

CHAPTER 1

INTRODUCTION

The earth and its inhabitants are facing a climate emergency.

Global heating creates extreme hazards that cause significant harm to people, homes, infrastructure, and the environment. In California, we are already facing many climate-related impacts: prolonged drought, extreme heat, massive wildfires, hazardous air quality, flooding, and severe weather.

As the earth heats, polar and glacial ice is melting much faster than predicted,¹ causing sea levels to rise world-wide and reducing the earth's defenses against further warming. Combined with new, more severe weather patterns like coastal storms, sea level rise (SLR) presents a daunting challenge for waterfront cities like San Francisco.

San Francisco already experiences flooding and erosion in our low-lying coastal areas during times of high tides and severe weather. As the century progresses, sea levels will continue to rise, and flooding and related hazards will become more frequent and intense, affecting ever-greater areas of the City. The City released the Sea Level Rise Action Plan in 2016, which called on City agencies to work together to address the impacts of SLR. We have already begun to tackle coastal erosion and flooding in the most urgent parts of the City and in new public and private projects.

¹ A recent study found that Arctic permafrost is thawing decades earlier than predicted: <https://www.theguardian.com/environment/2019/jun/18/arctic-permafrost-canada-science-climate-crisis>



Flooding along the Embarcadero. Mike Filippoff



Existing seawall along the Embarcadero. Port of San Francisco

We must continue to plan for SLR in earnest. With no action, significant areas of Downtown San Francisco, SoMa, Mission Bay, and Bayview will become permanently inundated or regularly flood. All or portions of Ocean Beach, Crissy Field, Marina Green, Heron's Head Park, and other waterfront open spaces will disappear. Thousands of homes and jobs will be affected, and critical infrastructure will be damaged or destroyed.

Some areas of the City are already affected by coastal flooding and require near-term solutions. Other areas may be affected within 10 years. Infrastructure solutions and capital investments will take years or decades to plan, engineer, and fund.

We are not sitting idly by. San Francisco is already focusing on addressing near-term threats while developing plans for the future. The City is developing and implementing plans and projects to protect people, buildings, infrastructure, and open space. For example, we are addressing coastal erosion at Ocean Beach, seismic safety and flooding along the Embarcadero Seawall, and coastal and overland flooding along the southeastern shoreline.

But we must do more. This report is an early step towards developing a comprehensive strategy to address SLR and coastal flooding and adapt San Francisco so that our City can continue to thrive into the future as our physical environment changes.

1.1 SEA LEVEL RISE ADAPTATION PLANNING

Approximately four square miles of San Francisco are located within the City of San Francisco's (City's) SLR Vulnerability Zone.² This area could be flooded by a 100-year coastal flood event coupled with 66 inches of SLR, a high-end scenario by end of century.³ These low-lying areas are home to approximately 37,200 residents, 17,100 businesses, 167,300 jobs, new development, and a host of vital infrastructure. This infrastructure includes roadways, water and wastewater pipelines, power infrastructure, emergency services, transit lines, parks and open spaces, the Port of San Francisco (Port), and San Francisco International Airport (SFO).⁴

2 Four square miles, not including Treasure Island or the San Francisco airport (SFO).

3 66 inches of SLR represents the upper-bound SLR projection for the end of the century (i.e., 2100) associated with the best available science (National Research Council, 2012) when the SLR Vulnerability Zone was adopted by the City in 2014. In 2017, three new reports were released that increased the upper-bound projections (USGCRP, 2017; Rising Seas, 2017; Sweet et al., 2017); however, a revised and expanded SLR Vulnerability Zone has not been adopted at this time.

4 San Francisco International Airport (SFO) is located south of San Francisco, within San Mateo County adjacent to San Francisco Bay. However, SFO is part of the jurisdiction of the City and County of San Francisco.

San Francisco has been considering SLR in its planning for many years. The Mission Bay development requirements from the 1990s required properties to raise their foundations by one to two feet in response to best known science at the time. The City approved SLR Capital Planning Guidance in 2014.⁵

In March 2015, then-Mayor Ed Lee assembled the Sea Level Rise Coordinating Committee in response to the immediate and long-term threats from SLR and coastal flooding. The SLR Committee was tasked with developing a comprehensive understanding of the threat of SLR to San Francisco and to create a decisive plan of action.

5 <http://onesanfrancisco.org/sea-level-rise-guidance/>

San Francisco waterfront and skyline. Sergio Ruiz, SPUR



1.1.1 Sea Level Rise Action Plan

The SLR Committee created the Sea Level Rise Action Plan, released in March 2016. The Action Plan called on Departments to work together to understand the impacts of rising sea levels and to develop strategies to protect our shoreline, critical public assets and infrastructure, and public and private lands and structures from current and future coastal and SLR flooding.

The Sea Level Rise Action Plan completes four strategic tasks:

- Establishes an overarching vision, goals, and a set of guiding principles for SLR planning;
- Summarizes current climate science, relevant policies and regulations, and vulnerability and risk assessments conducted to date;
- Identifies data gaps and establish a framework for further assessment, adaptation planning, and implementation; and
- Provides the foundation and guidance to develop a Citywide Sea Level Rise Adaptation Strategy

The Action Plan describes a series of steps to adapt San Francisco to SLR and coastal flooding.

1.1.2 Sea Level Rise Vulnerability and Consequences Assessment

This SLR Vulnerability and Consequences Assessment (Assessment) represents steps 2 and 3 in the process outlined in the SLR Action Plan: Assess Vulnerability and Assess Risk. These two steps have been combined into the Assessment.

The Assessment provides a deeper understanding of the vulnerabilities of public assets and infrastructure to SLR and the consequences of SLR-related flooding on people, the economy, and the environment. The Assessment identifies publicly owned infrastructure within the SLR Vulnerability Zone by

sector (Transportation, Water, Wastewater, Power, Public Safety, Open Space, and Port) and evaluates the infrastructure's vulnerability to temporary coastal flooding and long-term permanent inundation by SLR. It identifies the potential consequences for society and equity, the economy, and the environment. The project team worked closely with City departments that own and operate infrastructure and facilities to identify vulnerabilities of existing assets.

Based on the sector-based assessments, the Assessment includes neighborhood profiles that describe how neighborhoods would be impacted by SLR and coastal flooding over time. Within each neighborhood, the project team analyzed where and how flooding would occur, how this would impact infrastructure, and what the consequences of flooding would be. The project team also analyzed how different infrastructure types interact and the cascading consequences of those interactions.

The neighborhood profiles also include a broad-brush analysis of impacts to the community, with a focus on low-income communities and vulnerable populations. The goal of the neighborhood profiles is to provide information to support implementable and innovative neighborhood-scale solutions to rising sea levels and enhance Citywide and cross-sector collaboration.

1.1.3 Sea Level Rise Adaptation Strategy

The information in this SLR Vulnerability and Consequences Assessment will be used to develop adaptation strategies and policies, identify priorities for investment, and build future projects to protect the City from SLR and coastal flooding to complete steps 4-6 from the SLR Action Plan. As every San Francisco neighborhood has unique characteristics and community-specific needs, substantive community engagement to tailor strategies to the unique characteristics of every San Francisco neighborhood will be required to develop and implement neighborhood-based SLR adaptation solutions.

See Chapter 14, *Next Steps* for more detail.

1.2 VISION

The SLR Action Plan contains the following Vision statement:

Make San Francisco a more resilient City in the face of immediate and long-term threats of SLR by taking measures to protect and enhance public and private assets, the natural environment, and quality of life for all.

1.3 GOALS

The Assessment works toward this vision by providing information to decision makers, City agencies, and public stakeholders about the vulnerabilities of public infrastructure and the consequences for people, the economy, and the environment. This information will help the City in collaboration with community stakeholders to develop, prioritize, and implement appropriate adaptation strategies to build San Francisco's resilience to SLR. This information will identify adaptation opportunities for infrastructure to provide multiple benefits, such as open space, waterfront access, and circulation.

The goals of this report are to:

- Identify vulnerabilities across sectors and the consequences of inaction in vulnerable areas
- Provide information to decision makers to help them develop, prioritize, fund, and implement adaptation actions
- Build City agency capacity to enable leadership and staff to implement timely and responsible solutions
- Provide information to support community dialogue on SLR adaptation strategies and actions
- Encourage interagency, state, regional, and federal collaboration

1.4 OBJECTIVES

To move San Francisco toward achieving the overarching Vision and Goals, the Sea Level Rise Working Group⁶ has developed the following objectives to frame the Assessment. The Assessment is used to:

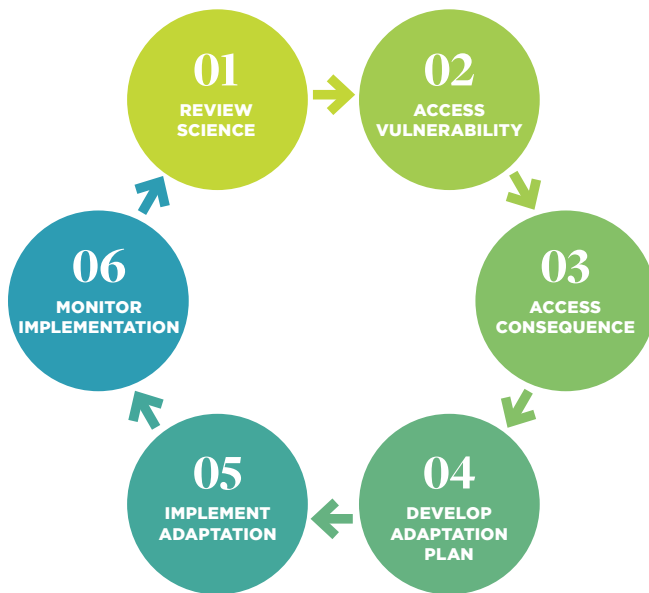
- Increase awareness of the potential threats and consequences to public assets and infrastructure from SLR and understanding of the shared Citywide responsibilities in SLR adaptation
- Support decision making under a range of SLR projections, over broad timespans, and across sectors
- Provide defensible and actionable information at the department, neighborhood, and Citywide scales regarding asset vulnerability to SLR
- Create shared baseline information and a framework for future investments
- Recognize interdependencies, promote collaboration, and incorporate lessons learned across City agencies and other Bay Area county-based SLR vulnerability assessments (e.g., Alameda, San Mateo, Marin)
- Contribute to interagency Citywide efforts to assess the City's vulnerabilities to multiple hazards (e.g., seismic, flooding, heat)
- Reduce overall costs associated with adaptation by providing holistic information about SLR vulnerabilities and how various infrastructure systems intersect

⁶ The Sea Level Rise Working Group is a sub-group of the Sea Level Rise Coordinating Committee that includes the project team and representatives from various City agencies and departments.

1.5 OUTCOMES

The overall Assessment approach was developed to provide detailed information to support effective and successful adaptation planning. By identifying the potential physical damages and consequences of the damage assets may incur when exposed to hazards, the Assessment considers risks and prioritizes strategies across four categories: capacity building within the City, external funding, sustainable growth, and Capital Planning. The Assessment approach is consistent with 2018 State of California Sea Level Rise Guidance.⁷

Figure 1.1 Adaptation Framework



1.5.1 Capacity Building

The Assessment approach and outcomes is intended to increase Citywide awareness of SLR vulnerabilities and consequences and increase interdepartmental coordination by:

- Developing a climate resilience working group to comprehensively support and implement climate mitigation and adaptation work across multiple climate hazards
- Developing a shared understanding of and consistent messaging about SLR vulnerabilities and consequences
- Enhancing Citywide coordination on SLR and coastal flooding hazards
- Building a centralized interagency database of public assets, vulnerabilities, consequences, and hot-spots of vulnerability
- Helping agencies understand their own assets' vulnerability and chronology of exposure, and identify opportunities to build resilience in current projects
- Helping agencies understand Citywide interagency vulnerabilities, chronology of exposure, and cascading consequences
- Building capacity to collaborate in the region and continue to lead on SLR planning

⁷ http://www.opc.ca.gov/webmaster/ftp/pdf/agenda_items/20180314/Item3_Exhibit-A_OPC_SLR_Guidance-rd3.pdf.

1.5.2 External Funding

Implementing SLR adaptation strategies and solutions across San Francisco will take considerable time and funding. Much of the necessary funding is likely to come from external sources.

The Assessment approach and outcomes were developed to:

- Provide information for grant submissions for SLR-related capital projects, studies, and planning efforts
- Support the City as it applies for state and federal funding related to reducing SLR and flooding risks
- Help the City identify its internal strategic priorities for SLR adaptation so the City can collectively pursue funding for the highest priority projects

1.5.3 Resilient Investment and Growth

The Assessment approach and outcomes is intended to help guide investments and growth within San Francisco considering SLR and coastal flooding by:

- Informing new policies, guidelines, and code amendments to protect and adapt existing infrastructure and assets to SLR
- Providing information to support planning, design, California Environmental Quality Act (CEQA) review, and permitting
- Identifying potential partnerships (e.g., multiple departments, stakeholders) in hot-spot areas of vulnerability
- Inform future adaptation efforts to provide multiple benefits, such as open space, waterfront access, and circulation

1.5.4 Capital Planning / Internal City Funding

The Assessment approach and outcomes will better prepare departments developing their capital programs and seeking Capital Plan funding by providing asset-based and neighborhood-based information that can:

- Support Capital Planning SLR guidance process and provide information needed to complete the checklists and support prudent investments
- Inform future adaptation efforts to support the development of resilient infrastructure that considers multiple hazards such as SLR, flooding, heat, air quality, and earthquakes
- Identify projects that can increase the resilience of at-risk infrastructure for submission to the Capital Plan
- Help the City's Capital Planning Committee (CPC) make strategic choices about funding SLR adaptation projects
- Supporting repairs and/or retrofits to aging infrastructure that consider SLR risks



King Tide along the Embarcadero.
Photo by Dave Rauenbuchler (CC BY-NC 2.0)