Preliminary Feasibility Study for South San Francisco Bay Shoreline

Economic Impact Areas 1 - 10

Executive Summary

Prepared For:

Department of Water Resource
Division of Flood Management
State Of California

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A preliminary feasibility study of storm damage evaluation and assessment along the South San Francisco Bay Shoreline, extending from San Francisquito Creek to Guadalupe River, was performed. This study was funded by the State Department of Water Resources through a Local Levee Evaluation Grant (No. 4600009957). The scope of work of this grant-funded study includes development of a conceptual plan for levee alignments that provides flood protection within the project area, restore the diminished tidal habitats, and provide recreation public access features. An engineering evaluation followed by a documented report is subsequently performed to inform the feasibility of levee improvements, environmental enhancements, and recreation improvements in the project area. The project boundary is illustrated in Figure 1. In total, ten Economic Impact Areas (EIAs) are designed for the economic evaluation associated with the potential storm damage in relation to the proposed protective levee. It is noted that the study period extends for 50 years from 2017 (Year 0) to 2067 (Year 50).

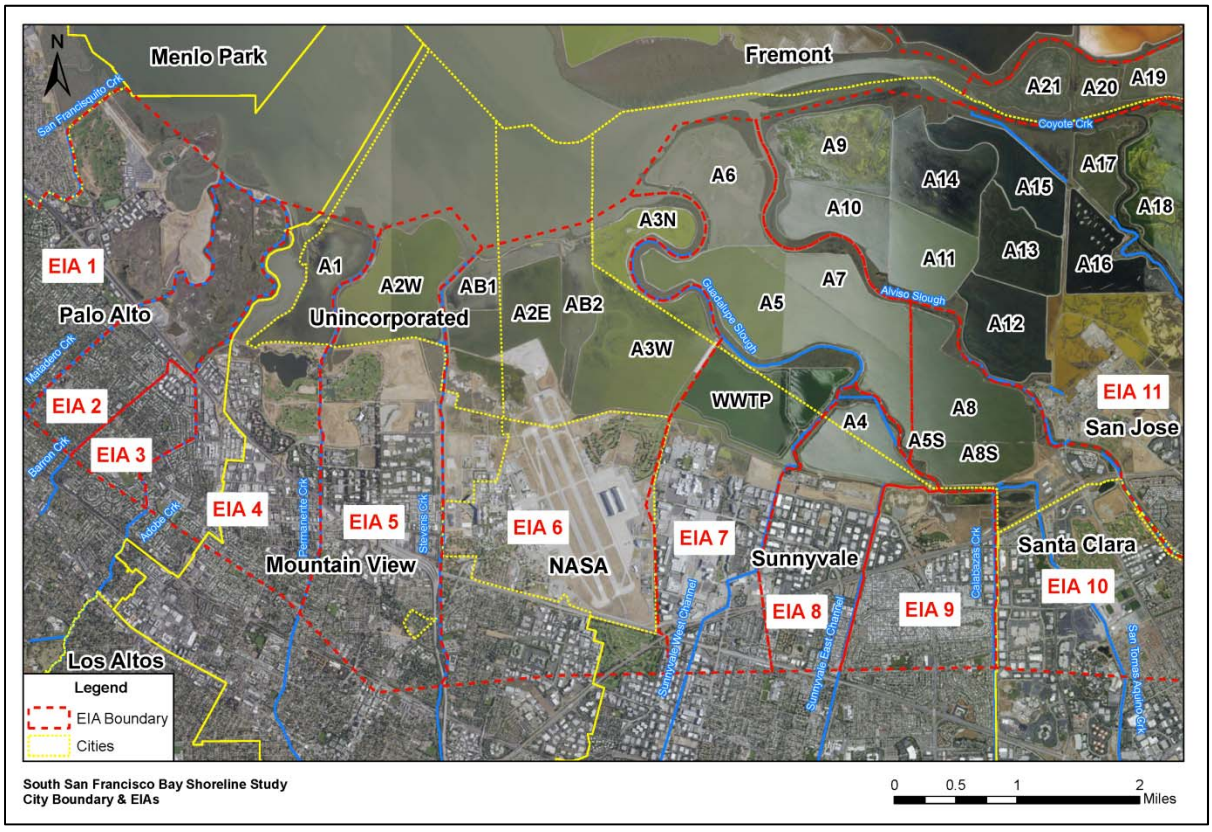


Figure 1. Project Site Location

The existing outer levees, located immediately adjacent to South San Francisco Bay in the project area, are predominantly composed of bay muds that were excavated from the neighboring ponds. The existing inner levees were also constructed with the same baymud material. Some of the inner levees were armored or built with a proper engineering design for additional protection against erosion. Both outer and inner levees were periodically raised or widened with the same practice. Geotechnical explorations for both outer and inner levees

were conducted to characterize the physical properties of levee material from EIAs 1 to 10. Geotechnical recommendations, based on the derived physical properties of levee material, were provided for any newly proposed protective levee in the project area.

The preliminarily proposed coastal levee alignment extends for approximately 14.3 miles, as illustrated in Figure 2. The alignment of individual levee sections was formulated after consultations with local and federal agencies in the area including Cities of Palo Alto, Mountain View, Sunnyvale, and San Jose, County of Santa Clara, California State Coastal Conservancy, U.S. Fish and Wildlife Service, and National Aeronautics and Space Administration (NASA). The new protective levee will not only improve the environmental opportunity but also enhance recreational activity. The proposed protective levee will contribute an additional 3.14 miles of new recreation trail to be integrated into the existing Bay Trail system, as illustrated in Figure 3. The proposed coastal levee along with the South Bay Salt Pond Restoration Project (SBSPRP) will connect the existing salt ponds with bay waters to restore vital ecosystems for a variety of threatened and endangered species. This coastal protective levee will also provide a sufficient habitat buffer zone which benefits the recovery of listed species by serving as refuge area during high tides and large storm events.

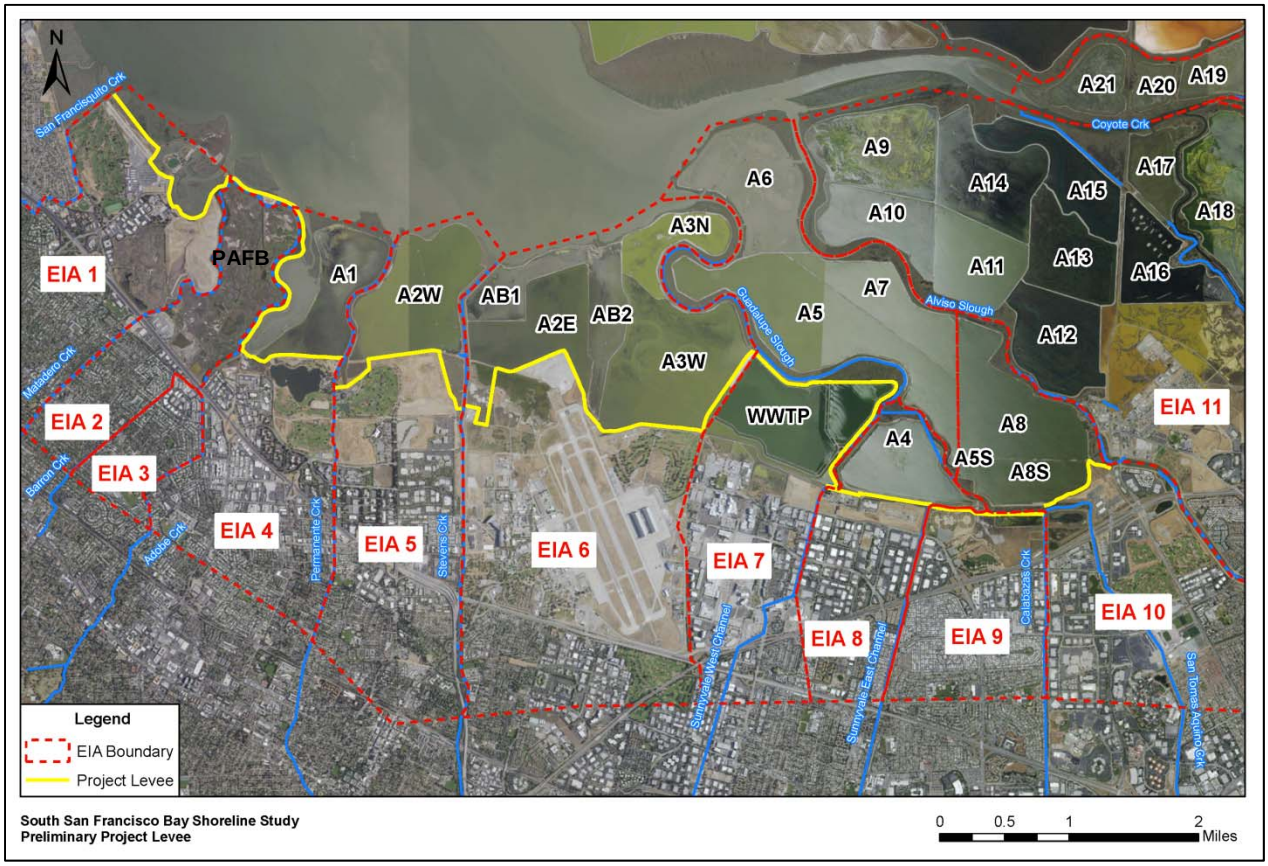


Figure 2. Proposed Protective Levee

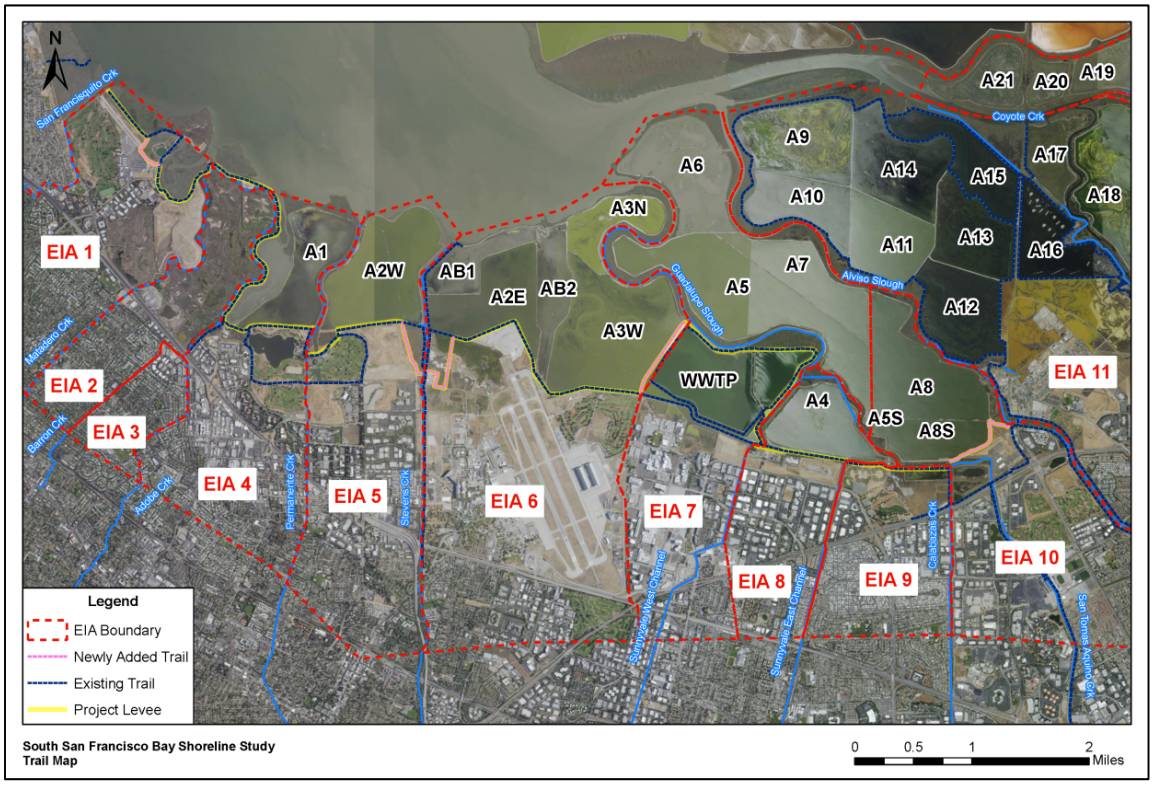


Figure 3 . Existing and Project-added Trail Map

Topographic and bathymetric data sources were acquired from U. S. Army Corps of Engineers (USACE), United States Geological Survey, and Santa Clara Valley Water District that were validated by the Corps of Engineers, San Francisco District. The collected data were applied to prepare the modeling grids for the long wave modeling effort (see Appendix I) to establish the Water Surface Elevation (WSE) look-up tables to be used in the statistic analysis. The long wave simulations for the with- and without- levee breaching scenarios consist of 720 events for the without-project conditions and 360 events for the with-project conditions in Year 0 and Year 50, respectively. The Year 50 simulations were based on the resulting accretion in the project area, erosion in the south bay and the marsh accretion within individually restored ponds, if applicable, as a consequence of future sea level rise (SLR).

The Monte Carlo simulation technique (see Appendix II) was applied to deduce the flood stage frequency in the project area from EIA1 to EIA 10, using the compiled WSE look-up tables. Inundation maps for the 100-year WSE were prepared under the existing and the three future SLR without-project conditions (i.e., low, intermediate and high). The estimated SLR values for the low, intermediate and high projections are 0.5, 1.01 and 2.59 feet in Year 50, respectively. Figure 4 and Figure 5 respectively show the derived inundation maps under the existing (Year 0) and the high SLR projection in Year 50.

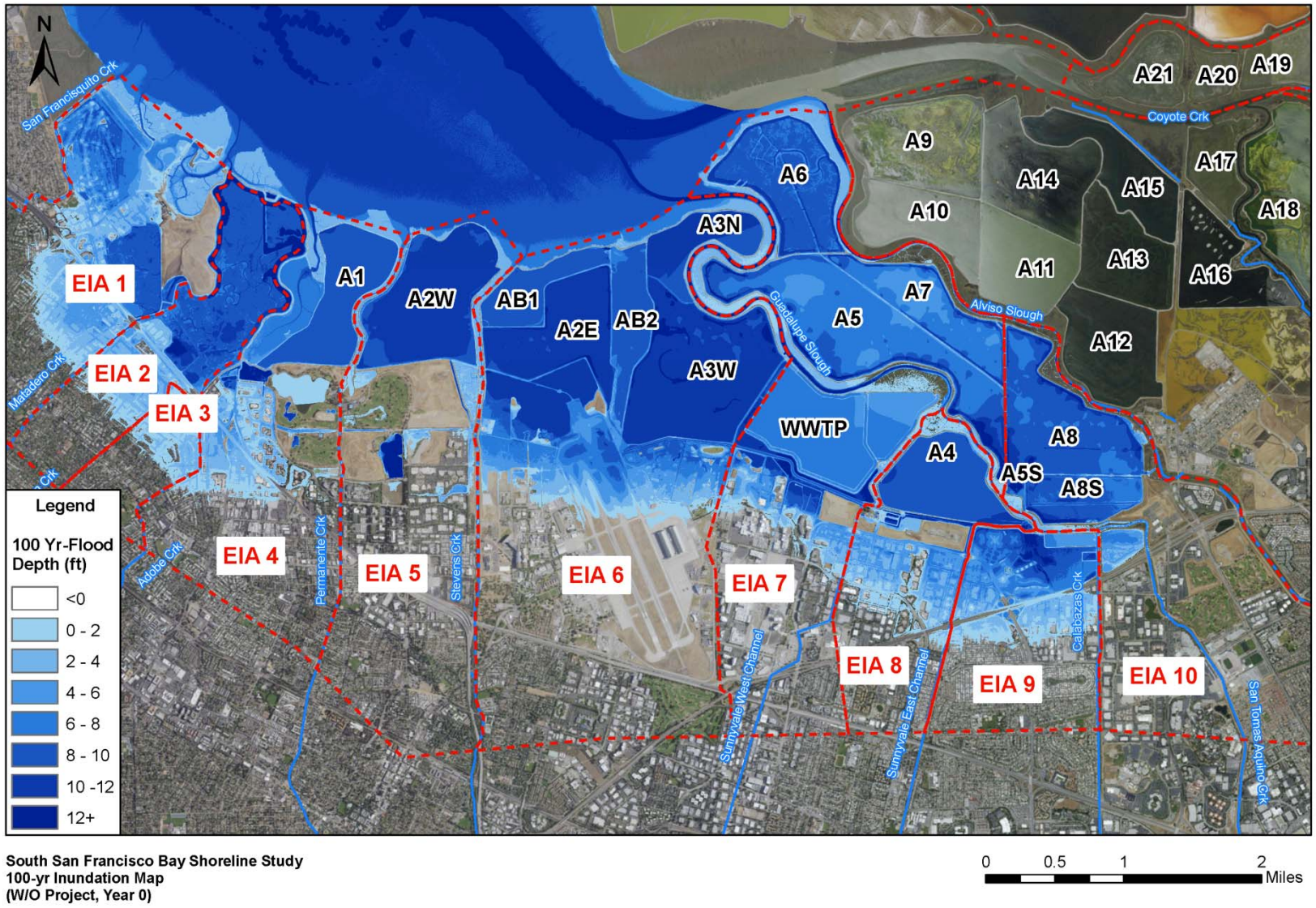
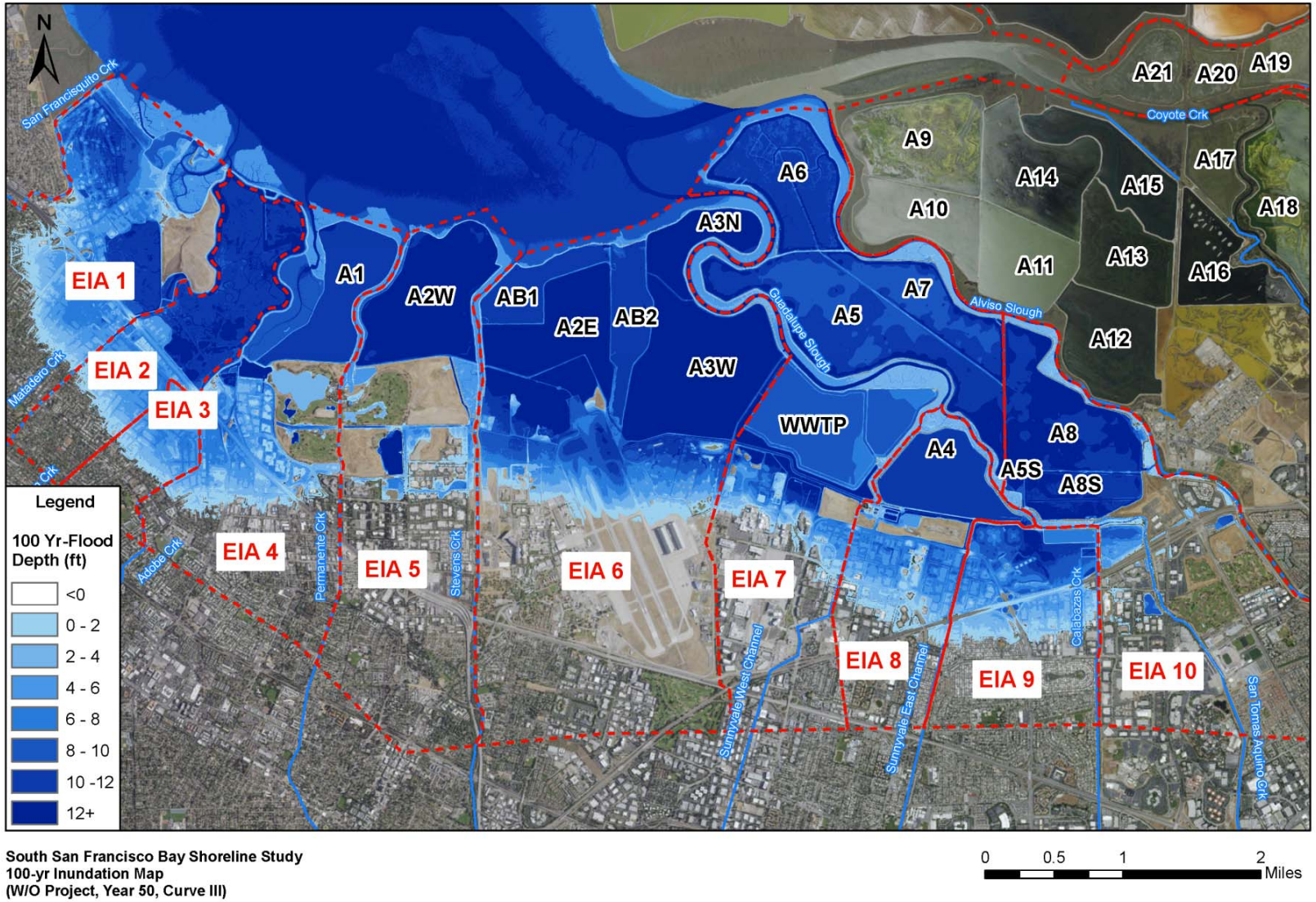


Figure 4. 100-year Inundation Map Without Project in Year 0



South San Francisco Bay Shoreline Study
100-yr Inundation Map
(W/O Project, Year 50, Curve III)

Figure 5. 100-year Inundation Map Without Project in Year 50 SLR Curve III

The computed WSEs under the high SLR projections range from +13.1 to +13.3 ft, NAVD as presented in Table 1. These estimated WSEs form the basis for designing the crest of individual levee sections with an additional 2-foot freeboard, which translates to +15.1 to 15.3 feet, NAVD for the crest elevation. Table 2 presents the initial proposed levee length in each EIA as well as the required levee section in each EIA, based on the existing ground elevation along the levee alignment.

Table 1. Highest WSE and Levee Crest Elevation Estimated in Individual EIAs

EIA	Highest WSE (ft, NAVD)	Proposed Crest Elv. (ft, NAVD)
EIAs 1 to 5	+13.0	+15.0
EIS 6 & EIA 7	+13.1	+15.1
EIA 8	+13.3	+15.3
EIA 9 & EIA 10	+13.2	+15.2

Note: Based on a 2-foot freeboard

Table 2. Breakdown of Levee length in Each EIA

EIA	Proposed Levee Length		Levee Length To be Built	
	(feet)	(Miles)	(feet)	(Miles)
1	9,408	1.78	9,408	1.78
2/3	10,595	2.01	10,595	2.01
4	4,355	0.82	1,358	0.26
5	7,638	1.45	1,369	0.26
6	14,776	2.80	14,776	2.80
7	15,968	3.02	15,968	3.02
8	4,359	0.83	4,359	0.83
9	4,613	0.87	4,613	0.87
10	3,957	0.75	577	0.11
Total	75,669	14.33	63,023	11.94

To evaluate the feasibility of constructing protective levee sections in the ten study EIAs, a preliminary economic analysis (see Appendix III) was conducted to quantify the coastal flood risk and the resulting benefit for the proposed levee alternative. Table 3 summarizes the preliminarily estimated benefit-to-cost (B/C) ratio in each individual EIA. The B/C ratio is defined as the reduced equivalent annual damage divided by the average annual project cost. If the resulting project benefit is higher than the cost required to complete the proposed project, the B/C ratio is greater than one, which implies a favorable and beneficial project.

EIAs 1 to 3 are primarily residential areas with a small percentage of non-residential parcels with structures for commercial and industrial use. The three EIAs are prone to storm-induced inundation without an elevated protective levee. The computed B/C ratios within this coastal

zone are similar. It is noted that EIA 2 and EIA 3 are combined since no protective levee section is proposed in EIA 3 and both EIAs are in the jurisdiction of the City of Palo Alto.

Table 3: Preliminarily Estimated Benefit-Cost Ratio in individual EIA

Individual EIA	Benefit-to-Cost Ratio		
	SLR Scenario		
	Low	Intermediate	High
EIA 1	12.9	12.8	12.6
EIA 2 & EIA 3	15.8	15.8	16.3
EIA 4	24.6	27.5	34.4
EIA 5	0.0	0.0	0.11
EIA 6	0.5	0.5	0.4
EIA 7	0.95	0.98	0.98
EIA 8	15.7	15.9	13.6
EIA 9	9.7	10.0	10.1
EIA 10	0.0	0.0	0.0

Notes: 1) 50-year period of analysis, 2) The assumed interest rate is 3.125%, & 3) Construction cost excludes real estate & maintenance

EIAs 4 and 5 are primarily commercial and industrial structures including many high-tech companies from the pharmaceutical, biotechnology and information technology (IT) industries. The B/C ratio would be high ranging from 20s to 30s in EIA 4. It is noted that the existing ground elevation immediately bayward of Sailing Lake is higher than the required elevation. Thus, the required levee section is shortened, as shown in Figure 6. Similarly, the raised area of Shoreline Park in EIA 5 indicates that no damage will occur even under the future high SLR scenario. Thus, the levee section to be built in EIA 5 is much shorter than the proposed sectional length (see Figure 6).

EIA 6 is essentially a military-related facility, namely NASA Ames and Moffett Field. Many of the structures on the NASA property contain specialized, non-standard contents such as lab equipment, supercomputing equipment, compressors, and aircraft parts. The actual replacement values of these contents are unknown. Thus, the estimated potential damages from storm-induced inundation tend to be underestimated. The actual B/C ratio in this EIA would be much higher.

EIA 7 is exclusively commercial and industrial structures including several well-known companies such as Lockheed Martin and Yahoo. The estimated B/C ratio is slightly less than one. However, the extended levee section in this EIA also protects the storage pond of the Sunnyvale Water Pollution Control Plant (SWPCP). The inundation damage without a protective levee would be extremely high, which is not included in this preliminary analysis.

EIA 8 consists exclusively of commercial and industrial buildings with a mix of 60 office structures as research and manufacturing facilities. This EIA also includes the main operation buildings of the SWPCP as well as the SMaRT Station used for processing recyclable materials from residents and businesses in the cities of Sunnyvale, Palo Alto and Mountain View. Thus, the actual B/C ratio would be much higher with the inclusion of damages associated with these

two public facilities. EIA 9 includes a mix of industrial, commercial, and residential structures for a total of 110 structures that are within the floodplain. The computed B/C ratios in both EIAs range from 10 to 16 approximately. In EIA 10, all flooding events under the base year (2017) and future conditions (2067) are confined to a low area north of Highway 237. No structures or vital infrastructure in this EIA are at risk from coastal flooding according to the preliminary modeling. Therefore, no benefit can be claimed with the proposed protective levee section meaning the computed B/C ratio is zero as seen in Table 3.

In this preliminary analysis, flood damages resulting from events more frequent than the 10-year event (10% ACE) were removed from the risk assessment to somewhat realistically reflect what has been observed in the past. However, it is plausible that flood damage may occur under the high SLR scenario as a result of these more frequent events. This would mean that the future equivalent annual damage estimate under the high SLR scenario (i.e., the SLR Curve III) may be underestimated.

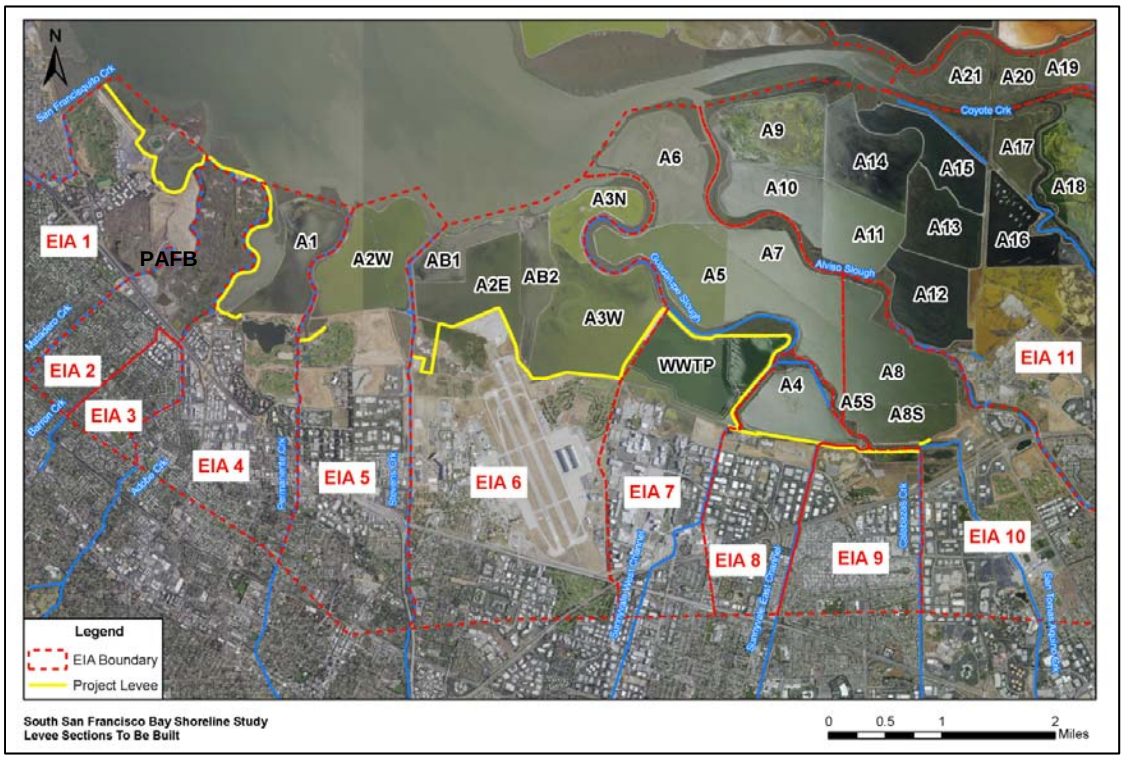


Figure 6. Required Protective Levee Sections

It is noted that several items associated to the project cost and implementation were not included in this preliminary feasibility study and are listed as follows.

- Project cost including real estate, project-associated mitigation, and maintenance following the completion of an EIR/EIS preparation;
- Estimation of the changes in land use in the floodplain that may occur in the face of significant or repetitive coastal flooding;

- Damages to the two waste water treatment plants and the SMaRT Station located in the study area;
- Transportation delay costs and any damages to roads and highways in the floodplain; and
- Damages to vehicles and the displacement cost incurred by residents whose homes have been flooded.

In a separate study, a hydraulic analysis (see Appendix IV) of nine creeks located in the project area was performed. The nine creeks are Matadero Creek, Barron Creek, Adobe Creek, Permanente Creek, Stevens Creek, Sunnyvale West Channel, Sunnyvale East Channel, Calabazas Creek and San Tomas Aquino Creek, as shown in Figure 7. The computed maximum water surface profiles during the 100-year flow event were used to assess whether the channel meets the 100-year protection criteria under the existing and three future SLR conditions. Individual creek sections susceptible to water overflowing the bank or protective levees were identified. It is noted that this hydraulic analysis excludes San Francisquito Creek since the creek's hydraulic conditions have been extensively studied by the Corps of Engineers, San Francisco District.

Source: NCI. 2016

Figure 7. Stream Lines of Nine Analyzed Creeks