8	8.3		7.7		8.1	61.1		9.3	7.4	19.9	6.5	7.7		4.5	6.5	5.4
11																				
12																				
13											6.4									
14																				
14.1																				
15																				
15.8																				

Lake Merced
North

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	7.6	9.2	8.7	7.6	7.6	6.4	6.9	6.6	7.1	8.7	7.3	7.9	10.8	19.5	12.5	8.1	9.6	9.0	7.1	
5	7.5	8.5	8.4	7.6	7.2	6.4	6.8	6.5	7.3	8.1	7.6	8.2	10.5	20.1	12.4	7.8	8.7	8.6	7.2	
10	7.5	8.6	10.4	7.5	7.6	6.2	7.0	6.8	7.2	8.5	7.7	8.9	10.9	19.8	12.8	7.6	8.5	8.7	7.4	
14																				
15	7.3		9.7	7.5	7.7	6.2	6.6	7.0	7.7	8.4	7.8	9.1	11.2	20.2	13.3	8.0	8.3	8.6	7.4	
16																				
17										9.2			6.8				7.5			
17.4																				
17.5																				
18												8.5						7.8	7.2	
18.8																				
19															12.3					
20																				
20.6																				

Lake Merced
North East

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	6.6	7.9	7.6	6.6	7.4	5.6	6.2	6.1	7.6	7.8	6.2	7.6	12.1	20.0	17.2	8.7	9.5	9.4	8.4	
5	6.2	7.4	7.1	6.2	6.5	5.7	6.6	6.1	7.3	7.6	6.1	6.9	10.8	19.0	16.2	8.2	8.4	8.5	6.8	
9																				
10	6.5		6.9	6.1	6.8		6.4	6.2	9.1	8.6		7.0	6.0		15.0	8.3	7.5	6.8		
11																				
12																				
13										8.7		7.5	6.5		13.5	7.3	7.4	7.4		
14																				
14.1																				
15																				
15.8																				

Lake Merced
North

Depth	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	7.1	6.3	7.9	8.12	12.8	9.2	8.4	9.2	13.0	10.2	10.0	10.3	12.4		
5	7.4	6.6	7.8	9.40	10.6	8.5	7.5	9.3	10.9	10.9	10.0	10.1	12.4		
10	6.9	6.7	7.3	8.07	13.6	8.6	7.9	9.1	13.7	11.0	10.8	10.3	11.6		
14															
15	6.9	6.8	7.6	7.82	13.1	8.7	8.0	9.1	16.2	10.9	9.2	10.4	13.4		
16															
17															
17.4															
17.5															
18	7.4					9.8				13.7					
18.8													11.2		
19		6.7	7.7	8.07	10.3		8.2	8.6	12.3		10.7				
20															
20.6												9.7			

Lake Merced
North East

Depth	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	8.4	6.7	8.0	8.45	11.7	14.6	8.9	10.4	12.0	11.1	9.3	8.6	13.4		
5	7.8	6.2	7.5	9.28	14.0	10.7	7.7	8.2	10.8	12.2	7.3	10.0	11.6		
9															
10	6.7	6.3	7.8	5.80	9.9	9.7	7.6	8.6	9.9	11.7	8.2	9.9	9.9		
11															
12															
13	7.0					8.7							10.9		
14		6.4		8.25	10.0					10.7					
14.1															
15			7.8				8.2	8.7	9.6		8.2				
15.8												11.4			

Lake Merced South - Pistol Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	6.2	15.4	8.2	5.9	6.7		5.6	7.1	7.5	9.6	5.8	7.5	6.6	16.3	5.1	7.6	10.2	5.0	6.4	5.9
5	6.5	12.7	7.5		6.8		5.9	6.5	7.5	8.9	6.0	7.3	6.6	27.0	5.9	7.0	***5.0***	5.4	6.9	6.3
6				7.1																
10	6.5	13.8	10.3		6.4		5.8	6.6	7.1	9.5	6.0	8.0	6.7	20.6	5.4	6.3	***5.0***	4.9	7.1	6.0
12				5.6																
15	6.4	10.0	8.3		6.5		7.0	6.5	9.2	9.7				15.4	5.9	5.3	***5.0***	4.7	6.5	
16	7.3																			
17																				
18				6.6								8.1	7.2							
19																				
20											6.3									
21																				
21.5																				
22																				

Lake Merced South - Pump Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC	TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	9.0	12.3	9.5	5.4	6.7		6.0	6.6	7.4	11.7	6.2	6.9	6.7	15.2	5.3	6.5	***5.0***	5.0	7.1	5.5
5	6.3	14.1	7.2	6.5	6.8		6.1	6.6	7.1	12.5	6.3	7.5	7.2	15.5	5.6	5.9	***5.0***	5.0	6.8	5.7
10	6.1	9.3	7.0		6.4		5.8	6.6	7.6	14.1	6.3	7.3	6.8	11.2	5.6	5.4	10.1	4.8	6.3	5.6
12				5.5																
15	6.3	9.8	9.5		6.5		6.4	6.4	7.6	10.8				16.4	5.6	5.8	***5.0***	4.7	6.1	5.7
16																				
17																				
18				6.2								6.6								
19													7.3							
20											6.2									
21																				
22																				
23.2																				

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	6.1	7.2	6.9	5.5	5.7	5.0	4.6	5.2	4.7	5.7	5.1	5.5	6.8	14.5	8.6	5.3	5.8	5.6	4.4	
5	6.3	7.1	7.2	5.6	5.7	5.1	4.8	4.7	4.7	5.7	4.8	5.2	7.2	18.0	10.4	5.0	5.7	5.3	4.4	
6																				
10	6.0	7.3	7.0	5.8	5.0	4.9	4.8	4.6	5.2	5.9	4.8	4.9	6.6	15.1	9.2	5.0	5.3	5.3	4.4	
12																				
15		6.8	7.2	5.4			4.8		4.6				7.2	13.4	8.7	5.4	5.4	5.8	4.2	
16																				
17												6.2	4.6							
18										6.1							5.4		4.0	
19																				
20																5.4		5.4		
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05
Depth	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**	**TOC**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	5.6	7.3	7.1	5.5	4.6	4.8	4.2	4.6		5.5	5.9	5.0	6.2	10.8		6.0	5.7	4.9	4.3	
5	6.1	7.0	7.2	5.6	5.5	4.8	4.7	4.6	4.7	5.9	5.8	5.0	6.8	14.5		5.1	5.1	6.9	4.3	
10	6.0	7.1	3.5	5.5	4.8	4.3	5.3	4.5	4.5	5.6	5.6	5.6	6.1	13.7		5.8	5.2	5.5	4.4	
12																				
15	5.6	7.1	3.4	5.5	4.7	4.4	4.7	4.6	4.5	5.4	5.3	6.3	6.6	12.2		5.5	5.2	5.2	4.3	
16																				
17													4.4							
18																	5.2			
19										7.0		6.2						5.8		
20																			4.3	
21																				
22																				
23.2																				

Lake Merced
South - Pistol
Range

Depth	23-Jan-06 TOC	01-Mar-06 TOC	26-Apr-06 TOC	14-Jun-06 TOC	24-Aug-06 TOC	25-Oct-06 TOC	20-Dec-06 TOC	29-Mar-07 TOC	26-Jun-07 TOC	20-Aug-07 TOC	27-Dec-07 TOC	28-Mar-08 TOC	10-Jun-08 TOC	24-Sep-08 TOC	4-Dec-08 TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	5.1	4.8	4.7	7.93	12.3	7.2	5.9	6.2	9.9	8.1	9.5	8.3	9.25		
5	***2.5***	4.4	5.0	6.98	8.9	6.9	5.3	6.1	8.1	7.8	10.0	7.0	8.98		
6															
10	***2.5***	4.2	5.2	8.22	8.8	6.8	7.2	6.1	18.6	7.0	9.0	8.9	9.16		
12															
15	***2.5***	4.3	4.8	7.21	10.2	6.0	5.4	6.0	13.9	7.1	9.3	8.6	8.89		
16															
17															
18	4.9														
19						5.9									
20		5.1	5.3		7.6		5.6						9.14		
21				6.33				7.9		7.7	9.5				
21.5												8.7			
22									8.0						

Lake Merced
South - Pump
Station

Depth	23-Jan-06 TOC	01-Mar-06 TOC	26-Apr-06 TOC	14-Jun-06 TOC	24-Aug-06 TOC	25-Oct-06 TOC	20-Dec-06 TOC	29-Mar-07 TOC	26-Jun-07 TOC	20-Aug-07 TOC	27-Dec-07 TOC	28-Mar-08 TOC	10-Jun-08 TOC	24-Sep-08 TOC	4-Dec-08 TOC
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***2.5***	4.2	4.7	8.38	8.6	7.3	7.3	7.1	10.0	10.6	8.0	9.3	8.56		
5	***2.5***	4.4	5.0	5.99	9.7	6.7	6.4	6.4	11.0	7.8	9.3	9.2	7.56		
10	***2.5***	4.3	5.2	6.59	11.0	6.3	5.4	6.4	7.4	8.4	8.2	7.1	8.56		
12															
15	5.3	4.5	4.8	6.01	9.6	5.9	5.4	6.4	7.6	7.5	8.6	9.1	8.94		
16															
17															
18						5.9									
19															
20	4.9														
21		4.7		6.68	7.6					7.6	7.9		7.37		
22			5.8				5.2	6.2	9.4						
23.2												7.5			

Lake Merced
North

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf							0.02		0.03	0.03	0.04	0.03	0.06	0.07	0.09	***0.005***	***0.005***	0.05	***0.005***	***0.005***
5																				
10							0.04		0.05	0.04		0.03	0.07	0.08	0.07	***0.005***	***0.005***	0.06	***0.005***	***0.005***
14																				
15																				
16																				
17																				
17.4																				
17.5																				
18											0.08									
18.8																				
19																				
20																				
20.6																				

Lake Merced
North East

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf							0.04		0.05	0.05	0.06	0.05	0.07	0.10	0.08	***0.005***	***0.005***	0.04	***0.005***	***0.005***
5																				
9																	***0.005***			
10							0.08		0.07	0.07		0.48	0.09	0.10	0.10	***0.005***		0.05	0.01	***0.005***
11																				
12																				
13											0.17									
14																				
14.1																				
15																				
15.8																				

Lake Merced
North

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.06	0.03	0.17	0.04	0.02	0.16	***0.005***	0.05	0.05	***0.005***	***0.005***	0.04	0.30
5																					
10	***0.005***	***0.005***	0.02		***0.005***	***0.005***	***0.005***	***0.005***	0.06				0.15	0.18		0.02	0.08	***0.005***			
14																					
15				***0.005***							0.25										
16																					
17										0.06											
17.4																					
17.5																					
18												0.13							***0.005***	***0.005***	0.10
18.8																					
19															***0.005***						
20																					
20.6																					

Lake Merced
North East

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.01	***0.005***	0.19	0.04	0.07	0.03	***0.005***	0.03	0.07	***0.005***	0.03	0.04	0.10
5																					
9																					
10	***0.005***	0.01	***0.005***	0.01	***0.005***	***0.005***	***0.005***	***0.005***	0.01		0.20		0.04	0.08		0.02	0.14	0.07			
11																					
12																					
13										0.02		0.07			***0.005***				0.02		0.20
14																				0.04	
14.1																					
15																					
15.8																					

Lake Merced
North

Depth	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.02	***0.005***	0.10	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.02	0.07	0.04	0.02		
5														
10														
14														
15														
16														
17														
17.4														
17.5														
18					***0.005***				0.04					
18.8												0.08		
19	0.02	***0.005***	0.04	***0.005***		***0.005***	0.03	***0.005***		0.09				
20														
20.6											0.07			

Lake Merced
North East

Depth	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe	Fe
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.02	***0.005***	0.03	0.01	0.05	0.07	0.05	***0.005***	0.03	0.13	0.11	0.05		
5														
9														
10														
11														
12														
13					***0.005***							0.04		
14	0.04		0.03	0.02					0.03					
14.1														
15		***0.005***				0.05	0.04	***0.005***		0.19				
15.8											0.09			

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf							0.02	0.01	0.05	0.05	0.05	0.01	0.05	0.07	0.06	***0.005***	***0.005***	0.02	***0.005***	***0.005***
5																				
6																				
10							0.03	0.02	0.14	0.05		0.02	0.08	0.08	0.08	***0.005***	***0.005***	0.04	***0.005***	0.02
12																				
15																				
16																				
17																				
18																				
19																				
20											0.14									
21																				
21.5																				
22																				

Lake Merced
South - Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf							0.02	0.01	0.02	0.14	0.07	0.02	0.05	0.07	0.07	***0.005***	***0.005***	0.01	***0.005***	***0.005***
5																				
10							0.03	0.01	0.04	0.07		0.02	0.05	0.09	0.07	0.11	***0.005***	0.08	***0.005***	***0.005***
12																				
15																				
16																				
17																				
18																				
19																				
20											0.06									
21																				
22																				
23.2																				

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
South - Pistol
Range

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	***0.005***	***0.005***	0.01	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.01	0.05	***0.005***	***0.005***	0.01	0.03
5																					
6																					
10	***0.005***	***0.005***	***0.005***		***0.005***	***0.005***	***0.005***	***0.005***	***0.005***				***0.005***	0.03		0.01	0.07	***0.005***			
12																					
15				0.02							***0.005***										
16																					
17												0.01									
18										***0.005***									***0.005***		0.07
19																				0.01	
20															***0.005***						
21																					
21.5																					
22																					

Lake Merced
South - Pump
Station

Depth	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	***0.005***	0.01	0.05	***0.005***	***0.005***	***0.005***	***0.005***
5																					
10	***0.005***	***0.005***	***0.005***		***0.005***	***0.005***	***0.005***	***0.005***	***0.005***				0.01	0.06		***0.005***	0.04	***0.005***			
12																					
15				***0.005***							***0.005***										
16																					
17																					
18																					
19										***0.005***		0.01									
20															***0.005***				***0.005***	***0.005***	0.07
21																					
22																					
23.2																					

Lake Merced South - Pistol Range

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.01	***0.005***	0.03	***0.005***	***0.005***	0.04	0.02	***0.005***	0.01	0.02	0.03	***0.005***		
5														
6														
10														
12														
15														
16														
17														
18														
19					***0.005***									
20	***0.005***	***0.005***		0.01		0.05						0.01		
21			0.05				***0.005***		0.01	0.03				
21.5											0.03			
22								***0.005***						

Lake Merced South - Pump Station

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**	**Fe**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	***0.005***	***0.005***	0.11	0.01	0.08	0.05	0.01	***0.005***	0.01	0.04	0.05	0.06		
5														
10														
12														
15														
16														
17														
18					***0.005***									
19														
20														
21	***0.005***		0.11	0.02					0.01	0.06		0.03		
22						0.07	0.04	***0.005***						
23.2											0.04			

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf							0.07		0.15	0.10	0.25	0.20	0.13	0.10	0.05	0.13	0.14	0.08	0.09	0.10
5																				
10							0.07		0.17	0.10		0.19	0.13	0.11	0.06	0.13	0.13	0.08	0.12	0.10
14																				
15																				
16																				
17																				
17.4																				
17.5																				
17.8																				
18											0.33									
18.8																				
19																				
19.3																				
19.9																				
20																				
20.6																				

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf							0.10		0.13	0.11	0.24	0.26	0.16	0.09	0.05	0.11	0.14	0.07	0.09	0.10
5																				
9																	0.26			
10							0.11		0.13	0.12		0.33	0.16	0.10	0.06	0.18		0.07	0.10	0.12
11																				
12																				
13											0.19									
13.8																				
14																				
14.1																				
14.7																				
15																				
15.8																				

Lake Merced
North

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.11	***0.005***	0.11	0.05	0.08	0.09	0.22	0.08	0.23	0.18	0.17	0.04	0.04	0.03	0.06	0.18	0.07	0.16	0.08	0.07	0.05
5																					
10	0.11	***0.005***	0.12		0.09	0.12	0.21	0.08	0.24				0.04	0.03		0.17	0.12	0.17			
14																					
15				0.05							0.19										
16																					
17										0.21											
17.4																					
17.5																					
17.8																					
18												0.08							0.09	0.07	0.05
18.8																					
19															0.57						
19.3																					
19.9																					
20																					
20.6																					

Lake Merced
North East

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.13	0.18	0.11	0.08	0.15	0.15	0.17	0.12	0.14	0.16	0.12	0.05	0.07	0.12	0.11	0.21	0.11	0.15	0.07	0.13	0.08
5																					
9																					
10	0.14	0.20	0.09	0.08	0.17	0.27	0.19	0.11	0.17		0.12		0.06	0.09		0.21	0.17	0.10			
11																					
12																					
13										0.20		0.07			0.28				0.08		0.09
13.8																					
14																				0.16	
14.1																					
14.7																					
15																					
15.8																					

Lake Merced
North

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.04	0.07	0.17	0.20	0.29	0.08	0.22	0.13	0.06	0.07	0.14	0.07	0.09	0.145	0.02	0.13	0.085	0.07
5																		
10																		
14																		
15																		
16																		
17																		
17.4													0.39					
17.5																		
17.8														0.171				
18					0.36				0.34									
18.8												0.06						0.09
19	0.05	0.25	0.28	0.21		0.08	0.31	0.49		0.07								
19.3																		
19.9																0.18		
20															0.1			
20.6											***0.005***							

Lake Merced
North East

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.09	0.23	0.14	0.18	0.23	0.11	0.16	0.15	0.07	0.09	***0.005***	0.10	0.10	0.130	0.1	0.07	0.09	
5																		
9																		
10																		
11																		
12																		
13					0.18							0.12						
13.8																		
14	0.11		0.15	0.20					0.12									
14.1														0.138				
14.7															0.09			0.07
15		0.24				0.12	0.19	0.25		0.09						0.1		
15.8											***0.005***							

Lake Merced South - Pistol Range

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf							0.03	0.05	0.11	0.05	0.12	0.10	0.11	0.06	0.02	0.03	0.04	0.04	0.03	0.04
5																				
6																				
10							0.04	0.05	0.13	0.07		0.13	0.12	0.06	0.02	0.03	0.04	0.05	0.03	0.04
12																				
15																				
16																				
17																				
18																				
18.2																				
18.5																				
18.9																				
19																				
20											0.11									
20.1																				
20.6																				
20.8																				
21																				
21.5																				
22																				

Lake Merced South - Pump Station

Depth	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn	Mn
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf							0.03	0.05	0.11	0.08	0.13	0.09	0.10	0.06	0.02	0.03	0.04	0.04	0.03	0.04
5																				
10							0.03	0.05	0.11	0.09		0.10	0.10	0.06	0.02	0.04	0.05	0.05	0.03	0.04
12																				
15																				
16																				
17																				
18																				
19																				
19.2																				
20											0.13									
20.4																				
20.9																				
21																				
21.5																				
22																				
22.8																				
23.2																				

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced South - Pistol Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.05	0.14	0.10	0.05	0.04	0.06	0.12	0.04	0.04	0.03	0.07	0.02	0.03	0.02	0.03	0.08	0.03	0.04	0.04	0.04	0.04
5																					
6																					
10	0.05	0.08	0.10		0.03	0.05	0.12	0.04	0.04				0.02	0.01		0.08	0.07	0.04			
12																					
15				0.05							0.07										
16																					
17												0.03									
18										0.05									0.04		0.04
18.2																					
18.5																					
18.9																					
19																				0.04	
20															0.14						
20.1																					
20.6																					
20.8																					
21																					
21.5																					
22																					

Lake Merced South - Pump Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.04	0.07	0.07	0.05	0.03	0.05	0.11	0.04	0.03	0.03	0.07	0.02	0.03	0.02	0.04	0.08	0.03	0.04	0.04	0.03	0.03
5																					
10	0.04	0.08	0.08		0.04	0.06	0.12	0.04	0.03				0.03	0.02		0.08	0.06	0.04			
12																					
15				0.05							0.08										
16																					
17																					
18																					
19										0.06		0.03									
19.2																					
20															0.18				0.04	0.03	0.03
20.4																					
20.9																					
21																					
21.5																					
22																					
22.8																					
23.2																					

Lake Merced
South - Pistol
Range

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.04	0.04	0.07	0.17	0.10	0.04	0.05	0.05	0.02	0.02	0.31	0.02	0.07	0.034	0.01	0.11	0.054	0.03
5																		
6																		
10																		
12																		
15																		
16																		
17																		
18																		
18.2																		0.03
18.5														0.061				
18.9																		
19					0.11													
20	0.03	0.04		0.19		0.04						0.01						
20.1													0.15					
20.6															0.01			
20.8																0.04		
21			0.10				0.04		0.03	0.02								
21.5											0.02							
22								0.06										

Lake Merced
South - Pump
Station

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**	**Mn**
Ft	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Surf	0.03	0.03	0.07	0.18	0.13	0.04	0.03	0.06	0.01	0.02	0.03	0.03	0.08	0.046	0.01	0.03	0.051	0.03
5																		
10																		
12																		
15																		
16																		
17																		
18					0.30													
19																		
19.2																		
20																		
20.4																		0.03
20.9														0.040				
21	0.03		0.09	0.20					0.02	0.02		0.04	0.14					
21.5																0.06		
22						0.04	0.05	0.05										
22.8															0.05			
23.2											0.02							

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.6	***0.25***	***0.25***	***0.25***	***0.25***				***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	0.50	***0.25***	2.1	***0.025***	***0.25***	***0.25***
5	0.7	***0.25***	***0.25***																	
10	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***				***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	0.50	***0.25***	1.9	***0.025***	***0.25***	***0.25***
14																				
15	***0.25***	***0.25***	***0.25***																	
16																				

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	***0.25***		***0.25***	***0.25***	***0.25***				***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	0.60	***0.25***	***0.25***	***0.025***	***0.25***	***0.25***
5	***0.25***		***0.25***																	
9																	***0.25***			
10	***0.25***		***0.25***	***0.25***	***0.25***				***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	0.50	***0.25***		***0.025***	***0.25***	***0.25***
15																				
16																				

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.7	***0.25***	0.6	1.9	***0.25***				***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	0.70	***0.25***	***0.25***	***0.025***	0.9	***0.25***
5	0.8	***0.25***	0.6																	
6																				
10	0.7	***0.25***	0.6	2.0	***0.25***				***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	0.70	***0.25***	***0.25***	***0.025***	0.8	***0.25***
15	0.9	***0.25***	0.6																	
16	0.8	***0.25***																		

Lake Merced
South -
Pump Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02
Depth	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.7	***0.25***	0.5	1.9	***0.25***				***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	0.68	***0.25***	***0.25***	***0.025***	0.8	***0.25***
5	0.7	***0.25***	0.6																	
10	0.7	***0.25***	0.6	1.9	***0.25***				***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	***0.25***	0.68	***0.25***	***0.25***	***0.025***	0.8	***0.25***
15	0.8	***0.25***	0.6																	

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

Lake Merced
North

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.25	0.25	0.25	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5																					
10	0.25	0.25	0.25	0.5	0.25	0.25	0.25	0.25													
14																					
15																					
16									0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

Lake Merced
North East

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.25	0.25	0.25	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5																					
9																					
10	0.25	0.25	0.25	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
15																					
16																					

Lake Merced
South - Pistol
Range

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.25	0.25	0.25	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5																					
6																					
10	0.25	0.25	0.25	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
15																					
16																					

Lake Merced
South -
Pump Station

	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06
Depth	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**	**MTBE**
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.25	0.025	0.25	0.5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
5									0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
10	0.25	0.025	0.25	0.5	0.25	0.25	0.25	0.25													
15																					

Lake Merced
North

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08
Depth	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		
5													
10											0.25		
14													
15										0.25			
16	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25				

Lake Merced
North East

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	27-Dec-07	28-Mar-08	10-Jun-08		
Depth	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		
5													
9													
10	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		
15													
16													

Lake Merced
South - Pistol
Range

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	27-Dec-07	28-Mar-08	10-Jun-08		
Depth	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		
5													
6													
10	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		
15													
16													

Lake Merced
South -
Pump Station

	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	27-Dec-07	28-Mar-08	10-Jun-08		
Depth	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE	MTBE
Ft	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25		
5	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25				
10										0.25	0.25		
15													

Lake Merced North

Bacteriological Data (MPN)	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01
Total Coliform														
E. Coli														

Lake Merced North East

Bacteriological Data (MPN)	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01
Total Coliform														
E. Coli														

Lake Merced South - Pistol Range

Bacteriological Data (MPN)	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01
Total Coliform														
E. Coli														

Lake Merced South - Pump Station

Bacteriological Data (MPN)	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01
Total Coliform														
E. Coli														

Lake Merced North

Bacteriological Data (MPN)	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04
Total Coliform				1109	1986	1300		1120	437	1120	756	2419	1733	>2419
E. Coli				34	14	17		62	63	13	6	9	22	19

Lake Merced North East

Bacteriological Data (MPN)	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04
Total Coliform				2419	>2419	>2419		1203	2419	2419	2419	2419	2419	>2419
E. Coli				13	36	11		25	11	7	7	10	15	12

Lake Merced South - Pistol Range

Bacteriological Data (MPN)	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04
Total Coliform				1203	1046	1120		649	436	344	770	2419	1986	197
E. Coli				15	14	6		336	22	15	26	48	53	4

Lake Merced South - Pump Station

Bacteriological Data (MPN)	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04
Total Coliform				1414	1120	1046		488	365	153	1203	2419	727	309
E. Coli				23	37	35		82	32	3	15	39	65	7

Lake Merced
North

Bacteriological Data (MPN)	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	1-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06
Total Coliform	7	11,000	>2419	>2419	124	354	1414	>2419	629	2419	579	691	179	2419	1986	510	>2420	>2420
E. Coli	135	200	35	2	33	25	26	5	4	20	18	8	21	17	46	7	5	20

Lake Merced
North East

Bacteriological Data (MPN)	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	1-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06
Total Coliform	>2419	8,130	2419	1120	2419	1046	1986	>2419	437	1986	>2419	>2419	>2419	914	2419	689	>2420	>2420
E. Coli	52	100	8	20	5	50	<1	5	1	13	38	1	10	2	34	3	5	5

Lake Merced
South - Pistol
Range

Bacteriological Data (MPN)	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	1-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06
Total Coliform	649	2690.0	2419	920	530.0	249.0	N/A	358	722	1733	755	501.0	921.0	1733.0	>2419	687.0	513	816
E. Coli	33	100.0	81	4	10.0	30.0	N/A	20	84	99	28	7.0	17.0	15.0	5.0	33.0	3	13

Lake Merced
South - Pump
Station

Bacteriological Data (MPN)	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	1-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06
Total Coliform	479	2260.0	1986	1986	420.0	299.0	109	110	687	1300	1300	436.0	816.0	1733.0	549.0	378.0	1300	687
E. Coli	23	100.0	99	2	20.0	10.0	16	12	37	78	56	13.0	29.0	13.0	11.0	41.0	18	59

Lake Merced
North

Bacteriological Data (MPN)	29-Mar-07	26-Jun-07	20-Aug-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Total Coliform	1553	96	>2419	437	272	516	>2420	534	961	1046	>2420
E. Coli	16	4	285	28	3	35	20	59	17	4	22

Lake Merced
North East

Bacteriological Data (MPN)	29-Mar-07	26-Jun-07	20-Aug-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Total Coliform	>2420	361	>2419	>2420	1986	2420	>2420	2420	>2420	579	1120
E. Coli	6	3	5	9	6	1	108	16	7	5	4

Lake Merced
South - Pistol
Range

Bacteriological Data (MPN)	29-Mar-07	26-Jun-07	20-Aug-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Total Coliform	1300.0	286	756	>2420	830	>2420	1120	727	530	517	961
E. Coli	47.0	5	34	91	11	33.0	37.0	27.0	11	15	10

Lake Merced
South - Pump
Station

Bacteriological Data (MPN)	29-Mar-07	26-Jun-07	20-Aug-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Total Coliform	1120.0	284	866	***2420***	1414		914	411	173	260	>2420
E. Coli	93.0	12	10	81	7		75	24	4	7	17

Lake
Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.							1,769		3,258	938	1,749	6,995	2,492	1,414	1,183	3,250	5,293	2,191	1209	4523	6,231
5																					
10							2,312		3,131	2,003	1,166	5,997	2,332	1,863	1,206	2,647	5,427	1,863	663	3853	5,963

Lake
Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.							2,834		4,085	1,126	1,983	2,117	1,956	1,956	2,013	3,082	3,953	2,827	1089	2198	3,853
5																					
10							2,908		3,333	1,172	1,869	2,090	2,660	1,863	1,997	2,580	3,886	1,668	1283	2198	3,035

Lake
Merced
South -
Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.							1,360	2,054	3,852	1,045	1,467	2,405	2,144	972	600	1,179	2,278	1,206	472	1266	~1600*
5																					
10							1,347	2,032	3,493	1,065	1,320	2,486	2,050	817	553	1,132	2,345	1,407	429	1240	N/A

Lake
Merced
South -
Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02
Depth	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.							1,253	2,016	6,705	1,253	1,769	3,719	2,144	737	700	1,199	2,613	1,655	442	1374	1,554
5																					
10							1,474	2,118	5,233	1,079	1,621	2,573	1,923	864	683	1,085	2,546	1,206	402	1280	1,467

Lake Merced North

	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07
Depth	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.	1,943	3260	1219	6,834	4,389	4,221	2435	650	2117	4288	851	1146	1099	1293	4858	5461	2385	2874	2198	3,317	9,514
5																					
10	2,312	2358	1441	6,499	4,556	3,551	2147	637	1923	4523	1698	1501	1025	1407	5327	3987	2720	2171	3229	3,219	5,561

Lake Merced North East

	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07
Depth	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.	1,997	2422	1528	3,082	2,399	5,729	2569	1,374	1816	2714	1491	2332	3417	1179	2982	3719	2412	1876	4255	2,389	2,352
5																					
10	1,910	2152	1635	3,618	2,204	3,886	2335	1,585	1695	2613	1521	2372	3243	1347	3819	3276	2955	1970	3920	2,750	4,757

Lake Merced South - Pistol Range

	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07
Depth	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.	2,472	1,826	750	2,144	2,278	2,915	1,782	1,183	N/A	1534	1695	985	1360.1	1635	2258	4824.0	2559	1467	1186	1,350	7,973
5																					
10	2,184	1,836	858	1,702	1,977	3,109	1,394	1,116	2358	2030	992	911	1206.0	1970	1956	4924.5	2486	1387	1367	1,273	2,178

Lake Merced South - Pump Station

	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07
Depth	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass	Algal Biomass
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.	2,513	2,191	757	2,037	2,064	3,109	1,374	1,226	2841	1923	995	1072	1139.0	1829	1809	4422.0	2640	1387	1079	1,554	2,131
5																					
10	2,298	2,334	750	2,037	2,023	2,325	1,732	1,484	2486	1461	905	992	1058.6	2231	2137	4891.0	2613	1367	1427	1,065	2,037

Lake Merced North

	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**
Ft	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
Surf.	4167	2117		4248	3162	1080	3377	4074	2137
5					3109	1072	3292	3404	2131
10	4308	2171		4020					

Lake Merced North East

	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**
Ft	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
Surf.	2466	2265		3886	2061	1166	2442	3176	3618
5					1560	1110	2602	2908	3430
10	2312	2760		3417					

Lake Merced South - Pistol Range

	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**
Ft	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
Surf.	2586.2	929	1376.9	1420	2117	777	1276	2533	1414
5					2262	683	1265	2452	1160
10	3430.4	1063	1450.6	1313					

Lake Merced South - Pump Station

	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**	**Algal Biomass**
Ft	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
Surf.	3001.6	990	1363.5	1487	2841	683	1260	2131	1809
5					3832	563	1284	1997	1487
10	3229.4	1142	1373.5	1394					

Lake Merced
North

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01
Depth							Chlorophyll a		Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a
Ft							☞g/L		µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L
Surf.							26.4		48.6	14.0	26.1	104.4	37.2	21.1	17.7
5															
10							34.5		46.7	29.9	17.4	89.5	34.8	27.8	18.0

Lake Merced
North East

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01
Depth							Chlorophyll a		Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a
Ft							☞g/L		µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L
Surf.							42.3		61.0	16.8	29.6	31.6	29.2	29.2	30.1
5															
10							43.4		49.8	17.5	27.9	31.2	39.7	27.8	29.8

Lake Merced
South - Pistol
Range

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01
Depth							Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a
Ft							☞g/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L
Surf.							20.3	30.7	57.5	15.6	21.9	35.9	32.0	14.5	9.0
5															
10							20.1	30.3	52.1	15.9	19.7	37.1	30.6	12.2	8.3

Lake Merced
South - Pump
Station

	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01
Depth							Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a	Chlorophyll a
Ft							☞g/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	µg/L
Surf.							18.7	30.1	100.1	18.7	26.4	55.5	32.0	11.0	10.5
5															
10							22.0	31.6	78.1	16.1	24.2	38.4	28.7	12.9	10.2

Lake Merced
North

	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	µg/L	mg/L	mg/L	ppb	ppb	mg/L	ppb	mg/L	µg/L	ppb	µg/L	ppb	µg/L	µg/L	µg/L
Surf.	48.5	79.0	32.7	18.1	67.5	93.0	29.0	48.7	18.2	102.0	65.5	63.0	36.4	9.7	31.6
5															
10	39.5	81.0	27.8	9.9	57.5	89.0	34.5	35.2	21.5	97.0	68.0	53.0	32.1	9.5	28.7

Lake Merced
North East

	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	µg/L	mg/L	mg/L	ppb	ppb	mg/L	ppb	mg/L	µg/L	ppb	µg/L	ppb	µg/L	µg/L	µg/L
Surf.	46.0	59.0	42.2	16.3	32.8	57.5	29.8	36.2	22.8	46.0	35.8	85.5	38.4	20.5	27.1
5															
10	38.5	58.0	24.9	19.2	32.8	45.3	28.5	32.1	24.4	54.0	32.9	58.0	34.9	23.7	25.3

Lake Merced
South - Pistol
Range

	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	µg/L	mg/L	mg/L	ppb	ppb	mg/L	ppb	mg/L	µg/L	ppb	µg/L	ppb	µg/L	µg/L	µg/L
Surf.	17.6	34.0	18.0	7.1	18.9	~24*	36.9	27.3	11.2	32.0	34.0	43.5	26.6	17.7	N/A
5															
10	16.9	35.0	21.0	6.4	18.5	N/A	32.6	27.4	12.8	25.4	29.5	46.4	20.8	16.7	35.2

Lake Merced
South - Pump
Station

	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	µg/L	mg/L	mg/L	ppb	ppb	mg/L	ppb	mg/L	µg/L	ppb	µg/L	ppb	µg/L	µg/L	µg/L
Surf.	17.9	39.0	24.7	6.6	20.5	23.2	37.5	32.7	11.3	30.4	30.8	46.4	20.5	18.3	42.4
5															
10	16.2	38.0	18.0	6.0	19.1	21.9	34.3	34.8	11.2	30.4	30.2	34.7	25.9	22.2	37.1

Lake Merced
North

	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
Surf.	64.0	12.7	9.9	3.3	17.7	41.1	36.6	7.7	24.2	45.4	17.1	16.4	19.3	72.5	81.5
5															
10	67.5	25.4	10.6	3.6	14.6	39.7	28.2	7.2	26.6	42.0	22.4	15.3	21.0	79.5	59.5

Lake Merced
North East

	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
Surf.	40.5	22.3	16.0	27.8	26.7	51.0	27.7	6.4	31.2	77.5	34.8	51.0	17.6	44.5	55.5
5															
10	39.0	22.7	15.8	22.1	24.1	46.4	34.1	7.4	31.1	42.8	35.4	48.4	20.1	57.0	48.9

Lake Merced
South - Pistol
Range

	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
Surf.	22.9	25.3	7.6	12.8	30.3	21.8	23.7	5.4	19.7	29.4	14.7	20.3	24.4	33.7	72.0
5															
10	30.3	14.8	7.0	13.0	32.1	21.6	23.3	4.8	21.4	32.2	13.6	18.0	29.4	29.2	73.5

Lake Merced
South - Pump
Station

	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05	29-Dec-05	23-Jan-06	01-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
Surf.	28.7	14.9	7.0	13.7	27.1	19.5	27.0	4.7	26.7	30.2	16.0	17.0	27.3	27.0	66.0
5															
10	21.8	13.5	7.0	14.5	27.7	23.5	26.0	4.8	19.9	34.5	14.8	15.8	33.3	31.9	73.0

Lake Merced
North

	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**		**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.	35.6	42.9	32.8	49.5	142.0	62.2	31.6		63.4	47.2	16.1	50.4	60.8	31.9
5										46.4	16.00	49.1	50.8	31.8
10	40.6	32.4	48.2	48.1	83.0	64.3	32.4		60.0					

Lake Merced
North East

	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**		**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.	36.0	28.0	63.5	35.7	35.1	36.8	33.8		58.0	30.8	17.4	36.4	47.4	54.0
5										23.3	16.6	38.8	43.4	51.2
10	44.1	29.4	58.5	41.1	71.0	34.5	41.2		51.0					

Lake Merced
South - Pistol
Range

	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.	38.2	21.9	17.7	20.2	119.0	38.6	13.9	20.6	21.2	31.6	11.6	19.0	37.8	21.1
5										33.8	10.2	18.9	36.6	17.3
10	37.1	20.7	20.4	19.0	32.5	51.2	15.9	21.7	19.6					

Lake Merced
South - Pump
Station

	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**	**Chlorophyll a**
Ft	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Surf.	39.4	20.7	16.1	23.2	31.8	44.8	14.8	20.4	22.2	42.4	10.2	18.8	31.8	27.0
5										57.2	8.4	19.2	29.8	22.2
10	39.0	20.4	21.3	15.9	30.4	48.2	17.0	20.5	20.8					

Plankton Count - Dominant Species (>98% of total population)

Lake Merced North

15-May-97

Organism	No./cuM	No./mL
Oscillatoria	160,000,000	160
Anabaena	15,000,000	15
Melosira	8,000,000	8
Spondylosium	4,000,000	4
Nauplius Larva	95,000	0.095
Rotifer	68,000	0.068
Copepod	55,000	0.055
Fragilaria	55,000	0.055
Total	187,273,000	187

10-Sep-97

Organism	No./cuM	No./mL
Oscillatoria	320,000,000	320
Anabaena	280,000	0.280
Melosira	41,000	0.041
Copepod	41,000	0.041
Nauplius Larva	25,000	0.025
Total	320,387,000	320

3-Dec-97

Organism	No./cuM	No./mL
Oscillatoria	1,200,000,000	1,200
Copepod	19,000	0.019
Rotifer	19,000	0.019
Cladoceran	19,000	0.019
Total	1,200,057,000	1,200

16-Mar-98

Organism	No./cuM	No./mL
Oscillatoria	410,000,000	410
Mougeotia	4,100,000	4.100
Nauplius	86,000	0.086
Copepod	35,000	0.035
Total	414,221,000	414

8-Jul-98

Organism	No./cuM	No./mL
Oscillatoria (1:100 dilution)	1,500,000,000	1,500
Anabaena	10,000,000	10
Copepod	89,000	0.089
Rotifer	13,000	0.013
Nauplius	13,000	0.013
Total	1,510,115,000	1,510

17-Mar-99

Organism	No./m^3	No./mL
Oscillatoria	1,100,000,000	1,100
Anabaena	1,000,000	1
Spirulina	440,000	0.440
Rotifer	230,000	0.230
Closterium	140,000	0.140
Copepoda	92,000	0.092
Mougeotia	23,000	0.023
Epithemia	23,000	0.023
Total	1,101,948,000	1,102

Lake Merced North East

15-May-97

Organism	No./cuM	No./mL
Oscillatoria	430,000,000	430
Melosira	22,000,000	22
Anabaena	15,000,000	15
Spondylosium	7,400,000	7
Rotifer	100,000	0
Copepod	100,000	0
Total	474,600,000	475

10-Sep-97

3-Dec-97

Organism	No./cuM	No./mL
Oscillatoria	370,000,000	370
Mougeotia	3,400,000	3
Ankistrodesmus	870,000	1
Copepod	310,000	0
Rotifer	85,000	0
Cladoceran	56,000	0
Total	374,721,000	375

16-Mar-98

Organism	No./cuM	No./mL
Osciilatoria	240,000,000	240
Rotifer	130,000	0
Anabaena	78,000	0
Copepod	65,000	0
Total	240,273,000	240

8-Jul-98

Organism	No./cuM	No./mL
Oscillatoria (1:100 dilution)	1,700,000,000	1,700
Anabaena	1,300,000	1
Copepod	140,000	0
Nauplius	60,000	0
Total	1,701,500,000	1,702

17-Mar-99

Organism	No./m^3	No./mL
Oscillatoria	2,200,000,000	2,200
Rotifer	180,000	0
Closterium	78,000	0
Nauplius	52,000	0
Cladoceran	52,000	0
Mougeotia	52,000	0
Synedra	26,000	0
Anabaena	26,000	0.026
Total	2,200,466,000	2,200

Lake Merced North

21-Jun-99	15-Sep-99			8-Dec-99			21-Mar-00			21-Jun-00		
	Organism	**No./m^3**	**No./mL**	**Organism**	**No./m^3**	**No./mL**	**Organism**	**No./m^3**	**No./mL**	**Organism**	**No./m^3**	**No./mL**
	Oscillatoria	1,900,000,000	1,900	*Oscillatoria*	1,100,000,000	1,100	*Oscillatoria*	1,800,000,000	1,800	*Oscillatoria*	550,000,000	550
	Anabaena	1,800,000	2	*Mougeotia*	410,000	0.410	*Mougeotia*	3,039,244	3	*Anabaena*	35,000,000	35
	Gomphosphaeria	770,000	1	*Closterium*	170,000	0.170	*Melosira*	1,823,546	2	*Melosira*	8,200,000	8
	Mougeotia	640,000	1	Rotifer	69,000	0.069	*Anabaena*	1,823,546	2	*Synedra*	490,000	0.490
	Anacystis	470,000	0.470	Naviculoid Diatom	69,000	0.069	*Closterium*	1,215,698	1.216	*Mougeotia*	230,000	0.230
	Closterium	430,000	0.430	*Cymbella*	69,000	0.069	*Fragilaria*	607,849	0.608	*Chlorella*	210,000	0.210
	Spirulina	210,000	0.210	Copepoda	34,000	0.034	*Copepoda*	607,849	0.608	*Ankistrodesmus*	110,000	0.110
	Mallomonas	170,000	0.170	*Mallomonas*	34,000	0.034	*Rhizolenia*	607,849	0.608	*Coelosphaerium*	61,000	0.061
	Naviculoid Diatom	130,000	0.130	*Scenedesmus*	34,000	0.034	*Synedra*	607,849	0.608	*Scenedesmus*	61,000	0.061
	Scenedesmus	85,000	0.085	*Coelastrum*	34,000	0.034	*Closteridium*	607,849	0.608	Rotifera	46,000	0.046
	Tetraedron	85,000	0.085	*Anabaena*	34,000	0.034	**Total**	1,810,941,278	1,811	Copepoda	31,000	0.031
	Fragilaria	85,000	0.085	**Total**	1,100,957,000	1,101				Nauplius	31,000	0.031
	Paramecium	43,000	0.043							*Navicula*	31,000	0.031
	Pediastrum	43,000	0.043							*Cymbella*	15,000	0.015
	Cladoceran	43,000	0.043							*Stephanodiscus*	15,000	0.015
	Selenastrum	43,000	0.043							*Closteriopsis*	15,000	0.015
	Total	1,905,047,000	1,905							**Total**	626,000	595

Lake Merced North East

21-Jun-99	15-Sep-99			8-Dec-99			21-Mar-00			21-Jun-00		
	Organism	**No./m^3**	**No./mL**	**Organism**	**No./m^3**	**No./mL**	**Organism**	**No./m^3**	**No./mL**	**Organism**	**No./m^3**	**No./mL**
	Oscillatoria	1,300,000,000	1,300	*Oscillatoria*	1,600,000,000	1,600	*Oscillatoria*	3,100,000,000	3,100	*Oscillatoria*	1,300,000,000	1,300
	Mougeotia	2,600,000	3	*Closterium*	690,000	1	*Melosira*	8,200,000	8	*Anabaena*	16,000,000	16
	Anabaena	560,000	1	*Mougeotia*	430,000	0	*Mougeotia*	5,700,000	6	*Melosira*	6,900,000	7
	Anacystis	530,000	1	Nauplius	170,000	0	*Synedra*	3,300,000	3	*Ankistrodesmus*	860,000	1
	Closterium	450,000	0	*Synedra*	130,000	0	*Anabaena*	2,400,000	2	*Synedra*	740,000	1
	Naviculoid Diatom	260,000	0	*Anabaena*	130,000	0	*Gleocystis*	820,000	1	*Mougeotia*	520,000	1
	Ankistrodesmis	230,000	0	*Spirulina*	87,000	0	**Total**	3,120,420,000	3,120	*Chlorella*	360,000	0
	Copepoda	190,000	0	*Closteridium*	87,000	0				*Cymbella*	140,000	0
	Nauplius	150,000	0	*Scenedesmus*	43,000	0				*Scenedesmus*	120,000	0
	Cymbella	150,000	0	*Cymbella*	43,000	0				*Fragilaria*	72,000	0
	Fragilaria	110,000	0	Copepoda	43,000	0				*Polypleblepharides*	48,000	0
	Actinastrum	75,000	0	*Actinastrum*	43,000	0				*Coelosphaerium*	48,000	0
	Pediastrum	38,000	0	Rotifer	43,000	0				*Stephanodiscus*	48,000	0
	Scenedesmus	38,000	0	*Coelosphaerium*	43,000	0				*Gomphoneis*	24,000	0
	Ostrocoda	38,000	0	**Total**	432,000	0				*Closterium*	24,000	0
	Mallomonas	38,000	0							*Closteriopsis*	24,000	0
	Rotifer	38,000	0							**Total**	1,325,928,000	1,326
	Total	525,000	1									

Lake Merced North

9-Aug-00

Organism	No./m^3	No./mL
Oscillatoria	1,900,000,000	1,900
Melosira	6,600,000	7
Anabaena	2,800,000	3
Ankistrodesmus	280,000	0.280
Coelosphaerium	170,000	0.170
Nauplius	130,000	0.130
Mougeotia	87,000	0.087
Rotifera	43,000	0.043
Closteriopsis	22,000	0.022
Stephanodiscus	22,000	0.022
Staurastrum	22,000	0.022
Copepoda	22,000	0.022
Pediastrum	22,000	0.022
Scenedesmus	22,000	0.022
Total	842,000	1,910

19-Dec-00

Organism	No./m^3	No./mL
Oscillatoria (20/1 dilution)	1,600,000,000	1,600
Melosira	1,400,000	1.400
Mougeotia	1,100,000	1.100
Closterium	370,000	0.370
Anabaena	250,000	0.250
Ankistrodesmus	250,000	0.250
Scenedesmus	120,000	0.120
Naviculoid Diatom	120,000	0.120
Copepoda	120,000	0.120
Total	1,603,730,000	1,604

7-Mar-01

Organism	No./m^3	No./mL
Oscillatoria	1,800,000,000	1,800
Melosira	1,600,000	2
Rotifera	300,000	0.300
Scenedesmus	250,000	0.250
Ankistrodesmus	220,000	0.220
Closterium	190,000	0.190
Copepoda	82,000	0.082
Anabaena	55,000	0.055
Synedra	55,000	0.055
Nauplius	55,000	0.055
Cymbella	27,000	0.027
Ceratium	27,000	0.027
Total	1,802,861,000	1,803

20-Jun-01

Organism	No./m^3	No./mL
Oscillatoria	1,200,000,000	1,200
Anabaena	14,000,000	14
Melosira	1,600,000	2
Synedra	1,200,000	1
Ankistrodesmus	160,000	0.160
Closterium	110,000	0.110
Fragilaria	90,000	0.090
Copepoda	45,000	0.045
Staurastrum	22,000	0.022
Cyclotella	22,000	0.022
Nauplius	22,000	0.022
Coelosphaerium	22,000	0.022
Total	1,217,293,000	1,217

1-Oct-01

Organism	No./m^3	No./mL
Oscillatoria	2,700,000,000	2,700
Melosira	970,000	1
Anabaena	600,000	1
Closterium	340,000	0.340
Ankistrodesmus	300,000	0.300
Coelosphaerium	150,000	0.150
Copepoda	150,000	0.150
Scenedesmus	75,000	0.075
Nauplius	38,000	0.038
Rotifera	38,000	0.038
Total	2,702,661,000	2,703

Lake Merced North East

9-Aug-00

Organism	No./m^3	No./mL
Oscillatoria	1,800,000,000	1,800
Melosira	10,000,000	10
Anabaena	3,300,000	3
Ankistrodesmus	1,600,000	2
Mougeotia	280,000	0
Closterium	250,000	0
Nauplius	140,000	0
Scenedesmus	110,000	0
Synedra	84,000	0
Rotifera	84,000	0
Cymbella	56,000	0
Ophiocytium	56,000	0
Coelosphaerium	56,000	0
Closteriopsis	56,000	0
Navicula	56,000	0
Copepoda	28,000	0
Nematoda	28,000	0
Total	1,816,184,000	1,816

19-Dec-00

Organism	No./m^3	No./mL
Oscillatoria (20/1 dilution)	1,400,000,000	1,400
Mougeotia	4,100,000	4
Melosira	1,600,000	2
Ankistrodesmus	570,000	1
Closterium	460,000	0
Cyclotella	230,000	0
Anacystis	110,000	0
Rotifera	110,000	0
Nauplius	110,000	0
Naviculoid Diatom	110,000	0
Zygnema	110,000	0
Gloeocystis	110,000	0
Stephanodiscus	110,000	0
Total	1,407,730,000	1,408

7-Mar-01

Organism	No./m^3	No./mL
Oscillatoria	4,800,000,000	4,800
Ankistrodesmus	730,000	0.730
Rotifera	380,000	0.380
Melosira	270,000	0.270
Synedra	190,000	0.190
Staurastrum	120,000	0.120
Scenedesmus	77,000	0.077
Nauplius	38,000	0.038
Closterium	38,000	0.038
Stephanodiscus	38,000	0.038
Copepoda	38,000	0.038
Total	4,801,919,000	4,802

20-Jun-01

Organism	No./m^3	No./mL
Oscillatoria	2,000,000,000	2,000
Anabaena	12,000,000	12
Melosira	4,800,000	5
Synedra	2,700,000	3
Ankistrodesmus	1,100,000	1.100
Closterium	400,000	0.400
Cyclotella	400,000	0.400
Ophiocytium	130,000	0.130
Copepoda	130,000	0.130
Nauplius	100,000	0.100
Fragilaria	67,000	0.067
Rotifera	67,000	0.067
Sphaerocystis	33,000	0.033
Staurastrum	33,000	0.033
Scenedesmus	33,000	0.033
Total	2,021,993,000	2,022

1-Oct-01

Organism	No./m^3	No./mL
Oscillatoria	2,600,000,000	2,600
Melosira	4,100,000	4
Ankistrodesmus	1,900,000	2
Rotifera	160,000	0.160
Nauplius	120,000	0.120
Cymbella	120,000	0.120
Closterium	120,000	0.120
Copepoda	120,000	0.120
Anabaena	41,000	0.041
Aphanizomenon	41,000	0.041
Total	2,606,722,000	2,607

Lake Merced North

18-Dec-01

Organism	No./m^3	No./mL
Oscillatoria	1,100,000,000	1,100
Melosira	2,000,000	2
Ankistrodesmus	230,000	0.230
Closterium	210,000	0.210
Anabaena	100,000	0.100
Fragilaria	63,000	0.063
Copepoda	21,000	0.021
Epithemia	21,000	0.021
Nauplius	21,000	0.021
Total	1,102,666,000	1,103

5-Mar-02

Organism	No./m^3	No./mL
Oscillatoria (50:1 dil)	960,000,000	960
Anabaena	380,000	0.380
Nauplius	230,000	0.230
Rotifera	140,000	0.140
Ankistrodesmus	110,000	0.110
Synedra	67,000	0.067
Copepoda	67,000	0.067
Stephanodiscus	45,000	0.045
Closterium	45,000	0.045
Mallomonas	23,000	0.023
Staurastrum	23,000	0.023
Cladocera	23,000	0.023
Scenedesmus	23,000	0.023
Fragilaria	23,000	0.023
Anacystis	23,000	0.023
Total	961,222,000	961

30-Apr-02

Organism	No./m^3	No./mL
Oscillatoria	1,300,000,000	1,300
Anabaena	82,000,000	82
Melosira	17,000,000	17
Ankistrodesmus	1,100,000	1
Closterium	980,000	1
Cyclotella	46,000	0.046
Copepoda	46,000	0.046
Nauplius	23,000	0.023
Fragilaria	23,000	0.023
Staurastrum	23,000	0.023
Ceratium	23,000	0.023
Rotifera	23,000	0.023
Epithemia	23,000	0.023
Total	1,401,310,000	1,401

18-Jun-02

Organism	No./m^3	No./mL
Oscillatoria	580,000,000	580
Anabaena	19,000,000	19
Melosira	3,500,000	4
Synedra	400,000	0.400
Closterium	290,000	0.290
Ankistrodesmus	230,000	0.230
Copepoda	90,000	0.090
Cyclotella	90,000	0.090
Nauplius	72,000	0.072
Rotifera	18,000	0.018
Total	603,690,000	604

23-Aug-02

Organism	No./m^3	No./mL
Oscillatoria(50:1dil)	1,000,000,000	1,000
Anabaena	1,100,000	1
Mougeotia	1,000,000	1
Melosira	310,000	0.310
Rotifera	280,000	0.280
Coelosphaerium	280,000	0.280
Nauplius	130,000	0.130
Copepoda	100,000	0.100
Closterium	77,000	0.077
Cladocera	26,000	0.026
Anacystis	26,000	0.026
Gloeocystis	26,000	0.026
Navicula	26,000	0.026
Scenedesmus	26,000	0.026
Total	1,006,814,000	1,007

Lake Merced North East

18-Dec-01

Organism	No./m^3	No./mL
Oscillatoria	1,800,000,000	1,800
Melosira	6,300,000	6
Ankistrodesmus	1,500,000	2
Closterium	300,000	0.300
Rotifera	130,000	0.130
Fragilaria	67,000	0.067
Staurastrum	67,000	0.067
Nauplius	34,000	0.034
Total	1,808,398,000	1,808

5-Mar-02

Organism	No./m^3	No./mL
Oscillatoria (50:1 dil)	1,800,000,000	1,800
Melosira	1,900,000	2
Rotifera	660,000	0.660
Closterium	540,000	0.540
Ankistrodesmus	370,000	0.370
Nauplius	250,000	0.250
Stephanodiscus	210,000	0.210
Copepoda	170,000	0.170
Anacystis	83,000	0.083
Anabaena	42,000	0.042
Synedra	42,000	0.042
Scenedesmus	42,000	0.042
Gloeocystis	42,000	0.042
Total	1,804,351,000	1,804

30-Apr-02

Organism	No./m^3	No./mL
Oscillatoria	1,900,000,000	1,900
Melosira	73,000,000	73
Anabaena	7,500,000	8
Closterium	1,600,000	2
Ankistrodesmus	1,200,000	1.200
Fragilaria	340,000	0.340
Copepoda	300,000	0.300
Coelosphaerium	110,000	0.110
Nauplius	75,000	0.075
Scenedesmus	75,000	0.075
Cymbella	37,000	0.037
Epithemia	37,000	0.037
Synedra	37,000	0.037
Total	1,984,311,000	1,984

18-Jun-02

Organism	No./m^3	No./mL
Oscillatoria	3,500,000,000	3,500
Anabaena	18,000,000	18
Melosira	16,000,000	16
Synedra	820,000	0.820
Ankistrodesmus	620,000	0.620
Closterium	270,000	0.270
Rotifera	140,000	0.140
Staurastrum	100,000	0.100
Nauplius	100,000	0.100
Copepoda	34,000	0.034
Total	3,536,084,000	3,536

23-Aug-02

Organism	No./m^3	No./mL
Oscillatoria (20:1 dil)	1,300,000,000	1,300
Melosira	2,100,000	2
Mougeotia	1,500,000	2
Anabaena	690,000	0.690
Ankistrodesmus	240,000	0.240
Closterium	180,000	0.180
Cladocera	120,000	0.120
Rotifera	120,000	0.120
Mallomonas	90,000	0.090
Synedra	90,000	0.090
Copepoda	90,000	0.090
Coelosphaerium	90,000	0.090
Ceratium	30,000	0.030
Nauplius	30,000	0.030
Cymbella	30,000	0.030
Scenedesmus	30,000	0.030
Pinnularia	30,000	0.030
Total	1,305,460,000	1,305

Lake Merced North

23-Oct-02

Organism	No./m^3	No./mL
Oscillatoria	1,500,000,000	1,500
Melosira	3,100,000	3
Anabaena	2,700,000	3
Closterium	500,000	0.500
Ankistrodesmus	150,000	0.150
Nauplius	88,000	0.088
Copepoda	59,000	0.059
Scenedesmus	29,000	0.029
Total	1,506,626,000	1,507

11-Feb-03

Organism	No./m^3	No./mL
Oscillatoria	1,700,000,000	1,700
Melosira	3,200,000	3
Ankistrodesmus	130,000	0.130
Closterium	130,000	0.130
Copepoda	25,000	0.025
Nauplius	25,000	0.025
Cymbella	25,000	0.025
Rotifera	25,000	0.025
Scenedesmus	25,000	0.025
Total	1,703,585,000	1,704

14-May-03

Organism	No./m^3	No./mL
Oscillatoria	1,600,000,000	1,600
Melosira	3,600,000	4
Anabaena	1,500,000	2
Synedra	710,000	0.710
Ankistrodesmus	630,000	0.630
Closterium	490,000	0.490
Cyclotella	220,000	0.220
Scenedesmus	110,000	0.110
Rotifera	82,000	0.082
Cymbella	27,000	0.027
Staurastrum	27,000	0.027
Fragilaria	27,000	0.027
Total	1,607,423,000	1,607

15-Jul-03

Organism	No./m^3	No./mL
Oscillatoria	1,400,000,000	1,400
Anabaena	7,400,000	7
Melosira	900,000	0.900
Ankistrodesmus	230,000	0.230
Closterium	120,000	0.120
Copepoda	100,000	0.100
Nauplius	84,000	0.084
Rotifera	63,000	0.063
Stephanodiscus	63,000	0.063
Scenedesmus	42,000	0.042
Synedra	42,000	0.042
Spirolina	21,000	0.021
Total	1,409,065,000	1,409

30-Sep-03

Organism	No./m^3	No./mL
Oscillatoria	980,000,000	980
Anabaena	1,400,000	1.400
Melosira	290,000	0.290
Closterium	150,000	0.150
Copepoda	77,000	0.077
Nauplius	46,000	0.046
Rotifera	31,000	0.031
Epithemia	31,000	0.031
Synedra	31,000	0.031
Cymbella	15,000	0.015
Scenedesmus	15,000	0.015
Total	982,086,000	982

Lake Merced North East

23-Oct-02

Organism	No./m^3	No./mL
Oscillatoria	2,300,000,000	2,300
Melosira	3,400,000	3
Anabaena	1,300,000	1.300
Closterium	760,000	0.760
Ankistrodesmus	610,000	0.610
Copepoda	230,000	0.230
Nauplius	150,000	0.150
Rotifera	110,000	0.110
Synedra	38,000	0.038
Cymbella	38,000	0.038
Ophiocytium	38,000	0.038
Total	2,306,674,000	2,307

11-Feb-03

Organism	No./m^3	No./mL
Oscillatoria	1,700,000,000	1,700
Melosira	1,800,000	2
Ankistrodesmus	220,000	0.220
Rotifera	220,000	0.220
Nauplius	190,000	0.190
Closterium	160,000	0.160
Synedra	120,000	0.120
Cymbella	31,000	0.031
Total	1,702,741,000	1,703

14-May-03

Organism	No./m^3	No./mL
Oscillatoria	1,700,000,000	1,700
Melosira	6,700,000	7
Anabaena	5,800,000	6
Closterium	790,000	0.790
Ankistrodesmus	400,000	0.400
Synedra	220,000	0.220
Fragilaria	110,000	0.110
Nauplius	85,000	0.085
Scenedesmus	85,000	0.085
Staurastrum	56,000	0.056
Cynbella	56,000	0.056
Copepoda	28,000	0.028
Ceratium	28,000	0.028
Rotifera	28,000	0.028
Total	1,714,386,000	1,714

15-Jul-03

Organism	No./m^3	No./mL
Oscillatoria	1,900,000,000	1,900
Melosira	5,500,000	6
Anabaena	300,000	0.300
Closterium	240,000	0.240
Rotifera	180,000	0.180
Ankistrodesmus	150,000	0.150
Synedra	150,000	0.150
Copepoda	89,000	0.089
Staurastrum	30,000	0.030
Nauplius	30,000	0.030
Navicula	30,000	0.030
Ophiocytium	30,000	0.030
Stephanodiscus	30,000	0.030
Sphaerocystis	30,000	0.030
Total	1,906,789,000	1,907

30-Sep-03

Lake Merced North

2-Dec-03

Organism	No./m^3	No./mL
Oscillatoria	890,000,000	890
Anabaena	440,000	0.440
Mougeotia	128,719	0.129
Nauplius	100,000	0.100
Ankistrodesmus	100,000	0.100
Rotifera	77,000	0.077
Stephanodiscus	51,000	0.051
Closterium	51,000	0.051
Copepoda	26,000	0.026
Mallomonas	26,000	0.026
Staurastrum	26,000	0.026
Cladocera	26,000	0.026
Scenedesmus	26,000	0.026
Fragilaria	26,000	0.026
Anacystis	26,000	0.026
Total	891,129,719	891

27-May-04

Organism	No./mL
Melosira	18
Oscillatoria	5
Ceratium	3.7
Sphaerocystis	1.1
Anabaena	0.55
Copepoda	0.2
Synedra	0.18
Fragilaria	0.13
Nauplius	0.18
Zygnema	0.05
Mallomonas	0.034
Staurastrum	0.034
Anacystis	0.017
Coelosphaerium	0.017
Total	29.192

29-Aug-04

Organism	No./mL
Coelosphaerium	60
Fragilaria	14
Anabaena	4.4
Melosira	1.9
Aphanizomenon	1.5
Asterionella	0.77
Cyclotella	0.13
Ceratium	0.077
Staurastrum	0.077
Oscillatoria	0.051
Gloeocystis	0.051
Synedra	0.026
Cladocera	0.026
Closterium	0.026
Copepoda	0.026
Total	83.06

27-Oct-04

Organism	No./mL
Oscillatoria	100
Anabaena	88
Fragilaria	11
Stephanodiscus	3.5
Melosira	1.1
Coelosphaerium	0.7
Rotifera	0.47
Staurastrum	0.28
Nauplius	0.1
Copepoda	0.073
Cladocera	0.058
Sphaerocystis	0.029
Ceratium	0.014
Asterionella	0.014
Synedra	0.014
Cymbella	0.014
Closterium	0.014
Total	205.38

9-Dec-04

Organism	No./mL
Oscillatoria	24
Anabaena	9.6
Coelosphaerium	0.77
Melosira	0.44
Stephanodiscus	0.2
Staurastrum	0.11
Closterium	0.11
Asterionella	0.086
Cladocera	0.086
Copepoda	0.071
Fragilaria	0.057
Ceratium	0.057
Cyclotella	0.057
Nauplius	0.028
Synedra	0.028
Pediastrum	0.014
Rotifera	0.014
Total	35.728

9-Feb-05

Organism	No./mL
Asterionella	140
Oscillatoria	140
Anabaena	8.2
Stephanodiscus	3.4
Closterium	1.3
Melosira	0.61
Coelosphaerium	0.49
Ceratium	0.2
Synedra	0.14
Fragilaria	0.098
Rotifera	0.039
Pediastrum	0.039
Staurastrum	0.039
Epithemia	0.02
Total	294.575

18-Apr-05

Organism	No./mL
Oscillatoria	9.1
Ceratium	0.83
Anabaena	0.54
Sphaerocystis	0.38
Synedra	0.064
Asterionella	0.064
Coelosphaerium	0.048
Cyclotella	0.024
Tabellaria	0.024
Copepoda	0.016
Fragilaria	0.016
Stephanodiscus	0.016
Pediastrum	0.008
Staurastrum	0.008
Melosira	0.008
Desmidium	0.008
Total	11.154

Lake Merced North East

2-Dec-03

Organism	No./m^3	No./mL
Oscillatoria	1,100,000,000	1,100
Anabaena	340,000	0.340
Nauplius	170,000	0.170
Melosira	140,000	0.140
Mougeotia	140,000	0.140
Closterium	100,000	0.100
Rotifera	69,000	0.069
Stephanodiscus	69,000	0.069
Copepoda	69,000	0.069
Coelosphaerium	69,000	0.069
Ankistrodesmus	34,000	0.034
Synedra	34,000	0.034
Scenedesmus	34,000	0.034
Cyclotella	34,000	0.034
Total	1,101,302,000	1,101.302

27-May-04

Organism	No./mL
Oscillatoria	520
Melosira	2.3
Anabaena	1.1
Ceratium	0.4
Rotifera	0.25
Synedra	0.15
Closterium	0.13
Nauplius	0.1
Pennate Diatom	0.1
Fragilaria	0.076
Cladocera	0.076001
Anacystis	0.076002
Sphaerocystis	0.076003
Coelosphaerium	0.05
Copepoda	0.025
Zygnema	0.025
Total	524.934006

29-Aug-04

Organism	No./mL
Oscillatoria	350
Coelosphaerium	7.4
Anabaena	2.3
Ceratium	2.1
Melosira	1.4
Fragilaria	0.87
Synedra	0.82
Asterionella	0.46
Ophiocytium	0.1
Copepoda	0.051
Closterium	0.051
Nauplius	0.051
Cladocera	0.026
Total	365.629

27-Oct-04

Organism	No./mL
Oscillatoria	310
Anabaena	5.5
Stephanodiscus	4.4
Closterium	4.1
Fragilaria	1
Synedra	0.78
Melosira	0.64
Rotifera	0.36
Asterionella	0.32
Coelosphaerium	0.11
Staurastrum	0.085
Ceratium	0.085
Cymbella	0.021
Total	327.401

9-Dec-04

Organism	No./mL
Oscillatoria	350
Anabaena	15
Stephanodiscus	2.7
Synedra	0.61
Closterium	0.52
Coelosphaerium	0.3
Asterionella	0.26
Melosira	0.16
Nauplius	0.07
Cladocera	0.07
Staurastrum	0.047
Copepoda	0.047
Rotifera	0.023
Fragilaria	0.023
Ceratium	0.023
Total	369.853

9-Feb-05

Organism	No./mL
Oscillatoria	350
Asterionella	33
Stephanodiscus	4.3
Synedra	3.7
Anabaena	0.59
Closterium	0.51
Melosira	0.18
Rotifera	0.12
Coelosphaerium	0.1
Staurastrum	0.081
Cladocera	0.061
Cymbella	0.041
Ceratium	0.02
Total	392.703

18-Apr-05

Organism	No./mL
Oscillatoria	640
Anabaena	8.6
Aphanizomenon	5.5
Stephanodiscus	1.5
Ceratium	0.77
Closterium	0.55
Asterionella	0.29
Melosira	0.27
Cyclotella	0.22
Staurastrum	0.18
Rotifera	0.18
Coelosphaerium	0.13
Fragilaria	0.11
Nauplius	0.11
Synedra	0.088
Copepoda	0.066
Sphaerocystis	0.044
Total	658.608

Lake Merced North

23-Jun-05		17-Aug-05		28-Sep-05		31-Oct-05			29-Nov-05		29-Dec-05		23-Jan-06		1-Mar-06	
Organism	**No./mL**	**Organism**	**No./m3**	**Organism**	**No./mL**	**Organism**	**No./m^3**	**No./mL**	**Organism**	**No./mL**			**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria (20:1dil)	290	*Oscillatoria*	270	*Oscillatoria*	480	*Oscillatoria*	280,000,000	280	*Oscillatoria*	460	*Oscillatoria*	360	*Oscillatoria*	190	*Oscillatoria*	260
Anabaena	4	*Closterium*	17	*Anabaena*	24.000	*Anabaena*	2,100,000	2	*Closterium*	4.3					*Melosira*	16
Aphanizomenon	1	*Melosira*	3.1	*Ceratium*	5.100	*Ceratium*	860,000	1	*Synedra*	0.45					*Anabaena*	14
Stephanodiscus	0.47	*Anabaena*	2.8	*Nauplius*	4.800	*Cladoceran*	170,000	0.17	*Stephanodiscus*	0.36					*Closterium*	12
Melosira	0.36	*Ceratium*	0.37	*Rotifera*	0.250	*Nauplius*	130,000	0.13	*Ceratium*	0.34					*Asterionella*	4.3
Nauplius	0.17	*Stephanodiscus*	0.21	Copepoda	0.170	*Rotifer*	77,000	0.08	*Melosira*	0.34					**Total**	306
Fragilaria	0.13	Copepoda	0.093	Cladocera	0.084	*Copepod*	58,000	0.06	Copepoda	0.23						
Copepoda	0.13	Nauplius	0.093	*Mallomonas*	0.084	**Total**	283,395,000	283	Rotifera	0.18						
Closterium	0.13	*Ankistrodesmus*	0.093	***Total***	514.000				Nauplius	0.16						
Rotifera	0.086	*Synedra*	0.093						*Anabaena*	0.14						
Ceratium	0.021	Rotifera	0.046						*Coelosphaerium*	0.11						
Nitzschia	0.021	*Epithemia*	0.023						Cladocera	0.09						
Scenedesmus	0.021	*Staurastrum*	0.023						*Pediastrum*	0.023						
Total	296.539	Cladocera	0.023						*Asterionella*	0.023						
		Pediastrum	0.023						*Ophiocytium*	0.023						
		Total	293.99						**Total**	466.769						

Lake Merced North East

23-Jun-05		17-Aug-05		28-Sep-05		31-Oct-05			29-Nov-05		29-Dec-05		23-Jan-06		1-Mar-06	
Organism	**No./mL**	**Organism**	**No./m3**	**Organism**	**No./mL**	**Organism**	**No./m3**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria (20:1 dil)	40	*Oscillatoria*	650	Oscillatoria	590	*Oscillatoria*	290,000,000	290	*Oscillatoria*	450	*Oscillatoria*	430	*Asterionella*	160	*Oscillatoria*	500
Anabaena	14	*Melosira*	6.3	Anabaena	3.1	*Ceratium*	1,700,000	2	*Closterium*	7.0			*Ceratium*	19	*Synedra*	5.9
Aphanizomenon	2.1	*Closterium*	5.0	Melosira	1.7	*Anabaena*	1,300,000	1	*Ceratium*	1.2			*Oscillatoria*	5.1	**Total**	506
Melosira	0.47	*Anabaena*	0.76	Rotifer	0.34	*Melosira*	700,000	1	*Stephanodiscus*	0.220			*Cyclotella*	1.3		
Rotifera	0.26	*Stephanodiscus*	0.55	Ceratium	0.26	*Ankistrodesmus*	690,000	1	Rotifera	0.190			*Copepoda*	1.3		
Closterium	0.26	*Synedra*	0.45	Nauplius	0.26	*Nauplius*	200,000	0.20	Nauplius	0.160			*Cladocera*	1.3		
Fragilaria	0.21	*Ceratium*	0.24	Copepoda	0.087	Rotifera	86,000	0.09	Cladocera	0.160			**Total**	188		
Stephanodiscus	0.21	Nauplius	0.21	**Total**	596	*Stephanodiscus*	86,000	0.09	*Asterionella*	0.064						
Nauplius	0.13	Rotifera	0.17			Cladocera	29,000	0.03	*Copepoda*	0.064						
Copepoda	0.064	*Sphaerocystis*	0.17			**Total**	294,791,000	295	*Pediastrum*	0.032						
Sphaerocystis	0.064	Copepoda	0.10						**Total**	918.020						
Ceratium	0.043	*Fragilaria*	0.034													
Asterionella	0.043	*Pinnularia*	0.034													
Coelosphaerium	0.043	*Asterionella*	0.034													
Dinobryon	0.021	**Total**	664													
Total	57.918															

Lake Merced North

26-Apr-06		14-Jun-06		24-Aug-06		25-Oct-06		20-Dec-06		29-Mar-07		26-Jun-07		20-Aug-07		27-Dec-07		28-Mar-08	
Organism	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	320	*Oscillatoria*	490	*Oscillatoria*	230	*Oscillatoria*	680	*Oscillatoria*	1100	*Oscillatoria*	1300	*Oscillatoria*	1570	*Oscillatoria*	300			*Oscillatoria*	44
Anabaena	64													*Dictyosphaerium*	7.4			*Melosira*	4.6
Synedra	4.7													Total	307.4				49
Closterium	0.79																		
Total	389																		

Lake Merced North East

26-Apr-06		14-Jun-06		24-Aug-06		25-Oct-06		20-Dec-06		29-Mar-07		26-Jun-07		20-Aug-07		27-Dec-07		28-Mar-08	
Organism	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	540	*Oscillatoria*	460	*Oscillatoria*	870	*Oscillatoria*	1100	*Oscillatoria*	1400	*Oscillatoria*	1680	*Oscillatoria*	270					*Oscillatoria*	4.7
																		Melosira	1.8
																		Total	6.5

Lake Merced North

10-Jun-08		24-Sep-08		4-Dec-08		24-Mar-09		4-Jun-09		22-Sep-09		15-Dec-09	
Organism	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	128	*Oscillatoria*	22.8	*Oscillatoria*	160	*Oscillatoria*	410	*Oscillatoria*	990	*Oscillatoria*	1000	*Oscillatoria*	410

Lake Merced North East

10-Jun-08		24-Sep-08		4-Dec-08		24-Mar-09		4-Jun-09		22-Sep-09		15-Dec-09	
Organism	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	74.6	*Oscillatoria*	29.4	*Oscillatoria*	120	*Oscillatoria*	610	*Oscillatoria*	1200	*Oscillatoria*	12000	*Oscillatoria*	550

Lake Merced South - Pistol Range

15-May-97

Organism	No./cuM	No./mL
Oscillatoria	1,300,000,000	1,300
Anabaena	7,500,000	7.5
Ceratium	300,000	0.30
Copepoda	138,000	0.14
Staurastrum	138,000	0.14
Rotifera	79,000	0.079
Total	1,308,155,000	1,308

10-Sep-97

Organism	No./cuM	No./mL
Oscillatoria	390,000,000	390
Anabaena	7,100,000	7
Total	397,100,000	397

3-Dec-97

Organism	No./cuM	No./mL
Oscillatoria	1,000,000,000	1,000
Anabaena	1,200,000	1
Copepod	86,000	0
Rotifer	64,000	0
Ceratium	43,000	0
Total	1,001,393,000	1,001

16-Mar-98

Organism	No./cuM	No./mL
Oscillatoria	540,000,000	540
Rotifer	130,000	0
Anabaena	78,000	0
Copepod	65,000	0
Total	540,273,000	540

8-Jul-98

Organism	No./cuM	No./mL
Oscillatoria (1:50 dilution)	240,000,000	240
Ulothrix	13,000,000	13
Anabaena	1,200,000	1
Melosira	1,100,000	1
Nauplius	170,000	0
Copepod	150,000	0
Total	255,620,000	256

17-Mar-99

Organism	No./m^3	No./mL
Oscillatoria	51,000,000	51
Mougeotia	110,000	0
Asterionella	840,000	1
Closterium	30,000	0
Nauplius	30,000	0
Spirulina	23,000	0
Copepoda	23,000	0
Actinastrum	15,000	0
Anabaena	15,000	0
Navicula	7,600	0
Fragilaria	7,600	0
Synedra	7,600	0
Anacystis	7,600	0
Staurastrum	7,600	0
Total	52,124,000	52

Lake Merced South - Pump Station

15-May-97

Organism	No./cuM	No./mL
Oscillatoria	1,000,000,000	1,000
Anabaena	8,100,000	8
Ceratium	180,000	0
Copepod	39,000	0
Total	1,008,319,000	1,008

10-Sep-97

Organism	No./cuM	No./mL
Oscillatoria	290,000,000	290
Anabaena	220,000	0
Dinobryon	56,000	0
Copepod	21,000	0
Total	290,297,000	290

3-Dec-97

Organism	No./cuM	No./mL
Oscillatoria	1,000,000,000	1,000
Anabaena	620,000	1
Copepod	94,000	0
Rotifer	19,000	0
Total	1,000,733,000	1,001

16-Mar-98

Organism	No./cuM	No./mL
Oscillatoria	87,000,000	87
Anabaena	28,000	0
Mougeotia	28,000	0
Rotifer	14,000	0
Total	87,070,000	87

8-Jul-98

Organism	No./cuM	No./mL
Oscillatoria (1:50 dilution)	360,000,000	360
Ulothrix	7,900,000	8
Anabaena	2,000,000	2
Melosira	890,000	1
Copepod	90,000	0
Nauplius	90,000	0
Total	370,970,000	371

17-Mar-99

Organism	No./m^3	No./mL
Oscillatoria	60,000,000	60
Mougeotia	130,000	0
Asterionella	100,000	0
Copepoda	46,000	0
Actinastrum	46,000	0
Spirulina	28,000	0
Nauplius	18,000	0
Rotifer	18,000	0
Closterium	18,000	0
Ankistrodesmus	18,000	0
Staurastrum	18,000	0
Ceratium	9,200	0
Anabaena	9,200	0
Synedra	9,200	0
Total	60,467,600	60

Lake Merced South - Pistol Range

21-Jun-99

Organism	No./m³	No./mL
Oscillatoria	500,000,000	500
Mougeotia	2,500,000	3
Anabaena	2,000,000	2
Spirulina	320,000	0
Closteridium	230,000	0
Closterium	200,000	0
Scenedesmus	120,000	0
Gomphosphaeria	73,000	0
Rotifer	29,000	0
Copepoda	29,000	0
Navicula	14,000	0
Staurastrum	14,000	0
Synedra	14,000	0
Nauplius	14,000	0
Cymbella	14,000	0
Total	505,571,000	506

15-Sep-99

Organism	No./m³	No./mL
Oscillatoria	450,000,000	450
Anabaena	8,900,000	9
Mougeotia	600,000	1
Spirulina	380,000	0
Mallomonas	220,000	0
Fragilaria	160,000	0
Anacystis	140,000	0
Copepoda	99,000	0
Staurastrum	99,000	0
Naviculoid Diatom	79,000	0
Gomphosphaeria	79,000	0
Cyclotella	40,000	0
Closterium	40,000	0
Nauplius	40,000	0
Actinastrum	20,000	0
Scenedesmus	20,000	0
Pinnularia	20,000	0
Tetraedron	20,000	0
Total	460,956,000	461

8-Dec-99

Organism	No./m³	No./mL
Oscillatoria	868,706,613	869
Mougeotia	251,495	0
Spirulina	188,621	0
Anabaena	167,664	0
Scenedesmus	104,790	0
Closterium	62,874	0
Microcystis	62,874	0
Nauplius	41,916	0
Naviculoid Diatom	41,916	0
Actinastrum	20,958	0
Rotifer	20,958	0
Pinnularia	20,958	0
Cymbella	20,958	0
Copepoda	20,958	0
Total	869,733,552	870

21-Mar-00

Organism	No./m³	No./mL
Oscillatoria	1,600,000,000	1,600
Melosira	2,900,000	3
Anabaena	2,500,000	3
Closterium	2,500,000	3
Mougeotia	1,800,000	2
Synedra	730,000	1
Scenedesmus	730,000	1
Microcystis	360,000	0
Nauplius	360,000	0
Staurastrum	360,000	0
Total	1,612,240,000	1,612

21-Jun-00

Organism	No./m³	No./mL
Oscillatoria	370,000,000	370
Anabaena	11,000,000	11
Melosira	1,700,000	2
Mougeotia	320,000	0
Chlorella	160,000	0
Ankistrodesmus	150,000	0
Closterium	84,000	0
Closteriopsis	84,000	0
Nauplius	66,000	0
Copepoda	56,000	0
Navicula	56,000	0
Coelosphaerium	47,000	0
Scenedesmus	38,000	0
Coelastrum	19,000	0
Amphora	19,000	0
Dinobryon	9,400	0
Staurastrum	9,400	0
Cladocera	9,400	0
Pinnularia	9,400	0
Synedra	9,400	0
Total	383,846,000	384

Lake Merced South - Pump Station

21-Jun-99

Organism	No./m³	No./mL
Oscillatoria	660,000,000	660
Anabaena	3,200,000	3
Mougeotia	1,900,000	2
Spirulina	550,000	1
Closteridium	280,000	0
Closterium	260,000	0
Scenedesmus	94,000	0
Copepoda	47,000	0
Navicula	47,000	0
Synedra	31,000	0
Anacystis	16,000	0
Gomphosphaeria	16,000	0
Epithemia	16,000	0
Pinnularia	16,000	0
Total	666,473,000	666

15-Sep-99

Organism	No./m³	No./mL
Oscillatoria	590,000,000	590
Anabaena	23,000,000	23
Spirulina	1,300,000	1
Mougeotia	500,000	1
Gomphosphaeria	120,000	0
Ceratium	99,000	0
Anacystis	99,000	0
Ankistrodesmis	99,000	0
Closterium	79,000	0
Staurastrum	60,000	0
Cymbella	40,000	0
Nauplius	40,000	0
Mallomonas	40,000	0
Tetraedron	20,000	0
Copepoda	20,000	0
Fragilaria	20,000	0
Pinnularia	20,000	0
Actinastrum	20,000	0
Total	615,576,000	616

8-Dec-99

Organism	No./m³	No./mL
Oscillatoria	1,060,499,160	1,060
Spirulina	362,449	0
Mougeotia	93,968	0
Microcystis	80,544	0
Anabaena	67,120	0
Naviculoid Diatom	53,696	0
Pinnularia	40,272	0
Gleocystis	13,424	0
Fragilaria	13,424	0
Total	1,061,224,058	1,061

21-Mar-00

Organism	No./m³	No./mL
Oscillatoria	1,600,000,000	1,600
Melosira	3,100,000	3
Synedra	1,600,000	2
Anabaena	1,500,000	2
Scenedesmus	1,000,000	1
Mougeotia	1,000,000	1
Total	1,608,200,000	1,608

21-Jun-00

Organism	No./m³	No./mL
Oscillatoria	330,000,000	330
Anabaena	12,000,000	12
Melosira	2,000,000	2
Coelosphaerium	110,000	0
Copepoda	99,000	0
Chlorella	99,000	0
Closterium	99,000	0
Ankistrodesmus	55,000	0
Fragilaria	44,000	0
Ceratium	44,000	0
Synedra	33,000	0
Nauplius	33,000	0
Rotifera	33,000	0
Navicula	33,000	0
Dinobryon	33,000	0
Polyblepharides	22,000	0
Staurastrum	22,000	0
Caloneis	11,000	0
Total	344,770,000	345

Lake Merced South - Pistol Range

9-Aug-00

Organism	No./m³	No./mL
Oscillatoria	1,300,000,000	1,300
Anabaena	5,500,000	6
Melosira	1,400,000	1
Ankistrodesmus	200,000	0
Coelosphaerium	180,000	0
Mougeotia	160,000	0
Closteriopsis	130,000	0
Actinastrum	110,000	0
Synedra	72,000	0
Copepoda	54,000	0
Scenedesmus	18,000	0
Amphora	18,000	0
Closterium	18,000	0
Total	1,307,860,000	1,308

19-Dec-00

Organism	No./m³	No./mL
Oscillatoria* (dil 10x)	400,000,000	400
Mougeotia	600,000	1
Melosira	490,000	0
Closterium	330,000	0
Anacystis	270,000	0
Coelosphaerium	190,000	0
Anabaena	120,000	0
Pinnularia	62,000	0
Epithemia	62,000	0
Copepoda	41,000	0
Rotifera	41,000	0
Synedra	41,000	0
Nauplius	21,000	0
Ankistrodesmus	21,000	0
Navicula	21,000	0
Total	402,310,000	402

7-Mar-01

Organism	No./m³	No./mL
Oscillatoria	520,000,000	520
Melosira	3,800,000	4
Closterium	180,000	0
Anacystis	140,000	0
Synedra	120,000	0
Anabaena	53,000	0
Copepoda	35,000	0
Nauplius	35,000	0
Rotifera	35,000	0
Ankistrodesmus	18,000	0
Navicula	18,000	0
Cymbella	18,000	0
Cocconeis	18,000	0
Total	524,470,000	524

20-Jun-01

Organism	No./m³	No./mL
Oscillatoria	840,000,000	840
Anabaena	6,800,000	7
Melosira	2,200,000	2
Stephanodiscus	1,700,000	2
Cyclotella	1,100,000	1
Aphanizomenon	1,100,000	1
Dinobryon	470,000	0
Fragilaria	420,000	0
Anacystis	210,000	0
Coelosphaerium	150,000	0
Rotifera	130,000	0
Copepoda	95,000	0
Closterium	95,000	0
Staurastrum	76,000	0
Gloeocystis	76,000	0
Nauplius	57,000	0
Kirchneriella	38,000	0
Synedra	38,000	0
Synedra	38,000	0
Ceratium	19,000	0
Epithemia	19,000	0
Tetraedron	19,000	0
Total	854,850,000	855

1-Oct-01

Organism	No./m³	No./mL
Oscillatoria	1,300,000,000	1,300
Anabaena	8,600,000	9
Melosira	2,400,000	2
Coelosphaerium	240,000	0
Ankistrodesmus	96,000	0
Closterium	96,000	0
Rotifera	72,000	0
Ceratium	72,000	0
Copepoda	24,000	0
Scenedesmus	24,000	0
Total	1,311,624,000	1,312

Lake Merced South - Pump Station

9-Aug-00

Organism	No./m³	No./mL
Oscillatoria	1,300,000,000	1,300
Anabaena	7,300,000	7
Melosira	1,300,000	1
Coelosphaerium	270,000	0
Ankistrodesmus	200,000	0
Mougeotia	98,000	0
Synedra	39,000	0
Copepoda	20,000	0
Closteriopsis	20,000	0
Epithemia	20,000	0
Scenedesmus	20,000	0
Nauplius	20,000	0
Ceratium	20,000	0
Rotifera	20,000	0
Chlorella	20,000	0
Stephanodiscus	20,000	0
Staurastrum	20,000	0
Cymbella	20,000	0
Total	1,309,427,000	1,309

19-Dec-00

Organism	No./m³	No./mL
Oscillatoria (dil 10x)	450,000,000	450
Melosira	550,000	1
Mougeotia	450,000	0
Copepoda	130,000	0
Anacystis	130,000	0
Coelosphaerium	85,000	0
Closterium	85,000	0
Anabaena	64,000	0
Rotifera	43,000	0
Pinnularia	43,000	0
Cymbella	43,000	0
Navicula	43,000	0
Epithemia	43,000	0
Synedra	21,000	0
Ankistrodesmus	21,000	0
Total	451,751,000	452

7-Mar-01

Organism	No./m³	No./mL
Oscillatoria	570,000,000	570
Melosira	4,000,000	4
Closterium	190,000	0
Synedra	140,000	0
Scenedesmus	85,000	0
Anacystis	51,000	0
Ankistrodesmus	51,000	0
Anabaena	51,000	0
Nauplius	51,000	0
Fragilaria	34,000	0
Ophiocytium	17,000	0
Epithemia	17,000	0
Coelosphaerium	17,000	0
Staurastrum	17,000	0
Copepoda	17,000	0
Total	574,738,000	575

20-Jun-01

Organism	No./m³	No./mL
Oscillatoria (dil 50:1)	870,000,000	870
Anabaena	3,000,000	3
Melosira	2,100,000	2
Aphanizomenon	650,000	1
Fragilaria	550,000	1
Anacystis	450,000	0
Dinobryon	380,000	0
Cyclotella	280,000	0
Coelosphaerium	120,000	0
Kirchneriella	120,000	0
Copepoda	83,000	0
Navicula	50,000	0
Cymbella	50,000	0
Closterium	50,000	0
Ceratium	33,000	0
Staurastrum	33,000	0
Synedra	17,000	0
Nauplius	17,000	0
Rotifera	17,000	0
Pinnularia	17,000	0
Gloeocystis	17,000	0
Amphora	17,000	0
Scenedesmus	17,000	0

1-Oct-01

Organism	No./m³	No./mL
Oscillatoria	990,000,000	990
Melosira	1,800,000	2
Anabaena	590,000	1
Dictyosphaerium	540,000	1
Ankistrodesmus	280,000	0
Closterium	240,000	0
Rotifera	160,000	0
Cyclotella	71,000	0
Copepoda	47,000	0
Nauplius	47,000	0
Ophiocytium	24,000	0
Pinnularia	24,000	0
Total	993,823,000	994

Lake Merced South - Pistol Range

18-Dec-01

Organism	No./m^3	No./mL
Oscillatoria	820,000,000	820
Melosira	4,000,000	4
Closterium	220,000	0
Anabaena	160,000	0
Ankistrodesmus	160,000	0
Copepoda	69,000	0
Pinnularia	69,000	0
Fragilaria	52,000	0
Staurastrum	34,000	0
Synedra	17,000	0
Rotifera	17,000	0
Pediastrum	17,000	0
Scenedesmus	17,000	0
Total	824,832,000	825

5-Mar-02

Organism	No./m^3	No./mL
Oscillatoria (50:1 dil)	600,000,000	600
Anabaena	1,000,000	1
Dinobryon	400,000	0
Mougeotia	360,000	0
Stephanodiscus	130,000	0
Anacystis	110,000	0
Rotifera	95,000	0
Synedra	76,000	0
Nauplius	76,000	0
Spirulina	76,000	0
Melosira	38,000	0
Fragilaria	19,000	0
Navicula	19,000	0
Closterium	19,000	0
Ankistrodesmus	19,000	0
Total	602,437,000	602

30-Apr-02

Organism	No./m^3	No./mL
Oscillatoria	760,000,000	760
Melosira	4,100,000	4
Anabaena	2,600,000	3
Closterium	210,000	0
Ankistrodesmus	170,000	0
Rotifera	150,000	0
Copepoda	58,000	0
Nauplius	39,000	0
Dictyosphaerium	39,000	0
Total	767,366,000	767

18-Jun-02

Organism	No./m^3	No./mL
Oscillatoria	1,700,000,000	1,700
Melosira	7,300,000	7
Anabaena	1,600,000	2
Ankistrodesmus	230,000	0
Closterium	210,000	0
Cyclotella	150,000	0
Rotifera	130,000	0
Scenedesmus	85,000	0
Copepoda	85,000	0
Cymbella	64,000	0
Nauplius	64,000	0
Synedra	42,000	0
Pinnularia	21,000	0
Staurastrum	21,000	0
Cladocera	21,000	0
Total	1,710,023,000	1,710

23-Aug-02

Organism	No./m^3	No./mL
Oscillatoria (50:1 dil)	1,000,000,000	1,000
Anabaena	12,000,000	12
Melosira	1,100,000	1
Ankistrodesmus	280,000	0
Nauplius	190,000	0
Closterium	160,000	0
Stephanodiscus	140,000	0
Copepoda	120,000	0
Diatoma	92,000	0
Coelosphaerium	92,000	0
Navicula	92,000	0
Rotifera	69,000	0
Scenedesmus	69,000	0
Gloeocystis	69,000	0
Staurastrum	46,000	0
Synedra	46,000	0
Pinnularia	46,000	0
Fragilaria	23,000	0
Mallomonas	23,000	0
Cladocera	23,000	0
Dictyosphaerium	23,000	0
Oedogonium	23,000	0
Pediastrum	23,000	0
Total	1,014,749,000	1,015

Lake Merced South - Pump Station

18-Dec-01

Organism	No./m^3	No./mL
Oscillatoria	960,000,000	960
Melosira	2,800,000	3
Anabaena	780,000	1
Closterium	98,000	0
Copepoda	49,000	0
Epithemia	49,000	0
Ankistrodesmus	33,000	0
Staurastrum	33,000	0
Fragilaria	16,000	0
Nauplius	16,000	0
Rotifera	16,000	0
Total	963,890,000	964

5-Mar-02

Organism	No./m^3	No./mL
Oscillatoria	600,000,000	600
Anabaena	380,000	0
Mougeotia	380,000	0
Dinobryon	330,000	0
Melosira	180,000	0
Rotifera	160,000	0
Coelosphaerium	130,000	0
Stephanodiscus	120,000	0
Nauplius	82,000	0
Closterium	82,000	0
Anacystis	66,000	0
Spirulina	66,000	0
Ankistrodesmus	49,000	0
Kirchneriella	33,000	0
Fragilaria	16,000	0
Mallomonas	16,000	0
Copepoda	16,000	0
Total	602,106,000	602

30-Apr-02

Organism	No./m^3	No./mL
Oscillatoria	900,000,000	900
Melosira	6,900,000	7
Anabaena	3,700,000	4
Closteridium	530,000	1
Rotifera	100,000	0
Ankistrodesmus	100,000	0
Nauplius	79,000	0
Synedra	26,000	0
Copepoda	26,000	0
Staurastrum	26,000	0
Total	911,487,000	911

18-Jun-02

Organism	No./m^3	No./mL
Oscillatoria	2,500,000,000	2,500
Melosira	8,900,000	9
Ankistrodesmus	510,000	1
Cyclotella	400,000	0
Anabaena	280,000	0
Staurastrum	260,000	0
Closterium	230,000	0
Copepoda	170,000	0
Rotifera	140,000	0
Scenedesmus	110,000	0
Cymbella	57,000	0
Cladocera	57,000	0
Pinnularia	28,000	0
Total	2,511,142,000	2,511

23-Aug-02

Organism	No./m^3	No./mL
Oscillatoria (50:1 dil)	930,000,000	930
Anabaena	7,600,000	8
Melosira	330,000	0
Mougeotia	130,000	0
Coelosphaerium	100,000	0
Stephanodiscus	83,000	0
Synedra	67,000	0
Nauplius	67,000	0
Scenedesmus	50,000	0
Ankistrodesmus	50,000	0
Diatoma	50,000	0
Copepoda	33,000	0
Rotifera	33,000	0
Closterium	33,000	0
Sphaerocystis	33,000	0
Euglena	33,000	0
Ceratium	17,000	0
Anacystis	17,000	0
Navicula	17,000	0
Tetraedron	17,000	0
Ophiocytium	17,000	0
Total	938,777,000	939

Lake Merced South - Pistol Range

23-Oct-02

Organism	No./m^3	No./mL
Oscillatoria	930,000,000	930
Anabaena	2,600,000	3
Melosira	780,000	1
Nauplius	280,000	0
Rotifera	87,000	0
Closterium	65,000	0
Epithemia	43,000	0
Synedra	22,000	0
Copepoda	22,000	0
Ankistrodesmus	22,000	0
Scenedesmus	22,000	0
Pinnularia	22,000	0
Total	933,965,000	934

11-Feb-03

Organism	No./m^3	No./mL
Oscillatoria	1,100,000,000	1,100
Melosira	3,100,000	3
Closterium	250,000	0
Rotifera	130,000	0
Copepoda	100,000	0
Cyclotella	100,000	0
Cymbella	51,000	0
Nauplius	25,000	0
Synedra	25,000	0
Scenedesmus	25,000	0
Ankistrodesmus	25,000	0
Total	1,103,831,000	1,104

14-May-03

Organism	No./m^3	No./mL
Oscillatoria	1,200,000,000	1,200
Melosira	8,400,000	8
Closterium	490,000	0
Synedra	380,000	0
Ankistrodesmus	380,000	0
Rotifera	220,000	0
Scenedesmus	160,000	0
Nauplius	82,000	0
Staurastrum	55,000	0
Anabaena	55,000	0
Asterionella	27,000	0
Epithemia	27,000	0
Ceratium	27,000	0
Copepoda	27,000	0
Total	1,210,330,000	1,210

15-Jul-03

Organism	No./m^3	No./mL
Oscillatoria	1,300,000,000	1,300
Anabaena	3,800,000	4
Melosira	1,900,000	2
Copepoda	110,000	0
Closterium	61,000	0
Nauplius	46,000	0
Cymbella	46,000	0
Rotifera	30,000	0
Staurastrum	15,000	0
Cyclotella	15,000	0
Total	1,306,023,000	1,306

30-Sep-03

Organism	No./m^3	No./mL
Oscillatoria	1,100,000,000	1,100
Anabaena	4,100,000	4
Melosira	190,000	0
Ceratium	160,000	0
Closterium	160,000	0
Copepoda	160,000	0
Rotifera	130,000	0
Nauplius	53,000	0
Epithemia	27,000	0
Total	1,104,980,000	1,105

Lake Merced South - Pump Station

23-Oct-02

Organism	No./m^3	No./mL
Oscillatoria	1,100,000,000	1,100
Anabaena	4,800,000	5
Melosira	370,000	0
Rotifera	110,000	0
Ankistrodesmus	65,000	0
Cyclotella	43,000	0
Nauplius	43,000	0
Closterium	43,000	0
Staurastrum	22,000	0
Copepoda	22,000	0
Epithemia	22,000	0
Ceratium	22,000	0
Total	1,105,562,000	1,106

11-Feb-03

Organism	No./m^3	No./mL
Oscillatoria	1,100,000,000	1,100
Melosira	3,300,000	3
Closterium	160,000	0
Rotifera	110,000	0
Cyclotella	90,000	0
Nauplius	45,000	0
Ankistrodesmus	45,000	0
Cymbella	45,000	0
Scenedesmus	45,000	0
Synedra	45,000	0
Anabaena	23,000	0
Staurastrum	23,000	0
Copepoda	23,000	0
Ophiocytium	23,000	0
Total	1,103,977,000	1,104

14-May-03

Organism	No./m^3	No./mL
Oscillatoria	980,000,000	980
Melosira	5,200,000	5
Anabaena	320,000	0
Ankistrodesmus	230,000	0
Synedra	110,000	0
Rotifera	85,000	0
Copepoda	64,000	0
Nauplius	21,000	0
Staurastrum	21,000	0
Scenedesmus	21,000	0
Total	986,072,000	986

15-Jul-03

Organism	No./m^3	No./mL
Oscillatoria	700,000,000	700
Anabaena	7,400,000	7
Melosira	1,800,000	2
Ankistrodesmus	75,000	0
Closterium	56,000	0
Copepoda	56,000	0
Staurastrum	37,000	0
Synedra	37,000	0
Cymbella	19,000	0
Cladocera	19,000	0
Nauplius	19,000	0
Cyclotella	19,000	0
Total	709,537,000	710

30-Sep-03

Organism	No./m^3	No./mL
Oscillatoria	550,000,000	550
Anabaena	3,800,000	4
Melosira	430,000	0
Ceratium	220,000	0
Rotifera	220,000	0
Nauplius	140,000	0
Closterium	68,000	0
0	45,000	0
Synedra	22,000	0
Total	554,945,000	555

Lake Merced South - Pistol Range

2-Dec-03			27-May-04		29-Aug-04		27-Oct-04		9-Dec-04		9-Feb-05		18-Apr-05	
Organism	**No./m^3**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	660,000,000	660	Oscillatoria	505	Oscillatoria	1600	Oscillatoria	2100	Oscillatoria	1400	Oscillatoria	910	Oscillatoria	630
Anabaena	540,000	1	Melosira	1.3	Anabaena	11	Anabaena	4.7	Melosira	0.33	Melosira	0.92	Melosira	5.4
Fragilaria	670,000	1	Anabaena	1.1	Melosira	1.1	Melosira	1.2	Anabaena	0.14	Anabaena	0.19	Anabaena	5.3
Mougeotia	200,000	0	Stephanodiscus	0.35	Copepoda	0.078	Ceratium	0.12	Closterium	0.094	Closterium	0.12	Asterionella	1
Ankistrodesmus	98,000	0	Closterium	0.24	Closterium	0.078	Rotifera	0.094	Copepoda	0.07	Coelosphaerium	0.073	Closterium	0.55
Nauplius	74,000	0	Ankistrodesmus	0.11	Rotifera	0.026	Fragilaria	0.031	Rotifera	0.047	Asterionella	0.073	Synedra	0.26
Coelosphaerium	74,000	0	Pennate Diatom	0.11	Ankistrodesmus	0.026	Coelosphaerium	0.031	Coelosphaerium	0.024	Nauplius	0.024	Rotifera	0.16
Closterium	74,000	0	Synedra	0.089	Nauplius	0.026	Scenedesmus	0.031	Nauplius	0.024	Rotifera	0.024	Ankistrodesmus	0.065
Rotifera	49,000	0	Scenedesmus	0.089	**Total**	1612.334	Closterium	0.031	**Total**	1400.729	Synedra	0.024	Nauplius	0.032
Melosira	49,000	0	Coelosphaerium	0.067			Synedra	0.031			**Total**	911.448	Epithemia	0.032
Cyclotella	49,000	0	Tetraedron	0.067			Nauplius	0.031					Copepoda	0.032
Ceratium	25,000	0	Staurastrum	0.044			**Total**	2106.3					**Total**	642.831
Synedra	25,000	0	Copepoda	0.044										
Cladocera	25,000	0	Nauplius	0.044										
Pennate Diatom	25,000	0	Rotifera	0.044										
Total	661,977,000	662	Anacystis	0.044										
			Dinobryon	0.022										
			Asterionella	0.022										
			Total	508.786										

Lake Merced South - Pump Station

2-Dec-03			27-May-04		29-Aug-04		27-Oct-04		9-Dec-04		9-Feb-05		18-Apr-05	
Organism	**No./m^3**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	700,000,000	700	Oscillatoria (10:1)	440	Oscillatoria	1400	Oscillatoria	1900	Oscillatoria	850	Oscillatoria	1200	Oscillatoria	500
Anabaena	250,000	0	Melosira	0.92	Anabaena	1.6	Anabaena	3	Melosira	0.27	Melosira	1.2	Melosira	4.5
Mougeotia	250,000	0	Anabaena	0.9	Melosira	1.3	Melosira	0.81	Closterium	0.11	Anabaena	0.17	Anabaena	2.8
Melosira	250,000	0	Stephanodiscus	0.26	Ankistrodesmus	0.12	Ceratium	0.21	Anabaena	0.08	Synedra	0.11	Asterionella	0.42
Ankistrodesmus	230,000	0	Closterium	0.13	Rotifera	0.093	Rotifera	0.12	Coelosphaerium	0.027	Coelosphaerium	0.083	Closterium	0.29
Fragilaria	140,000	0	Copepoda	0.064	Ceratium	0.093	Closterium	0.09	Copepoda	0.027	Nauplius	0.083	Synedra	0.13
Nauplius	91,000	0	Rotifera	0.064	Closterium	0.07	Ankistrodesmus	0.06	Cymbella	0.027	Rotifera	0.055	Rotifera	0.032
Closterium	91,000	0	Anacystis	0.064	Synedra	0.023	Staurastrum	0.03	**Total**	850.541	Copepoda	0.055	Copepoda	0.016
Ankistrodesmus	68,000	0	Dinobryon	0.043	**Total**	1403.299	Copepoda	0.03			Closterium	0.055	Epithemia	0.016
Cladocera	23,000	0	Synedra	0.043			Stephanodiscus	0.03			Ankistrodesmus	0.028	Coelosphaerium	0.016
Copepoda	23,000	0	Nauplius	0.043			**Total**	1904.38			Scenedesmus	0.028	**Total**	508.22
Rotifera	23,000	0	Coelosphaerium	0.043							**Total**	1201.867		
Xanthidium	23,000	0	Pennate Diatom	0.043										
Pennate Diatom	23,000	0	Tetraedron	0.043										
Cyclotella	23,000	0	Scenedesmus	0.043										
Total	701,508,000	702	Staurastrum	0.021										
			Ankistrodesmus	0.021										
			Spirogyra	0.021										
			Total	442.766										

Lake Merced South - Pistol Range

23-Jun-05

Organism	No./mL
Oscillatoria (20:1 dil)	580
Anabaena	25
Aphanizomenon	13
Melosira	0.41
Stephanodiscus	0.22
Coelosphaerium	0.12
Ceratium	0.059
Closterium	0.059
Mallomonas	0.039
Nauplius	0.039
Scenedesmus	0.039
Fragilaria	0.039
Asterionella	0.039
Cladocera	0.02
Copepoda	0.02
Rotifera	0.02
Staurastrum	0.02
Synedra	0.02
Total	619.2

17-Aug-05

Organism	No./m3
Oscillatoria	410
Melosira	16
Anabaena	3.5
Closterium	0.32
Ceratium	0.065
Ankistrodesmus	0.043
Nauplius	0.043
Copepoda	0.022
Total	429.993

28-Sep-05

Organism	No./mL
Oscillatoria	620
Anabaena	12
Copepod	0.59
Nauplius	0.39
Melosira	0.28
Ceratium	0.19
Pediastrum	0.095
Total	634

31-Oct-05

Organism	No./m3	No./mL
Oscillatoria	870,000,000	870
Anabaena	5,700,000	6
Rotifera	170,000	0.17
Nauplius	83,000	0.08
Ceratium	63,000	0.06
Copepod	21,000	0.02
Total	876,078,988	876

29-Nov-05

Organism	No./mL
Oscillatoria	840
Melosira	11
Anabaena	3
Copepoda	0.082
Closterium	0.055
Ankistrodesmus	0.028
Asterionella	0.028
Total	854

29-Dec-05		23-Jan-06		1-Mar-06	
Organism	No./mL	Organism	No./mL	Organism	No./mL
Oscillatoria	1100	Oscillatoria	940	Oscillatoria	830

Lake Merced South - Pump Station

23-Jun-05

Organism	No./mL
Oscillatoria (20:1 dil)	651.8251425
Anabaena	25.5122959
Aphanizomenon	16.42412456
Melosira	0.350443625
Stephanodiscus	0.186903267
Cyclotella	0.163540358
Ceratium	0.14017745
Nauplius	0.070088725
Rotifera	0.070088725
Coelosphaerium	0.070088725
Fragilaria	0.046725817
Copepoda	0.046725817
Navicula	0.046725817
Dinobryon	0.023362908
Cladocera	0.023362908
Closterium	0.023362908
Pinnularia	0.023362908
Scenedesmus	0.023362908
Total	695.0698858

17-Aug-05

Organism	No./m3
Oscillatoria	700
Melosira	18
Anabaena	4
Ceratium	0.28
Closterium	0.17
Copepoda	0.087
Rotifera	0.065
Ankistrodesmus	0.065
Stephanodiscus	0.043
Coelosphaerium	0.022
Asterionella	0.022
Nauplius	0.022
Epithemia	0.022
Total	722.798

28-Sep-05

Organism	No./mL
Oscillatoria	590
Anabaena	6.5
Nauplius	0.16
Ceratium	0.16
Copepoda	0.082
Melosira	0.082
Total	597

31-Oct-05

Organism	No./m3
Oscillatoria	810
Anacystis	140
Melosira	11
Anabaena	8.1
Closterium	0.4
Stephanodiscus	0.06
Rotifera	0.04
Epithemia	0.04
Copepoda	0.04
Ophiocytium	0.02
Nauplius	0.02
Total	969.72

29-Nov-05

Organism	No./mL
Oscillatoria	980
Melosira	10
Anabaena	3.4
Closterium	0.1
Nauplius	0.05
Asterionella	0.025
Epithemia	0.025
Coelosphaerium	0.025
Ankistrodesmus	0.025
Total	994

29-Dec-05		23-Jan-06		1-Mar-06	
Organism	No./mL	Organism	No./mL	Organism	No./mL
Oscillatoria	1200	Oscillatoria	1000	Oscillatoria	850

Lake Merced South - Pistol Range

26-Apr-06		14-Jun-06		24-Aug-06		25-Oct-06		20-Dec-06		29-Mar-07		26-Jun-07		20-Aug-07		27-Dec-07		28-Mar-08	
Organism	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	1200	*Oscillatoria*	1300	*Oscillatoria*	1,000	*Oscillatoria*	1,700	*Oscillatoria*	840	*Oscillatoria*	430	*Oscillatoria*	510	*Oscillatoria*	790	*Oscillatoria*	630	*Oscillatoria*	35
Melosira	36	*Anabeana*	3.8																
Synedra	9.0	*Melosira*	2.5																
Asterionella	6.4	**Total**	1306.3																
Anabaena	6.4																		
Closterium	3.9																		
Fragilaria	1.3																		
Total	1263																		

Lake Merced South - Pump Station

26-Apr-06		14-Jun-06		24-Aug-06		25-Oct-06		20-Dec-06		29-Mar-07		26-Jun-07		20-Aug-07		27-Dec-07		28-Mar-08	
Organism	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	970	*Oscillatoria*	730	*Oscillatoria*	1200	*Oscillatoria*	1,700	*Oscillatoria*	1000	*Oscillatoria*	400	*Oscillatoria*	550	NA		*Oscillatoria*	740	*Oscillatoria*	63
Melosira	44	*Anabaena*	3.4																
Anabaena	14	*Melosira*	2.3																
Synedra	6.4	**Total**	736																
Asterionella	4.8																		
Closterium	3.2																		
Total	1042																		

Lake Merced South - Pistol Range

10-Jun-08		24-Sep-08		4-Dec-08		24-Mar-09		4-Jun-09		22-Sep-09		15-Dec-09	
Organism	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	35	*Oscillatoria*	52	*Oscillatoria*	76	*Oscillatoria*	320	*Oscillatoria*	630	*Oscillatoria*	1800	*Oscillatoria*	910

Lake Merced South - Pump Station

10-Jun-08		24-Sep-08		4-Dec-08		24-Mar-09		4-Jun-09		22-Sep-09		15-Dec-09	
Organism	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**	**Organism**	**No./mL**
Oscillatoria	17	*Oscillatoria*	54	*Oscillatoria*	340	*Oscillatoria*	430	*Oscillatoria*	750	*Oscillatoria*	1500	*Oscillatoria*	850

Lake Merced North

Secchi Disc	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02
Depth (feet)	2.0	1.2	1.5	2.0	1.0	1.0	2.0		1.0	1.0	1.5	1.0	1.0	1.0	1.5	1.0	1.0	1.0	2.0

Lake Merced North East

Secchi Disc	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02
Depth (feet)	2.5		3.3	2.0	1.5	1.5	1.0		1.0	1.0	1.2	1.5	1.5	1.0	1.0	1.0	1.0	1.0	2.0

Lake Merced South - Pistol Range

Secchi Disc	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02
Depth (feet)	1.7	1.0	1.5	2.0	2.5	1.5	2.5	1.5	1.0	1.0	1.4	1.5	1.5	2.5	2.5	1.0	1.0	1.5	2.5

Lake Merced South - Pump Station

Secchi Disc	15-May-97	10-Sep-97	3-Dec-97	16-Mar-98	8-Jul-98	23-Sep-98	17-Mar-99	21-Jun-99	15-Sep-99	8-Dec-99	21-Mar-00	21-Jun-00	9-Aug-00	19-Dec-00	7-Mar-01	20-Jun-01	1-Oct-01	18-Dec-01	5-Mar-02
Depth (feet)	1.7	1.0	1.5	2.0	2.5	1.5	2.5	1.5	1.0	1.0	1.8	1.5	1.5	2.0	2.5	1.0	1.0	1.5	2.0

Lake Merced North

Secchi Disc	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05
Depth (feet)	1.0	1.0	1.0	1.5	1.0	1.0	1.0		1.0	7.0	2.5	2.0	5.0	4.5	10.0		2.0	1.5	2.0	2.0

Lake Merced North East

Secchi Disc	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05
Depth (feet)	1.0	1.0	1.0	1.5	1.0	1.5	1.5	1.5	1.0	2.5	1.5	2.5	2.0	2.5	2.0		1.5	1.5	2.0	2.0

Lake Merced South - Pistol Range

Secchi Disc	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05
Depth (feet)	2.0	1.5	2.0	2.0	1.5	1.5	1.5	2.0	1.5	2.5	1.5	1.5	2.0	2.5	3.0	1.5	2.0	2.0	2.0	2.0

Lake Merced South - Pump Station

Secchi Disc	30-Apr-02	18-Jun-02	23-Aug-02	23-Oct-02	11-Feb-03	14-May-03	15-Jul-03	30-Sep-03	2-Dec-03	27-May-04	29-Aug-04	27-Oct-04	9-Dec-04	9-Feb-05	18-Apr-05	23-Jun-05	17-Aug-05	28-Sep-05	31-Oct-05	29-Nov-05
Depth (feet)	2.0	1.5	2.0	1.5	1.5	2.0	1.5	1.5	2.0	2.5	1.3	1.5	2.0	2.5	3.0	1.5	2.5	2.0	1.5	2.0

Lake Merced North

Secchi Disc	29-Dec-05	23-Jan-06	1-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth (feet)	2.5	2.5	3.0		1.5	1.0	1.5	1.0	1.5	1.0	0.5	1.5	2.5	1.0	0.8	2.0	2.0	1.3	1.0	1.5

Lake Merced North East

Secchi Disc	29-Dec-05	23-Jan-06	1-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth (feet)	1.5	1.5	1.5	6.5	1.5	1.0	1.5	1.5	1.5	1.0	0.5	2.5	3.0	1.0	0.5	2.0	2.0	1.5	1.0	1.5

Lake Merced South - Pistol Range

Secchi Disc	29-Dec-05	23-Jan-06	1-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth (feet)	2.0	2.0	2.0	2.0	1.5	1.5	1.5	2.5	2.5	1.5	1.5	2.0	3.0	2.0	1.2	1.8	2.5	2.0	1.3	2.0

Lake Merced South - Pump Station

Secchi Disc	29-Dec-05	23-Jan-06	1-Mar-06	26-Apr-06	14-Jun-06	24-Aug-06	25-Oct-06	20-Dec-06	29-Mar-07	26-Jun-07	20-Aug-07	27-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09	15-Dec-09
Depth (feet)	2.0	2.0	2.0	2.0	1.5	1.5	1.5	2.5	2.5	1.5	1.5	2.0	3.0	2.0	1.0	1.5	2.5	2.0	1.3	2.0

Lake Merced North

Depth	15-May-97 Br	10-Sep-97 Br	03-Dec-97 Br	16-Mar-98 Br
Ft	mg/L	mg/L	mg/L	mg/L
Surf	0.43	0.54	0.52	0.42
5	0.43	0.54	0.54	0.42
10	0.44	0.54	0.51	0.42
15	0.42	0.53	0.53	0.42

Lake Merced North East

Depth	15-May-97 Br	10-Sep-97 Br	03-Dec-97 Br	16-Mar-98 Br
Ft	mg/L	mg/L	mg/L	mg/L
0	0.39		0.49	0.35
5	0.39		0.48	0.35
10	0.38		0.48	0.35

Lake Merced South - Pistol Range

Depth	15-May-97 Br	10-Sep-97 Br	03-Dec-97 Br	16-Mar-98 Br
Ft	mg/L	mg/L	mg/L	mg/L
Surf	0.23	0.26	0.34	0.26
5	0.23	0.28	0.34	
6				0.26
10	0.23	0.29	0.33	
12				0.26
15	0.23	0.29	0.33	
16	0.22	0.32		
18				0.26

Lake Merced South - Pump Station

Depth	15-May-97 Br	10-Sep-97 Br	03-Dec-97 Br	16-Mar-98 Br
Ft	mg/L	mg/L	mg/L	mg/L
Surf	0.23	0.28	0.34	0.26
5	0.23	0.29	0.34	0.26
10	0.22	0.28	0.33	
12				0.26
15	0.23	0.26	0.33	
18				0.26

Lake Merced North

Depth	SO4 (15-May-97)	SO4 (10-Sep-97)	SO4 (03-Dec-97)	SO4 (16-Mar-98)
Ft	mg/L	mg/L	mg/L	mg/L
Surf	22	16	13	16
5	22	16	13	16
10	22	16	13	16
15	22	15	13	16

Lake Merced North East

Depth	SO4 (15-May-97)	SO4 (10-Sep-97)	SO4 (03-Dec-97)	SO4 (16-Mar-98)
Ft	mg/L	mg/L	mg/L	mg/L
0	30		23	26
5	30		23	26
10	30		22	26

Lake Merced South - Pistol Range

Depth	SO4 (15-May-97)	SO4 (10-Sep-97)	SO4 (03-Dec-97)	SO4 (16-Mar-98)
Ft	mg/L	mg/L	mg/L	mg/L
Surf	11	7.1	7.4	16
5	11	7.1	7.5	
6				16
10	11	6.8	7.5	
12				16
15	11	6.4	7.4	
16	11	6.4		
18				16

Lake Merced South - Pump Station

Depth	SO4 (15-May-97)	SO4 (10-Sep-97)	SO4 (03-Dec-97)	SO4 (16-Mar-98)
Ft	mg/L	mg/L	mg/L	mg/L
Surf	11	7.0	7.6	16
5	11	6.9	7.5	16
10	11	6.8	7.6	
12				16
15	11	6.5	7.6	
18				16

Lake Merced North

Depth	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb
	26-Jun-07	20-Aug-07	26-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***
Btm	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***

Lake Merced North East

Depth	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb
	26-Jun-07	20-Aug-07	26-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***
Btm	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***		***0.5***	***0.5***	***0.5***	***0.5***

Lake Merced South - Pistol Range

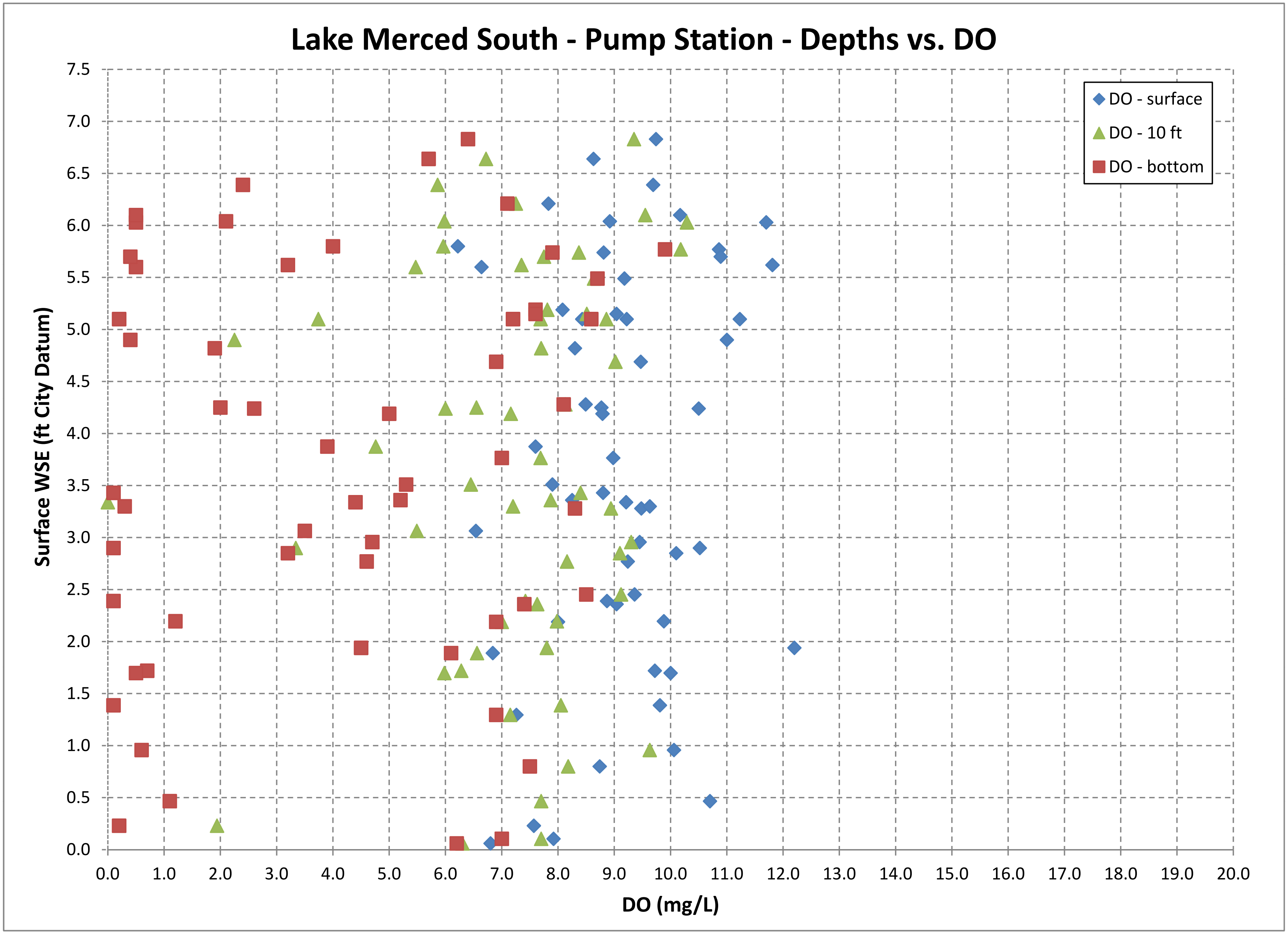
Depth	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb
	26-Jun-07	20-Aug-07	26-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***
Btm		***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	1.42	***0.5***	***0.5***	***0.5***

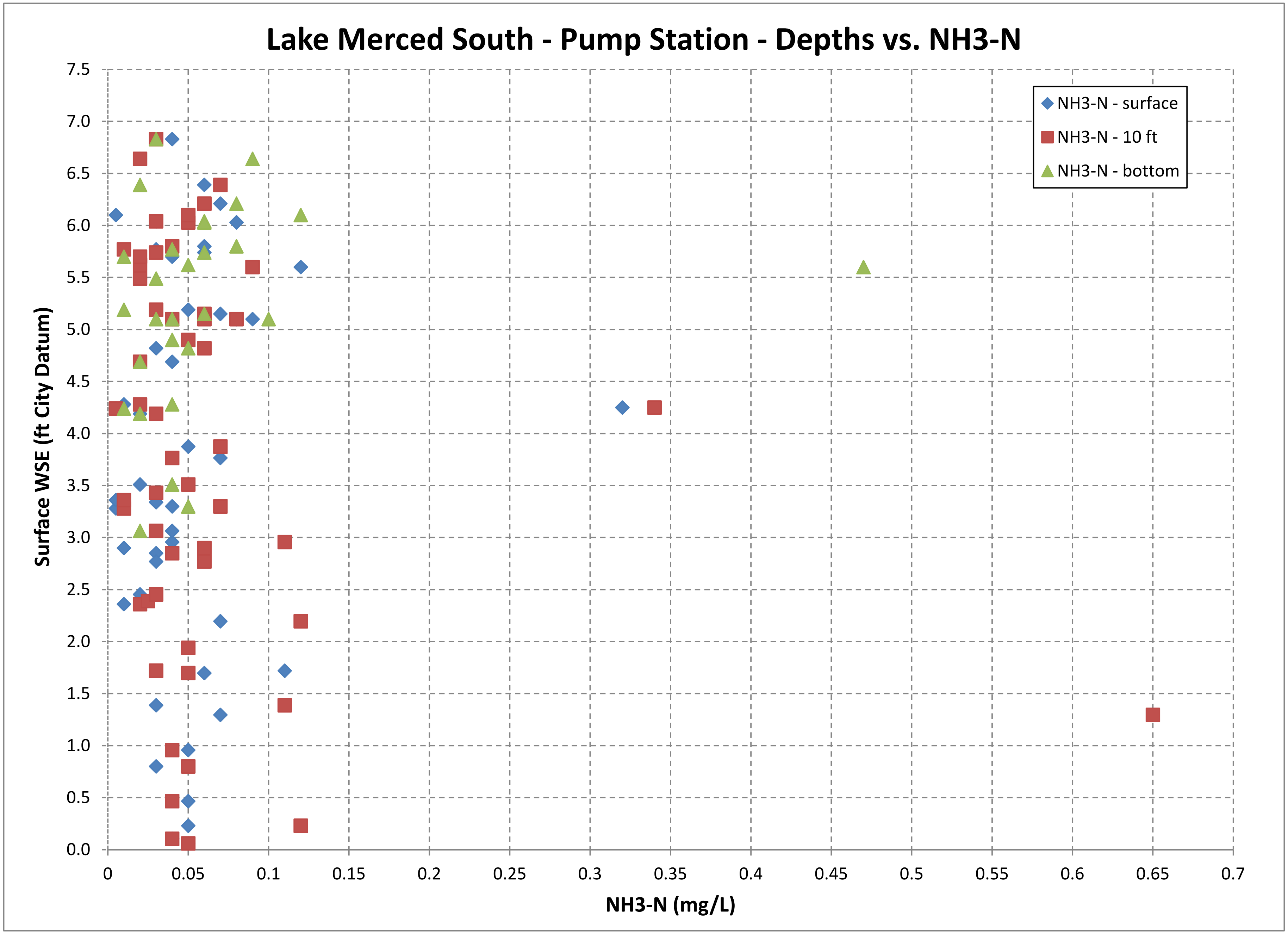
Lake Merced South - Pump Station

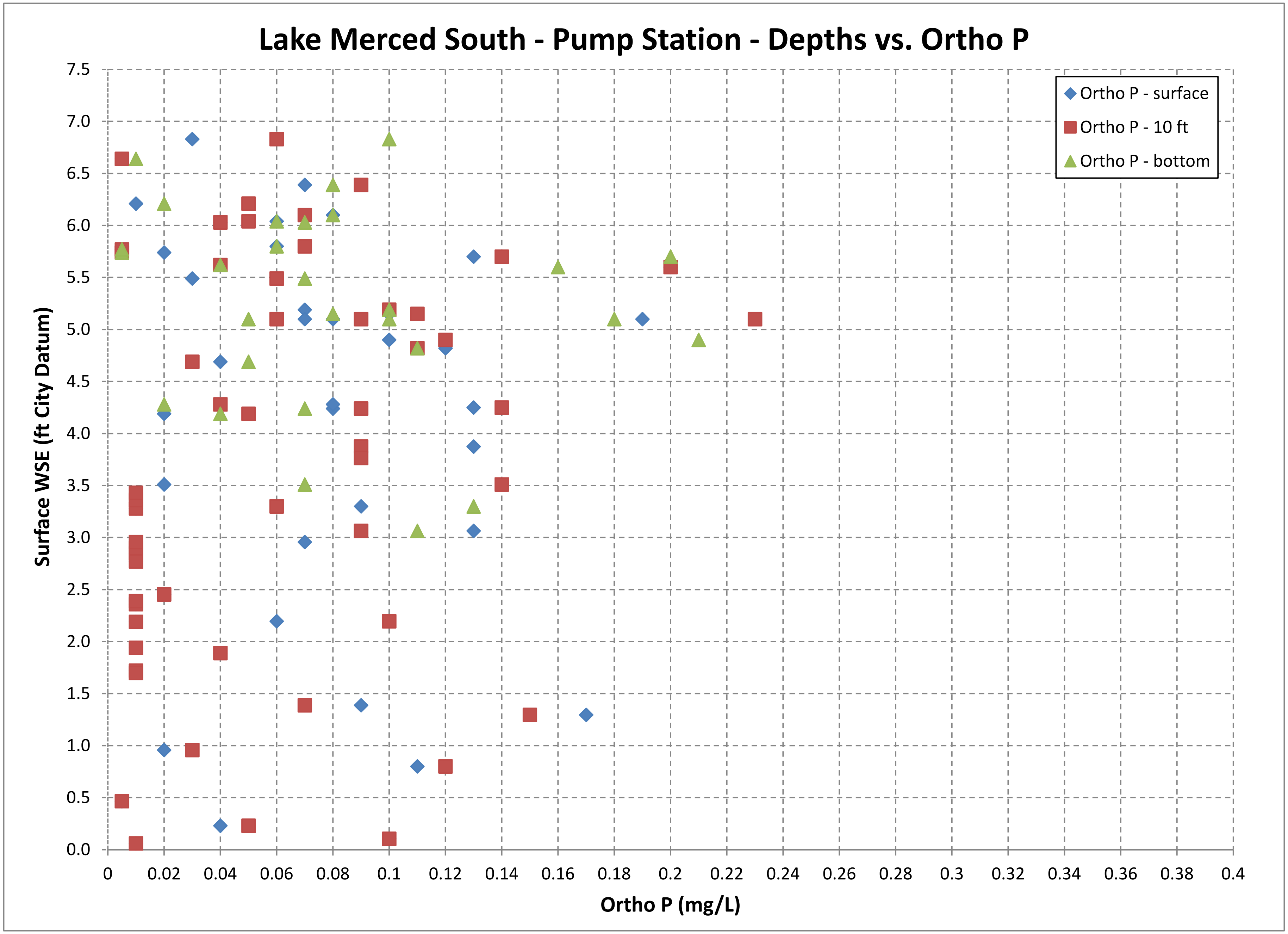
Depth	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb	Pb
	26-Jun-07	20-Aug-07	26-Dec-07	28-Mar-08	10-Jun-08	24-Sep-08	4-Dec-08	24-Mar-09	4-Jun-09	22-Sep-09
	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Surf	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***
Btm	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***	***0.5***

Note: Bold, italicized formats indicate half the reported value for statistical purposes.

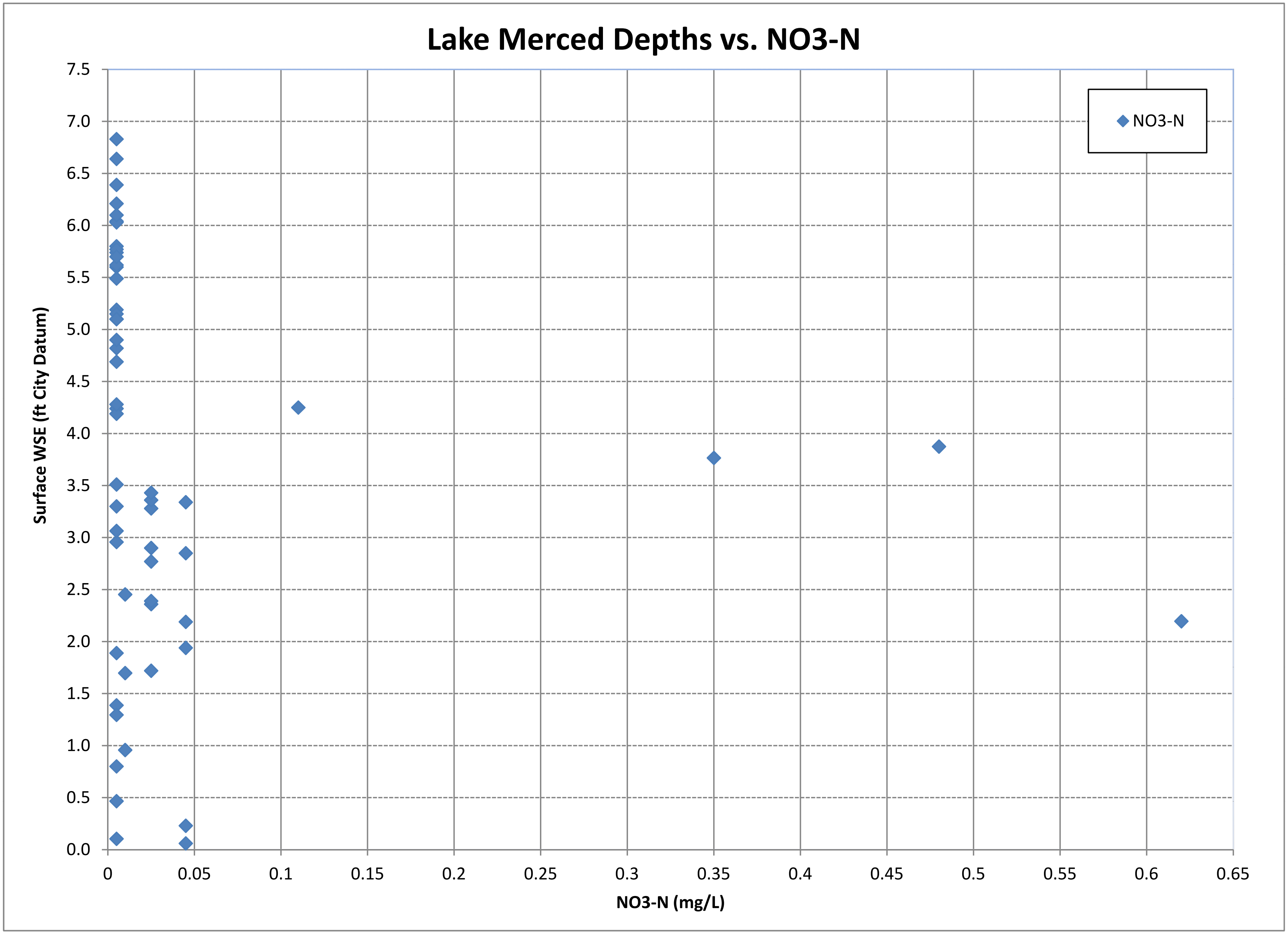
WATER QUALITY GRAPHS

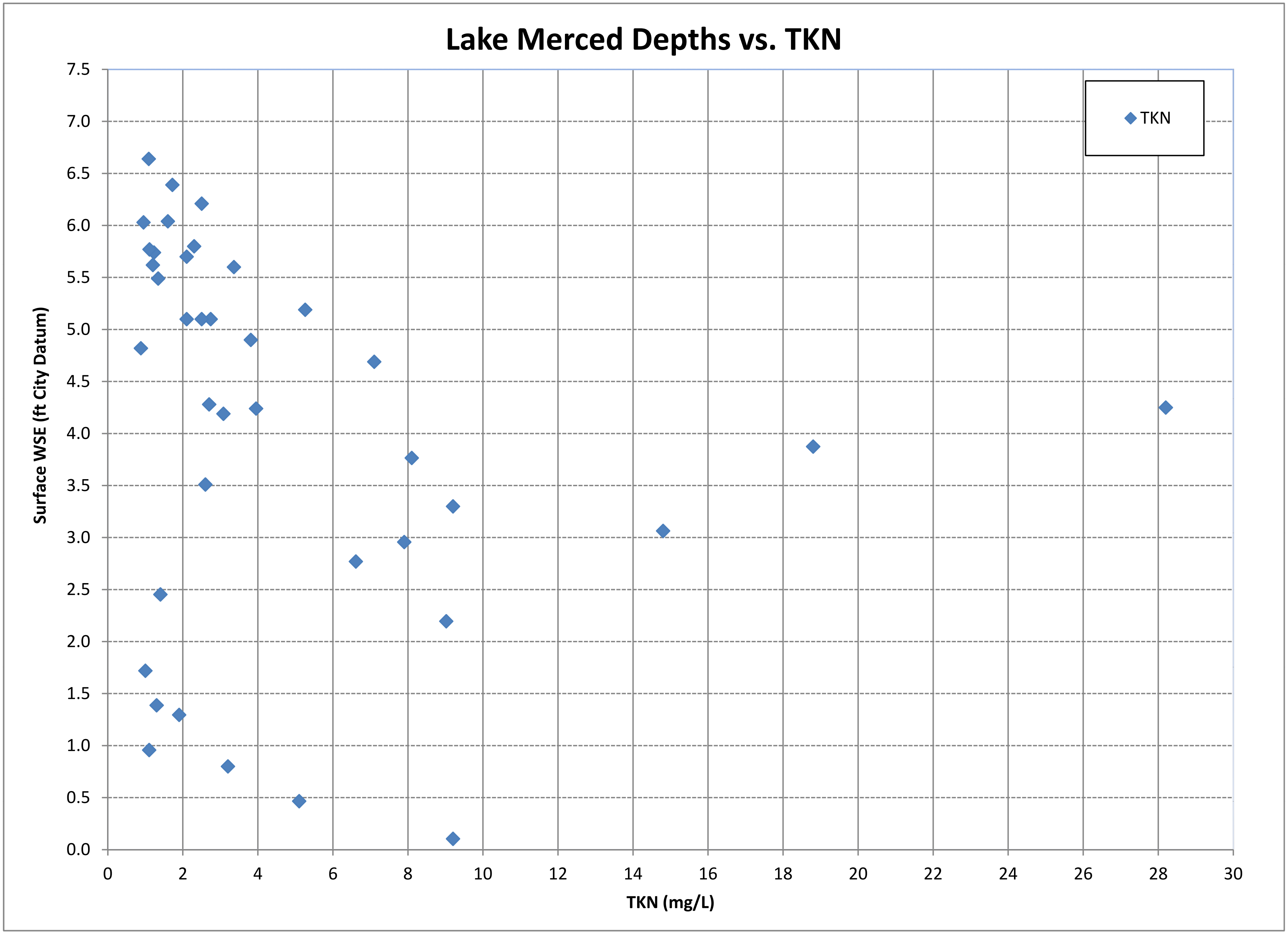

Lake Merced South - Pump Station - Depths vs. DO
Surface WSE (ft City Datum)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
DO (mg/L)
DO - surface
DO - 10 ft
DO - bottom

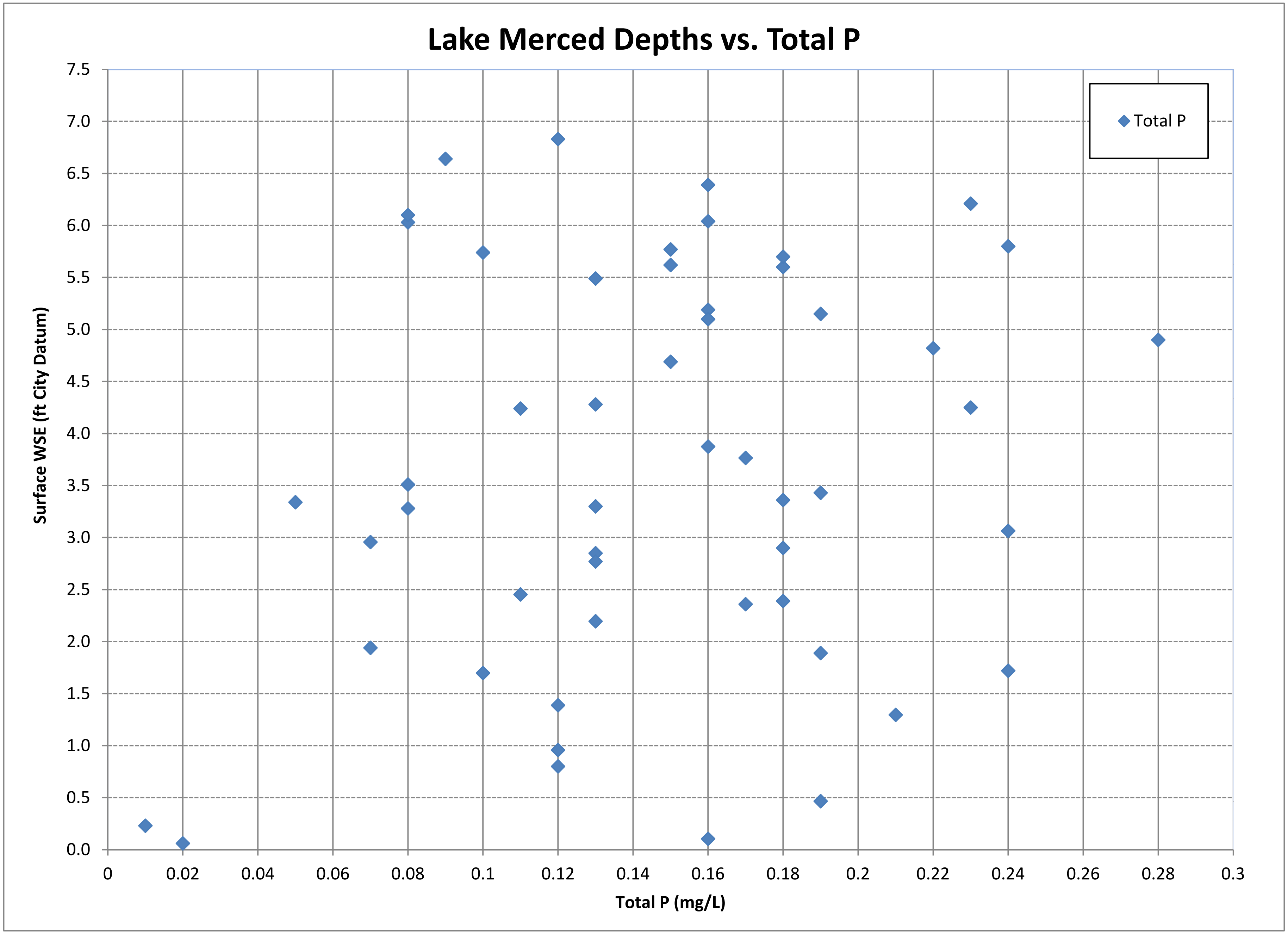

Lake Merced South - Pump Station - Depths vs. NH3-N
NH3-N - surface
NH3-N - 10 ft
NH3-N - bottom
Surface WSE (ft City Datum)
NH3-N (mg/L)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7

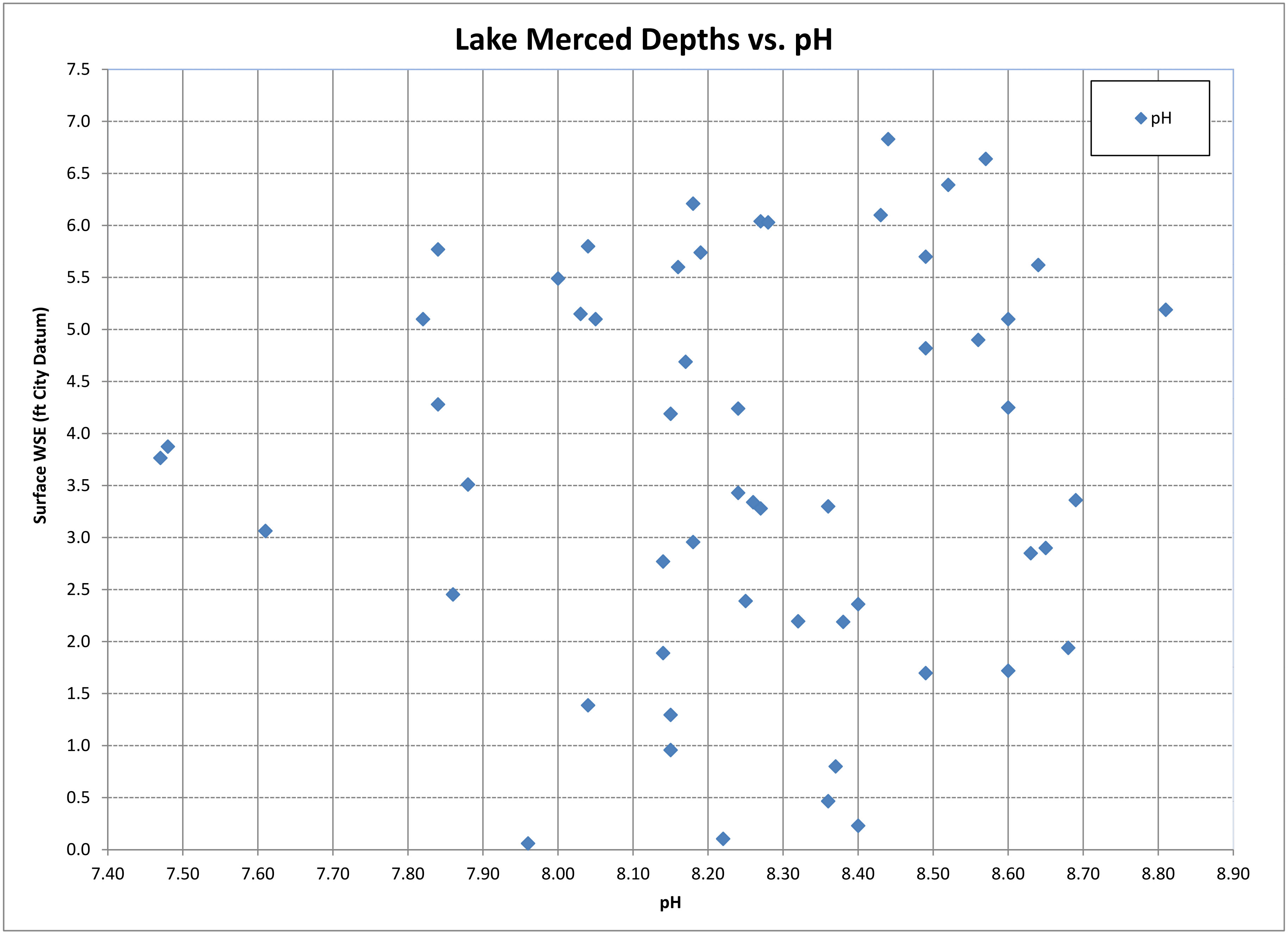


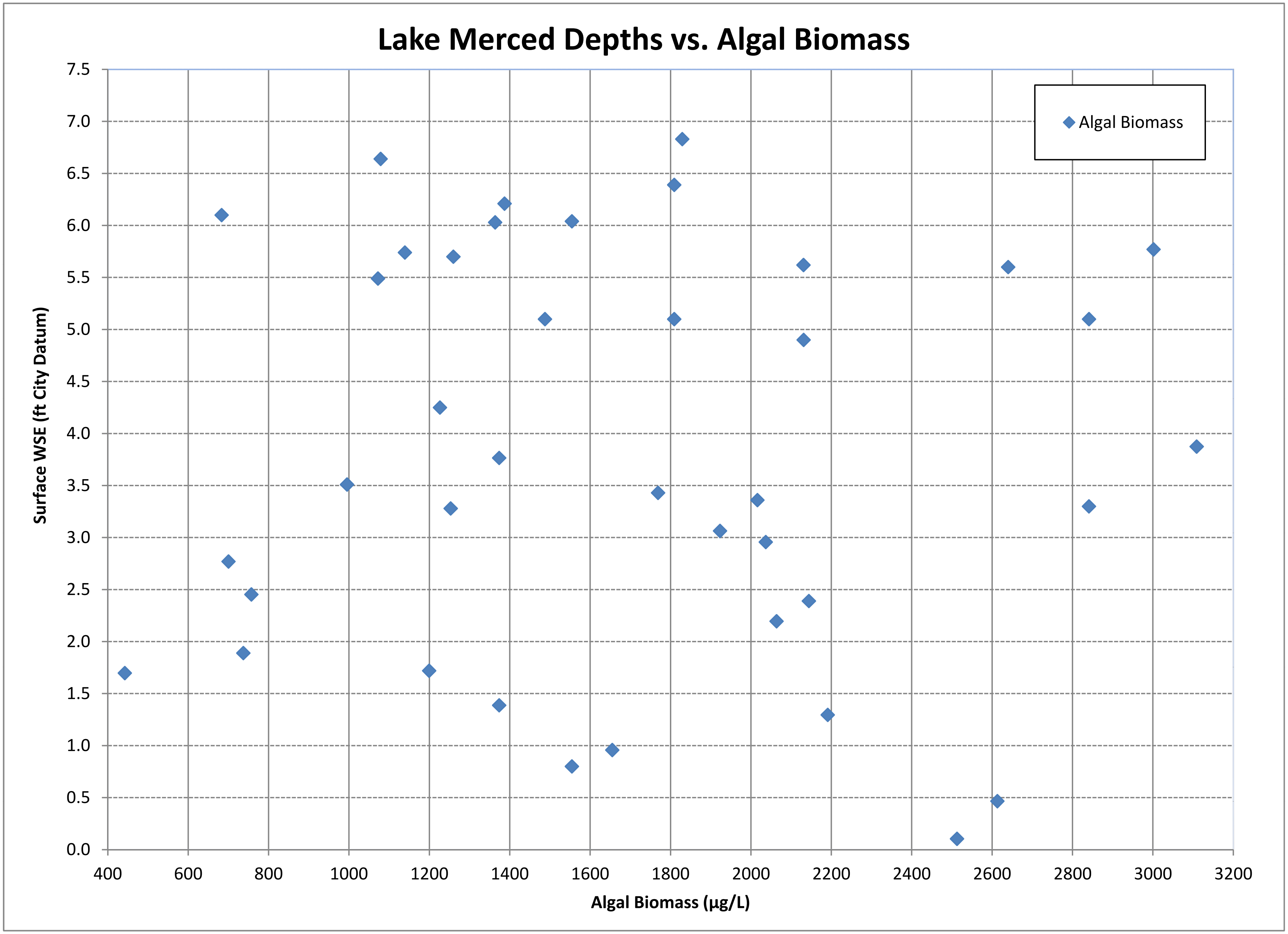
Lake Merced South - Pump Station - Depths vs. Ortho P
Surface WSE (ft City Datum)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4
Ortho P (mg/L)
Ortho P - surface
Ortho P - 10 ft
Ortho P - bottom

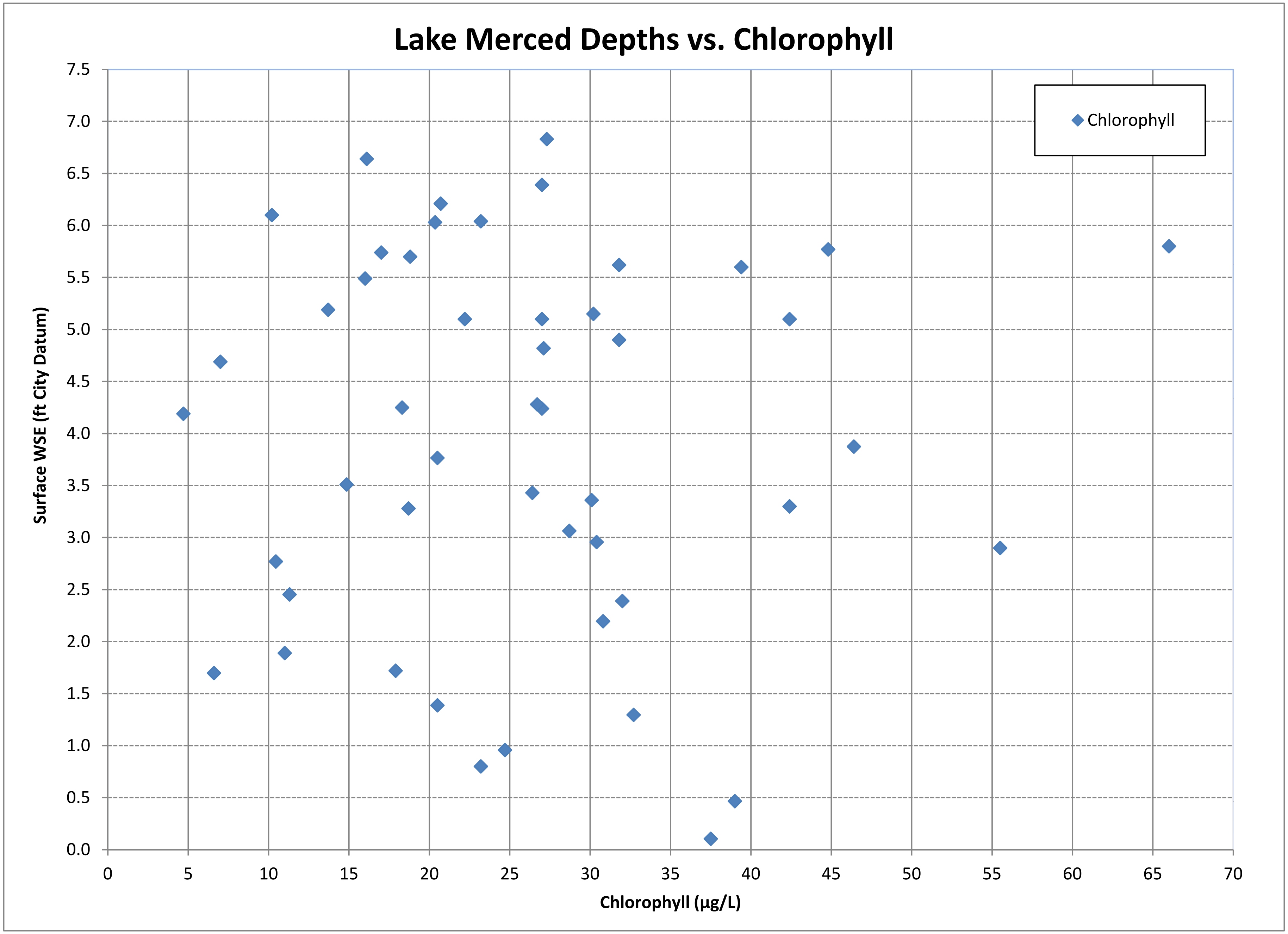

Lake Merced Depths vs. NO3-N
Surface WSE (ft City Datum)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
NO3-N (mg/L)
NO3-N

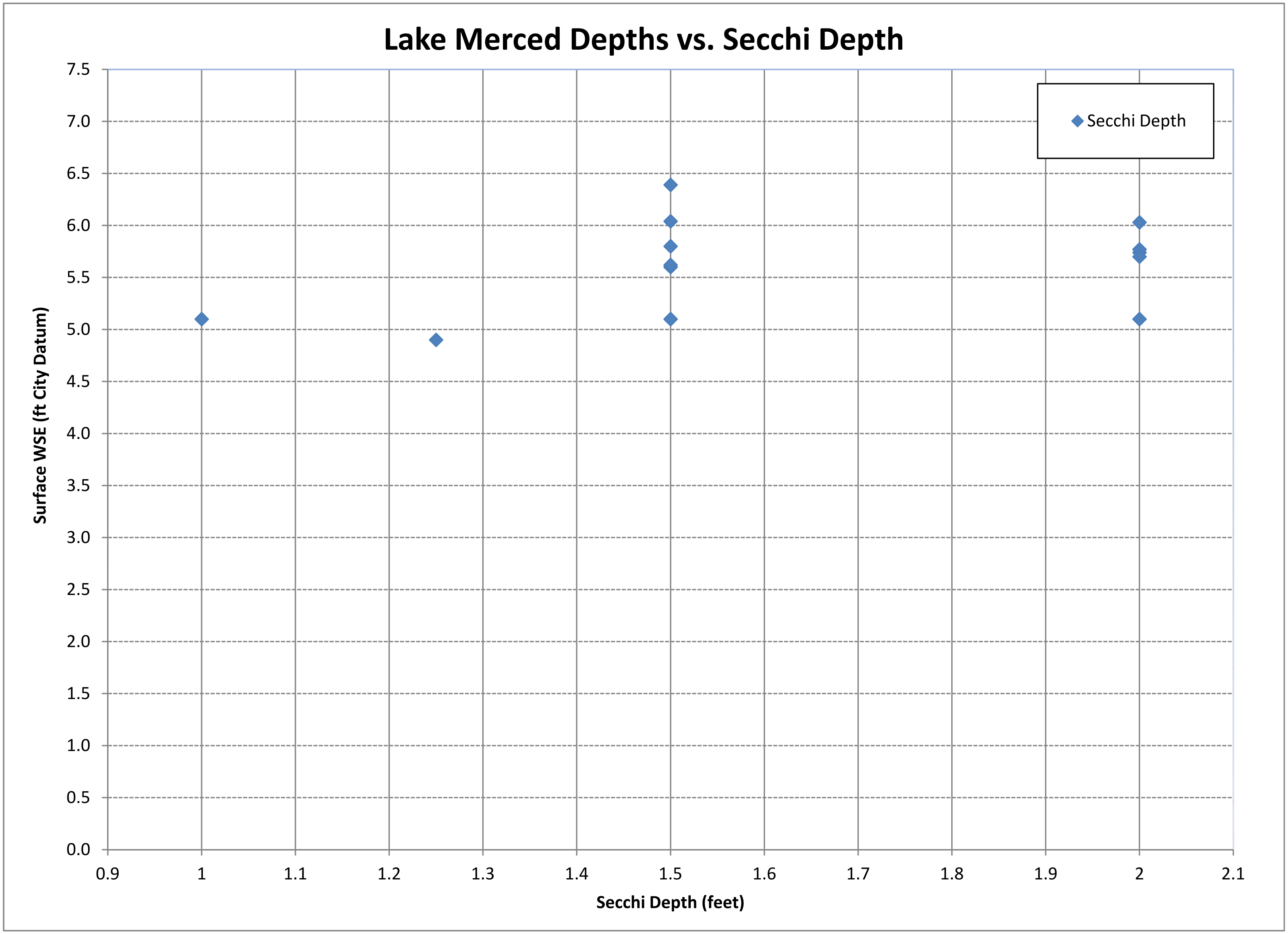

Lake Merced Depths vs. TKN
Surface WSE (ft City Datum)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
TKN (mg/L)
TKN

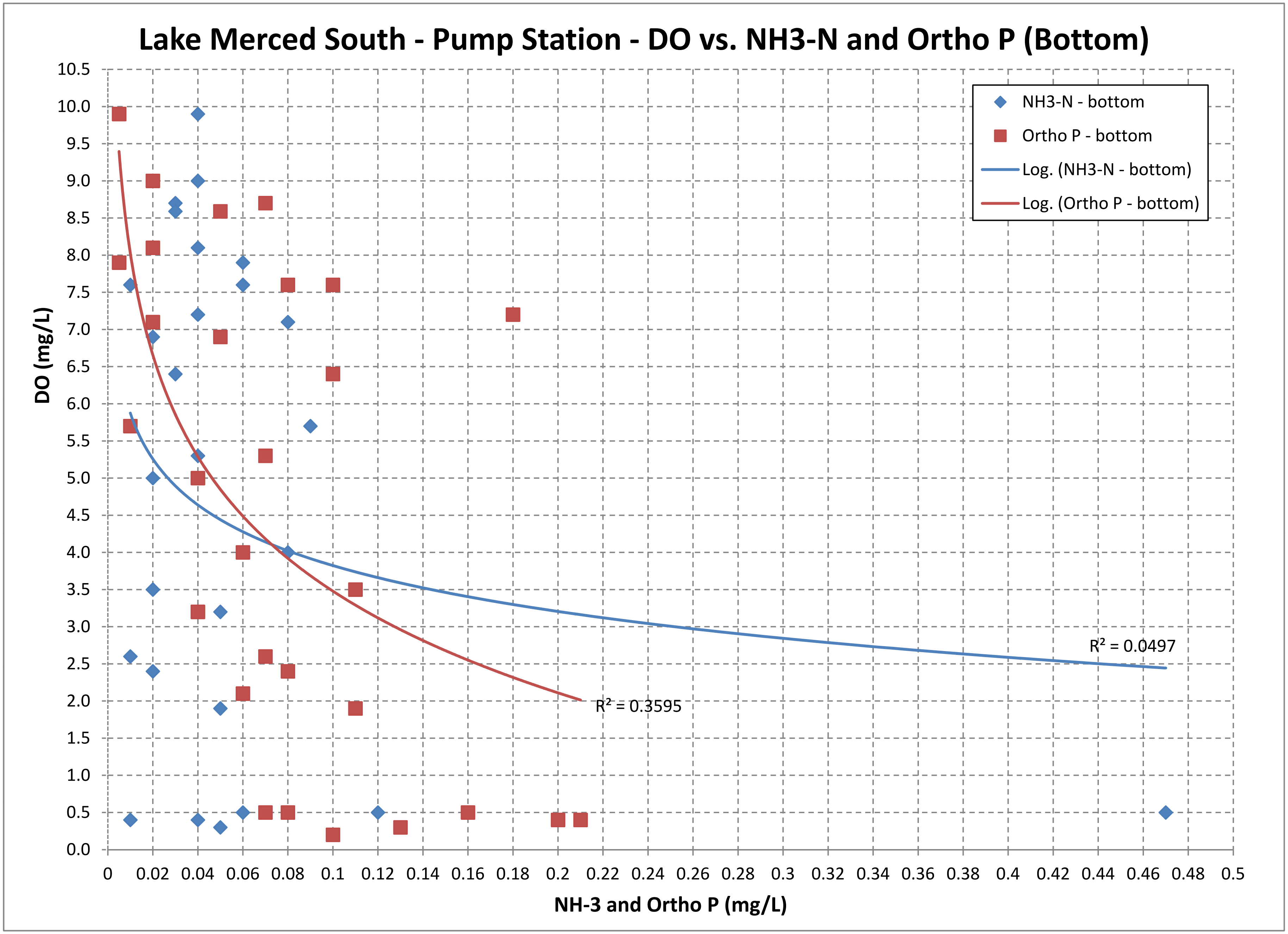

Lake Merced Depths vs. Total P
Surface WSE (ft City Datum)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
Total P (mg/L)
Total P

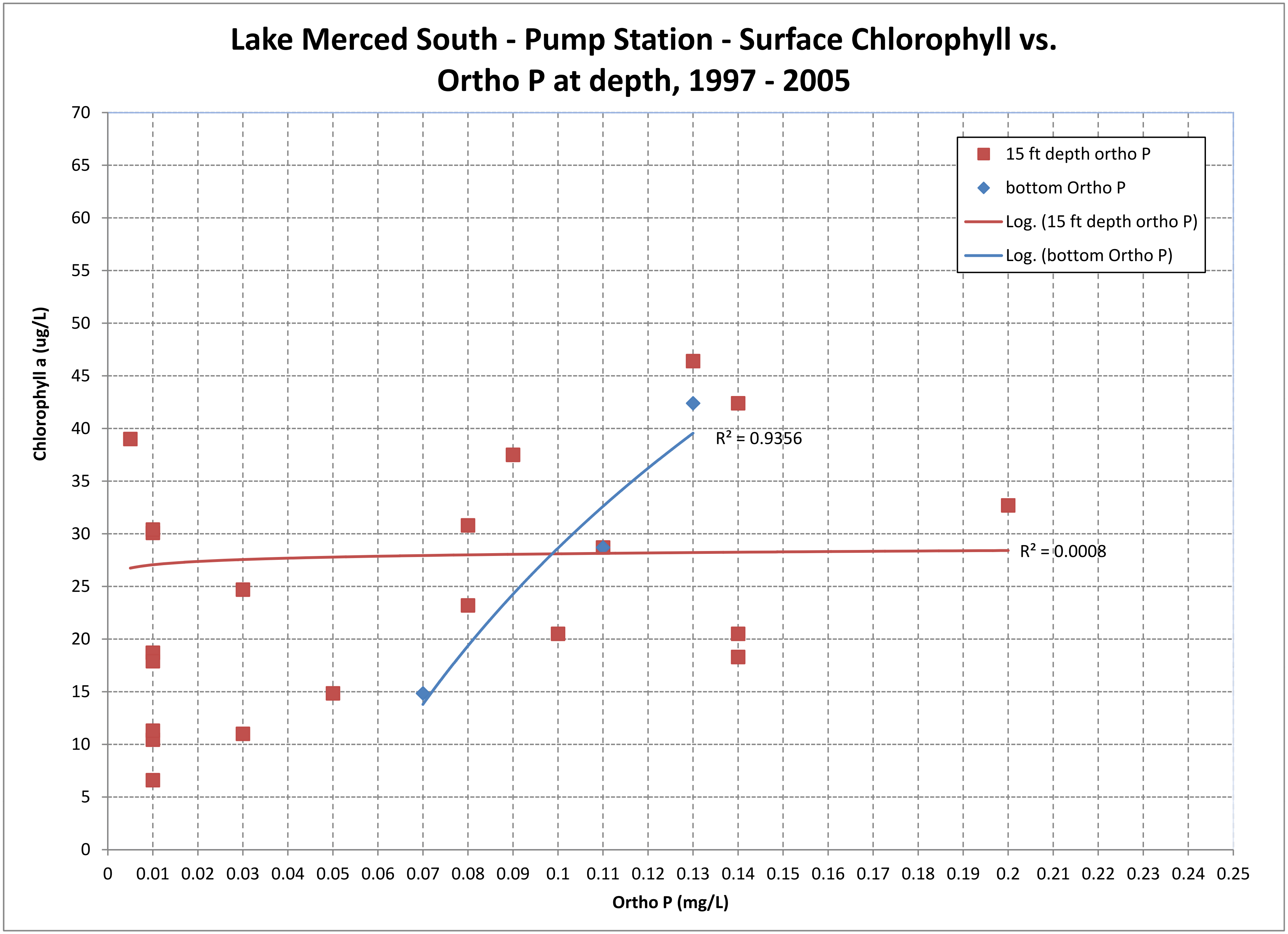

Lake Merced Depths vs. pH
Surface WSE (ft City Datum)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
7.40
7.50
7.60
7.70
7.80
7.90
8.00
8.10
8.20
8.30
8.40
8.50
8.60
8.70
8.80
8.90
pH
pH

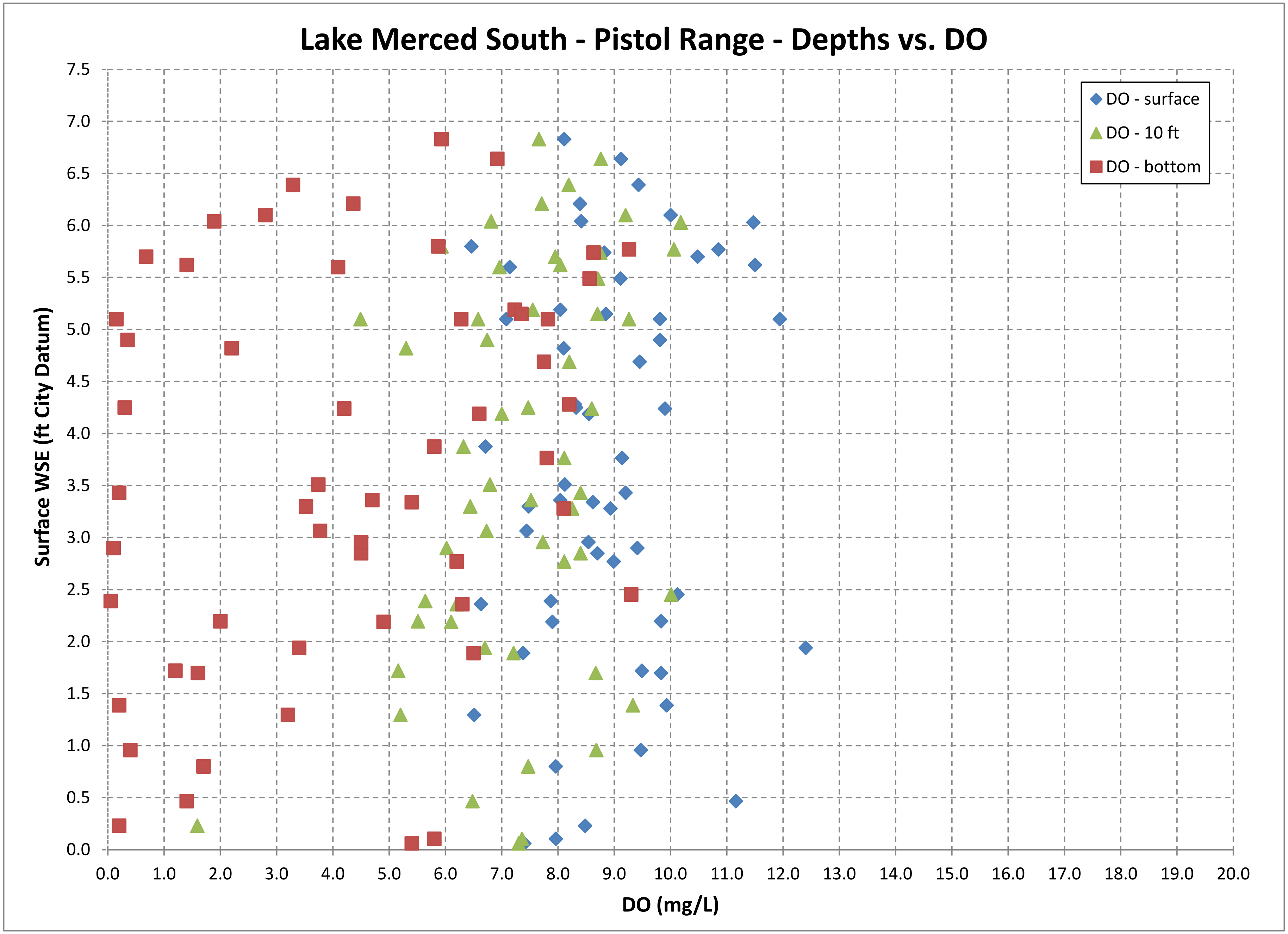

Lake Merced Depths vs. Algal Biomass
Algal Biomass
Surface WSE (ft City Datum)
Algal Biomass (µg/L)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200


Lake Merced Depths vs. Chlorophyll
Surface WSE (ft City Datum)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Chlorophyll (µg/L)
Chlorophyll

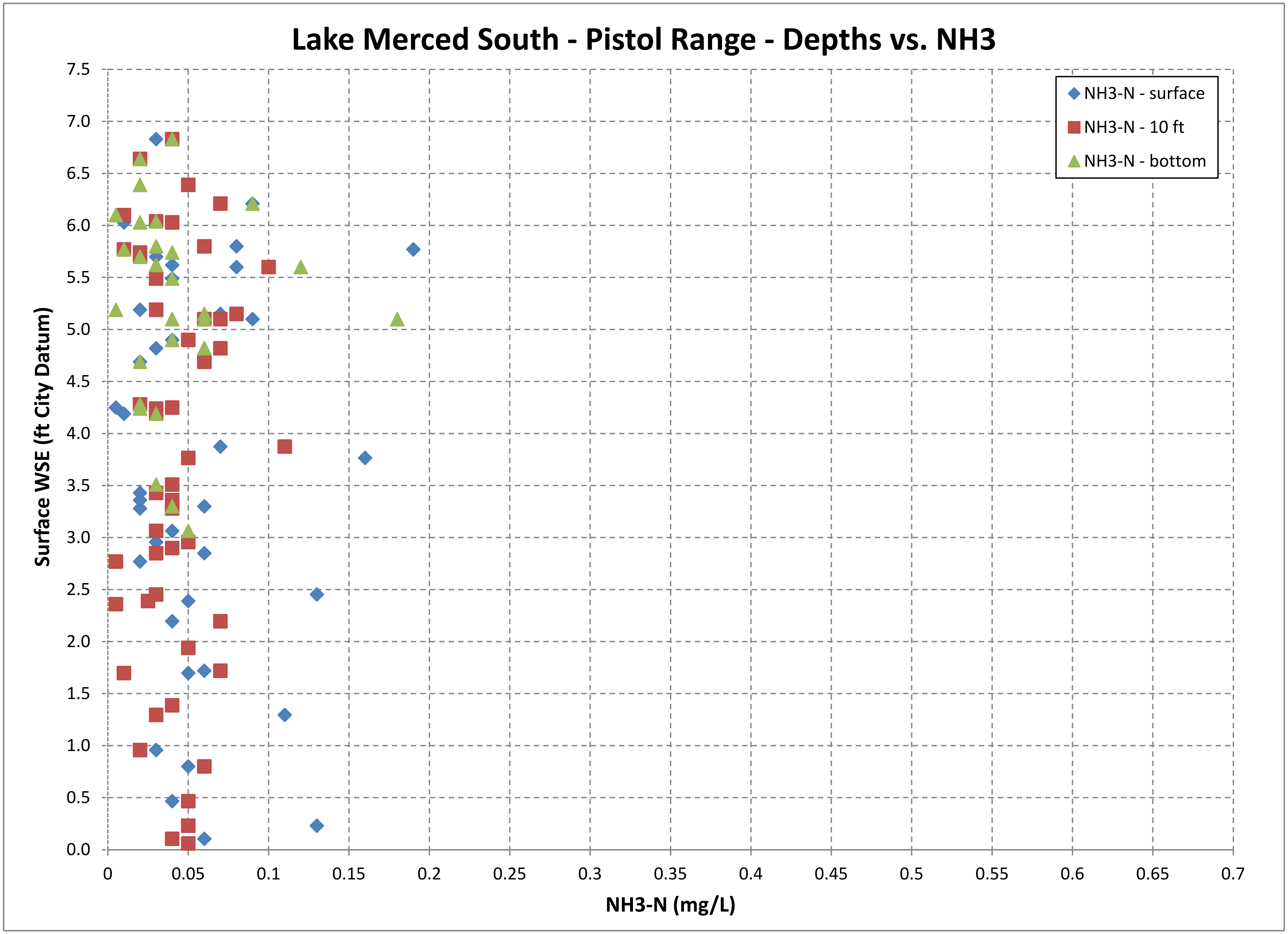

Lake Merced Depths vs. Secchi Depth
Surface WSE (ft City Datum)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.9
1
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
2
2.1
Secchi Depth (feet)
Secchi Depth

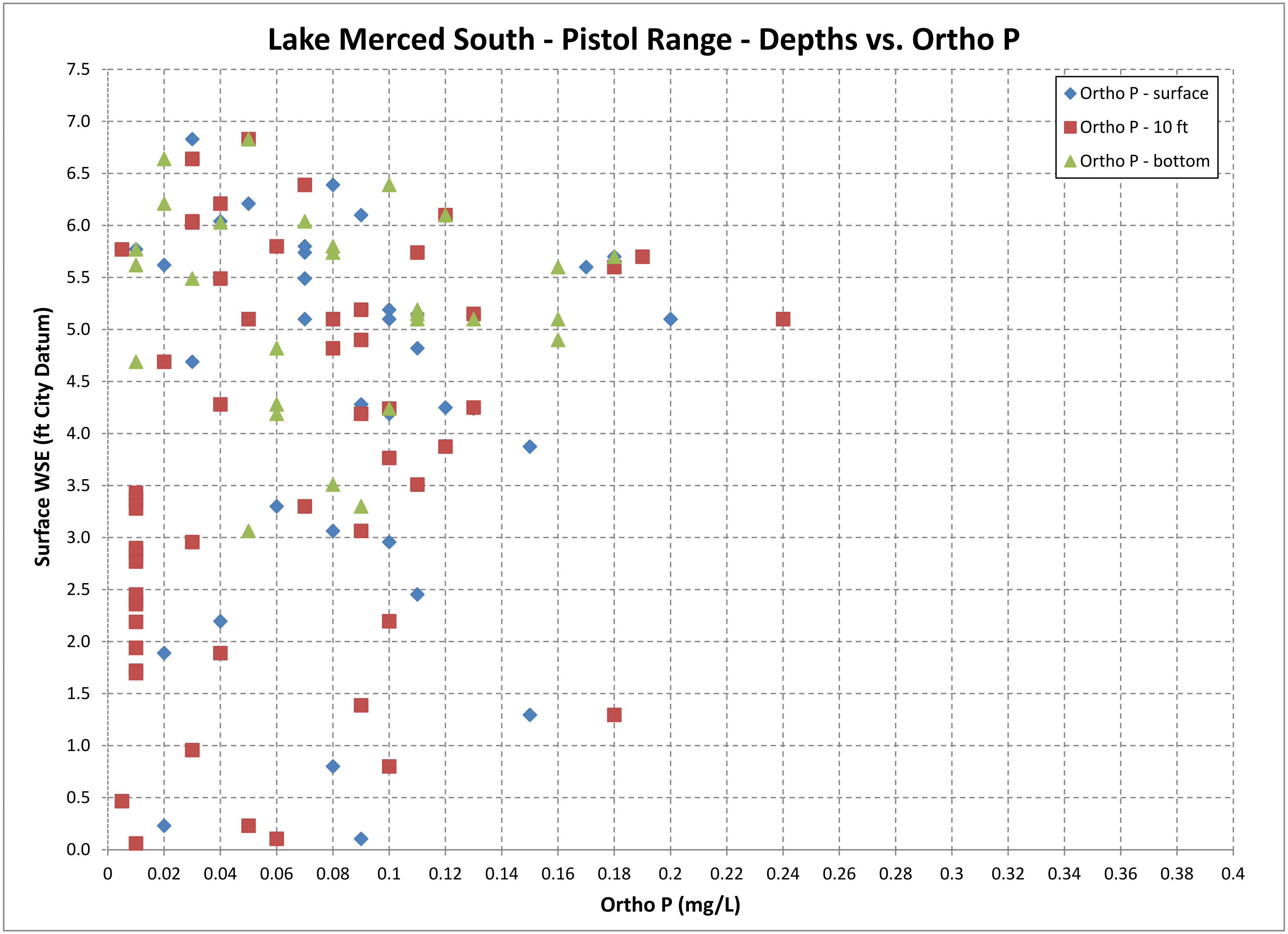

Lake Merced South - Pump Station - DO vs. NH3-N and Ortho P (Bottom)
DO (mg/L)
NH-3 and Ortho P (mg/L)
NH3-N - bottom
Ortho P - bottom
Log. (NH3-N - bottom)
Log. (Ortho P - bottom)
R² = 0.0497
R² = 0.3595
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0 0.02 0.04 0.06 0.08 0.1 0.12 0.14 0.16 0.18 0.2 0.22 0.24 0.26 0.28 0.3 0.32 0.34 0.36 0.38 0.4 0.42 0.44 0.46 0.48 0.5

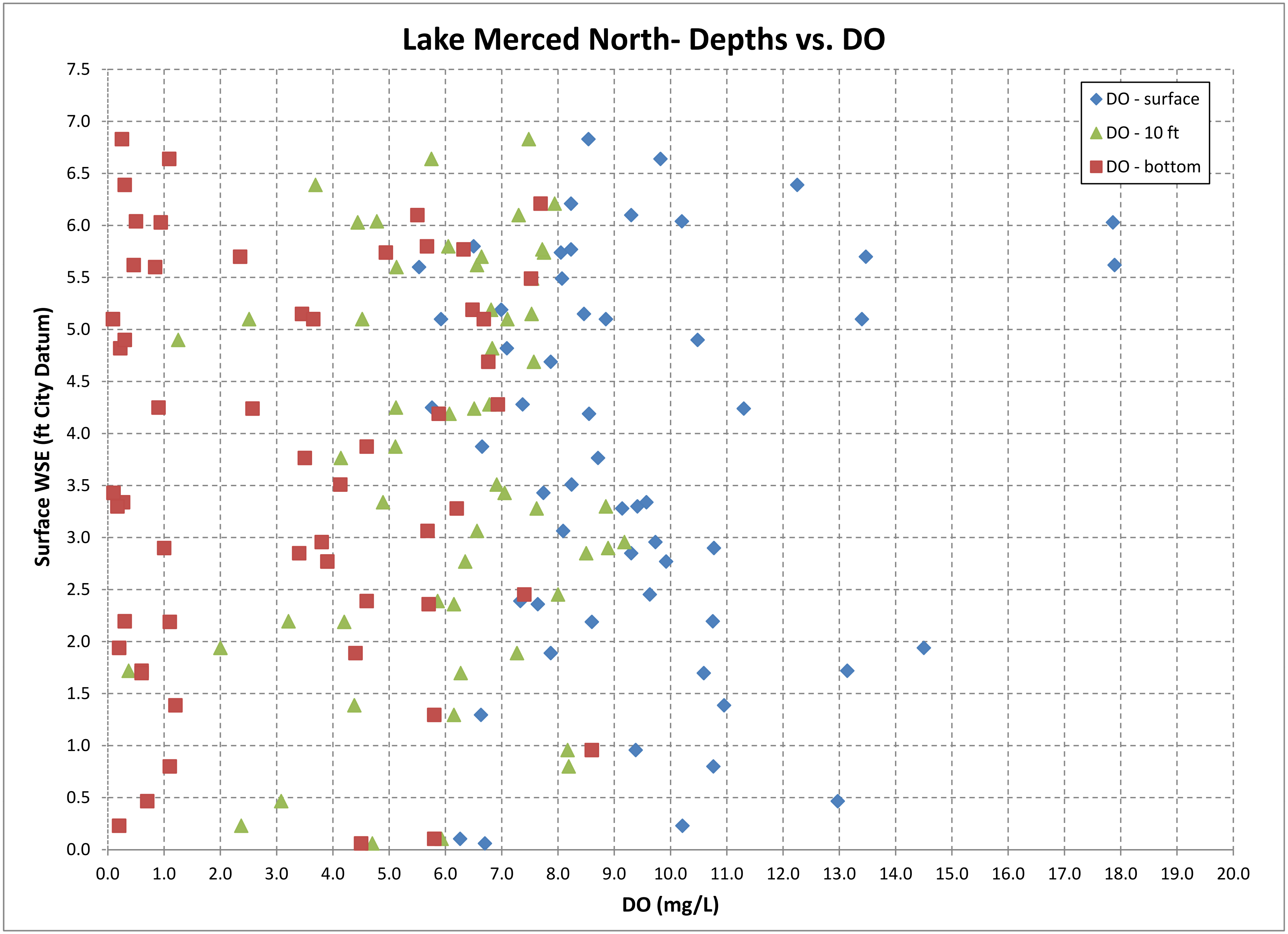

Lake Merced South - Pump Station - Surface Chlorophyll vs. Ortho P at depth, 1997 - 2005
Chlorophyll a (ug/L)
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14
0.15
0.16
0.17
0.18
0.19
0.2
0.21
0.22
0.23
0.24
0.25
Ortho P (mg/L)
15 ft depth ortho P
bottom Ortho P
Log. (15 ft depth ortho P)
Log. (bottom Ortho P)
R² = 0.9356
R² = 0.0008

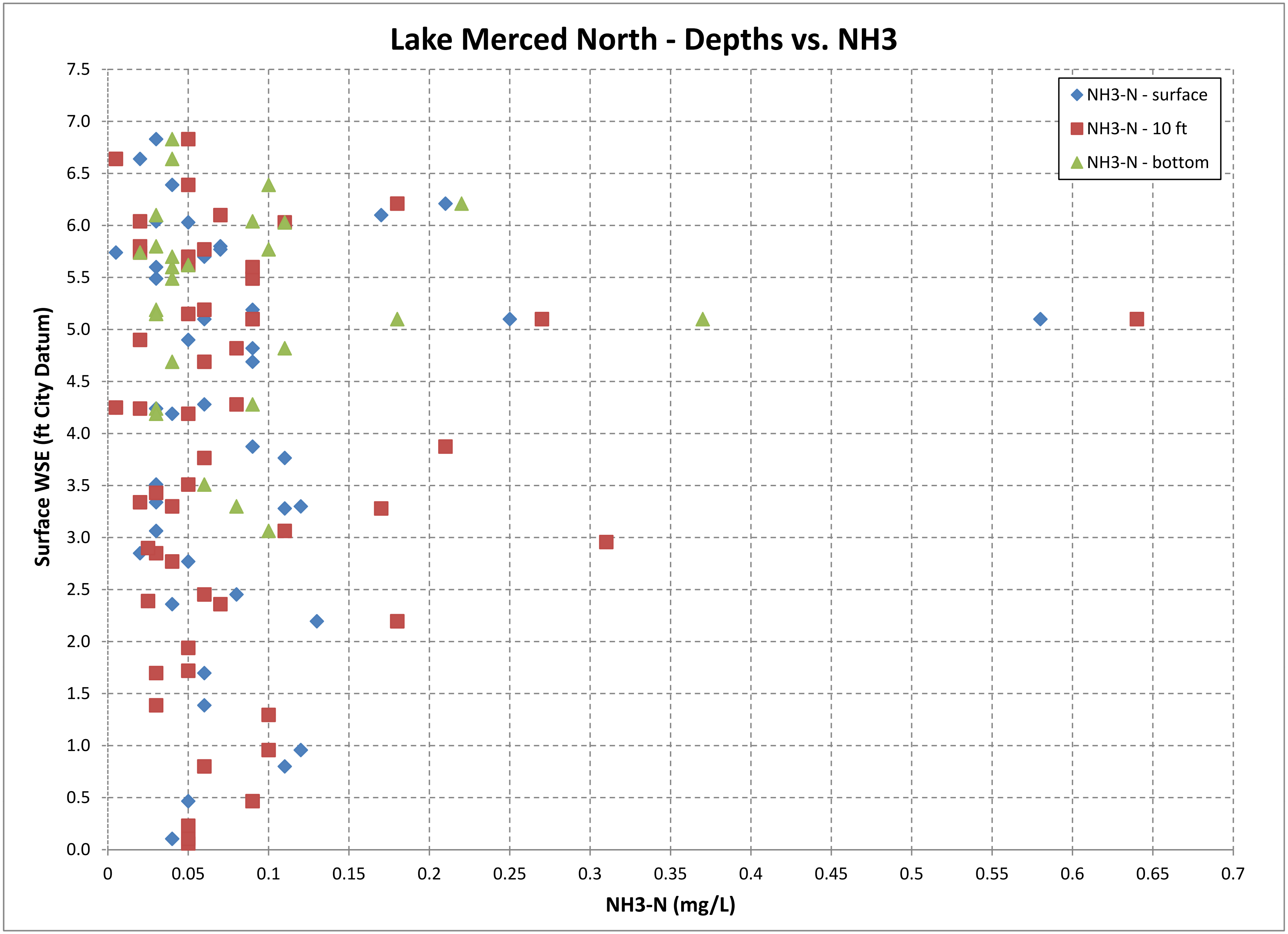


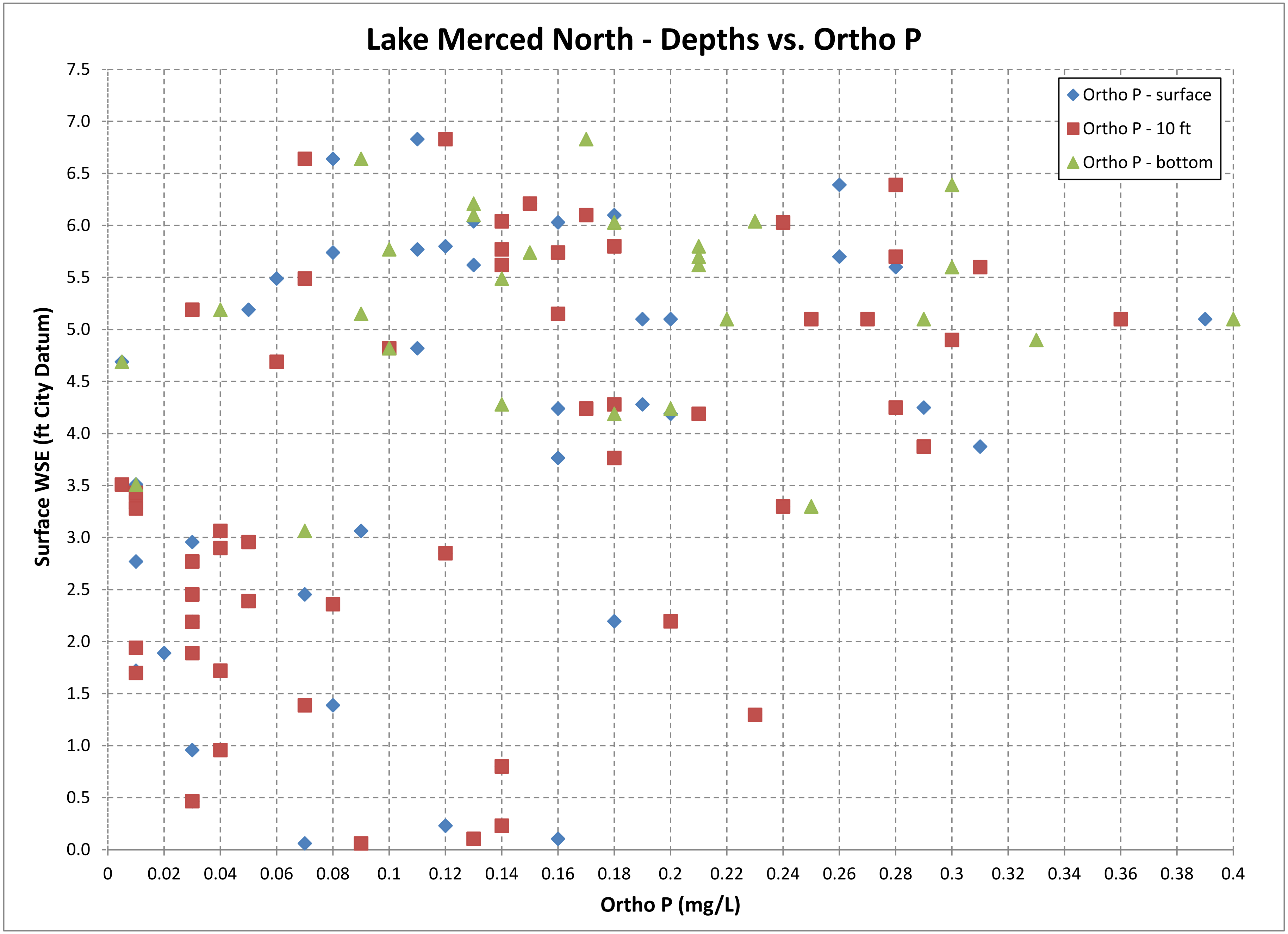
Lake Merced South - Pistol Range - Depths vs. DO
DO - surface
DO - 10 ft
DO - bottom
Surface WSE (ft City Datum)
DO (mg/L)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0

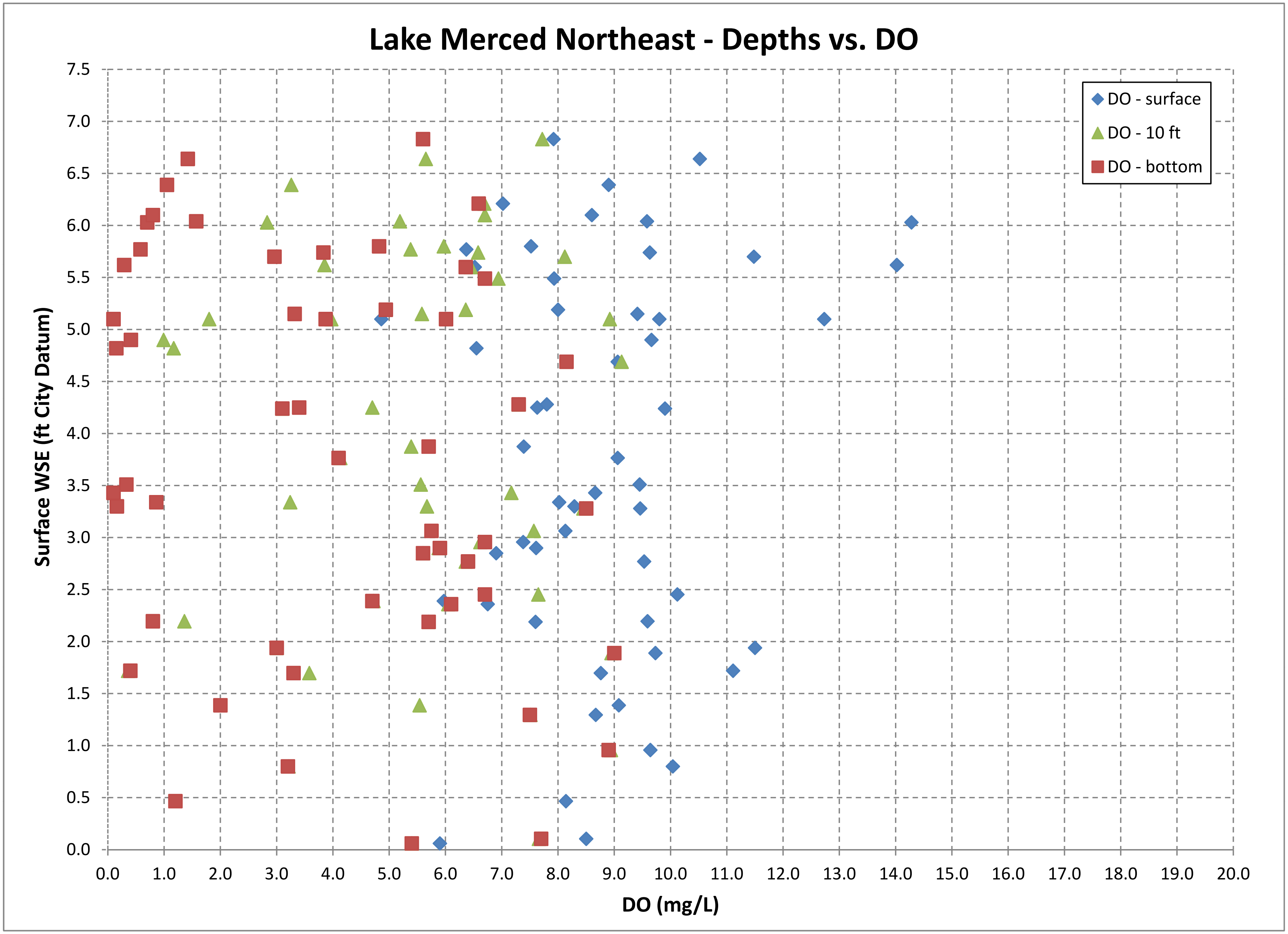

Lake Merced South - Pistol Range - Depths vs. NH3
Surface WSE (ft City Datum)
NH3-N (mg/L)
NH3-N - surface
NH3-N - 10 ft
NH3-N - bottom
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7

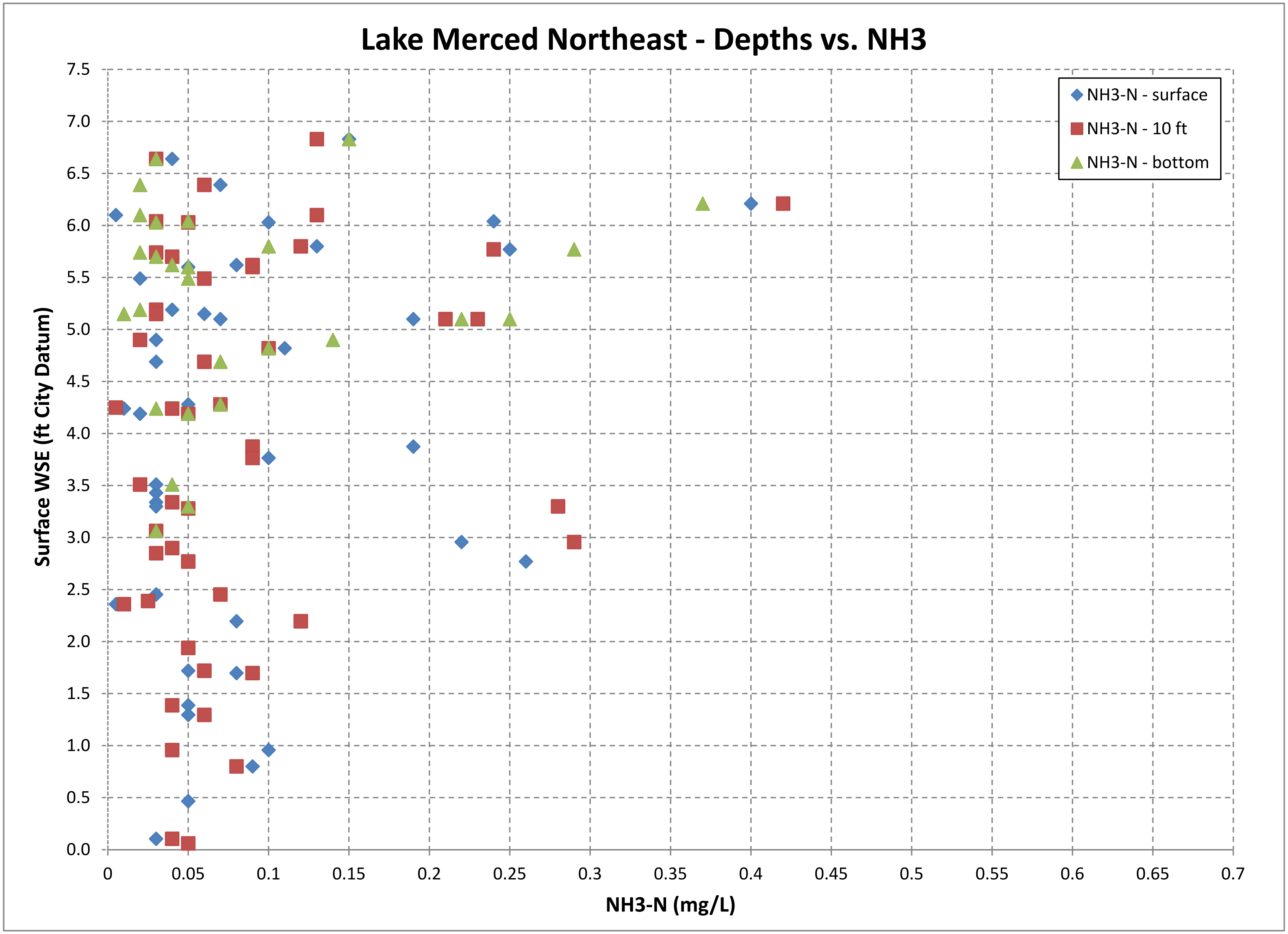

Lake Merced South - Pistol Range - Depths vs. Ortho P
Surface WSE (ft City Datum)
Ortho P (mg/L)
Ortho P - surface
Ortho P - 10 ft
Ortho P - bottom
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4

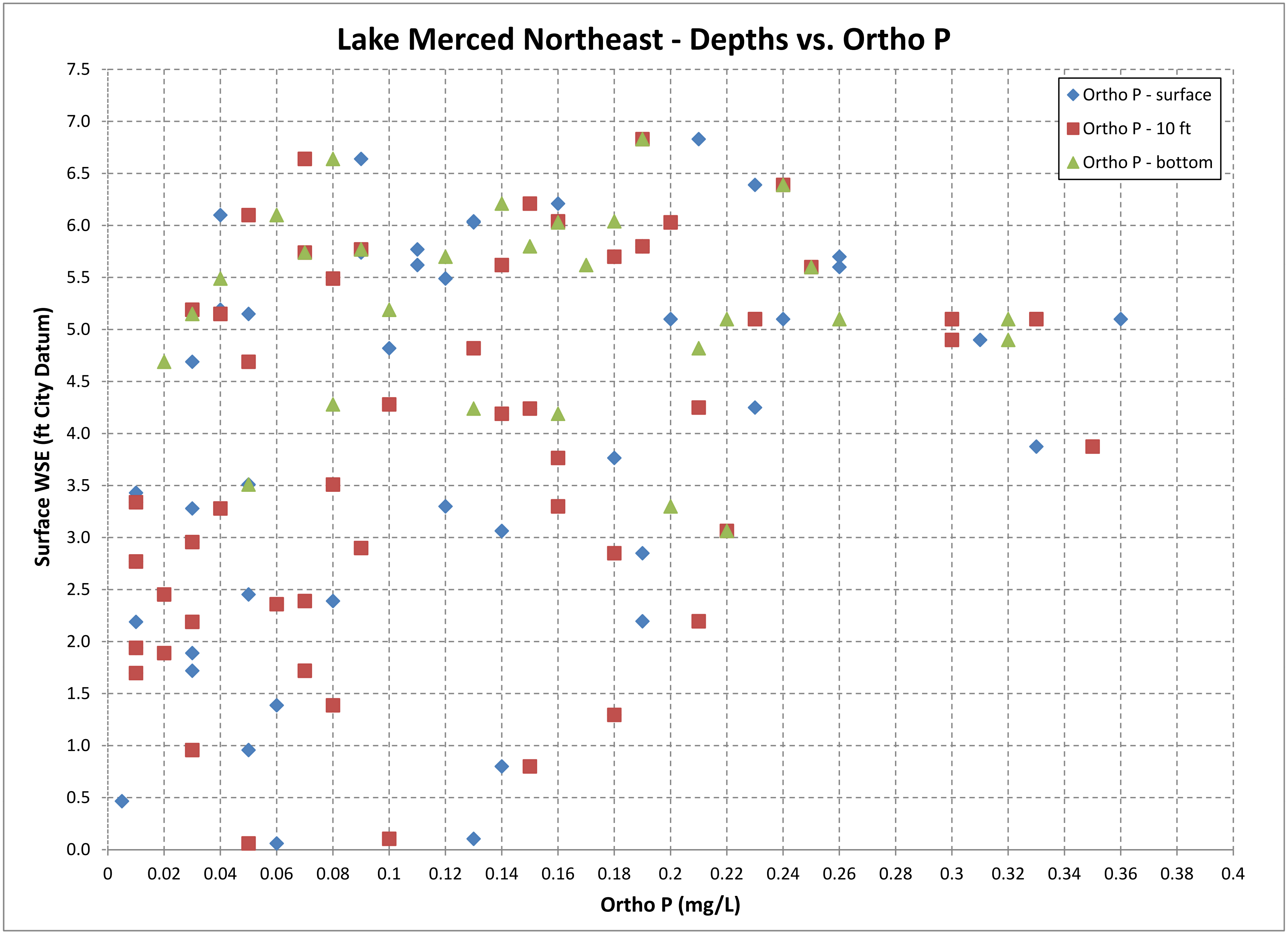

Lake Merced North- Depths vs. DO
Surface WSE (ft City Datum)
DO (mg/L)
DO - surface
DO - 10 ft
DO - bottom
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0


Lake Merced North - Depths vs. NH3
NH3-N - surface
NH3-N - 10 ft
NH3-N - bottom
Surface WSE (ft City Datum)
NH3-N (mg/L)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7


Lake Merced North - Depths vs. Ortho P
Surface WSE (ft City Datum)
Ortho P (mg/L)
Ortho P - surface
Ortho P - 10 ft
Ortho P - bottom
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4


Lake Merced Northeast - Depths vs. DO
Surface WSE (ft City Datum)
DO (mg/L)
DO - surface
DO - 10 ft
DO - bottom
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0
12.0
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0


Lake Merced Northeast - Depths vs. NH3
Surface WSE (ft City Datum)
NH3-N (mg/L)
NH3-N - surface
NH3-N - 10 ft
NH3-N - bottom
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0.65
0.7


Lake Merced Northeast - Depths vs. Ortho P
Surface WSE (ft City Datum)
Ortho P (mg/L)
Ortho P - surface
Ortho P - 10 ft
Ortho P - bottom
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
0.22
0.24
0.26
0.28
0.3
0.32
0.34
0.36
0.38
0.4