SUPPLEMENTAL DOCUMENT

SEA LEVEL RISE SCENARIO SELECTION AND DESIGN TIDE CALCULATION

FOR THE

GUIDANCE FOR INCORPORATING SEA LEVEL RISE INTO CAPITAL PLANNING IN SAN FRANCISCO: ASSESSING VULNERABILITY AND RISK TO SUPPORT ADAPTATION

Prepared by the City and County of San Francisco

Sea Level Rise Technical Committee

for the San Francisco Capital Planning Committee

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SEA LEVEL RISE SCENARIO SELECTION AND DESIGN TIDE CALCULATION

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Introduction

This document provides supplemental information to support the Capital Planning Committee (CPC) Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco: Assessing Vulnerability and Risk to Support Adaptation (CPC Guidance). This document is intended as a companion document to the CPC Guidance, to be used with Sea Level Rise (SLR) Vulnerability Zone map and the SLR Checklist.

This document provides a step-by step process for selecting an appropriate planning horizon and sea level rise scenario for project planning. This document also provides information to assist project planners in calculating a design tide water level elevation. Design tides are often used to set future grade requirements, first floor elevations, and the elevation of electrical equipment. To reduce the potential for inundation and flooding under existing and future sea level conditions, project components that are sensitive to flooding should be constructed above the design tide elevation. A Project Design Tide Elevation Worksheet is included with this document. This worksheet can be used to guide the project proponent through this selection and calculation process. However, if detailed, site-specific analysis and modeling is available for the project, the more detailed information should be used to support the selection of an appropriate design tide elevation for design purposes.

Step-by-Step Process

1. **Choose the appropriate Planning Horizon.**

   Projects should adopt a planning horizon based on the functional lifespan of the project. In many cases, the functional lifespan is substantially longer than the design lifespan. To determine the projected functional lifespan, consider how long the project will be in use at this location, factoring in regular repair and maintenance. For example, although a pump station may have a 30-year design life, the pump station may be projected to be in service at the selected location for 75 years. Although some elements of the pump station may undergo significant rehabilitation over the 75-year functional lifespan, other elements may not. In this case, the functional lifespan would be 75 years; therefore, the project planning horizon would be 2015 + 75 = 2090 (assuming 2015 is year construction is complete).

   If the asset is an existing asset, the calculation of the planning horizon should consider the year the asset was placed into service (i.e., the year it was constructed). For example, if a pump station was originally constructed in 1980, and it has a functional lifespan of 75 years, the project planning horizon would be 1980 + 75 = 2055.

2. **Choose whether to use the likely or upper range sea level rise projection for design and/or evaluation purposes.**

   a. Choose the upper range estimate if the project is sensitive to inundation and flooding, and it has low adaptive capacity (i.e., the project cannot be easily adapted to accommodate the upper range SLR estimate in the future if it is designed and constructed to the likely SLR estimate today) See Section 2 of the CPC Guidance for more on adaptive capacity.

   b. Choose the likely scenario if the project is not sensitive to inundation or flooding, or if adaptive capacity can be included in project design for later modifications if SLR rates

exceed the likely projections. See Section 2 of the CPC Guidance for more on adaptive capacity.

c. Calculate the project's SLR planning estimate for either the upper range or likely projection at the end of the planning horizon. The included worksheet (as well as Appendix 3 of the CPC Guidance) provides the equations for needed for this calculation.

3. **Bayside: Identify the appropriate base elevation at the location of the planned project**

The *base elevation* is the starting point elevation above which a project should be built today, whether or not seas continue to rise. On the Bayside, where a project may be exposed to increased frequency of flooding prior to permanent inundation, the base elevation can be selected based on project tolerance to temporary flooding.[1]

a. For projects involving assets that will be sensitive to periodic flooding, i.e. projects that should be built above the 100-year flood elevation, use the 100-year extreme tide elevation as the base elevation.

b. For projects that can be flooded periodically without experiencing damage, MHHW can be selected as the base elevation.[2]

c. Figure 1 provides a map for 70 data points on the Bayside of San Francisco. This figure can be used to select the point closest to the project location. Tables 1 and 2 provide tidal elevations (in ft-SFCD and ft NAVD88, respectively), for each of these 70 locations. Use these tables to select either the 100-year extreme tide or the MHHW elevation as the base elevation for the project.

d. For projects directly adjacent to the Bayside shoreline, wave runup should also be considered during project planning and design. Figure 2 provides a map of transect locations where wave runup has been calculated along the existing shoreline. This figure can be used to select the transect closest to the project location. Table 3 provides the 1% annual chance total water levels (1% TWL) at these transect locations (in ft-SFCD and ft NAVD88).

4. Westside: Identify the appropriate base elevations at the location of the planned project

The base elevation is the elevation above which a project should be built today, whether or not seas continue to rise. West of the Golden Gate, projects should be built above the 1% annual chance dynamic water level (1% DWL), which includes wave setup. Wave setup is the increase in water level due to the presence of waves. The 1% DWL (also referred to as 100-year DWL), is the water level which will cause inundation due storm surge and waves during a "100-year coastal storm condition." Use of the 1% DWL is recommended[3] for all projects on the Westside of the City.

[1] These recommendations are consistent with the City and County of San Francisco's Floodplain Management Ordinance.

[2] Use of MHHW as a base elevation means the project is within the existing 100-year coastal flood zone. Use of an intermediate base elevation, such as a 20-year or 50-year coastal flood zone, would provide an increased factor of safety in the near term, if desired, for projects which can tolerate some level of flooding. Tables 1 and 2 provide several intermediate base elevations which may be chosen as more conservative alternatives to MHHW.

[3] Use of 1% annual chance DWL as the base elevation is a conservative measure which provides protection of the asset from most waves. Tables 3 and 4 also provide 1% annual chance total water level (TWL) for the Bayside and Westside,

Projects directly adjacent to the shoreline should also consider the 1% Total Water Level (1% TWL) which includes wave setup and wave runup. Wave runup is the maximum vertical extent of wave uprush on a beach or structure.

Table 4 provides the 1% DWL and 1% TWL for 28 points on the Westside of San Francisco. Figure 3 shows the location of these 28 points. Use Figure 3 to locate the point closest to the project location. Use Table 4 to find the 1% DWL (or 1% TWL) for the location closest to the planned project.

5. **SFO: Identify the appropriate base elevation at the location of the planned project**

   The *base elevation* is the starting point elevation above which a project should be built today, whether or not seas continue to rise. At SFO, where a project may be exposed to increased frequency of flooding prior to permanent inundation, the base elevation can be selected based on project tolerance to temporary flooding.

   a. For projects involving assets that will be sensitive to periodic flooding, i.e. projects that should be built above the 100-year flood elevation, use the 100-year extreme tide elevation as the base elevation.

   b. For projects that can be flooded periodically without experiencing damage, MHHW can be selected as the base elevation.[4]

   c. Figure 4 provides a map for 19 data points on the SFO shoreline. This figure can be used to select the point closest to the project location. Tables 5 and 6 provide tidal elevations (in ft-SFCD and ft NAVD88, respectively), for each of these 19 locations. Use these tables to select either the 100-year extreme tide or the MHHW elevation as the base elevation for the project.

respectively. The 1% TWL includes wave run-up and is therefore more conservative than DWL. Use of the 1% annual chance TWL is recommended for projects that are directly adjacent to the shoreline.

[4] Use of MHHW as a base elevation means the project is within the existing 100-year coastal flood zone. Use of an intermediate base elevation, such as a 20-year or 50-year coastal flood zone, would provide an increased factor of safety in the near term, if desired, for projects which can tolerate some level of flooding. Tables 1 and 2 provide several intermediate base elevations which may be chosen as more conservative alternatives to MHHW.

Project Design Tide Elevation Worksheet

1. **Project Planning Horizon:**

   □ 1a. Year construction complete _____
   □ 1b. Functional lifespan _____.
   □ 1c. Project Planning Horizon = 1a + 1b = _____
   - 1a + 1b = (Write sum on line A)

2. **Sea Level Scenario. Choose one:**

   □ 2a. If project is sensitive to periodic flooding and/or adaptive capacity cannot easily be included in project design, calculate **upper range** sea level rise. Write answer on line B:
   - t = 1a + 1b - 2000
   - Sea level rise = $(0.0093t^2 + 0.7457t)/30.48$

   □ 2b. If project is not sensitive to periodic flooding, and adaptive capacity can be included within project design for later modifications, calculate **most likely** sea level rise. Write answer on line B.
   - t = 1a + 1b - 2000
   - Sea level rise = $(0.000045t^3 + 0.00037t^2 + 0.428t)/30.48$

Answers:

Project Planning Horizon (year)

A._____

(t = Line A – 2000 = _____)

Sea Level rise (feet)

B. _____

Project Location (point id #)

C._____

Base elevation or (ft-SFCD) or (ft-NAVD88)

D._____

Design Tide Elevation (B + D)

E. _____

3. **Is the project located on the Bayside (including SFO)? If Yes, is it sensitive to periodic flooding? Choose one:**

   □ 3a. No, Go to Question 4.

   □ 3b. Yes, and the project is NOT sensitive to periodic flooding. From Figure 1, find point closest to the project location. Write answer on line C.
   From either Table 1 (ft-SFCD) or Table 2 (ft-NAVD88) find the MHHW elevation at that point. This is the base elevation.[Error! Bookmark not defined.] Write answer on line D.

   □ 3c. Yes, and the project IS sensitive to periodic flooding. From Figure 1, find point closest to the project location. Write answer on line C.
   From either Table 1 (ft-SFCD) or Table 2 (ft-NAVD88), find the 100-year extreme tide elevation at that point. This is the base elevation. Write answer on line D.

4. **For Westside projects: Choose one.**

   □ 4a. Use Figure 2 to find the location closest to the planned project. Write answer on line C. Use Table 3 to select the 1% annual chance DWL (or 1% annual change TWL if appropriate) at that point. This is the base elevation.[Error! Bookmark not defined.] Write answer on line D.

5. **Calculate design tide elevation**

   Add line B to line D. Write answer on line E. This is the design tide elevation.

The project is located between Pier 41 and Pier 22½ along the Bay shoreline.

The project will complete construction in 2020, with a functional lifespan of 80 years. Your project planning horizon = 2020 + 80 = 2100 (Write on line A).

The project has high adaptive capacity – if needed, sensitive equipment can be moved to a higher level, or flood protection and flood proofing can be added without significant expanse, so you choose the most likely sea level rise scenario for planning and design. You choose to calculate the likely sea level rise, with t = 100 (e.g., t = 2100 – 2000 = 100).

- Sea level rise = $(0.000045t^3 + 0.00037t^2 + 0.428t)/30.48$
- Where t= 100
- Sea level rise = 3.00 ft
- Write on Line B.

Because it will need to be adapted in the future for flood risk, it is currently sensitive to floods. You will use the 100-year extreme tide rather than MHHW as your base elevation.

From Figure 2, you determine the closest data point to your project is Point 917. Write on Line C.

From Table 2 and 3 you determine that the 100-year extreme tide is -1.70 (ft-SFCD). Write on Line D.

Add Line B to Line D, write on Line E.

The **design tide elevation** is 1.3 ft-SFCD

Answers from worksheet:

Project Planning Horizon (year)

A. 2100

(t = Line A – 2000 = 100)

Sea Level rise (feet)

B. 3.00

Project Location (point id #)

C. 917

Base elevation ~~(ft-NAVD88)~~ or (ft-SFCD)

D. (-) 1.70

Design Tide Elevation: (B + D)

E. 1.3 (ft-SFCD)

Bayside Daily and Extreme Tide Elevations

This section provides the existing tidal elevations at specific points on the Bayside of San Francisco, as well as the calculation of flood heights under storm surge conditions for 1-year to 500-year storm events. The data are presented relative to the City datum (ft-SFCD) and ft-NAVD88. The data in this attachment does not include values that would occur under any sea level rise scenarios. This data is presented with permission from the SFPUC.

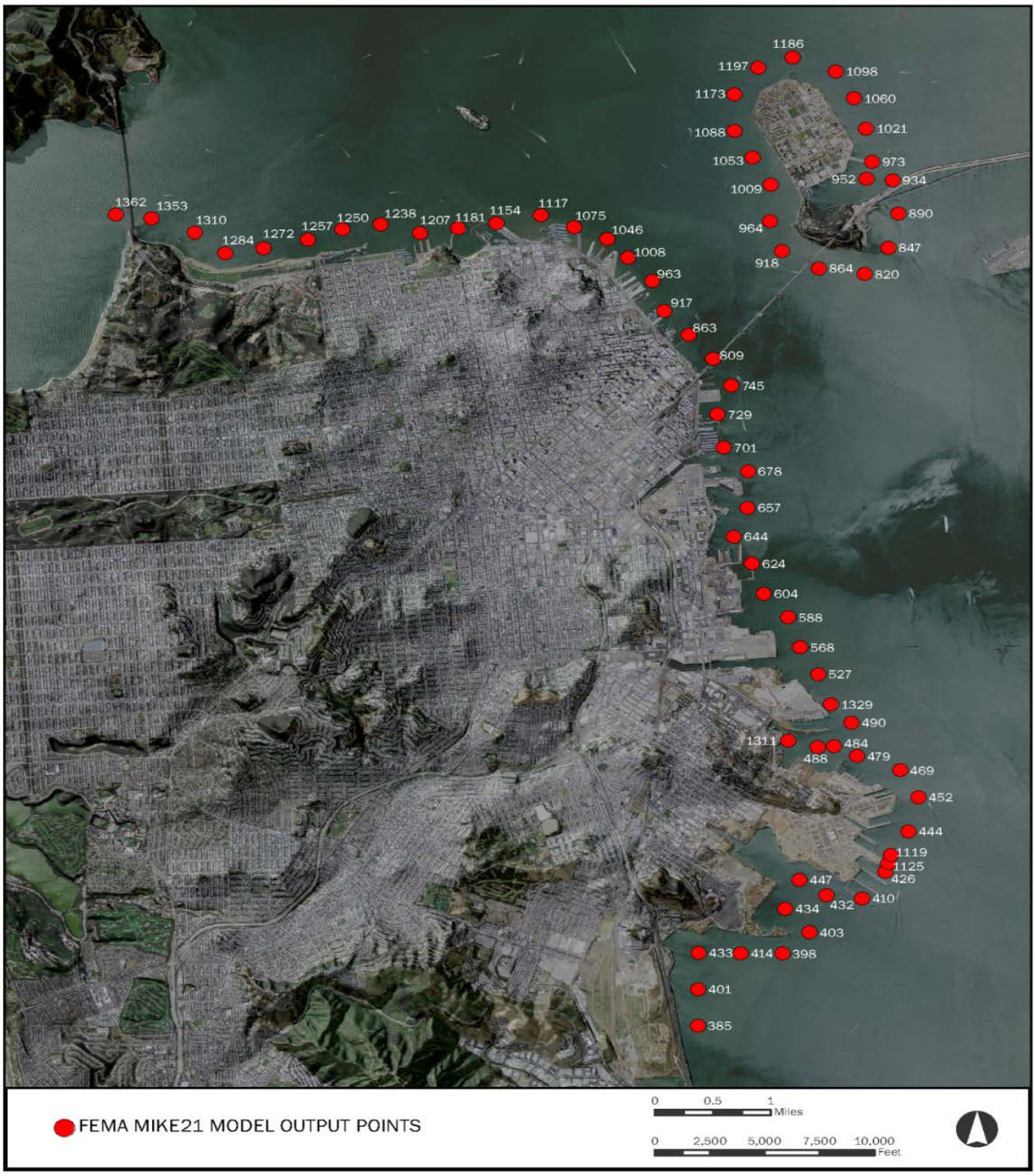

Figure 1: Tide Calculation Locations for the Bayside of the City

Table 1: Existing Conditions Daily and Extreme Tide Elevation for the Bayside Shoreline (FT-SFCD)

Point ID[(a)]	Coordinates		Tidal Datum						Extreme Tide Elevations[(b)]							
	Lat.	Long.	FT-SFCD						FT-SFCD							
			MLLW	MLW	MTL	MSL	MHW	MHHW	2-Yr	5-Yr	10-Yr	20-Yr	25-Yr	50-Yr	100-Yr	500-Yr
385	37.695	-122.389	-11.93	-10.77	-8.03	-8.05	-5.29	-4.67	-3.08	-2.71	-2.42	-2.09	-1.98	-1.59	-1.16	0.12
398	37.706	-122.375	-11.90	-10.74	-8.03	-8.06	-5.31	-4.70	-3.11	-2.74	-2.45	-2.12	-2.01	-1.64	-1.21	0.02
401	37.701	-122.389	-11.92	-10.76	-8.03	-8.05	-5.29	-4.68	-3.08	-2.71	-2.42	-2.09	-1.98	-1.60	-1.16	0.10
403	37.709	-122.371	-11.88	-10.73	-8.03	-8.06	-5.32	-4.71	-3.13	-2.76	-2.47	-2.15	-2.04	-1.67	-1.25	-0.04
410	37.714	-122.363	-11.86	-10.71	-8.02	-8.07	-5.34	-4.74	-3.15	-2.78	-2.49	-2.17	-2.06	-1.69	-1.28	-0.09
414	37.706	-122.382	-11.91	-10.76	-8.02	-8.05	-5.29	-4.68	-3.08	-2.72	-2.42	-2.10	-1.99	-1.61	-1.18	0.07
426	37.718	-122.359	-11.84	-10.70	-8.03	-8.08	-5.36	-4.75	-3.17	-2.80	-2.51	-2.19	-2.08	-1.72	-1.30	-0.13
432	37.714	-122.368	-11.87	-10.72	-8.02	-8.07	-5.33	-4.72	-3.13	-2.76	-2.47	-2.15	-2.04	-1.68	-1.26	-0.06
433	37.706	-122.388	-11.92	-10.76	-8.03	-8.05	-5.29	-4.68	-3.08	-2.71	-2.42	-2.09	-1.98	-1.60	-1.16	0.09
434	37.712	-122.375	-11.88	-10.72	-8.03	-8.07	-5.33	-4.72	-3.13	-2.76	-2.47	-2.15	-2.04	-1.67	-1.25	-0.04
444	37.723	-122.355	-11.81	-10.67	-8.02	-8.10	-5.37	-4.77	-3.19	-2.82	-2.53	-2.21	-2.10	-1.74	-1.33	-0.17
447	37.716	-122.372	-11.87	-10.72	-8.02	-8.07	-5.33	-4.71	-3.13	-2.76	-2.47	-2.15	-2.04	-1.67	-1.25	-0.05
452	37.728	-122.354	-11.79	-10.65	-8.02	-8.09	-5.39	-4.79	-3.21	-2.84	-2.55	-2.23	-2.12	-1.76	-1.36	-0.21
469	37.732	-122.356	-11.77	-10.63	-8.02	-8.08	-5.41	-4.81	-3.23	-2.86	-2.57	-2.25	-2.14	-1.78	-1.38	-0.25
479	37.734	-122.363	-11.75	-10.62	-8.02	-8.08	-5.43	-4.83	-3.25	-2.88	-2.59	-2.27	-2.16	-1.80	-1.40	-0.28
484	37.736	-122.367	-11.74	-10.61	-8.02	-8.08	-5.43	-4.83	-3.26	-2.88	-2.59	-2.27	-2.17	-1.81	-1.41	-0.28
488	37.736	-122.369	-11.74	-10.61	-8.02	-8.08	-5.43	-4.83	-3.26	-2.88	-2.59	-2.27	-2.16	-1.80	-1.40	-0.27
490	37.739	-122.364	-11.74	-10.61	-8.02	-8.08	-5.44	-4.85	-3.27	-2.89	-2.60	-2.29	-2.18	-1.82	-1.43	-0.32
527	37.746	-122.369	-11.70	-10.58	-8.03	-8.08	-5.48	-4.88	-3.31	-2.93	-2.64	-2.33	-2.22	-1.86	-1.47	-0.37
568	37.750	-122.372	-11.69	-10.56	-8.03	-8.08	-5.49	-4.90	-3.33	-2.94	-2.65	-2.34	-2.23	-1.87	-1.48	-0.39
588	37.754	-122.374	-11.67	-10.55	-8.03	-8.08	-5.51	-4.92	-3.35	-2.97	-2.68	-2.36	-2.26	-1.90	-1.51	-0.44
604	37.758	-122.378	-11.65	-10.54	-8.03	-8.08	-5.52	-4.93	-3.37	-2.98	-2.69	-2.38	-2.27	-1.92	-1.53	-0.47
624	37.762	-122.380	-11.64	-10.52	-8.03	-8.08	-5.53	-4.94	-3.38	-3.00	-2.70	-2.39	-2.29	-1.94	-1.55	-0.50
644	37.766	-122.382	-11.62	-10.51	-8.03	-8.08	-5.54	-4.95	-3.39	-3.01	-2.71	-2.40	-2.29	-1.94	-1.56	-0.51
657	37.770	-122.380	-11.61	-10.50	-8.03	-8.09	-5.55	-4.97	-3.41	-3.02	-2.73	-2.42	-2.31	-1.96	-1.58	-0.55
678	37.775	-122.380	-11.58	-10.48	-8.03	-8.11	-5.58	-5.00	-3.44	-3.05	-2.76	-2.45	-2.35	-2.00	-1.62	-0.61
701	37.779	-122.384	-11.56	-10.47	-8.03	-8.10	-5.60	-5.02	-3.46	-3.07	-2.77	-2.46	-2.36	-2.02	-1.64	-0.62

Point ID[(a)]	Coordinates		Tidal Datum						Extreme Tide Elevations[(b)]							
	Lat.	Long.	FT-SFCD						FT-SFCD							
			MLLW	MLW	MTL	MSL	MHW	MHHW	2-Yr	5-Yr	10-Yr	20-Yr	25-Yr	50-Yr	100-Yr	500-Yr
729	37.784	-122.385	-11.54	-10.46	-8.03	-8.10	-5.61	-5.03	-3.47	-3.08	-2.79	-2.48	-2.37	-2.03	-1.65	-0.64
745	37.788	-122.383	-11.53	-10.45	-8.04	-8.12	-5.62	-5.05	-3.50	-3.11	-2.81	-2.50	-2.39	-2.04	-1.66	-0.63
809	37.792	-122.385	-11.51	-10.43	-8.03	-8.10	-5.64	-5.07	-3.52	-3.13	-2.83	-2.52	-2.41	-2.06	-1.67	-0.63
863	37.795	-122.389	-11.48	-10.41	-8.04	-8.11	-5.66	-5.09	-3.54	-3.15	-2.85	-2.54	-2.43	-2.07	-1.69	-0.63
917	37.799	-122.393	-11.47	-10.40	-8.04	-8.10	-5.68	-5.11	-3.57	-3.17	-2.87	-2.55	-2.45	-2.09	-1.70	-0.64
963	37.803	-122.395	-11.45	-10.40	-8.05	-8.13	-5.70	-5.14	-3.59	-3.20	-2.90	-2.58	-2.47	-2.11	-1.72	-0.64
1008	37.806	-122.399	-11.43	-10.39	-8.05	-8.13	-5.71	-5.15	-3.62	-3.22	-2.92	-2.60	-2.49	-2.13	-1.74	-0.66
1046	37.809	-122.402	-11.42	-10.38	-8.06	-8.13	-5.74	-5.18	-3.65	-3.25	-2.94	-2.62	-2.51	-2.15	-1.74	-0.64
1075	37.811	-122.407	-11.40	-10.37	-8.06	-8.14	-5.75	-5.20	-3.67	-3.27	-2.97	-2.64	-2.53	-2.16	-1.76	-0.65
1117	37.813	-122.412	-11.39	-10.36	-8.07	-8.14	-5.78	-5.22	-3.70	-3.30	-2.99	-2.66	-2.55	-2.18	-1.76	-0.60
1154	37.811	-122.419	-11.37	-10.34	-8.07	-8.12	-5.80	-5.24	-3.72	-3.33	-3.02	-2.69	-2.57	-2.19	-1.77	-0.59
1181	37.811	-122.426	-11.36	-10.33	-8.07	-8.11	-5.81	-5.26	-3.74	-3.35	-3.04	-2.71	-2.59	-2.21	-1.79	-0.59
1207	37.810	-122.432	-11.35	-10.32	-8.07	-8.11	-5.83	-5.28	-3.76	-3.36	-3.06	-2.72	-2.61	-2.23	-1.80	-0.60
1238	37.811	-122.438	-11.34	-10.32	-8.08	-8.12	-5.84	-5.29	-3.78	-3.38	-3.07	-2.74	-2.62	-2.24	-1.81	-0.60
1250	37.811	-122.444	-11.33	-10.31	-8.09	-8.12	-5.86	-5.31	-3.80	-3.40	-3.10	-2.76	-2.64	-2.26	-1.83	-0.62
1257	37.809	-122.449	-11.32	-10.31	-8.09	-8.12	-5.87	-5.33	-3.82	-3.42	-3.11	-2.78	-2.66	-2.28	-1.85	-0.64
1272	37.808	-122.456	-11.32	-10.30	-8.10	-8.11	-5.89	-5.35	-3.84	-3.45	-3.14	-2.80	-2.69	-2.30	-1.87	-0.66
1284	37.807	-122.462	-11.31	-10.30	-8.10	-8.12	-5.91	-5.36	-3.86	-3.47	-3.16	-2.82	-2.71	-2.32	-1.89	-0.67
1310	37.810	-122.467	-11.29	-10.30	-8.11	-8.13	-5.93	-5.39	-3.90	-3.50	-3.19	-2.85	-2.74	-2.35	-1.92	-0.71
1353	37.812	-122.474	-11.27	-10.29	-8.11	-8.13	-5.94	-5.41	-3.92	-3.52	-3.22	-2.88	-2.77	-2.38	-1.96	-0.76
1362	37.813	-122.480	-11.40	-10.44	-8.20	-8.28	-5.97	-5.45	-3.97	-3.58	-3.27	-2.94	-2.82	-2.45	-2.03	-0.87
1119	37.719	-122.358	-11.84	-10.69	-8.02	-8.09	-5.36	-4.75	-3.17	-2.80	-2.51	-2.19	-2.08	-1.72	-1.31	-0.13
1125	37.720	-122.358	-11.83	-10.68	-8.03	-8.10	-5.37	-4.77	-3.18	-2.81	-2.52	-2.20	-2.10	-1.73	-1.32	-0.16
1311	37.737	-122.374	-11.68	-10.58	-8.01	-8.07	-5.43	-4.84	-3.26	-2.88	-2.59	-2.27	-2.16	-1.80	-1.40	-0.27
1329	37.742	-122.367	-11.72	-10.59	-8.03	-8.09	-5.46	-4.86	-3.29	-2.91	-2.62	-2.30	-2.20	-1.84	-1.45	-0.35
820	37.804	-122.361	-11.47	-10.38	-8.02	-8.06	-5.65	-5.08	-3.53	-3.13	-2.84	-2.53	-2.42	-2.07	-1.69	-0.67
847	37.808	-122.358	-11.48	-10.39	-8.02	-8.07	-5.65	-5.08	-3.53	-3.14	-2.84	-2.53	-2.42	-2.08	-1.70	-0.68
864	37.805	-122.369	-11.46	-10.38	-8.02	-8.07	-5.66	-5.10	-3.55	-3.15	-2.86	-2.54	-2.44	-2.09	-1.70	-0.67

Point ID[(a)]	Coordinates		Tidal Datum						Extreme Tide Elevations[(b)]							
	Lat.	Long.	FT-SFCD						FT-SFCD							
			MLLW	MLW	MTL	MSL	MHW	MHHW	2-Yr	5-Yr	10-Yr	20-Yr	25-Yr	50-Yr	100-Yr	500-Yr
890	37.813	-122.356	-11.46	-10.38	-8.02	-8.07	-5.66	-5.09	-3.54	-3.15	-2.85	-2.53	-2.42	-2.07	-1.69	-0.66
918	37.807	-122.374	-11.45	-10.39	-8.03	-8.11	-5.68	-5.12	-3.57	-3.18	-2.88	-2.56	-2.46	-2.11	-1.72	-0.68
934	37.817	-122.357	-11.45	-10.37	-8.02	-8.06	-5.67	-5.10	-3.55	-3.15	-2.85	-2.54	-2.43	-2.08	-1.69	-0.65
952	37.818	-122.361	-11.44	-10.37	-8.02	-8.06	-5.67	-5.10	-3.55	-3.15	-2.85	-2.54	-2.43	-2.07	-1.69	-0.63
964	37.812	-122.376	-11.43	-10.37	-8.03	-8.10	-5.70	-5.13	-3.59	-3.20	-2.90	-2.58	-2.47	-2.12	-1.73	-0.67
973	37.820	-122.360	-11.44	-10.37	-8.02	-8.06	-5.68	-5.10	-3.56	-3.16	-2.86	-2.54	-2.43	-2.08	-1.69	-0.64
1009	37.817	-122.376	-11.41	-10.35	-8.03	-8.08	-5.71	-5.15	-3.61	-3.21	-2.91	-2.59	-2.48	-2.12	-1.73	-0.66
1021	37.825	-122.361	-11.43	-10.36	-8.02	-8.07	-5.69	-5.12	-3.57	-3.17	-2.87	-2.55	-2.44	-2.09	-1.70	-0.63
1053	37.821	-122.379	-11.39	-10.34	-8.03	-8.07	-5.73	-5.16	-3.63	-3.23	-2.93	-2.60	-2.50	-2.13	-1.74	-0.66
1060	37.829	-122.363	-11.41	-10.35	-8.02	-8.07	-5.70	-5.13	-3.59	-3.19	-2.88	-2.56	-2.45	-2.09	-1.70	-0.63
1088	37.825	-122.382	-11.38	-10.33	-8.03	-8.07	-5.74	-5.18	-3.64	-3.24	-2.94	-2.62	-2.51	-2.14	-1.74	-0.65
1098	37.833	-122.366	-11.39	-10.34	-8.02	-8.07	-5.71	-5.14	-3.60	-3.20	-2.90	-2.57	-2.46	-2.10	-1.70	-0.60
1173	37.830	-122.382	-11.36	-10.31	-8.03	-8.05	-5.74	-5.18	-3.65	-3.25	-2.94	-2.61	-2.50	-2.12	-1.71	-0.56
1186	37.835	-122.372	-11.38	-10.32	-8.02	-8.06	-5.72	-5.16	-3.62	-3.22	-2.92	-2.59	-2.47	-2.10	-1.68	-0.53
1197	37.834	-122.378	-11.36	-10.31	-8.02	-8.05	-5.73	-5.17	-3.63	-3.24	-2.93	-2.60	-2.48	-2.10	-1.68	-0.50

(a) See Figure 1.

(b) Extreme tide elevations are the elevations that would occur if a 2-year, 5-year, 10-year, etc. storm surge event were to occur under existing tidal conditions. The timeframes listed here (2-year, 5-year, etc.) are indicative of storm surge frequency. This table presents potential tide elevations under existing conditions only and does not present tides under sea level rise scenarios.

1. Tidal datums calculated based on National Tidal Datum Epoch (1983–2001)
2. Tidal data and extreme tide elevations calculated using data from FEMA MIKE21 regional model (Central/North) for San Francisco Bay (DHI 2011)
3. Extreme tide elevations calculated using generalized extreme value distribution – maximum likelihood method
4. 100-Yr = the 1% annual chance extreme tide elevation based on modeled water level output, determined from statistical analysis of modeled annual maximum water levels at each FEMA model output point

Table 2: Daily and Extreme Tide Elevations for the Bayside SFPUC Shoreline (FT-NAVD88)

Point ID	Coordinates		Tidal Datums						Extreme Tide Elevations							
	Lat.	Long.	FT-NAVD88						FT-NAVD88							
			MLLW	MLW	MSL	MTL	MHW	MHHW	2-Yr	5-Yr	10-Yr	20-Yr	25-Yr	50-Yr	100-Yr	500-Yr
385	37.696	-122.389	-0.60	0.57	3.28	3.31	6.05	6.67	8.26	8.63	8.92	9.25	9.36	9.74	10.18	11.46
398	37.706	-122.375	-0.57	0.59	3.28	3.31	6.03	6.64	8.23	8.60	8.89	9.21	9.32	9.70	10.13	11.36
401	37.701	-122.389	-0.59	0.58	3.28	3.31	6.05	6.66	8.26	8.63	8.92	9.24	9.36	9.74	10.17	11.44
403	37.709	-122.371	-0.55	0.61	3.27	3.31	6.01	6.63	8.21	8.58	8.87	9.19	9.30	9.67	10.09	11.30
410	37.714	-122.363	-0.53	0.63	3.27	3.31	6.00	6.60	8.19	8.56	8.85	9.17	9.28	9.64	10.06	11.25
414	37.706	-122.382	-0.58	0.58	3.28	3.31	6.04	6.66	8.25	8.62	8.91	9.24	9.35	9.73	10.16	11.41
426	37.718	-122.359	-0.51	0.64	3.25	3.31	5.98	6.59	8.17	8.54	8.83	9.15	9.26	9.62	10.03	11.21
432	37.714	-122.368	-0.54	0.62	3.27	3.31	6.01	6.62	8.21	8.57	8.86	9.18	9.29	9.66	10.08	11.27
433	37.706	-122.388	-0.58	0.58	3.28	3.31	6.05	6.66	8.26	8.63	8.92	9.25	9.36	9.74	10.17	11.43
434	37.712	-122.375	-0.54	0.61	3.27	3.31	6.01	6.62	8.21	8.58	8.87	9.19	9.30	9.67	10.09	11.29
444	37.723	-122.355	-0.48	0.67	3.24	3.31	5.96	6.57	8.15	8.52	8.81	9.13	9.24	9.60	10.01	11.17
447	37.716	-122.373	-0.54	0.61	3.27	3.31	6.01	6.62	8.21	8.58	8.87	9.19	9.30	9.67	10.09	11.29
452	37.728	-122.354	-0.45	0.69	3.25	3.32	5.94	6.55	8.13	8.50	8.79	9.10	9.21	9.57	9.98	11.13
469	37.732	-122.356	-0.43	0.70	3.25	3.32	5.93	6.53	8.10	8.48	8.77	9.08	9.19	9.55	9.96	11.09
479	37.734	-122.363	-0.42	0.72	3.26	3.31	5.91	6.51	8.08	8.46	8.75	9.07	9.17	9.53	9.93	11.06
484	37.736	-122.367	-0.41	0.73	3.26	3.32	5.90	6.50	8.08	8.46	8.75	9.06	9.17	9.53	9.93	11.05
488	37.736	-122.369	-0.41	0.73	3.26	3.32	5.91	6.50	8.08	8.46	8.75	9.06	9.17	9.53	9.94	11.06
490	37.739	-122.364	-0.40	0.73	3.26	3.31	5.89	6.49	8.07	8.44	8.73	9.05	9.16	9.51	9.91	11.02
527	37.746	-122.369	-0.37	0.76	3.26	3.31	5.86	6.45	8.02	8.41	8.70	9.01	9.12	9.47	9.87	10.96
568	37.750	-122.372	-0.35	0.77	3.26	3.31	5.85	6.44	8.01	8.39	8.68	9.00	9.11	9.46	9.86	10.95
588	37.754	-122.374	-0.33	0.79	3.25	3.31	5.83	6.42	7.98	8.37	8.66	8.97	9.08	9.43	9.82	10.89
604	37.758	-122.378	-0.31	0.80	3.25	3.31	5.81	6.40	7.97	8.35	8.64	8.96	9.06	9.42	9.80	10.86
624	37.762	-122.380	-0.30	0.81	3.26	3.31	5.80	6.39	7.95	8.34	8.63	8.94	9.05	9.40	9.79	10.84
644	37.766	-122.382	-0.28	0.82	3.26	3.31	5.80	6.38	7.94	8.33	8.62	8.94	9.04	9.39	9.78	10.83
657	37.770	-122.380	-0.27	0.83	3.25	3.31	5.78	6.37	7.93	8.32	8.61	8.92	9.03	9.37	9.75	10.79
678	37.775	-122.380	-0.24	0.85	3.23	3.30	5.75	6.34	7.89	8.28	8.58	8.89	8.99	9.34	9.71	10.73

Point ID	Coordinates		Tidal Datums						Extreme Tide Elevations							
	Lat.	Long.	FT-NAVD88						FT-NAVD88							
			MLLW	MLW	MSL	MTL	MHW	MHHW	2-Yr	5-Yr	10-Yr	20-Yr	25-Yr	50-Yr	100-Yr	500-Yr
701	37.779	-122.384	-0.23	0.87	3.24	3.30	5.74	6.32	7.88	8.27	8.56	8.87	8.98	9.32	9.70	10.71
729	37.784	-122.385	-0.21	0.88	3.23	3.31	5.73	6.31	7.86	8.26	8.55	8.86	8.96	9.31	9.68	10.70
745	37.788	-122.383	-0.19	0.89	3.22	3.30	5.71	6.29	7.84	8.23	8.53	8.84	8.95	9.29	9.68	10.71
809	37.792	-122.385	-0.17	0.91	3.23	3.30	5.69	6.26	7.81	8.21	8.50	8.82	8.93	9.28	9.66	10.71
863	37.795	-122.389	-0.15	0.93	3.23	3.30	5.68	6.25	7.79	8.19	8.48	8.80	8.91	9.26	9.65	10.71
917	37.799	-122.393	-0.13	0.94	3.24	3.30	5.66	6.23	7.77	8.17	8.46	8.78	8.89	9.25	9.64	10.70
963	37.803	-122.395	-0.12	0.94	3.20	3.29	5.64	6.20	7.74	8.14	8.44	8.76	8.87	9.23	9.62	10.70
1008	37.806	-122.399	-0.10	0.95	3.21	3.29	5.62	6.18	7.72	8.12	8.42	8.74	8.85	9.21	9.60	10.68
1046	37.809	-122.402	-0.08	0.96	3.20	3.28	5.60	6.16	7.69	8.09	8.39	8.72	8.83	9.19	9.59	10.69
1075	37.811	-122.407	-0.07	0.97	3.20	3.28	5.58	6.14	7.67	8.07	8.37	8.70	8.81	9.17	9.58	10.69
1117	37.813	-122.413	-0.06	0.97	3.19	3.27	5.56	6.11	7.64	8.04	8.34	8.67	8.79	9.16	9.58	10.73
1154	37.811	-122.420	-0.04	1.00	3.22	3.27	5.54	6.09	7.62	8.01	8.32	8.65	8.76	9.14	9.56	10.75
1181	37.811	-122.426	-0.03	1.01	3.22	3.27	5.52	6.08	7.60	7.99	8.30	8.63	8.74	9.12	9.55	10.74
1207	37.810	-122.432	-0.01	1.02	3.23	3.26	5.51	6.06	7.58	7.97	8.28	8.61	8.73	9.11	9.54	10.74
1238	37.811	-122.438	-0.01	1.02	3.22	3.26	5.50	6.05	7.56	7.95	8.26	8.60	8.71	9.10	9.53	10.74
1250	37.811	-122.444	0.01	1.02	3.22	3.25	5.48	6.03	7.54	7.93	8.24	8.58	8.69	9.08	9.51	10.72
1257	37.809	-122.449	0.01	1.03	3.22	3.25	5.46	6.01	7.52	7.91	8.22	8.56	8.67	9.06	9.49	10.70
1272	37.808	-122.456	0.02	1.03	3.22	3.24	5.45	5.99	7.49	7.89	8.20	8.53	8.65	9.03	9.46	10.68
1284	37.807	-122.462	0.03	1.04	3.22	3.23	5.43	5.97	7.47	7.87	8.18	8.51	8.63	9.02	9.45	10.66
1310	37.810	-122.467	0.05	1.04	3.21	3.22	5.41	5.95	7.44	7.84	8.15	8.48	8.60	8.98	9.41	10.63
1353	37.812	-122.474	0.07	1.05	3.21	3.22	5.39	5.93	7.41	7.81	8.12	8.46	8.57	8.95	9.38	10.58
1362	37.813	-122.480	-0.06	0.90	3.06	3.13	5.37	5.89	7.36	7.76	8.07	8.40	8.51	8.89	9.31	10.47
1119	37.719	-122.358	-0.50	0.65	3.25	3.31	5.98	6.58	8.17	8.54	8.83	9.14	9.25	9.62	10.03	11.20
1125	37.720	-122.358	-0.49	0.65	3.24	3.31	5.97	6.57	8.16	8.53	8.82	9.13	9.24	9.61	10.01	11.18
1311	37.737	-122.374	-0.35	0.76	3.26	3.33	5.90	6.50	8.08	8.46	8.75	9.07	9.18	9.54	9.94	11.07
1329	37.742	-122.367	-0.38	0.74	3.25	3.31	5.88	6.47	8.05	8.43	8.72	9.03	9.14	9.50	9.89	10.99
820	37.804	-122.361	-0.13	0.95	3.28	3.32	5.69	6.26	7.81	8.20	8.50	8.81	8.92	9.26	9.64	10.67
847	37.808	-122.358	-0.14	0.94	3.27	3.31	5.68	6.25	7.80	8.20	8.49	8.81	8.91	9.26	9.64	10.65

Point ID	Coordinates		Tidal Datums						Extreme Tide Elevations							
	Lat.	Long.	FT-NAVD88						FT-NAVD88							
			MLLW	MLW	MSL	MTL	MHW	MHHW	2-Yr	5-Yr	10-Yr	20-Yr	25-Yr	50-Yr	100-Yr	500-Yr
864	37.805	-122.369	-0.12	0.96	3.26	3.31	5.67	6.24	7.79	8.18	8.48	8.79	8.90	9.25	9.63	10.67
890	37.813	-122.356	-0.12	0.95	3.27	3.31	5.67	6.25	7.79	8.19	8.49	8.80	8.91	9.26	9.64	10.68
918	37.807	-122.374	-0.11	0.95	3.23	3.30	5.66	6.22	7.76	8.16	8.46	8.77	8.88	9.23	9.61	10.66
934	37.817	-122.357	-0.12	0.97	3.28	3.32	5.67	6.23	7.79	8.18	8.48	8.80	8.91	9.26	9.64	10.69
952	37.818	-122.361	-0.11	0.97	3.28	3.32	5.66	6.24	7.79	8.18	8.48	8.80	8.91	9.26	9.65	10.70
964	37.812	-122.376	-0.09	0.97	3.24	3.30	5.64	6.20	7.74	8.14	8.44	8.76	8.86	9.22	9.61	10.67
973	37.820	-122.360	-0.10	0.97	3.28	3.32	5.66	6.23	7.78	8.18	8.48	8.80	8.90	9.26	9.64	10.69
1009	37.817	-122.376	-0.07	0.99	3.26	3.31	5.62	6.19	7.73	8.12	8.42	8.74	8.85	9.21	9.61	10.68
1021	37.825	-122.361	-0.09	0.98	3.27	3.31	5.65	6.22	7.76	8.16	8.47	8.79	8.89	9.25	9.64	10.70
1053	37.821	-122.379	-0.06	1.00	3.27	3.30	5.61	6.17	7.71	8.11	8.41	8.73	8.84	9.20	9.60	10.68
1060	37.829	-122.363	-0.07	0.99	3.27	3.31	5.64	6.21	7.75	8.15	8.45	8.77	8.88	9.24	9.64	10.71
1088	37.825	-122.382	-0.04	1.01	3.27	3.30	5.60	6.16	7.69	8.09	8.40	8.72	8.83	9.19	9.59	10.69
1098	37.833	-122.366	-0.06	1.00	3.27	3.31	5.63	6.19	7.73	8.13	8.44	8.76	8.87	9.24	9.64	10.73
1173	37.830	-122.382	-0.03	1.03	3.28	3.31	5.59	6.15	7.69	8.09	8.40	8.73	8.84	9.21	9.63	10.77
1186	37.835	-122.373	-0.04	1.01	3.27	3.31	5.61	6.17	7.71	8.11	8.42	8.75	8.86	9.24	9.65	10.80
1197	37.834	-122.378	-0.03	1.02	3.29	3.31	5.60	6.17	7.70	8.10	8.41	8.74	8.85	9.23	9.65	10.83

1. Tidal datums calculated based on National Tidal Datum Epoch (1983–2001)
2. Tidal data and extreme tide elevations calculated using data from FEMA model (Central/North) for San Francisco Bay (DHI 2011)
3. Extreme tide elevations calculated using generalized extreme value distribution – maximum likelihood method
4. 100-Yr = the 1% annual chance extreme tide elevation based on modeled water levels, determined from statistical analysis of modeled annual maximum water levels at each FEMA model output point
5. The following datum conversions were applied to the FEMA modeled water levels: San Francisco City Datum is 8.616 feet above NGVD29 and 11.336 feet above NAVD88

Bayside and Westside Dynamic and Total Water Levels

This attachment provides the total water levels (TWL) for the Bayside shoreline as well as the dynamic water levels (DWL) and TWL for the Westside shoreline. The DWL and TWL values include the impact of wave setup and wave run-up, respectively.

The TWLs values for the Bayside shoreline were leveraged from the FEMA San Francisco Bay Area Coastal Study (2015) and the Port of San Francisco Sea Level Rise Adaptation Study (2011). The DWL and TWL values for the Westside shoreline were leveraged from the FEMA Open Pacific Coast Study (2015).

For additional details, please see the SFPUC SSIP *Climate Stressors and Impact: Shoreline Assessment Technical Memorandum* (October 10, 2014). This data is presented with permission from the SFPUC.

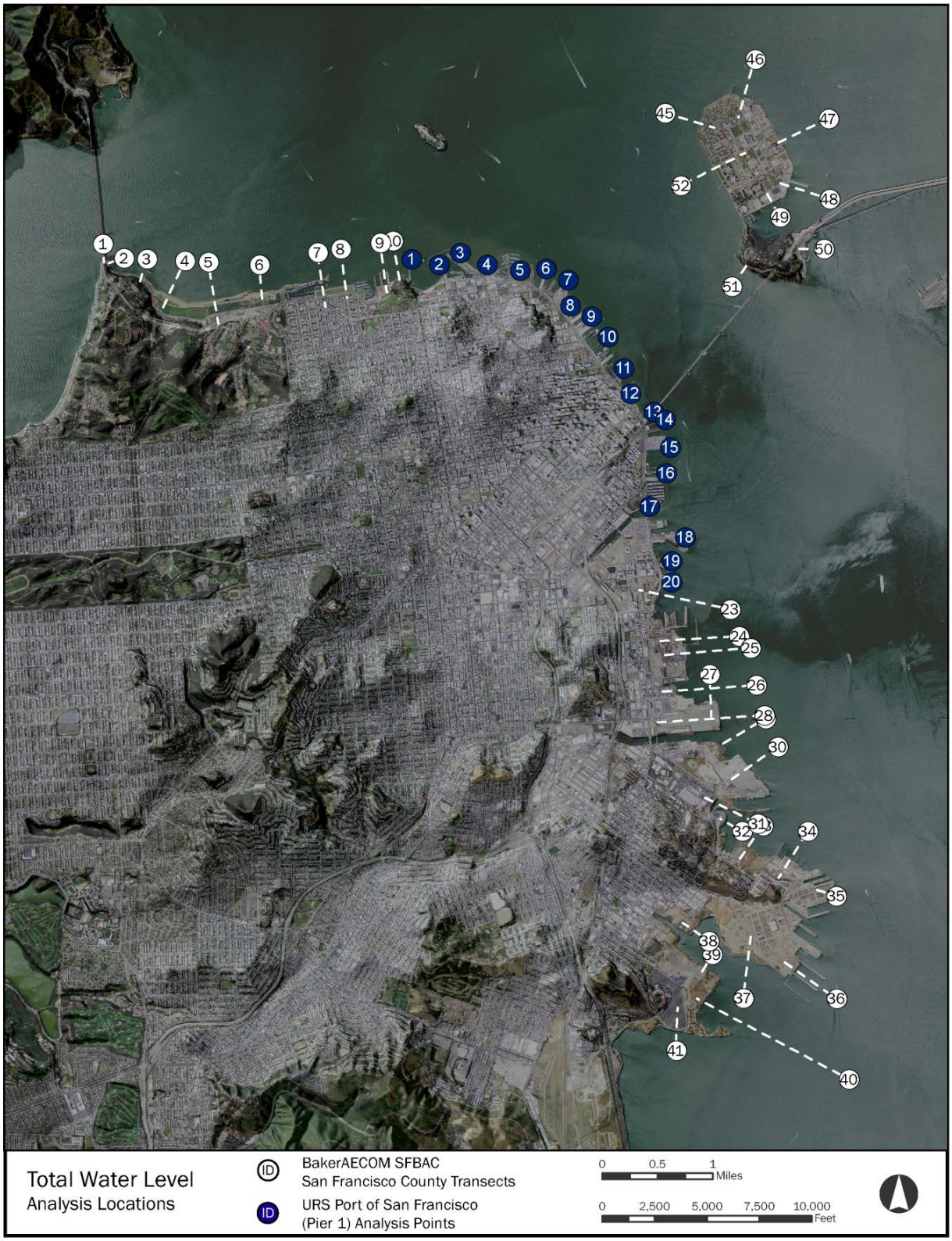

Figure 2: Total Water Level (1% Annual Chance) Locations for Bayside Shoreline

Table 3: Total Water Levels (1% Annual Chance) for the Bayside Shoreline

Source Study	Transect / Point ID	1% Annual Chance TWL (100-Year)	
		FT-SFCD	FT-NAVD88
URS Port of SF (Pier 1)	1	-0.54	10.8
	2	-0.54	10.8
	3	-0.64	10.7
	4	-0.54	10.8
	5	-0.74	10.6
	6	1.06	12.4
	7	1.86	13.2
	8	-0.94	10.4
	9	0.36	11.7
	10	0.46	11.8
	11	0.26	11.6
	12	-0.94	10.4
	13	-1.14	10.2
	14	1.26	12.6
	15	1.16	12.5
	16	1.46	12.8
	17	0.66	12.0
	18	1.26	12.6
	19	0.96	12.3
	20	0.96	12.3
FEMA Coastal Flood Hazard (Bayside)	1	9.96	21.3
	2	2.46	13.8
	3	4.76	16.1
	4	0.86	12.2
	5	0.26	11.6
	6	0.26	11.6
	7	3.86	15.2
	8	3.66	15.0
	9	3.56	14.9
	10	6.46	17.8
	23	0.76	12.1
	24	3.46	14.8
	25	-0.04	11.3
	26	0.36	11.7
	27	0.26	11.6
	28	1.96	13.3
	30	0.46	11.8
	32	1.36	12.7
	33	0.26	11.6

Table 3: Total Water Levels (1% Annual Chance) for the Bayside Shoreline

Source Study	Transect / Point ID	1% Annual Chance TWL (100-Year)	
		FT-SFCD	FT-NAVD88
	34	0.16	11.5
	35	3.86	15.2
	36	3.16	14.5
	37	-0.64	10.7
	38	-1.24	10.1
	39	-1.34	10.0
	40	-0.74	10.6
	41	-0.24	11.1
	42	1.36	12.7

Figure 3: Existing Conditions Extreme Dynamic Water Levels and Total Water Levels for the Westside SFPUC Shoreline

Table 4: Existing Conditions Extreme Dynamic Water Levels and Total Water Levels for the Westside SFPUC Shoreline

Transect	1% Annual Chance DWL Existing Conditions		1% Annual Chance TWL Existing Conditions	
	(FT-SFCD)	(FT-NAVD88)	(FT-SFCD)	(FT-NAVD88)
2	5.9	17.2	7.7	19.0
8	5.7	17	7.3	18.6
100	4.6	15.9	6.0	17.3
12	3.6	14.9	5.9	17.2
13	8.3	19.6	11.3	22.6
14	2.6	13.9	14.4	25.7
15	7.3	18.6	8.8	20.1
17	8	19.3	10.4	21.7
101	8.9	20.2	11.2	22.5
22	8.4	19.7	10.7	22.0
24	9.6	20.9	12.0	23.3
26	4.6	15.9	5.4	16.7
29	7.2	18.5	9.6	20.9
32	4.4	15.7	5.2	16.5
37	4.2	15.5	5.0	16.3
39	6.4	17.7	-	-
40	8.7	20	14.0	25.3
41	3	14.3	16.7	28.0
45	5.1	16.4	6.5	17.8
50	5.3	16.6	7.6	18.9
52	3.4	14.7	4.4	15.7
55	2.9	14.2	4.2	15.5
56	3.4	14.7	-	-
102	3.1	14.4	4.5	15.8
59	5.9	17.2	8.6	19.9
60	2.9	14.2	4.2	15.5
62	2.6	13.9	3.8	15.1
66	3.3	14.6	5.8	17.1

San Francisco International Airport Daily and Extreme Tide Elevations

This section provides the existing tidal elevations at specific points along the Bay shoreline of the San Francisco International Airport (SFO), as well as the calculation of flood heights under storm surge conditions for 1-year to 500-year storm events. The data are presented relative to the City datum (ft-SFCD) and ft-NAVD88. The data in this attachment does not include values that would occur under any sea level rise scenarios. This data is presented with permission from SFO (2014).

Figure 4: Tide Calculation Locations for SFO

Table 5: San Francisco International Airport Existing Daily and Extreme Tide Levels (FT-SFCD)

			Tidal Datum						Extreme Tide Elevation (Stillwater Elevation)								
	Coordinates (State Plane CAIII - Feet)		FT-SFCD						FT-SFCD								
ID	Easting	Northing	MLLW	MLW	MTL	MSL	MHW	MHHW	1-yr	2-yr	5 -yr	10-yr	20-yr	25- yr	50- yr	100-yr	500- yr
1	6017773.562	2063107.750	-11.99	-10.84	-8.01	-8.02	-5.18	-4.56	-3.27	-2.95	-2.59	-2.31	-2.00	-1.90	-1.55	-1.15	-0.03
2	6016020.415	2062888.689	-11.54	-10.61	-7.90	-7.98	-5.18	-4.56	-3.25	-2.95	-2.59	-2.31	-2.00	-1.90	-1.55	-1.16	-0.06
3	6015476.256	2061838.330	-11.85	-10.76	-7.97	-8.01	-5.18	-4.57	-3.26	-2.95	-2.59	-2.31	-2.00	-1.90	-1.54	-1.14	-0.01
4	6017100.925	2061611.559	-12.05	-10.86	-8.02	-8.02	-5.18	-4.57	-3.26	-2.95	-2.59	-2.31	-2.00	-1.89	-1.54	-1.14	0.00
5	6017894.296	2060175.768	-12.05	-10.86	-8.02	-8.02	-5.18	-4.56	-3.26	-2.95	-2.59	-2.30	-2.00	-1.89	-1.54	-1.14	-0.02
6	6016042.856	2058777.871	-12.06	-10.87	-8.02	-8.02	-5.18	-4.56	-3.25	-2.94	-2.58	-2.30	-1.99	-1.88	-1.53	-1.14	-0.02
7	6015052.898	2057856.022	-12.07	-10.88	-8.03	-8.02	-5.17	-4.56	-3.25	-2.94	-2.58	-2.29	-1.99	-1.88	-1.52	-1.12	0.01
8	6016390.395	2057470.557	-12.06	-10.87	-8.02	-8.02	-5.18	-4.56	-3.26	-2.94	-2.58	-2.30	-1.99	-1.88	-1.52	-1.12	0.03
9	6017984.880	2057976.757	-12.06	-10.87	-8.02	-8.02	-5.17	-4.56	-3.26	-2.95	-2.59	-2.30	-1.99	-1.88	-1.52	-1.12	0.04
10	6019609.549	2057749.986	-12.05	-10.86	-8.02	-8.01	-5.17	-4.55	-3.27	-2.95	-2.59	-2.30	-1.99	-1.88	-1.52	-1.11	0.07
11	6021521.356	2057681.876	-12.06	-10.87	-8.02	-8.02	-5.17	-4.55	-3.27	-2.94	-2.58	-2.30	-1.98	-1.88	-1.51	-1.10	0.08
12	6022601.898	2056404.745	-12.06	-10.88	-8.02	-8.02	-5.16	-4.54	-3.26	-2.94	-2.57	-2.29	-1.98	-1.87	-1.50	-1.09	0.09
13	6022087.956	2054621.416	-12.08	-10.89	-8.02	-8.02	-5.16	-4.54	-3.25	-2.93	-2.57	-2.28	-1.97	-1.86	-1.50	-1.09	0.10
14	6023455.637	2053502.947	-12.08	-10.89	-8.02	-8.02	-5.15	-4.53	-3.25	-2.93	-2.57	-2.28	-1.96	-1.85	-1.48	-1.06	0.15
15	6025110.489	2052543.172	-12.09	-10.90	-8.02	-8.02	-5.14	-4.52	8.09	8.42	8.78	9.06	9.38	9.49	9.86	10.28	11.50
16	6022616.629	2048916.112	-12.05	-10.89	-8.01	-8.02	-5.13	-4.51	8.10	8.43	8.79	9.08	9.40	9.51	9.88	10.30	11.52
17	6023508.294	2048659.157	-11.63	-10.68	-7.90	-7.97	-5.13	-4.51	8.11	8.44	8.80	9.08	9.40	9.51	9.87	10.29	11.50
18	6024014.494	2047064.672	-12.06	-10.90	-8.01	-8.01	-5.12	-4.51	8.11	8.44	8.80	9.08	9.40	9.50	9.87	10.29	11.50
19	6025095.036	2045787.542	-12.11	-10.93	-8.02	-8.01	-5.12	-4.50	8.11	8.44	8.80	9.08	9.40	9.51	9.88	10.30	11.52

1. Tidal data calculated based on National Tidal Datum Epoch (1983–2001).
2. Tidal data and surge elevations calculated using data from South Bay regional model of San Francisco Bay (DHI 2013).
3. Surge elevations calculated using generalized extreme value distribution – maximum likelihood method.
4. 100-year extreme tide stillwater elevation = the 1% annual chance extreme tide elevation based on the FEMA model simulations, without including the effect of wind waves.

Table 6: San Francisco International Airport Existing Daily and Extreme Tide Levels (FT-NAVD88)

			Tidal Datum						Extreme Tide Elevation (Stillwater Elevation)								
	Coordinates (State Plane CAIII - Feet)		FT-NAVD88						FT-NAVD88								
ID	Easting	Northing	MLLW	MLW	MTL	MSL	MHW	MHHW	1-yr	2-yr	5 -yr	10-yr	20-yr	25- yr	50- yr	100-yr	500-yr
1	6017773.562	2063107.750	-0.66	0.50	3.33	3.32	6.15	6.77	8.07	8.38	8.74	9.03	9.33	9.44	9.79	10.19	11.31
2	6016020.415	2062888.689	-0.21	0.73	3.44	3.36	6.15	6.77	8.09	8.39	8.75	9.03	9.33	9.44	9.78	10.17	11.27
3	6015476.256	2061838.330	-0.51	0.57	3.36	3.33	6.15	6.77	8.08	8.39	8.75	9.03	9.33	9.44	9.79	10.19	11.32
4	6017100.925	2061611.559	-0.71	0.47	3.31	3.32	6.16	6.77	8.08	8.39	8.75	9.03	9.34	9.44	9.80	10.20	11.34
5	6017894.296	2060175.768	-0.71	0.47	3.32	3.32	6.16	6.78	8.08	8.39	8.75	9.03	9.34	9.44	9.80	10.19	11.32
6	6016042.856	2058777.871	-0.73	0.46	3.31	3.32	6.16	6.78	8.08	8.39	8.76	9.04	9.35	9.45	9.80	10.20	11.32
7	6015052.898	2057856.022	-0.73	0.46	3.31	3.32	6.16	6.78	8.09	8.40	8.76	9.04	9.35	9.46	9.81	10.21	11.34
8	6016390.395	2057470.557	-0.73	0.46	3.31	3.32	6.16	6.78	8.07	8.39	8.75	9.04	9.35	9.46	9.81	10.22	11.37
9	6017984.880	2057976.757	-0.72	0.47	3.32	3.32	6.16	6.78	8.07	8.39	8.75	9.03	9.35	9.45	9.81	10.22	11.38
10	6019609.549	2057749.986	-0.71	0.47	3.32	3.32	6.16	6.78	8.07	8.39	8.75	9.03	9.35	9.46	9.82	10.23	11.40
11	6021521.356	2057681.876	-0.72	0.47	3.32	3.32	6.17	6.79	8.07	8.39	8.75	9.04	9.35	9.46	9.82	10.23	11.41
12	6022601.898	2056404.745	-0.73	0.46	3.32	3.32	6.18	6.79	8.08	8.40	8.76	9.05	9.36	9.47	9.83	10.24	11.43
13	6022087.956	2054621.416	-0.74	0.45	3.31	3.32	6.18	6.80	8.09	8.41	8.77	9.05	9.36	9.47	9.84	10.25	11.44
14	6023455.637	2053502.947	-0.74	0.45	3.32	3.32	6.19	6.80	8.08	8.41	8.77	9.06	9.37	9.48	9.85	10.27	11.49
15	6025110.489	2052543.172	-0.76	0.44	3.31	3.32	6.19	6.81	8.09	8.42	8.78	9.06	9.38	9.49	9.86	10.28	11.50
16	6022616.629	2048916.112	-0.71	0.44	3.33	3.32	6.21	6.83	8.10	8.43	8.79	9.08	9.40	9.51	9.88	10.30	11.52
17	6023508.294	2048659.157	-0.29	0.66	3.43	3.36	6.21	6.83	8.11	8.44	8.80	9.08	9.40	9.51	9.87	10.29	11.50
18	6024014.494	2047064.672	-0.73	0.43	3.32	3.32	6.21	6.83	8.11	8.44	8.80	9.08	9.40	9.50	9.87	10.29	11.50
19	6025095.036	2045787.542	-0.78	0.41	3.31	3.32	6.21	6.83	8.11	8.44	8.80	9.08	9.40	9.51	9.88	10.30	11.52

1. Tidal data calculated based on National Tidal Datum Epoch (1983–2001).
2. Tidal data and surge elevations calculated using data from South Bay regional model of San Francisco Bay (DHI 2013).
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