SAN FRANCISCO
PLANNING DEPARTMENT

MEMO

# Appendix F
# Travel Demand Memorandum

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| *Date:* | February 14, 2019 |
| *To:* | Record No. 2015-012094GEN |
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| *RE:* | **Transportation Impact Analysis Guidelines Update, Travel Demand** |

## INTRODUCTION

In 2015, the department and the San Francisco Municipal Transportation Agency (SFMTA) hired a consultant to assist with an update to the travel demand methodology and estimates within the Transportation Impact Analysis Guidelines. For those prior travel demand estimates, the department relied on a series of sources, such as Citywide Travel Behavior Surveys and Institute of Transportation Engineers Trip Generation rates, from the 1980s through the 2000s. The consultant's specific tasks were to review the existing methodology and data; conduct primary data collection and analysis; derive updated parameters including trip generation rates, way people travel (also known as mode split), common origins and destinations (also known as trip distribution), and loading demand rates; and review the current geographic analysis structure. In addition to the department, the SFMTA and San Francisco County Transportation Authority (SFCTA) also provided feedback on this effort.

This memorandum updates the guidance provided in the prior guidelines for the travel demand topic. The department prepared this memorandum in consultation with stakeholders (e.g., city and county agencies, consultants). The department will issue memoranda that provide updates to other topics (e.g., transit, loading) within the guidelines. When the department issues a memorandum about a topic, it will supersede existing guidance regarding that topic. This travel demand memorandum informs the analysis of other transportation topics. This memorandum provides specific guidance on the methodology for conducting a travel demand analysis. However, summary guidance on the typical methodology for this topic is provided in the guidelines.

The guidance provided herein assumes a typical land use development project including residential, office, retail, and hotel that requires a transportation study. The "Other" subsection provides guidance on other types of projects. The department may use this guidance for multiple projects, but the department has discretion on applying the guidance on a project by project basis.

The organization of the memorandum is as follows:

1) Travel Demand (typical projects)
2) Loading Demand
3) Other (covers different types of projects)

Attachments are under separate cover. The department may update the attachments to the memoranda more frequently than the body of the memoranda.

## TRAVEL DEMAND

The section identifies the approach to calculate travel demand, including describing typical geography, period, and methodology for typical projects.

### Basics

*Geographic Unit of Analysis*

There are two travel demand geographic units of analysis – neighborhoods and place type (defined below). Neighborhoods consist of a collection of transportation analysis zones, which are units used by planners as part of transportation models and for other planning purposes. The San Francisco County Transportation Authority manages San Francisco's transportation model and developed boundaries for 12 neighborhoods (nine in San Francisco proper, and three external districts – north bay, east bay, and south bay). Figure 1 in Attachment A shows these neighborhoods and districts.

This methodology sorts each of nine San Francisco neighborhoods developed into one of three place types based on each neighborhood's auto mode share. Figure 2 in Attachment A shows the three place types based on the nine neighborhoods, including an overlay of the neighborhood boundaries. These place types are "urban high density" (place type 1), "urban medium density" (place type 2), and "urban low density" (place type 3).

*Period*

In San Francisco, the weekday extended p.m. peak period (Tuesday, Wednesday, or Thursday, 3 p.m. to 7 p.m.) is typically the period when the most overall travel happens.[1] Although a substantial amount of travel occurs throughout the day and impacts from projects would typically be less during other periods, the methodology should typically focus on this period (including limiting the hours within the extended p.m. peak period) as changes in travel demand would be acute during these periods compared to other times of the day and days of the week. However, the methodology should also use the weekday daily time period as a unit of analysis to examine the overall daily activity travel patterns and behavior of a project in its entirety. The loading, construction, and vehicular parking memoranda provide specific guidance on the appropriate period of study for those transportation topics.

### Methodology

The typical methodology consists of four steps: 1) trip generation, 2) ways people travel, 3) common origins and destinations, and 4) trip assignment. The following subsections summarize each of these steps. Attachment B summarizes the data collection and analysis used to develop the methodology described below. The department developed a tool for travel demand analysis; Attachment C provides details on how to use the tool to implement the methodology described below.

*Step 1. Trip Generation*

Trip generation refers to the number of estimated trips people would take to and from the project, regardless of the way they travel (see step 2 below). The following methodology refers to these trips as

[1] Examples that illustrate this statement: within the San Francisco County Congestion Management Program network transit and vehicular travel speeds are lower during the p.m. peak period (4:30-6:30 p.m.) than during the a.m. peak period (7-9a.m.) as documented in San Francisco County Transportation Authority, *Congestion Management Program*, December 2015; demand at transit stations is consistent and generally higher throughout the p.m. peak period relative to demand at transit stations during the a.m. peak period, as documented in the Metropolitan Transportation Commission, *Core Capacity Transit Study Briefing Book*, July 2016; the weekday peak period for for-hire vehicles occurs from 6:30 p.m. to 7p.m., as documented in San Francisco County Transportation Authority, *TNCs Today: a Profile of San Francisco Transportation Network Company Activity*, June 2017.

person trips. The methodology applies person trip rates, accounting for the size and type of land use, to estimate the number of project person trips. Table 1 shows the estimated daily and p.m. peak hour person trip generation rates by typical land use type.

The department developed these trip generation rates for daily and pm peak hour based on data collection in spring 2017 at 65 typical office, retail, residential, and hotel sites throughout San Francisco. The trip generation rates below include pass-by trips or trips people make en-route two primary locations, such as home and work.[2]

**Table 1 – Person Daily and P.M. Peak Hour Trip Generation Rates by Land Use**

| Land Use | Unit of Land Use | | Trip Generation Rate |
|---|---|---|---|
| **Residential** | Per Bedroom | Daily | 4.5 |
| | | PM Peak | 0.4 |
| **Office** | Per 1k square feet of land use | Daily | 15.7 |
| | | PM Peak | 1.4 |
| **Retail – General** | Per 1k square feet of land use | Daily | 150 |
| | | PM Peak | 13.5 |
| **Retail – Supermarket** | | Daily | 297 |
| | | PM Peak | 21.7 |
| **Eating Restaurant** | Per 1k square feet of land use | Daily | 200 |
| | | PM Peak | 27 |
| **Eating Composite** | | Daily | 600 |
| | | PM Peak | 81 |
| **Hotel** | Per Hotel Room | Daily | 8.4 |
| | | PM Peak | 0.6 |

The department caps residential trip generation rates at the 3-bedroom rate, meaning that a 4-bedroom unit has the same estimated daily and p.m. peak hour number of person trips as a 3-bedroom unit.

*Step 2. Ways People Travel*

Ways people travel, also known as mode split, refers to the estimated way or method people travel. This methodology defines five methods: automobile modes (driving alone or with passengers), taxi/TNC, walking, public transit (such as bus, light rail, BART, or Caltrain), and bicycling.[3] Figure 1 summarizes extended p.m. peak mode split by one of the three place types and land use. Each place type displays

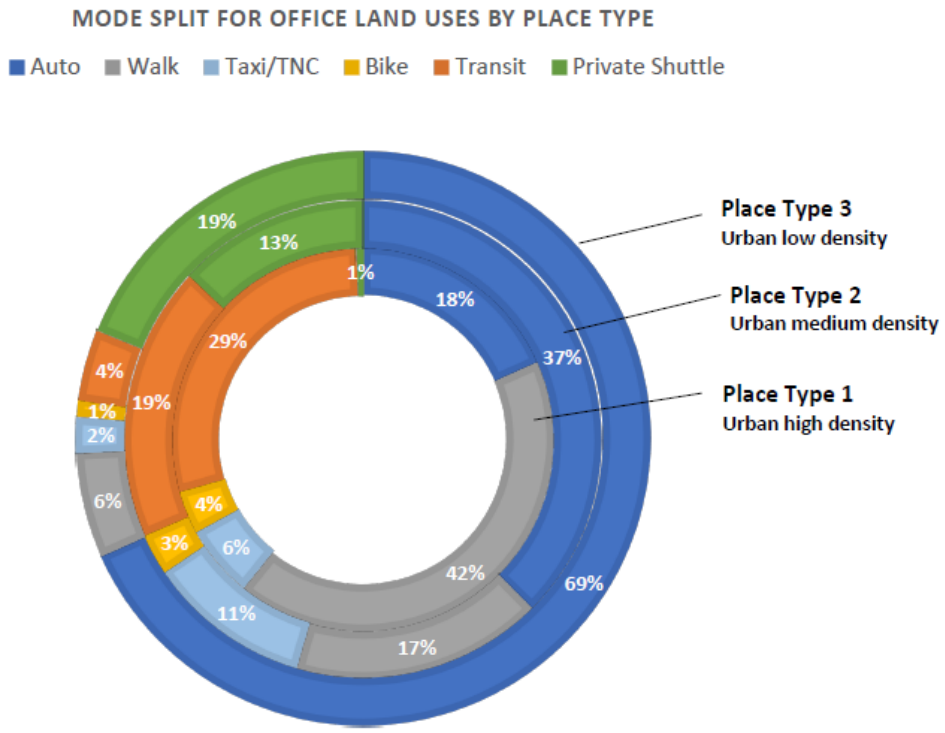
[2] Therefore, models (e.g., California Emissions Estimator Model) should generally assume 0 percent for pass-by trips when inserting projects trips.

[3] While private transit trips are included as a percentage of the observed total person trips, the department excludes private transit from impact analysis. Therefore, private transit is not mentioned as a method although it is shown in figure 1.

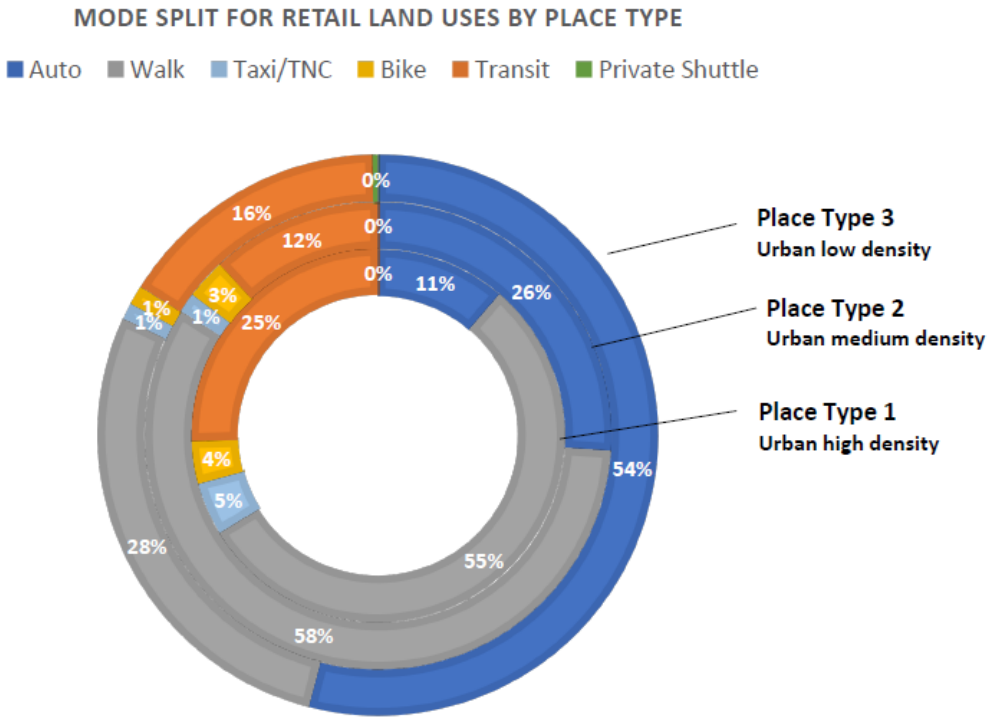
different mode split ratios due to factors that influence travel behavior, such as transit accessibility, walkability, roadway and transit infrastructure.

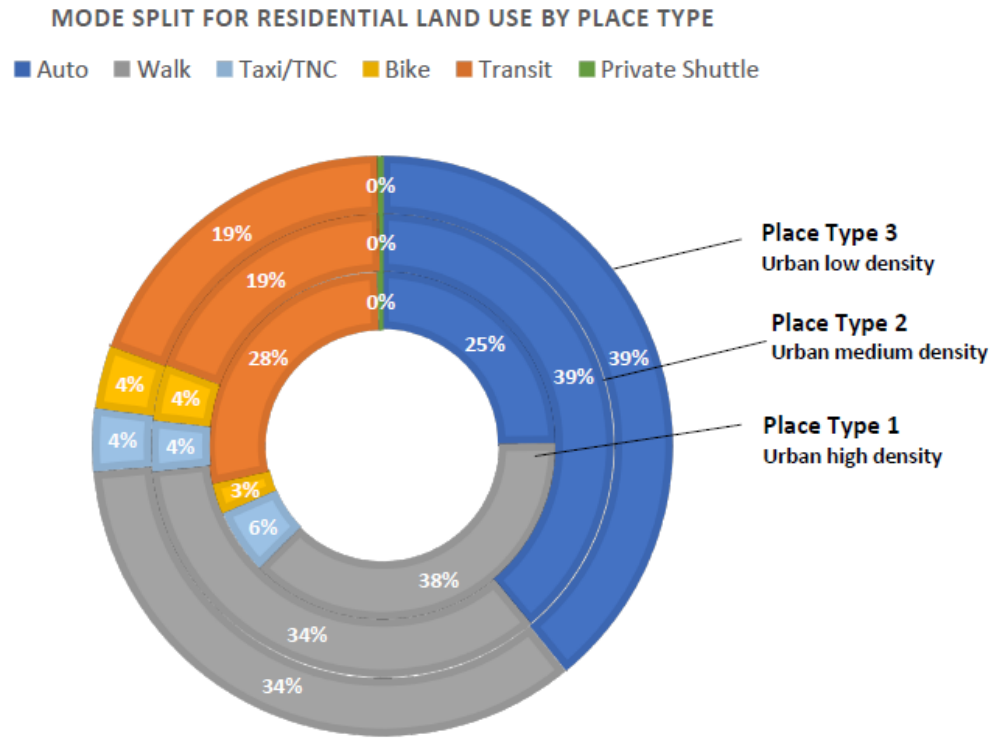
The methodology will typically assume the extended p.m. peak period mode splits would apply to both daily and p.m. peak hour person trip generation to determine person trips by mode.

The department developed mode splits[4] based on data collection in spring 2017 at 65 typical office, retail, residential, and hotel sites throughout San Francisco. Attachment B provides more details on this data collection effort.




[4] The department calculated mode splits based on intercept survey data collected during the PM peak period (3:00-7:00pm);


MODE SPLIT FOR RETAIL LAND USES BY PLACE TYPE
Auto
Walk
Taxi/TNC
Bike
Transit
Private Shuttle
0%
16%
0%
12%
0%
11%
26%
3%
1%
1%
25%
4%
5%
54%
28%
55%
58%
Place Type 3
Urban low density
Place Type 2
Urban medium density
Place Type 1
Urban high density


MODE SPLIT FOR RESIDENTIAL LAND USE BY PLACE TYPE
Auto
Walk
Taxi/TNC
Bike
Transit
Private Shuttle
0%
19%
0%
19%
0%
25%
39%
28%
4%
4%
4%
4%
3%
6%
38%
34%
34%
Place Type 3
Urban low density
Place Type 2
Urban medium density
Place Type 1
Urban high density

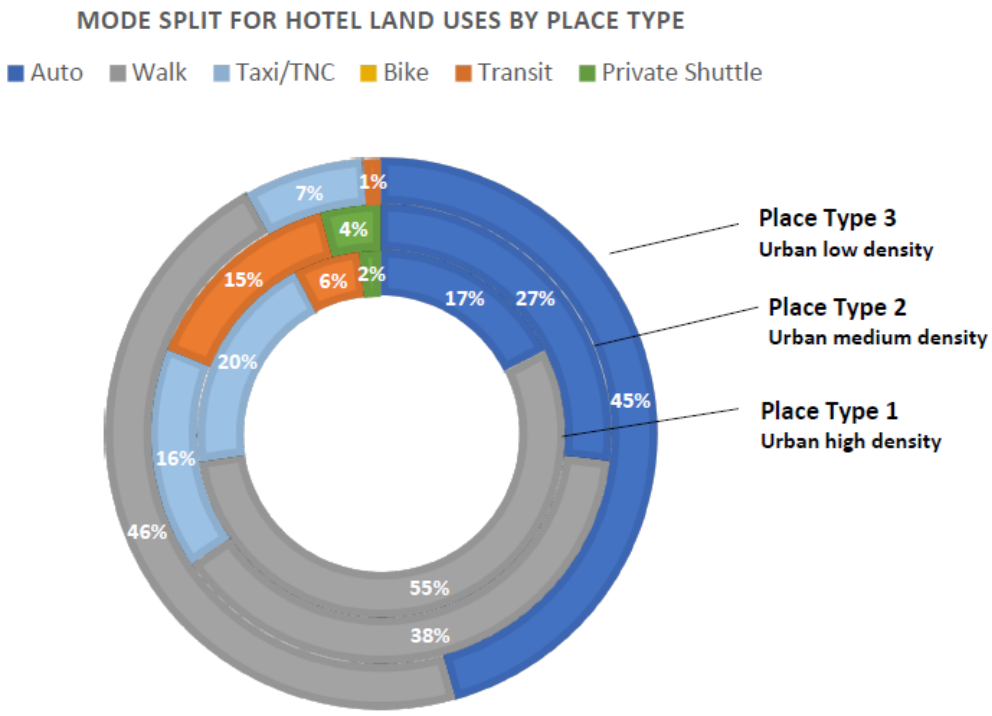



**Figure 1 Mode Split by Land Use Type and Place Type**

*Step 3. Common Origins and Destinations*

Common origins and destinations, also known as trip distribution, refer to the estimated number of trips people would take to (inbound) and from (outbound) the project and another place (e.g., another neighborhood). Common origins and destinations consist of locations in the nine San Francisco neighborhoods, east bay, north bay, and the south bay.

The methodology uses the aforementioned travel demand analysis tool to distribute a project's person[5] and vehicle[6] trips to/from a project site's neighborhood district or place type to the 12 neighborhood districts based on the following categories:

- Origin/destination (residential, office, or retail[7])
- Trip purpose (work or non-work)
- Mode (drive alone, shared ride, and transit)

[5] The department does not distribute walk and bicycle as the impact analysis for walking/accessibility, and bicycles assume these trips to be localized and not traveling between different neighborhoods. The department does not evaluate impacts to private transit.

[6] To calculate vehicle trips, the methodology uses vehicle occupancy rates, defined as the number of passengers in a vehicle during a trip, and calculated as vehicle person trips divided by vehicle drive trips from the California Household Travel Survey trips records between different neighborhood districts. Each neighborhood district's land use type has its own unique vehicle occupancy rate. Vehicle person trip is the sum of carpool (two occupants), carpool (three of more occupants), and drive alone in the Travel Survey. Vehicle drive trips are vehicle person trips divided by assumed vehicle occupancy of 2 for carpool (two occupants), 3.5 for carpool (three or more occupants), and 1 for drive alone tripsperson(s).

[7] The California Household Travel Survey does not provide hotel or visitor trip patterns. The methodology distributes hotel or visitor trips using retail trip patterns based on the department's comparative assessment of retail trip patterns with neighborhoods visited according to the San Francisco Travel Association's 2017 San Francisco Visitor Profile.

- Directionality (inbound or outbound)

The department with the SFCTA developed trip distribution tables, stratified by the above four categories, based on the California Household Travel Survey data; this data includes 5,000 trip records starting or ending in San Francisco. Using the relative weight of these trips, per each of the four categories, the methodology provides a better granularity to assign trips to roadways and transit routes in the subsequent step as described below. See Attachment C for more details and instructions for accessing and using the tool.

The department developed recommendations on whether a project should use auto or transit trip distribution based on the project's neighborhood or place type as shown in Table 2 Recommended Level of Trip Distribution below. The department developed these recommendations by analyzing the number of California Household Travel Survey trip records available for each given neighborhood, land use type, and mode of travel (auto versus transit); the recommended geographic level of distribution below reflects the department's assessment of whether the number of trip records for a given neighborhood and mode of travel is sufficient; if it is not, then a project would use place type level of trip distribution.

**Table 2. Recommended Level of Trip Distribution**

| Mode | Recommended Level of Trip Distribution | Example |
|---|---|---|
| **Auto** | Projects should distribute by neighborhood district, except for:<br>• Projects in SoMa (distribute by place type), or<br>• Projects with office in urban medium or urban low place types (distribute by place type for all project land use types) | Project with 500,000 square feet of office and 400 residential units in the Mission (a district in urban medium place type) would use place type trip distribution for the project's office and residential components |
| **Transit** | Projects should distribute by neighborhood district, except for:<br>• Projects in urban low place type (distribute by place type), or<br>• Projects with office in urban medium place types (distribute by place type for all project land use types) | Project with 150 residential units and 5,000 square feet of retail in the Sunset (a district in urban low place type) would use place type level trip distribution for project's residential and retail components |

*Step 4. Assignment*

Assignment refers to the location or assignment of project vehicle trips to different streets, on-street loading zones, and driveways, and project transit trips to specific transit routes. In other words, assignment uses the results of step 2: number of project trips by different ways of travel, and step 3, percentages of those projects trips to and from common origins and destinations, to place project vehicle and transit trips onto physical locations. Roadway assignment between an origin or destination and the project site can be based on factors such as consideration for one-way versus two-way streets, access to on and off-ramps, or prohibited movements in the study area intersections. Transit assignment between an

origin and destination can be based on factors such as transit travel time, number of transfers, and location of transit stop.

The methodology will multiply the percentage of taxi/TNC trips calculated from the total estimated number of vehicle trips by two to account for separate vehicle trips both to and from a site (one as the vehicle arrives, and one as the vehicle departs). The methodology will assign taxi/TNC vehicle trips to the nearest study intersection(s). At the intersection, the methodology will assign taxi/TNC vehicle trips to critical movement to the extent applicable.[8] This same methodology will apply for parent/guardian vehicle trips (pick-up/drop-off) to and from childcare and schools to the extent applicable.

## FREIGHT AND PASSENGER LOADING DEMAND

The section identifies the approach to calculate loading demand, including a description of geographic unit by the study area, period, and methodology for a typical project. Refer to the loading memorandum for further guidance.

### Basics

*Geographic Unit of Analysis*

The methodology will typically focus on the streets, including alleys, adjacent to the project site, and on-street and off-street passenger and commercial loading (and potential shared loading) zones within convenient locations of the project site, which is typically 250 linear feet of the project site.[9] The project will use the nine San Francisco neighborhoods and three place types units as described under the travel demand geographic unit of analysis subsection.

*Period*

For loading demand, the period will differ depending upon the land use and type of loading activity. The periods defined below assume residential, office, and commercial land uses and commercial or passenger loading. For other land uses and other loading activities, the department will determine the appropriate period that loading demand and activity should be analyzed.

For commercial vehicle loading, such as freight and delivery service vehicles, the weekday mid-day is the peak period (Tuesday, Wednesday, or Thursday from 11 a.m. to 2 p.m.).

For passenger vehicle loading, consisting of private and for-hire vehicles, the weekday p.m. hours are the peak period (Wednesday, Thursday, or Friday, from 5 p.m. to 8 p.m.).

### Methodology

Loading demand analysis represents how the estimated number of loading trips will affect the use of available loading facilities. The methodology calculates demand for freight and delivery, and passenger loading.

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[8] The department data collection effort in spring 2017 estimated the number of person trips by mode generated by a development. While there is limited information regarding the distribution of TNCs across the surrounding street network beyond an immediate block face, the methodology above intends to appropriately account for the vehicle trips produced by TNCs to adequately analyze their effects on localized issues (e.g., passenger loading, localized safety).

[9] For the purposes of this memorandum, "convenient" refers to locations that meet people's loading and unloading needs, including people with disabilities. Convenient generally is within 250 linear feet of the project site, but depends on contextual characteristics such as proximity to an alley, curb lane, or ADA curb ramp; distance and type of intersections in relation to the project site; and directionality of project frontage roadways.

*Freight and Delivery Loading*

Freight and delivery loading demand represents the number of spaces generated by a particular land use during the peak hour throughout the average weekday peak period. Table 3 presents freight and delivery loading daily demand rates.

The department bases these rates on a 1980 study of goods movement activity in San Francisco.

**Table 3. Freight and Delivery Daily Trip Demand Rates per 1,000 Square Feet of Floor Area by Land Use**

| Land Use | Rate per 1,000 square feet |
|---|---|
| **Office** | 0.21 |
| **Retail (Composite)**[10] | 0.22 |
| Restaurant/Bar | 3.60 |
| **Services** | |
| Hotel | 0.09 |
| Institution | 0.10 |
| **Warehousing** | 0.46 |
| **Manufacturing** | 0.51 |
| **Light Industry** | 0.65 |
| **Residential** | 0.03 |

Source: Center City Pedestrian Circulation and Goods Movement Study (Wilbur Smith & Associates for San Francisco Department of City Planning). September 1980.

The freight and delivery loading demand calculation formula is:

Number of spaces per 1,000 GSF = $\left[\frac{(1.25)(R)}{9}\right]/(2.4)$

Where,

R = Daily truck trip demand rates per 1,000 GSF of use from Table 3;

1.25 = Peak hour deliveries at 25% higher rate than other hours;

9 = Number of hours deliveries are made (8:00 a.m. – 5:00 p.m.); and

2.4 = Assuming average truck delivery/pick up of 25 minutes, 2.4 trucks could be accommodated per hour.

Round up the demand calculation to the nearest whole number of loading spaces (e.g. 1.4 spaces would round up to two spaces).

[10] Retail includes but not limited to personal services, wholesale, apparel, drug store, and specialty shops.

*Passenger Loading*

Passenger loading demand is expressed as the required number of loading spaces generated by the land use during any one minute of the peak hour throughout the average peak period or if the project site is located along a non-center running public transit rapid network route or unprotected bicycle facility (e.g., no safe hit post, parking/loading in between, or raised sidewalk), then calculate demand for any one minute of the peak 15 minutes of the average peak period.

Passenger loading demand is calculated by using the mode split percentage of all person trips going to a particular project site that would involve a passenger loading instance occurring at the curb near the project site. These percentages (also known as passenger loading percentage), are shown in Table 4 by land use and place type. These passenger loading percentages are calculated using the planning department's intercept survey data collection in spring 2017.

**Table 4. Curb Loading-type p.m. Peak Period Mode Splits by Land Use and Place Type Geography**

| Land Use | Geography | Number of Sites | Taxi/TNC% | Private Vehicle Drop-off (50% of HOV Passenger Mode) | Passenger Loading % |
|---|---|---|---|---|---|
| **Office** | Place Type 1 | 8 | 6.1% | 1.2% | 7.3% |
| | Place Type 2 | 7 | 11.0% | 2.4% | 13.4% |
| | Place Type 3 | 3 | 2.0% | 5.1% | 7.1% |
| **Retail** | Place Type 1 | 4 | 4.6% | 0.9% | 5.5% |
| | Place Type 2 | 10 | 1.4% | 1.6% | 3.0% |
| | Place Type 3 | 7 | 1.0% | 4.2% | 5.2% |
| **Residential** | Place Type 1 | 4 | 6.0% | 2.8% | 8.8% |
| | Place Type 2 | 9 | 3.5% | 3.7% | 7.2% |
| | Place Type 3 | 2 | 4.2% | 2.7% | 6.9% |
| **Hotel** | Place Type 1 | 4 | 19.6% | 2.2% | 21.8% |
| | Place Type 2 | 5 | 15.6% | 4.1% | 19.7% |
| | Place Type 3 | 2 | 7.5% | 6.0% | 13.5% |

**Note:** Because survey respondents were not asked to specify if they were dropped off or simply part of a group arriving in single vehicle, the methodology assumed a 50 percent factor for HOV trips for purposes of loading analysis.

The passenger loading demand calculation formula is as such:

$$\text{Peak hour spaces of passenger loading demand} = \left[\frac{P * L * D}{60}\right]$$

Where,

P = Person trip generated by the land use during the p.m. peak hour based on the land use type's trip generation rate as shown in Table 1 and the amount of land use;

L = Loading mode type percentage (mode split of all person trips going to a project site

involving passenger loading occurring at the curb) as shown in Table 4 for the land use and place type; and

D = The average stop duration is assumed to be 1 minute.

Peak 15 minutes spaces of passenger loading demand = $\left[\left(\left(\frac{P*L}{2}\right)*D\right)/15)\right]$

Where,

P = Person trip generated by the land use during the p.m. peak hour based on the land use type's trip generation rate as shown in Table 1 and the amount of land use;

L = Loading mode type percentage (mode split of all person trips going to a project site involving passenger loading occurring at the curb) as shown in Table 4 for the land use and place type;

2 = Assumes that half of peak hour loading demand occurs during the peak 15 minutes; and

D = The average stop duration is assumed to be 1 minute.

Round up the demand calculation to the nearest whole number of loading spaces (e.g. 1.4 spaces would round up to two spaces). For projects that consist of more than one building, the methodology should calculate passenger loading demand for the lobby entrance at each individual building.

## OTHER

The guidance provided in this memorandum assumes a typical land use development project. This section describes the type of additional or different information that may be necessary to calculate travel demand for the following circumstances: atypical land use, cumulative, an area plan, and substantial rezoning outside of area plans.

### Atypical Land Use

This section applies to projects that are not typical land use types (e.g. residential, office, retail, or hotel) or do not have the same travel behaviors as these typical land use types.

*Project Description*

The project description must include the physical features to the extent applicable to calculate trip generation. Examples include:

- For student housing, number of rooms [text, table]
- For entertainment uses, number of seats and/or standing capacity (maximum occupancy) [text, table]
- For schools and child care facilities, capacity by age and number of teaches and employees [text, table]

*Period*

In some instances, the most overall trips people would take to and from a proposed project, may occur at different periods (a.m., midday, post p.m. peak, and/or weekend) for smaller geographic areas (e.g., a segment of a street) in existing conditions or as a result of the project, or the project may result in substantial disparity in travel demand at different periods (e.g., special events). In these instances, the methodology may substantiate the use of different periods in addition to or other than the weekday p.m. peak. The methodology should also use the weekday daily time period as a unit of analysis to examine the overall daily activity travel patterns and behavior of a project in its entirety. Trip generation rates to estimate the number of project person trips during an atypical peak period must be justified and in consultation with the department. Refer to Chapter 6 of Attachment B for a.m. peak hour trip generation rates based on the department data collection in spring 2017.

*Counts*

The methodology should include counts of people approaching and leaving sites with similar characteristics (e.g. project size and use) and location as those of the proposed project in order to estimate trip generation. The methodology may include prior counts collected from other studies or sources combined with (e.g., an average of three different dates with counts at sites with similar characteristics) or counts collected specifically for the project. To conduct a full accounting of person trips to and from individual sites, the methodology may conduct video counts of all access and egress points to a site (e.g. pedestrian entryways to garages and pedestrian doors with exterior access). Refer to Chapter 3 of Attachment B for an example of the department's effort to conduct video counts collection. The use of prior counts or the counts collection approach must be justified and in consultation with the department.

*Intercept Survey*

The intercept survey should gather two key pieces of information: how an individual arriving at the survey site traveled to that site and where they traveled from. In the case of individuals intercepted while leaving the site, the survey should ask how they are traveling to their next destination and location of that destination. These data points allow for an assessment of both mode split and trip distribution at the site level. Refer to Chapter 3 of Attachment B for an example intercept survey.

*Methodology*

The methodology to calculate demand for freight and delivery, and passenger loading could vary for atypical land uses. In those instances, the department will determine the appropriate methodology.

### Cumulative

For certain projects, reasonably foreseeable projects in the study area may affect mode split for the project. Examples include major transit projects such as new or increased service or a significant change in density nearby. In these cases, trip generation and trip distribution assumptions would remain the same as existing conditions. However, the analysis could consider changes to the mode split under cumulative conditions derived through approaches such as modeling future travel behaviors with SFCTA's travel demand model or based on policy goals.

### Area Plans

For area plans, the methodology would require running a travel demand model with the project's proposed land use and/or infrastructure improvement to estimate trip generation, mode split, and trip distribution. The planning department will determine whether to use a list –based, projections-based, or modified approach to identify a list of cumulative projects in the project study area to include in the cumulative model run. Refer to the guidelines for direction on developing a list of and or modeling reasonably foreseeable projects.

### Substantial Rezoning Outside of Area Plans

On occasion, project sponsors may propose redevelopment of large areas consisting of multi-structure, multi-phased development. The methodology to estimate travel demand for these rezoning projects would mostly remain the same as the typical land uses, except that these rezoning projects shall also account for the number of person trips that may remain inside the project area, also known as trip internalization. Trip internalization is mostly relevant to large, mixed-use developments that include various land uses that would produce a significant number of trips that remain within the development. Refer to Attachment D for an example steps on how to estimate trip internalization.

As noted above, should the travel demand methodology choose to substantiate the use of periods in addition to or other than the weekday p.m. peak, the methodology must also substantiate how to estimate these different period's trip generation rates. Examples include using Chapter 6 of Attachment B, the existing *Institute of Transportation Engineers Trip Generation Manual* to calculate a.m. percentage of daily trip rates, or if a land use has a majority of outbound trips in the a.m. peak period and a majority of p.m. inbound trips in the p.m. peak period, such as a residential use, the methodology may choose to reverse the distribution of the p.m. peak period to estimate a.m. peak distribution. The department will determine the appropriate approach based on the characteristics of the project.