Attachment 8 – Benefits and Cost Analysis

Attachment 8 describes and quantifies the benefits and costs of the San Francisquito Creek Flood Protection Project. The analysis of benefits and cost for the project is consistent with the physical benefits presented in Attachment 7 – Technical Justification.

General Principles

The following principles were adhered to during preparation of this attachment.

- Consistency – The analysis was completed for the entire project and is consistent with other data and information provided about the San Francisquito Creek Flood Protection Project.
- Completeness – All new facilities, policies, and actions required to obtain the benefits were revealed and their costs have been included.
- With-Project and Without-Project Comparison – The analysis is based on a comparison of expected conditions with and without the project over the period of analysis.
- Period of Analysis – The analysis was based on a project life cycle of 50 years as specified by the San Francisquito Creek Joint Powers Authority (JPA). This includes the construction period and operational life.

Project Overview

The project for which Proposition 1E funding is sought is entitled the San Francisquito Creek Flood Protection and Ecosystem Restoration Capital Improvement Project, Highway 101 to El Camino Real.

The project proponent and Proposition 1E applicant is the San Francisquito Creek Joint Powers Authority.

The project consists of several project elements, collectively referred to as the Reach 2 project. The Reach 2 project builds upon Reach 1 project phases (partially funded by Round 1 Prop 1E) to provide comprehensive flood protection, ecosystem and recreational enhancements for the region.

The Reach 2 project will reduce local flood risks to homes, business and public facilities within the Cities of East Palo Alto, Menlo Park and Palo Alto. The project will provide significant benefits to the portion of the City of East Palo Alto west of Highway 101, which has been designated as a disadvantaged community (DAC) within the Bay Area IRWMP.

The project will increase the Creek's flow capacity from the Pope-Chaucer Bridge to Highway 101 by (1) creating an inlet to an expanded highway 101 bridge being built by Caltrans, (2) widening the channel in 4 locations, (3) Replacing the Newell Street Bridge, which represents a hydraulic constriction, and (4) Replacing the Pope-Chaucer Bridge, which represents a hydraulic constriction.

Benefits of the project include conveyance of creek flows up to the 50-year event, improved riparian habitat for special status species, and improved recreational opportunities for the community.

Additional work needed to accommodate Reach 2 project construction includes completion of Reach 1 (construction start in 2013) and the replacement of the Highway 101 Bridge (construction start in 2014).

Land acquisition needs for the project are limited to temporary and permanent easements without structures, but owned by private residents.

The Project elements are at various levels of design completion. The SFCJPA wishes to use State funding for the West Bayshore Inlet, the first constructible element within the project reach, which is at a 90% design level completion.

The total project cost for Reach 2 is $24.5M. The SFCJPA is requesting $3.5M in Prop 1E funding to accompany $21M in secured local funding to implement Reach 2.

Construction on the project is planned to begin in April or June 2014, depending on conditions set forth by the permitting agencies. Construction of the West Bayshore Inlet will be completed in one construction season. All construction activities will be completed by Fall 2016.

In November 2012, the voters of Santa Clara County approved the Safe Clean Water initiative, which provides funding to improve flood and erosion protection for channels and creeks within the Santa Clara Valley Water District's (District) jurisdiction. As part of this program, local funding is provided for construction of the Reach 2 project.

Figure 8-1. Map of San Francisquito Creek Flood Protection Project Limits

Figure 8-2. Map of San Francisquito Creek Flood Protection Project Reaches

Method of Analysis

The economic analysis was performed as follows:

- **Flood Damage Reduction Benefit Analysis (D1)** – Section D1 was completed using the RWMG method. In 2011, the United States Army Corps of Engineers performed a thorough hydraulic / hydrologic and economic analysis of with- and without-Project conditions. This analysis has been modified for consistency with the DWR method by incorporating the following modifications: 2012 dollars were used, a 6 percent discount factor was used, and benefits to economic impact areas (EIAs) Santa Clara 3 (SC_3) and San Mateo 5 (SM_5) were omitted to reflect the extent of benefits from the proposed Project. The assessment provided in the Corps of Engineers assessment focused on the 0.2 percent floodplain. This analysis has been revised to focus on the 2 percent floodplain, which would be addressed by the proposed Project.
- **Non-Monetized Benefits Analysis (D2)** – Section D2 was completed using the DWR method.
- **Other Monetized Benefits (D3)** - Section D3 was completed using the DWR method.

The following sections summarize the results of these analyses.

Key Technical Studies Justifying Economic Benefits

Specific project details and physical and economic benefits are supported by the following documents, which have been appended to this Attachment.

- **Draft Planning Study Report for the San Francisquito Creek Flood Protection Project, Santa Clara Valley Water District, October 2012 (included as Appendix 8-1):**documents the Project objectives, flooding and erosion problems, the development and evaluation of solutions to these problems. Provides a staff-recommended alternative to solve identified flooding problems.
- **San Francisquito Creek – Preliminary Flood Damage Analysis, United States Army Corps of Engineers, San Francisco District, 2011 (included as Appendix 8-2):** Completed detailed hydrologic modeling and analysis of without- and with-Project conditions. Developed a complete economic analysis consistent with Army Corps of Engineers standards.
- **90 Percent Design Drawingsfor the Inlet of West Bayshore(included as Appendix 8-3):**90 percent design has been completed, identifying specific improvements to be completed as part of the Project and substantiating the claimed physical benefits.

Flood Damage Reduction Benefit Analysis (D1)

An estimated $64.8 million in present value avoided flood damages will be realized through Project implementation over the 50-year life of the project, assuming a 6 percent discount rate. The following sections describe flood damage reduction benefits and project costs.[1]

[1] In 2011, the United States Army Corps of Engineers (Corps) completed the San Francisquito Creek – Preliminary Flood Damage Analysis(included as Appendix 8-2). This document, including its Economic Appendix, provides a

Approach to Determining Flood Damage Reduction Benefits

As discussed on pages 1-3 of the San Francisquito Creek – Preliminary Flood Damage Analysis(included as Appendix 8-2),the principal guidance referenced for the referenced analysis comes from the USACE "*Planning Guidance Notebook*", ER 1105-2-100, with specific guidance from Appendix D – Economic and Social Considerations. Additional guidance on risk-based analysis was obtained from USACE ER 1105-2-101, *Risk Analysis for Flood Damage Reduction Studies*, dated January 3, 2006. Benefits and costs are expressed in average annual terms at FY 2011 (Oct 2010) price levels using the mandated federal discount rate of 4%. The period of analysis is 50 years. The study/project Base Year, defined as the year when the project is expected to be operational and benefits begin to be realized, is 2017. Within the floodplain there is little or no vacant, developable land, and for this reason the analysis assumes that the future without-project floodplain inventory of structures and land use is equivalent to the current without-project condition.

By policy, USACE Flood Risk Management feasibility reports must evaluate the flooding problem (and potential measures to reduce the risk of flooding) against four "accounts." These are National Economic Development (NED), Regional Economic Development (RED), Environmental Quality (EQ), and Other Social Effects (OSE). While all four accounts will ultimately be considered in the evaluation of potential federal investments, this without-project flood damage analysis focuses primarily on the NED account. The OSE account is of increasing importance from an agency perspective, and a preliminary description of the effects is included at the end of this report.

The primary damage categories evaluated were structure and content damages to residences, business & industry, and public buildings.

The damage to structures, contents, automobiles, and the cost of residential displacement are all estimated within the computer program HEC-FDA v.1.2.5a, while damages related to the other categories will be estimated outside of the HEC-FDA program. Traffic delay costs are typically estimated via a simple spreadsheet model that is based on the methodology and value of time recommended by IWR Report 91-R-12 "*Value of Time Saved for Use in Corps Planning Studies*." For those damage categories calculated in HEC-FDA, the value of these assets was estimated outside of the program, and then imported into the program along with probability-stage data for each particular structure. The base structure elevation data (not including a first floor adjustment) was provided to the USACE San Francisco Economics Section by the Geographic Information System (GIS) Section.

The HEC-FDA models were built with data for each structure for each exceedance probability – 4%, 2%, 1%, .4% and .2% events. The referenced report uses exceedance probabilities to describe flood events. The exceedance probability is the reciprocal of what is often referred to as the "return period." The return period (or recurrence interval) of an annual maximum flood event has a return period of X years if its magnitude is equaled or exceeded once, on the average, every X years. As an example, a 1% return period (1/100) means that there is a 1% probability of an occurrence in any one year. HEC-FDA uses

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detailed explanation of the processes implemented to determine the with- and without-Project flood damages and resultant flood damage reduction. Excerpts from that study are provided below; additional information can be found in Appendix 8-2.

Monte Carlo simulation to calculate a stage-damage relationship with uncertainty, and the program then annualizes the probability-weighted damages to calculate an equivalent annual damage value for each scenario considered.

The referenced report addresses the fluvial and coastal flood risk in the study area. This study focuses on fluvial flood risk.

The referenced analysis used the procedures of directly inputting the set of water depths for each of the economic impact areas (EIAs) into HEC-FDA as a water surface profile, then calculating the exceedance-probability stage data within HEC-FDA, and including the ground elevations of the structures (with first floor elevation (FFE) adjustments) in the inventory import file. As such, HEC-FDA calculates the depth of flooding at each structure for each event and develops an aggregated stage-damage curve. Finally, the program calculates an Expected Annual Damage figure by linking the exceedance probabilities to stage-damages, incorporating risk and uncertainty based upon the Period of Record assigned to the probability-stage curve and the standard deviations resulting from the aggregated stage-damage curves.

Brief Overview of Flood Modeling

With respect to fluvial flooding, according to the Without-Project H&H analysis, flooding in the EIAs is primarily caused by a lack of capacity for conveying water volumes under several bridges that cross San Francisquito within the study area. Moreover, there are existing levees at the downstream end of the study area that would be overtopped during the 4% event and greater. Geotechnical investigations completed for this study indicates that the levees have fragility curves (i.e., there is a probability of some type of engineering failure before being overtopped), but due to the volume of water escaping into the upstream floodplains because of the too-small bridge underpasses, the geotechnical fragility curves were not used for the Without Project damages calculation. These levee fragility curves will be incorporated in the subsequent Alternatives Analysis phase of this feasibility study.

For the area north of the creek, the only future condition fully modeled to date assumes the National Research Council's (NRC) Curve 3 sea-level rise scenario.[2] The Curve 3 projections are most similar to the State of California's requirements for the consideration of sea-level rise in project planning. The area south of the creek has data for multiple future sea-level rise scenarios, but for consistency's sake the results for the Curve 3 scenario will be the primary focus of the report. Importantly, the coastal modeling in this area is preliminary, and has not been completed to a level of detail that is commensurate with either the fluvial floodplain or the area south of the creek. For this reason, it should be expected that the results for this area shown in this report will change.

[2]Corresponds to 2.13 feet of sea level rise at project year 50 (year 2067) USACE, San Francisco District San Francisquito Creek – Preliminary Flood Damage Analysis 4

Damagesto Structures, Contents, and Infrastructure due to Fluvial Flooding

Structures, contents, and infrastructure at risk from fluvial and coastal flooding are discussed on pages 5-28 of the San Francisquito Creek – Preliminary Flood Damage Analysis (included as Appendix 8-2).

Delineation of Fluvial Economic Impact Areas

The Economic Impact Areas (EIAs) were generally constructed based upon the following main criteria:

1. visual examination of the floodplain maps showing several flooded areas within the overall study area,
2. consideration of major streets and roads within the floodplains that obviously serve as de facto borders between residential and commercial/industrial neighborhoods, and
3. ensuring that no EIA straddled San Francisquito Creek due to its role as the natural borderline between San Mateo and Santa Clara counties; five (5) EIAs in San Mateo and three (3) are in Santa Clara counties. Figure 8-3 and Table 8-1 describe and show the general location of each of the EIAs.

Figure 8-3 shows the fluvial EIAs in the study area. In the figure, EIAs San Mateo County are called SM_1 through SM_5, while those in Santa Clara County are called SC_1 through SC_3. Table 8-1 and the sections that follow further describe the location of each of the impact areas and the land use within each area. The proposed Project would benefits all EIAs except Santa Clara 3 (SC_3) and San Mateo 5 (SM_5).

Figure 8-3. Fluvial Economic Impact Areas

Table 8-1. Description of Fluvial Economic Impact Areas

Fluvial EIA	Description
San Mateo 1	BAYFRONT EXPRESSWAY (mostly industrial/commercial area north of Bohannon Dr/RR tracks between Marsh and Willow Rds.)
San Mateo 2	FLOOD PARK TRIANGLE (mostly residential generally bound by Bohannon, Van Buren, and Bay Rd. -- west of US 101)
San Mateo 3	BELLE HAVEN (mostly residential with some industrial located south of Bohannon/RR tracks, east of US 101 and west of Ralmar Ave)
San Mateo 4	WILLOWS/VINTAGE OAKS (mostly residential west of US 101, east of Middlefield Rd, between the north bank of San Francisquito Creek and Willow Rd)
San Mateo 5	PULGAS AVENUE (mostly residential straddling Pulgas Ave east and west by several blocks, bounded between Bay Rd to the north and US 101 to the south)
Santa Clara 1	CRESCENT PARK/DUVENECK-ST FRANCIS (mostly residential with commercial; south of San FrancisquitoCrk. across University, north of Embarcadero Rd between Waverly St and US 101)
Santa Clara 2	OREGON EXPRESSWAY (residential south of Embarcadero Rd. and north of Clara Dr. between Ross Rd. and US 101)
Santa Clara 3	EMBARCADERO/EAST BAYSHORE (mostly commercial with industrial located west of US 101 straddling Embarcadero Rd eastward to Embarcadero Way

Structure Types and Flooding Characteristics by EIA

This section describes the types of structures and flooding characteristics in each of the eight EIAs. The land use maps were created based on the structure inventory work performed by the Corps between during February and March 2011. The source of the raw data (particularly square footage) was county assessor parcel data obtained directly from San Mateo and Santa Clara counties, with field investigations done by Corps economists. The construction characteristics of the homes and businesses in the study area are consistent with other regions of California.

The structure inventory database and the flood damage analysis contain 16 structure types. The extent of the inventory was based on an estimate of the .2% floodplain extent of the Curve III sea-level rise scenario. Due to FFE adjustments, in reality the number of structures susceptible to flood damage is somewhat fewer than is reflected in the inventory maps. Further analysis evaluated modeling results to determine the related extent of flood damages to the 2 percent floodplain, which would be avoided with implementation of the proposed Project.

For the Base Year 2017, each EIA was assigned a water surface elevation profile which was created by overlaying floodplain depths generated by FLO2D and overlaid onto GIS maps of the study area. All of the EIAs floodplains were then attached to an H&H (hydrology and hydraulics) index point at the upper end of the creek. This adjustment was necessary due to the relatively “flat” probability-stage

relationship within the overbank floodplains. Since HEC-FDA is largely dependent upon change-in-depth flooding (as opposed to sheet-flow flooding where subsequent larger events tend to have similar depths but larger geographical extents), the FLO2D floodplains depths were attached to an in-channel HEC-RAS probability-stage curve. This methodology has been used in other San Francisco and Sacramento District studies as an appropriate way to accurately model damages while using the USACE-approved HEC-FDA model. Flood maps are displayed showing the depths of flooding for the 5 modeled events previously noted. The actual depths in and around the structures generally averages no more than a few feet, due to the sheet-flow nature of the overbank flooding.

San Mateo EIAs

Bayfront Expressway (San Mateo 1) is primarily a commercial and industrial area located between the San Francisco Bay and US 101. There is one small pocket of residential structures at the most eastern extent of this EIA called Harbor Village Mobile Home Park. This EIA contains the Carlsen Porsche dealership as well as several industrial and commercial park areas with a wide variety of companies: mailing & shipping, medical technology, banking, and machining to name a few.

San Mateo 2 – 5 contain the neighborhoods of Belle Haven and the Pulgas Avenue area on the east side of US 101 (generally, East Palo Alto). West of US 101 the neighborhoods of Flood Park Triangle and Vintage Oaks (Menlo Park) lie within the study area. All are almost completely residential, with only a few commercial structures susceptible to flood damage. In addition to residences, these neighborhood EIAs have several schools, parks, libraries, hospitals, and churches. In Base Year 2017, the first significant floodplain damage occurs at approximately the 4% event.

Santa Clara EIAs

Santa Clara 1 (Crescent Park/Duveneck-St Francis) is the largest geographic EIA within the study area (Palo Alto). It covers several older and more established neighborhoods and the accompanying shops, restaurants, and grocery stores typical near residential areas. The Edgewood Plaza Shopping Center is located within this EIA. It also has several schools and medical facilities, as well as a community center and library branches. This EIA is directly adjacent to San Francisquito Creek. The Oregon Expressway EIA (Santa Clara 2) shares Embarcadero Road as a border; EIA 2 is similar in structure type and land use to Santa Clara 1.

Santa Clara 3 is also within the city limits of Palo Alto, although it is located across US 101 from both Santa Clara 1 & 2. This EIA contains mostly commercial structures (restaurants, office parks, and car dealerships) as well as several public buildings including the Palo Alto Post Office. Nearby, there is the Palo Alto commercial airport and the Palo Alto Municipal Golf course; neither of these land parcels were shown to incur flooding at the .2% event however and do not factor into this economic damage analysis. Santa Clara 3 would not benefit from the proposed Project.

Structure, Content & Vehicle Valuation

In order to estimate the value of damages to property as a result of flood events within the study's floodplains, it is first necessary to inventory the structures and other assets within the floodplain. This

section describes how the inventory and valuation of structures were accomplished. The next section will describe how this data was used to develop an estimate of the value of the damages expected to occur from flooding.

Structure Inventory

An initial inventory of the parcels in each 0.2% floodplain was compiled in ArcGIS (ArcMap) software by linking the raster flooding depth file with a point shapefile containing the parcel information, and then exporting those parcels in the modeled floodplains to a spreadsheet. For each parcel, the data was linked to the geographic center of mass of the particular parcel by creating a data centroid within the ArcMap program. Because only those parcels whose centroid overlaps the floodplain are considered as impacted, only those parcels that are at least bisected by the floodplain are included in the inventory. This is done in an attempt to improve the accuracy of the structure inventory – eliminating the inclusion (and ultimate valuation) of those parcels that are least likely to have structures that are actually impacted by the flooding, even while a portion of the parcels receive some non-zero level of flooding. However, there are cases where the centroid of the parcel shape does not accurately enough reflect the location of the structure – for instance, some commercial, industrial, or public parcels contain more than one structure. In order to manage this eventuality, and to make sure the damage model includes all of the structures at risk of flooding, spot checking of the parcels and structures along the outer edge of each floodplain was conducted during the economic fieldwork. When it was the case that aerial photography showed a structure to be located in the floodplain when the ArcMap centroid method did not, this structure was added to the database with the appropriate depth of flooding referenced.

ArcGIS was also used to assess the extent of structures in the 2 percent floodplain, which would be protected by the proposed Project.

Structure Valuation

The parcels identified as within the 0.2% floodplain via the procedure described above were then matched to data obtained from the San Mateo and Santa Clara assessor offices. These real property databases include parcel-specific information on structure type, square footage, construction date, information on improvements, etc. The vast majority of the residential structures inventoried fit into the Class D category. Class D buildings are characterized by combustible construction. The exterior walls may be made up of closely spaced wood or steel studs, as in the case of a typical frame house, with an exterior covering of wood siding, shingles, stucco, brick, stone veneer, or other materials. They may also consist of an open-skeleton wood frame on which some form of a curtain wall is applied including the pre-engineered pole or post-frame buildings. For the valuation of the structures in the floodplain, structures were classified as one of the following 16 categories listed below:

- Single Family Residential (SFR) 1-Story
- Office D (Marshall & Swift)
- SFR 2-Story
- Restaurants
- Multi-Family Residential (MFR) 1-Story

- Retail
- MFR 2-Story
- Public - Wood Frame
- Manufactured Housing (MH)
- Public – Masonry
- Commercial
- Industrial (Generic)
- Grocery & Gasoline
- Ind. R&D
- Office C (Marshall & Swift)
- Ind. Warehouse

The calculation of structure value in a floodplain can be done several different ways, each having their advantages and disadvantages. One method, estimating the Depreciated Replacement Cost of the structures in the floodplain, involves integrating the following: size of the structure, the unit cost of construction as measured in cost per square foot, and an allowance for deterioration as measured as a percent of total value. An alternative way of calculating the total structure value in the floodplain would be to use tax assessment records on each parcel's improvement value. While this assessment information is readily available, California's Proposition 13, which limits increased assessments until a home is sold, results in unequal valuations of one home relative to another. It is primarily for this reason that this study uses the Depreciated Replacement Cost method. More information on the different structure valuation methods can be found in IWR Report 95-R-9, Procedural Guidelines for Estimating Residential and Business Structure Value for Use in Flood Damage Estimations. The Depreciated Replacement Cost method requires visits to the structures themselves in order to attain the necessary information, which includes foundation height, structure type, and structure condition. This process is explained below.

The valuation of the structures in the floodplain requires information on structure type, construction quality, current condition, and number of stories. Once collected, this information was used to calculate the structure depreciated replacement values. Base per square foot construction cost estimates for each structure type were determined by utilizing the Marshall and Swift Real Estate Valuation Service method according to the following procedure:

- Construction quality and current condition of the structures were noted from field surveys.
- For a given structure type, the per square foot construction cost (replacement cost) was determined using the most current Marshall & Swift Valuation Service data. This per square foot cost estimate reflects the construction quality of the structure.
- The per square foot costs, which are based on a national average, were modified to reflect local cost conditions using Marshall & Swift local cost multipliers.
- This current, locally adjusted cost per square foot was then adjusted additionally for the condition of the structure, which determines the appropriate depreciation factor to apply. In order to correlate the current condition of the structure to a percent depreciation, the study

used Tables 7 through 9 of IWR Report 95-R-9, 'Procedural Guidelines for Estimating Residential and Business Structure Value for Use in Flood Damage Estimations'.

- The depreciated replacement cost per square foot values were multiplied by square footage to arrive at the total depreciated replacement value for the different types of structures.
- If the square footage was not available within the real estate records for a particular property, square footage estimates were made from aerial photography measurements using the Google Earth application.

The profile and valuation of structures in the 50-year floodplain was assumed to be proportional to those in the 500-year floodplain.

Content Valuation

As described above, under this study's methodology, the value of the contents within each structure is assumed to be a function of the value of the structure. The value of the contents of each structure was estimated by multiplying the Content Structure Value Ratio (CSVR) for the particular structure type by the estimated structure value (as calculated per the method described in the previous section).

Table 8-3 shows the ratios assumed for the content-to-structure values of the different classifications of residential and non-residential buildings in the floodplain. The primary source of CSVR estimates used for this analysis is a report produced for the USACE New Orleans District. The report is the product of a very thorough and extremely detailed expert panel elicitation.

Table 8-3. CSVRs per Structure Type

	Structure Type	CSVR	Standard Deviation
Residential	SFR	0.5	0.12
	MFR	0.5	0.12
	MH	0.5	0.12
Commercial	Eating and Recreation	0.4	0.7
	Groceries & Gas Stations	1.4	0.7
	Professional Businesses	0.9	0.9
	Retail and Personal Services	1.7	1.45
Other	Industrial	0.7	1.0
	Public	0.4	0.5

Structure Inventory and Valuation Results – Fluvial Floodplain

Table 8-4 shows the numbers of structures by type that was inventoried for the 0.2% floodplain. Not all of these buildings ultimately end up contributing to damage estimates. Based upon the depth of water for the 0.2% flood event and the data gathered during the economic fieldwork—specifically the building foundation height-- many of these structures' first floor were in fact elevated well above the floodplain. Values presented in the San Francisquito Creek – Preliminary Flood Damage Analysis (Appendix 8-2)

were converted from 2010 to 2012 dollars by multiplying by 1.02. Based on inundation mapping for the 2 percent floodplain, it is assumed that approximately 4,500 structures are located within the 50-year floodplain, the profile and value of these structures was assumed to eb comparable to that of the 0.2 percent floodplain.

Table 8-4. Structures in the 2% Floodplain[1]

EIA	Residential	Commercial	Industrial	Public
SM 1	3	21	62	0
SM 2	247	2	0	1
SM 3	548	4	39	11
SM 4	778	17	1	4
SM 5	875	6	3	7
SC 1	1833	42	0	6
SC 2	877	1	0	3
SC 3	0	18	3	1
Total	5161	112	107	33
Total Excluding SM 5 and SC 3	4,286	88	101	25

1. Estimated based on modeling for the 0.2 percent floodplain. Totals may not equal the sum of the structure counts due to rounding.

Table 8-5. Value of Structures and Contents in the2% Floodplain, 2012 Dollars ($1,000s)[1]

Residential		Commercial		Industrial		Public		Total	
Structure	Content	Structure	Content	Structure	Content	Structure	Content	Structure	Content
SM 1	11,093	5,582	109,309	97,580	90,938	61,897	0	0	376,400
SM 2	26,992	13,496	777	678	0	0	88	33	42,042
SM 3	44,515	22,328	3,038	3,038	65,713	44,727	6,006	2,226	191,627
SM 4	90,867	45,434	17,453	15,545	40	28	9,186	3,392	181,947
SM 5	80,198	40,134	530	480	1,554	1,060	7,914	2,968	134,817
SC 1	423,883	211,977	26,002	23,388	0	0	6,218	2,332	693,729
SC 2	126,055	63,028	2,049	1,837	0	0	1,201	432	194,595
SC 3	0	0	64,116	57,728	2,261	1,554	1,131	410	127,186
Total	803,603	401,978	223,275	200,275	160,507	109,266	31,743	11,791	1,942,342
Total Excluding SM 5 and SC 3	759,088	379,650	156,121	139,509	92,533	62,985	24,606	9,155	1,623,529

1. Estimated based on modeling for the 0.2 percent floodplain.

Table 8-6 shows the median depreciated replacement value, as well as square footage statistics for the four broad structure categories included in this study. The residential value is consistent with those calculated for other recent Corps studies in the area, while the commercial and industrial are somewhat higher than usual because of the large size of the structures of these types.

Table 8-6. Depreciated Replacement Value ($2012) and Square Footage of Structures

County	Structure Type	Mean DRV (1,000s)	Mean Sq. Footage	Median Sq Footage
San Mateo	Commercial	$2,664	24,850	8,900
	Industrial	$1,586	31,600	20,289
	Public	$1,043	8,560	5,616
	Residential	$104	1,435	1,225
Santa Clara	Commercial	$1,566	13,200	5,000
	Industrial	$736	15,230	14,640
	Public	$845	7,700	4,850
	Residential	$203	2,185	1,800

1. Estimated based on modeling for the 0.2 percent floodplain.

Elevation and Flood Damage Relationships

For structure and content damages, depth of flooding relative to the structure's first floor is the primary factor in the magnitude of the damage. The GIS database, provided by San Mateo and Santa Clara County, contained spatially-referenced polygons for each parcel in the study area. Each parcel was then assigned a centroid in order to determine the ground elevation at the parcel, which was taken from the latest Digital Elevation Model available.

The USACE San Francisco GIS Section ran statistics on the elevation of each of the parcel centroids, and provided the Economics Section with data tables containing depths at each centroid for each probability event modeled.

The centroid elevation method described above reasonably describes the elevation at a structure only to the extent that the structure is located approximately at the center of the parcel. Using this method to determine flooding depth and damage, it is possible that structures located on large parcels could be left out of the analysis and assumed to not be impacted for a particular event or events. It could also be the case that the elevation varies across the large parcel, and that the depth of flooding at the centroid does not reasonably represent the depth of flooding at the structure. This error would be expected to occur most often for non-residential parcels, especially some commercial and public parcels. In order to minimize the chance of this error, the study area parcels, centroids, and floodplains were reviewed in combination with aerial photography. In several cases the elevation assigned to a structure was changed to more accurately reflect the observed floodplain characteristics.

The elevation of each structure in the study area - along with an adjustment for the first floor elevation (FFE) - was combined with economic data (structure and content value, uncertainty of value expressed as a standard deviation percentage, etc.) and imported into the HEC-FDA model. For residential structures, a representative sample of first floor heights was observed in the field and applied with

uncertainty to the population of structures in that EIA. For the non-residential structures, the complete inventory was observed in the field. Table 8-10 shows the average FFE adjustment for each of the major structure categories in each of the EIAs. FFE adjustments for the 2 percent floodplain were assumed to be approximately equal to those for the 0.2 percent floodplain.

Table 8-10. Average FFE Adjustments by EIA and Structure Type

EIA	Structure Type			
	Residential	Commercial	Industrial	Public
SM 1	2.5	0.5	0.5	N.A.
SM 2	0.5	0.7	N.A.	1.0
SM 3	0.5	0.7	0.2	0.6
SM 4	1	0.5	0.5	0.6
SM 5	0.8	0.5	0.8	0.6
SC 1	0.7	0.5	N.A.	0.6
SC 2	0.5	1.0	N.A.	0.3
SC 3	N.A.	0.3	0.3	0.4

The table below shows some of the descriptive statistics of the flooding in the study area as calculated at the parcel centroid. The depths were calculated in the HEC-FDA models using WSEL data, structure value data, and FFEs. Three exceedance probabilities are shown for each of the floodplain scenarios. The decrease in mean depth for less frequent events at Year Zero can be explained by a greater number of structures getting shallow flooding as the outer edge of the floodplain expands.

Table 8-11. Selected Depth of Flooding Statistics (ft), Base Year Curve III)

Scenario		Year Zero		
Return Period		1%	2%	4%
Depth (ft)	Mean	1.4	1.1	0.6
	Median	0.9	0.8	0.4
	Maximum	7.6	6.0	3.8

Structure and Content Depth-Damage Relationships

Flooding can cause significant damage to structures of all types. Water can cause a structure's structural components to shift or warp – including the studs and foundation. Water can also damage the wiring, gas lines, and septic system. For high water, ceilings may sag under the weight of trapped water or soggy drywall, wet floorboards can bend and buckle, and the roof may leak or break altogether. Flooding in a basement can be especially dangerous; if the water is removed too quickly, pressure from the soaked earth outside can push inward and crack the foundation walls. In all types of residential housing flooding will most likely destroy the interior walls. Soaked wallboard becomes so weak that it must be replaced, as do most kinds of wall insulation, and any plywood in the walls is likely to swell and peel apart. Water can also dissolve the mortar in a chimney, which creates leaks and thus a risk of carbon monoxide poisoning once the heat comes back on.

Also, floods often deposit dirt and microorganisms throughout the house. Silt and sediment can create short circuits in the electrical system as residue collects in walls and in the spaces behind each switch box and outlet. Appliances, furnaces, and lighting fixtures also fill with mud, making them dangerous to use. Anything that gets soaked through with water may contain sewage contaminants or provide a substrate for mold. Most upholstered items must be thrown away, as well as carpets and bedding.

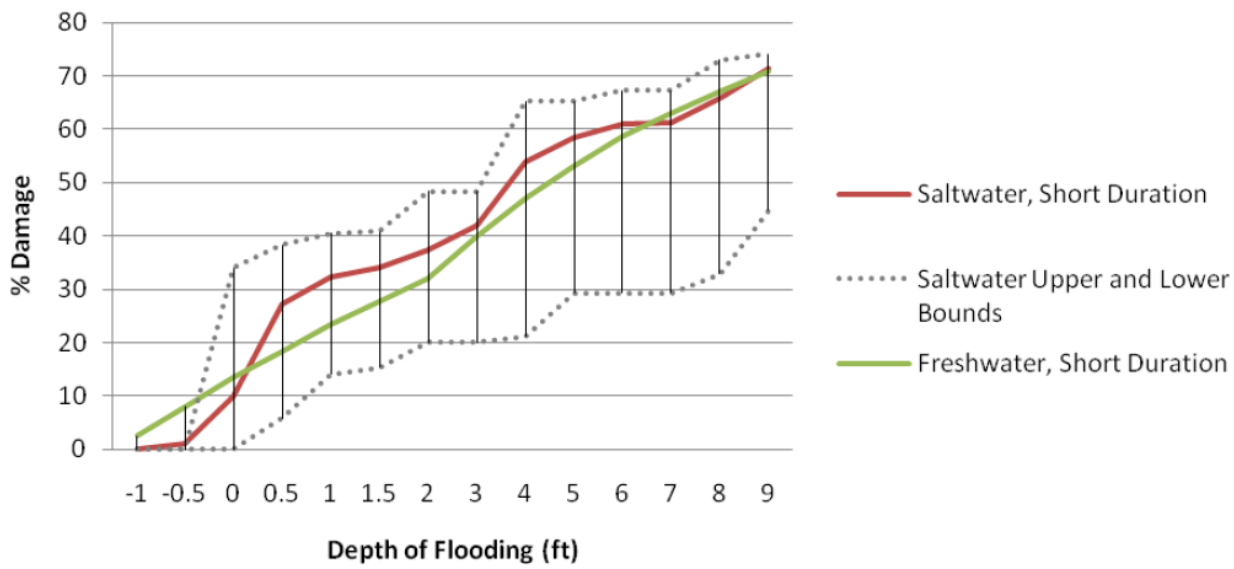
Damages to structures, contents, and vehicles were determined based on depth of flooding relative to the structure's first floor elevation. To compute these damages, depth damage curves were used. These curves assign loss as a percentage of value for each parcel or structure. The deeper the relative depth, the greater the percentage of value damaged. The sources of the relationships were different depending on structure type.

The depth-damage relationships for the primary structure types, contents, and vehicles are shown in the following figures below. SFR1 and SFR2 stand for Single Family Residential 1-Story and 2-Story, respectively. The curves for these are taken from USACE Economic Guidance Memorandum (EGM) 04-01, and are shown for comparison's sake.

The freshwater curves are used for the fluvial flood damage analysis, and the saltwater curves were used for the coastal damage analysis. Because of the corrosive nature of salt, for any given depth of flooding, damage should be greater for saltwater than for freshwater. The figures below show that the saltwater damage is generally greater than the freshwater damage for a given depth of flooding. However, because the curves were developed separately by different sources, they are not totally consistent with the idea that saltwater causes greater damage than freshwater at all depths. For consistency's sake, in the HEC-FDA models the saltwater curves have been adjusted so that they are at least equivalent to the freshwater damage at all depths.

Figure 8-6 below shows the structure depth-damage curves for freshwater and saltwater flooding. The Addendum contains figures for the remainder of the damage curves for both structures and their contents.

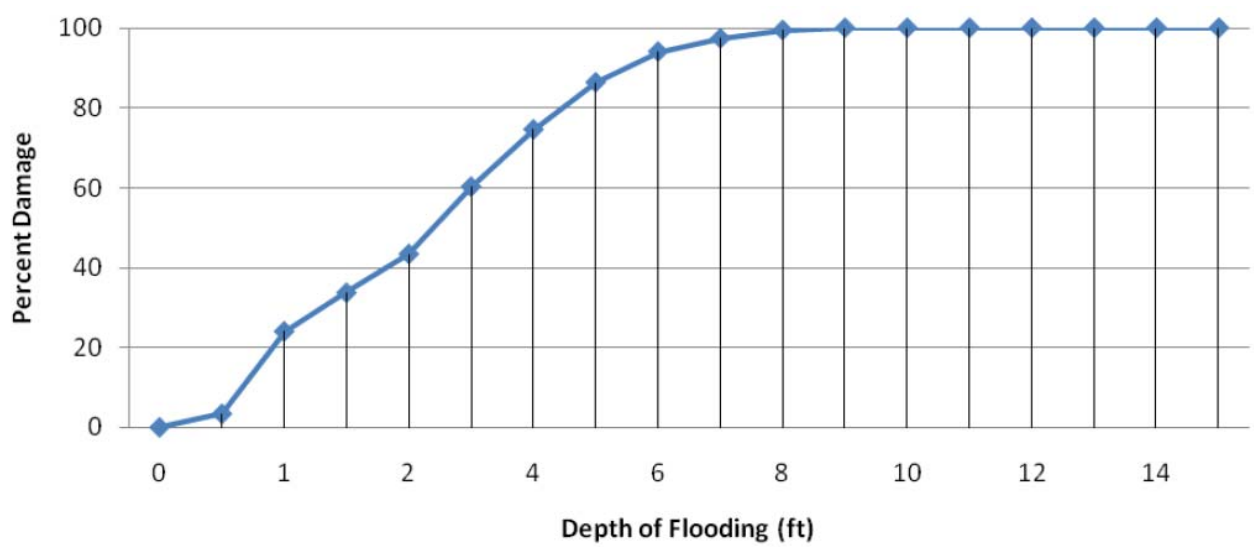
Figure 8-6: SFR1 Structure Depth-Damage Curve



Automobile Depth Damage Relationship

Damage to automobiles was estimated as a function of the number of vehicles per residence, average value per automobile, estimated percentage of autos removed from area prior to inundation, and depth of flooding above the ground elevation. Depth-damage relationships for autos come from USACE Economic Guidance Memorandum (EGM) 09-04 and modified based on weighted average of distributions of car types (SUV, truck, sedan, sports car, etc) in California. Damages for autos begin once flood depth has reached 0.5 feet, and this damage curve can be seen in the figure below. Since these curves were developed for freshwater flooding, they can be expected to slightly understate the damages from coastal flooding, but they are assumed to be reasonable for use in this study.

Figure 8-7. Depth-Damage Function for Vehicles



According to the U.S. Census, the average number of vehicles at households in the study area is just less than two. In general there should be significant warning time before a potential flood event, since regional gauges and storm tracking should effectively inform the communities of an approaching risk. The survey described in EGM 09-04 indicates that when there is greater than twelve hours warning time, almost 90% of residents are expected to move at least one vehicle to higher ground. The EGM does not indicate the percentage that moved both vehicles to higher ground. For this analysis, it will be assumed that all households remove at least once vehicle out of the floodplain, and that half of the households remove both vehicles. The result of these two assumptions is that 25% of the vehicles in the floodplain are exposed to flood risk. Vehicles that were exposed to flood risk are assumed to be at the structure first floor elevation, except for those structures that have been significantly raised from ground elevation. For those structures that are more than three feet above the ground elevation, the vehicles are assumed to be located at ground elevation.

Residential Displacement Costs Depth Damage Relationship

Displacement costs were estimated for the relocation and emergency services provided for those displaced both during the peak flood event and during post-flood structural renovations. In order to estimate displacement costs, it is necessary to make assumptions regarding a) the level of structure damage from flooding that generally results in temporary displacement, b) the relationship between structure damage and displacement time, and c) the percentage of households that would be forced to find rental accommodations versus the percentage that would stay with friends or family. To this end, the analysis uses an algorithm contained in FEMA's 'Full Data Module for Benefit-Cost Analysis of Riverine Hazard Mitigation Projects, Mitigation BCA Toolkit CD, Version 2.0, January 2005'.

This algorithm has the following features:

- If building damage is <10% of building replacement value, displacement time is zero.
- If building damage is 10%, displacement equals 30 days.
- If building damage is >10%, displacement time is 30 days plus 8 days for each one percent increase in building damage above 10%.
- Displacement time is capped at 365 days.

According to this approach, for example, 30% building damage results in a displacement time of 30 days plus 20 times 8 days, for a total of 190 days. The 365-day cap on displacement means that occupants of buildings with more than about 50% damage (52%) are assumed to be typically displaced for one year. Given that a structure that is over 50% damaged would have to be extensively renovated or rebuilt, a year of displacement seems reasonable.

No specific study has yet been conducted by the Corps to help estimate the percentage of displaced households that would be forced to rent alternative accommodations versus those that could relocate. This analysis makes the simple assumption that half of the displaced households would be able to temporarily relocate at little or no direct cost – that is, with family or friends3.

The remaining variable in the equation for the estimate of total displacement costs are the monthly rental and one-time relocation costs. For the purposes of this analysis, $2,000 is assumed as the total

furnished monthly rental rate, and is based on the results of internet research on the cost of rental properties in the area. The one-time cost of moving is assumed to be $500. The result is a maximum cost of $24,900 was determined and used as the total value imported into FDA, (cost if displaced for 1 year). Uncertainty parameters applied for Displacement Costs were 10% about the mean for value and 0.5 ft foundation height – the same as used for the structures themselves. The relationship between percent structure damage and both displacement cost and days displaced is shown in the Figure 8-8. Figure 8-9 displays the depth-damage function for displacement for each of the residential structure categories. These functions were calculated by relating the depth of flooding to the percent damage to the structure, to the number of days per the FEMA algorithm, to the cost associated with that number of days, to the proportion of a full year displacement that the displaced number of days represents.

Figure 8-8. Displacement Cost and Days Displaced

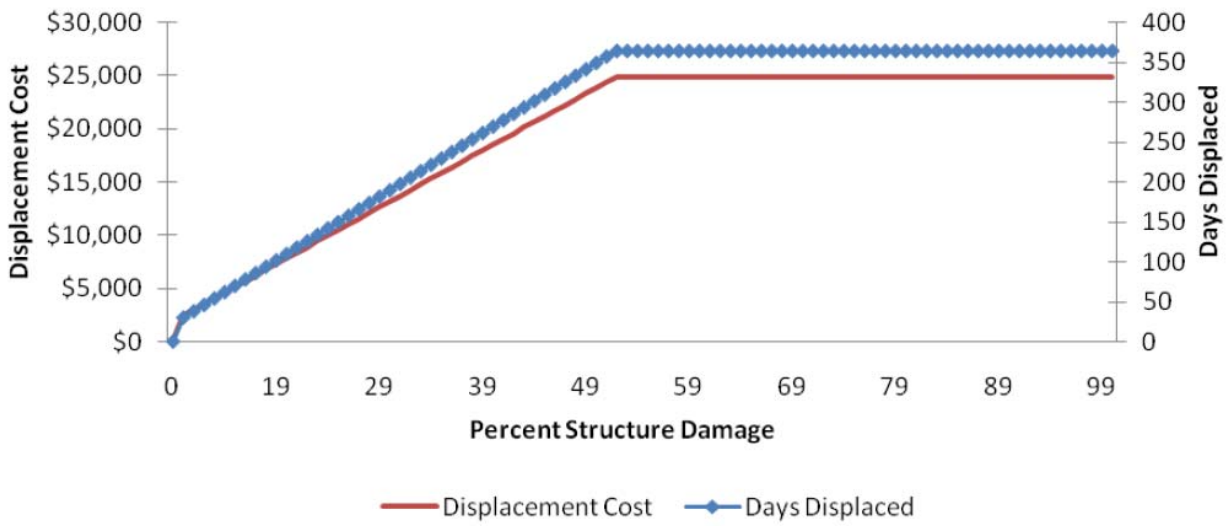
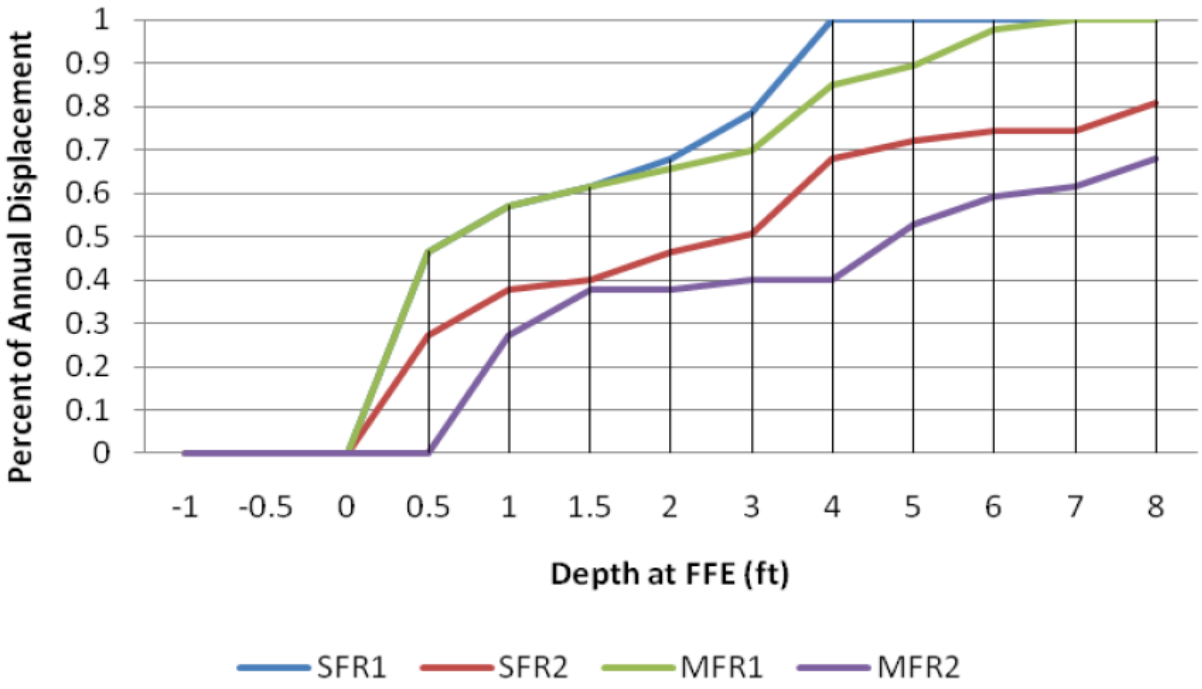


Figure 8-9. Displacement Depth Damage Curve



Expected Annual Damage (EAD)

The HEC-FDA program is used to combine water surface profile data and economic data (structure inventory values, FFEs, standard coefficients, etc.) in order to derive a probability-stage-damage function for each reach or impact area. HEC-FDA version 1.2.5a was used, which is a USACE certified model, and its use complies with EC 1105-2-412 (Planning Model Improvement Program: Model Certification).

Typically, among other inputs to this procedure are water surface profiles for the various channel or river reaches, which are an output of the HEC-RAS program that is used by engineers. For this study though, since the FLO2D program was used for reasons described in the H&H appendix, there are no discharges or rating curves (discharge-stage relationship), rather just an exceedance-probability to depth relationship for each EIA.

Additionally, for the fluvial part of the study, while there are existing levees at the downstream end of the portion of San Francisquito Creek under study, and while levee performance is a significant issue for the study, the existing levee features or levee failure probabilities were not included in the HEC-FDA models. The main reason for this is that the FLO2D floodplains were developed by modeling the water in the floodplain strictly as a result of levee overtopping. Therefore, there were no probability-based water surface profiles for any flood events that did not go over the downstream levees. That is, the mean depths of flooding provided to the Economics Section for use in the damage analysis were developed with the consideration of the existence and performance of the various levees in the study area. As a

result of discussions in May 2009 with team members from SPN Geosciences Section as well as from the Hydrologic Engineering Center (HEC), it was decided that the consideration of the levees in the coastal modeling was sufficient, and that it would not be appropriate or necessary to include levee features in the HEC-FDA models.

Furthermore, the primary constraint causing overbank flooding is numerous bridge underpasses that restrict water-flow upstream of the existing levees. Thus, the H&H analysis shows that most of the floodwaters leave the channel before reaching the levees under the Without Project condition. The reliability of the existing levees will be a key concern to consider during the Alternatives Analysis phase of this feasibility study.

For each of the Base Year 2017, the FLO2D grids with depths for each flood event attached to GIS centroids were imported into HEC-FDA as HEC-RAS water surface profiles, and the exceedance-probability stage curves were derived with uncertainty (period of record 30 years gauge data).

EAD – Structures, Contents, Vehicles, and Residential Displacement

The Expected Annual Damage (EAD) for an EIA can be thought of as the average annual value of damage that would be expected to occur over a very long period of record. For example, if over a thousand years the total flood damage to an area were summed and divided by one-thousand, the result would be the expected annual damage for that area. We use what are believed to be the probabilities associated with storms of various sizes in order to calculate the probability-weighted value of damage for each area when considering the depth of flooding and the economic factors such as the number and type of structures.

Table 8-12 shows the EAD by category for each of the six categories analyzed in HEC-FDA for the fluvial floodplain. EAD is based on values for the 0.2 percent floodplain presented in Table 8 of Appendix 8-2, adjusted as follows to reflect EAD for the 2 percent floodplain:

- Escalated to 2012 dollars
- Proportionately reduced to reflect 4,500 structures as opposed to 6,496 structures protected (2 percent floodplain as opposed to 0.2 percent floodplain)
- Scaled back by 10% to reflect reduced depth / extent of flood damage in the 2% flood as compared to the 0.2 percent flood

Estimated EAD, incorporating these assumptions, is shown in Table 8-12.

Table 8-12. Expected Annual Damages ($1,000s), Fluvial Flooding, 2012 Dollars

	Auto	Commercial	Displacement	Industrial	Public	Res.	Total
SM 1	1	211	1	75	0	3	291
SM 2	13	2	27	0	1	106	147
SM 3	11	8	24	32	4	83	162
SM 4	16	7	40	0	1	272	336
SM 5	114	0	242	0	13	672	1,042
SC 1	59	37	141	0	6	1,553	1,795
SC 2	144	0	257	0	7	963	1,372
SC 3	0	158	0	3	9	0	170
Total	357	424	731	111	40	3,652	5,314
Total Excluding SM5 and SC3	243	265	489	107	18	2,980	4,102

Present Value of Expected Annual Damage Benefits

Thetotal expected annual damage for a 2% fluvial flood event without the Project is estimated to be $5.3 million. The Project would be expected to provide flood protection for the 2% event for all EIAs except SM5 and SC3. As such, the expected annual damages with the Project would be expected to equal $1.2 million, for an annual benefit of $4.1 million per year. As shown in Table 8-14 (PSP table 12), assuming a 50-year project life and 6 percent discount rate, this equates to a present value of expected annual damage benefits of approximately $64.6 million.

Table 8-14 (PSP Table 12). Present Value of Expected Annual Damage Benefits, Fluvial Flooding, 2012 Dollars

Table 12 – Present Value of Expected Annual Damage Benefits Project: San Francisquito Creek Flood Protection Project			
(a)	Expected Annual Damage Without Project (1)		**$5,313,829.43**
(b)	Expected Annual Damage With Project (1)		**$1,212,082.20**
(c)	Expected Annual Benefit	(a) – (b)	**$4,101,747.23**
(d)	Present Value Coefficient (2)		**15.76**
(e)	**Present Value of Future Benefits Transfer to Table 17, column (d).**	**(c) x (d)**	**$64,643,536.33**

(1) This program assumes no land use changes in the floodplain. So, EAD will be constant over analysis period.

(2) 6% discount rate; 50-year analysis period (could vary depending upon lifecycle of project).

This estimate is considered conservative, because it does not account for various other benefits that would be expected to accrue from the Project but that have not been reliably quantified and / or monetized:

- **Emergency costs**, including emergency response costs that would not have been incurred in the absence of flooding, such as evacuation of the floodplain, flood fighting, disaster relief, and overtime pay for first responders and governmental employees. The ultimate cost of emergency services for a flood event depends on many factors, including the reach, depth and duration of flooding, the flood warning time, and the population and housing density within the flooded area.
- **Insurance Policy Administration** cost reductions, resulting from a decrease in the number of flood insurance policies as a result of the removal of structures from the 1% floodplain.
- **Income Loss to Businesses**, such as reductions in the national income when flooding or the threat of flooding halts production or delivery of goods and services. National losses occur 1) when the production or delivery of these goods and services are not recuperated by postponing the activity or transferring it to another location, or, 2) when there are additional costs caused by delay or transfer of the activity. These losses can occur before, during, and after the flood event, and are not recuperated (non-recoverable). Businesses where losses would be expected to be non-recoverable include public utilities, those where delays in delivery or processing causes spoilage of perishable items, businesses that produce unique products or whose competitors are at full production, and media outlets such as newspapers and radio stations that provide the only sources of local or national information.
- **Travel Delay and Detour Impacts**, resulting from closure of minor roads as well as Highway 101, a heavily traveled freeway running parallel to the bay coastline.
- **Impacts to Palo Alto Airport**, resulting from large storm events under the Base Year scenario, and relatively frequent events under the future scenarios – with flood depths as much as five feet in large storm events under the Curve 3 scenario. According to representatives of the airport, there are approximately three-hundred planes located at the airport at any given time. There are several private hangars, and an adjacent area with commercial shops.
- **Impacts to the Pal Alto Water Quality Control Plant** (WQCP), one of three plants in the South San Francisco Bay region. There are no standardized depth damage curves or established methodologies for determining a) the value of structural/mechanical/electrical damage from flooding to these types of facilities, or b) the economic impact to the serviced communities from a decrease or cessation of waste water treatment services of various lengths of time. In the instance of a flood event, the WQCP would take measures to insulate critical mechanical and electrical components to prevent inundation. These measures include placing sandbags and soil at entrances to pump stations or motor control centers, to act as a physical barrier between flood waters and vital operational equipment. Temporary sump pumps are also used to drain any flood waters that seep in. If flooding of the equipment seems inevitable, mechanical and electrical components are turned off immediately, resulting in limited to no treatment capabilities during inundation. Shutting down these components helps to reduce damage to

equipment and shorten overall operational downtime. All of these measures will require special means of transportation for implementation by plant employees depending on flood depths.

Project Costs

As discussed in Section D3, capital costs to implement the Project are approximately $24.5 million, with annual operations and maintenance costs of approximately $8,000 per year for vegetation and graffiti removal activities, beginning on completion of construction in 2016. Assuming a 50-year Project life and 6 percent discount factor, this equates to a present value cost of approximately $49.8 million.

Non-Monetized Benefits Analysis (D2)

The above discussion of flood damage reduction benefits focused upon physical tangible assets (such as structures) that can be monetarily valued. However, the Stormwater Flood Management grant may also result in other types of FDR benefits that are just as important, but cannot easily be quantified, and/or valued monetarily (for example, reductions in the loss of life and other injuries associated with flooding). These types of benefits are qualitatively described in this section. No projects will be avoided, delayed, or reduced in size as a result of project implementation; as such, PSP Table 15 has not been completed.

Table 8-15 (PSP Table 13)identifies non-monetized benefits that will accrue from project implementation. Each benefit is described in further detail following the table.

Table 8-15 (PSP Table 13). Non-Monetized Benefits Checklist

Table 13 – Non-monetized Benefits Checklist		
No.	Question	Enter "Yes", "No" or "Neg"
	Community/Social Benefits **Will the proposal**	
1	**Provide education or technology benefits?**	**No**
	Examples are not limited to, but may include: - Include educational features that should result in water supply, water quality, or flood damage reduction benefits? - Develop, test or document a new technology for water supply, water quality, or flood damage reduction management? - Provide some other education or technological benefit?	
2	**Provide social recreation or access benefits?**	**No**
	Examples are not limited to, but may include: - Provide new or improved outdoor recreation opportunities? - Provide more access to open space? - Provide some other recreation or public access benefit?	
3	**Help avoid, reduce or resolve various public water resources conflicts?**	**No**
	Examples are not limited to, but may include:	

Table 13 – Non-monetized Benefits Checklist		
No.	Question	Enter "Yes", "No" or "Neg"
	- Provide more opportunities for public involvement in water management? - Help avoid or resolve an existing conflict as evidenced by recurring fines or litigation? - Help meet an existing state mandate (e.g., water quality, water conservation, flood control)?	
4	**Promote social health and safety?**	**Yes**
	Examples are not limited to, but may include: - Increase urban water supply reliability for fire-fighting and critical services following seismic events? - Reduce risk to life from dam failure or flooding? - Reduce exposure to water-related hazards?	
5	**Have other social benefits?**	**No**
	Examples are not limited to, but may include: - Redress or increase inequitable distribution of environmental burdens? - Have disproportionate beneficial or adverse effects on disadvantaged communities, Native Americans, or other distinct cultural groups?	
	Environmental Stewardship Benefits: **Will the proposal**	
6	**Benefit wildlife or habitat in ways that were not quantified in Attachment 7?**	**Yes**
	Examples are not limited to, but may include: - Cause an increase in the amount or quality of terrestrial, aquatic, riparian or wetland habitat? - Contribute to an existing biological opinion or recovery plan for a listed special status species? - Preserve or restore designated critical habitat of a listed species? - Enhance wildlife protection or habitat?	
7	**Improve water qualityin ways that were not quantified in Attachment 7?**	**Yes**
	Examples are not limited to, but may include: - Cause an improvement in water quality in an impaired water body or sensitive habitat? - Prevent water quality degradation? - Cause some other improvement in water quality?	
8	**Reduce net emissions in ways that were not quantified in Attachment 7?**	**Yes**
	Examples are not limited to, but may include: - Reduce net production of greenhouse gasses? - Reduce net emissions of other harmful chemicals into the air or water?	
9	**Provide other environmental stewardship benefits, other than those claimed in Sections D1, D3 or D4?**	**No**
	Sustainability Benefits: **Will the proposal**	

Table 13 – Non-monetized Benefits Checklist		
No.	Question	Enter "Yes", "No" or "Neg"
10	**Improve the overall, long-term management of California groundwater resources?**	**No**
	Examples are not limited to, but may include: - Reduce extraction of non-renewable groundwater? - Promote aquifer storage or recharge?	
11	**Reduce demand for net diversions for the regions from the Delta?**	**No**
12	**Provide a long-term solution in place of a short-term one?**	**Yes**
	Examples are not limited to, but may include: - Replace a temporary water supply with a more permanent supply? - Replace a temporary water quality solution with a more permanent solution? - Replace temporary flood control management with a more permanent solution? - Replace temporary habitat with a more permanent solution?	
13	**Reduce water consumption on a permanent basis?**	**No**
14	**Promote energy savings or replace fossil fuel based energy sources with renewable energy and resources?**	**Yes**
	Examples are not limited to, but may include: - Reduce net energy use on a permanent basis? - Increase renewable energy production? - Include new buildings or modify buildings to include certified LEED features? - Provide a net increase in recycling or reuse of materials? - Replace unsustainable land or water management practices with recognized sustainable practices?	
15	**Improve water supply reliabilityin ways not quantified in Attachment 7?**	**No**
	Examples are not limited to, but may include: - Provide a more flexible mix of water sources? - Reduce likelihood of catastrophic supply outages? - Reduce supply uncertainty? - Reduce supply variability?	
16	**Other (If the above listed categories do not apply, provide non-monetized benefit description)?**	**No**

4. Improve Social Health and Safety

According to the National Oceanic and Atmospheric Administration (NOAA), flash and river floods claimed 113 lives nationwide in 2011, up from 103 in 2010. Flooding represents a major hazard that threatens the health and safety of those affected. As discussed in Attachment 7, this project will protect nearly 6,500 structures from the 100-year flood. This represents a significant improvement in public health and safety.

6. Benefit wildlife or habitat in ways that were not quantified in Attachment 7?

The Project will provide benefits to habitat and environmental resources by significantly reducing sedimentation in San Francisquito Creek, and ultimately the San Francisco Bay. The reduction in sedimentation is estimated at 1,700 cubic yards per year.

In addition, as discussed in Attachment 7, the Project will remove approximately 234 cubic yards of concrete from upstream of the University Avenue bridge, enabling establishment of native vegetation and habitat; and average channel velocity will be reduced by up to 52% (from 8.1 to 4.2 ft/s) during the 2 percent storm, improving fish passage.7. Improve water quality in ways that were not quantified in Attachment 7?

The Project will significantly reduce erosion and sediment loading to San Francisquito Creek and the San Francisco bay. It is estimated that sediment loading will be reduced by approximately 1,700 cubic yards per year; however, the corresponding reduction in total suspended solids (TSS) and turbidity have not been estimated.

8. Reduce net emissions in ways that were not quantified in Attachment 7?

The Project will construct new and / or enhanced sidewalks and bicycle lanes along nearly 300 feet of bridges. It is assumed that motor vehicle usage would be expected to be reduced due to enhanced bicycle facilities and reduced sediment removal requirements; however, the uncertainty associated with greenhouse gas (GHG) reductions was too great to merit quantification.

12. Provide a long-term solution in place of a short-term one?

As described in Attachment 7, San Francisquito Creek overtopped its banks and caused severe flood damages at numerous locations in 1955. Local areas suffered flooding again in 1958 when an earthen levee failed and creek flows inundated the Palo Alto Golf Course and Airport. As a result of these flood events, the District and SMCFCD partnered to construct “Interim Flood Channel Improvements” along San Francisquito Creek. These improvements, including lining approximately 800 linear feet of the south bank in Santa Clara County with sacked concrete upstream of Highway 101; constructing about 800 linear feet of low berm along the south bank; installation of low berms at Middlefield Road and Pope/Chaucer Street bridges, and intermittent sacked concrete revetment and low floodwalls along both banks from approximately 1,200 feet upstream of University Avenue to Highway 101; did not provide a long-term solution to the flooding problems. This Project would provide a long-term solution in place of these short-term, or admittedly “interim”, measures.

14. Promote energy savings or replace fossil fuel based energy sources with renewable energy and resources?

The Project would construct new and / or enhanced sidewalks and bicycle lanes along nearly 300 feet of bridges.Motor vehicle usage would be expected to be reduced due to enhanced bicycle facilities and reduced sediment removal requirements; however, the uncertainty associated with greenhouse gas (GHG) reductions was too great to merit quantification.

Monetized Benefits Analysis (D3)

This section describes the non-flood protection monetized benefits of the project. The following principles were followed in quantifying economic benefits.

- Monetized benefits are the value, measured as willingness to pay, for project physical benefits. In general, cost savings (avoided costs or alternative costs) equate to willingness to pay, but cost savings were calculated from the State, not just the local, perspective.
- Monetized benefits were counted from the perspective of the overall State, not only the local perspective. Where benefits involve costs for other areas of the State, those costs were also included.
- Costs and benefits were not double-counted. Only one type of monetized benefit was claimed for a unit of physical benefit occurring in any year of the planning horizon.

As discussed in Attachment 7, in addition to avoided flood protection benefits, the following quantified benefits are expected from this Project.

- Reduction in up to 1,700 cubic yards of sediment deposition per year.
- New and / or enhanced sidewalks and bicycle lanes along nearly 300 feet of bridges.

Monetization of these benefits is discussed below.

Benefit: Enhanced Recreation Benefits

As discussed in Attachment 7, the Project will create or restore approximately 400 feet of new sidewalks and bicycle trails. Assuming only one quarter of the people living adjacent to the new / restored sidewalks and bicycle lanes utilize these facilities on a daily basis, and applying the FY12 unit day value for general recreation with a zero point value of $3.72, the present value of this benefit is approximately $10,184 / year (10 parcels adjacent to new sidewalks * 3 people per parcel / 4 * $3.72 / day * 365 days/year), as shown in Table 8-16 (PSP Table 14) below.

Project Costs

As discussed in Section D3, capital costs to implement the Project are approximately $24.5 million, with annual operations and maintenance costs of approximately $8,000per year for vegetation and graffiti removal activities, beginning on completion of construction in 2016. Assuming a 50-year Project life and 6 percent discount factor, this equates to a present value cost of approximately $49.8 million.

Annual Benefit and Annual Cost of Avoided Projects

Table 8-16 presents monetized benefits per unit of physical benefit. Because no future projects were avoided with this Project, no avoided costs have been developed and PSP Table 15 is not provided. As shown in Table 8-16, the present value of non-flood monetized benefits is approximately $134,768.

Table 8-16 (PSP Table 14): Annual Benefit

Table 14 – Annual Benefit (All benefits should be in 2012 dollars) Project: San Francisquito Creek Flood Protection Project									
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value (1)	Annual $ Value (1) (f) x (g)	Discount Factor (1)	Discounted Benefits (1) (h) x (i)
2012								1.000	
2013								0.943	
2014								0.890	
2015								0.840	
2016	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.792	**$8,066**
2017	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.747	**$7,610**
2018	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.705	**$7,179**
2019	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.665	**$6,773**
2020	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.627	**$6,389**
2021	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.592	**$6,028**
2022	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.558	**$5,686**
2023	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.527	**$5,365**
2024	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.497	**$5,061**
2025	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.469	**$4,774**
2026	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.442	**$4,504**
2027	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.417	**$4,249**
2028	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.394	**$4,009**
2029	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.371	**$3,782**
2030	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.350	**$3,568**
2031	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.331	**$3,366**
2032	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.312	**$3,175**

Table 14 – Annual Benefit

(All benefits should be in 2012 dollars)

Project: San Francisquito Creek Flood Protection Project

(a) Year	(b) Type of Benefit	(c) Measure of Benefit (Units)	(d) Without Project	(e) With Project	(f) Change Resulting from Project (e) – (d)	(g) Unit $ Value (1)	(h) Annual $ Value (1) (f) x (g)	(i) Discount Factor (1)	(j) Discounted Benefits (1) (h) x (i)
2033	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.294	**$2,996**
2034	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.278	**$2,826**
2035	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.262	**$2,666**
2036	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.247	**$2,515**
2037	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.233	**$2,373**
2038	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.220	**$2,238**
2039	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.207	**$2,112**
2040	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.196	**$1,992**
2041	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.185	**$1,879**
2042	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.174	**$1,773**
2043	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.164	**$1,673**
2044	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.155	**$1,578**
2045	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.146	**$1,489**
2046	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.138	**$1,404**
2047	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.130	**$1,325**
2048	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.123	**$1,250**
2049	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.116	**$1,179**
2050	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.109	**$1,112**
2051	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.103	**$1,049**
2052	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.097	**$990**
2053	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.092	**$934**

Table 14 – Annual Benefit (All benefits should be in 2012 dollars) Project: San Francisquito Creek Flood Protection Project									
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
Year	Type of Benefit	Measure of Benefit (Units)	Without Project	With Project	Change Resulting from Project (e) – (d)	Unit $ Value (1)	Annual $ Value (1) (f) x (g)	Discount Factor (1)	Discounted Benefits (1) (h) x (i)
2054	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.087	**$881**
2055	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.082	**$831**
2056	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.077	**$784**
2057	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.073	**$740**
2058	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.069	**$698**
2059	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.065	**$658**
2060	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.061	**$621**
2061	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.058	**$586**
2062	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.054	**$553**
2063	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.051	**$522**
2064	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.048	**$492**
2065	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.046	**$464**
2066	Recreation Benefits	users / year	0	2,738	2,738	$4	$10,184	0.043	**$438**
Total Present Value of Discounted Benefits Based on Unit Value (Sum of the values in Column (j) for all Benefits shown in table)									**$134,768**
Comments:									

Project Benefit and Cost Summary (D4)

Annual Costs of Projects (Table 16) was completed for the project, and Proposal Benefits and Costs Summary (Table 17) was completed for the entire proposal (which only includes one project). Tables 16 and 17 are provided in the following sections.

Project Costs

The estimated Project cost is $24.5 million, as described in Attachment 4. These costs would be incurred over the three year period from 2013 through 2015, as discussed below.

- In 2013, approximately $1.7 million in would be incurred, as follows:
  - $258,333 in direct project administration costs (one-third of total budget for line item a)
  - $1,412,500 in planning, design, and environmental costs (one-half of total budget for line item c)
  - $0 in construction/implementation costs
  - $0 in environmental compliance/ mitigation/enhancement costs
  - $0 in construction administration costs
  - $0 in other costs
  - $0 in construction/implementation contingency costs
- In 2014, approximately $13.0 million in would be incurred, as follows:
  - $258,333 in direct project administration costs (one-third of total budget for line item a)
  - $1.7 million in land purchase/easement costs (all costs for line item b)
  - $1,412,500 in planning, design, and environmental costs (one-half of total budget for line item c)
  - $8.25 million in construction/implementation costs (one-half of costs for line item d)
  - $600,000 in environmental compliance/ mitigation/enhancement costs (one-half of costs in line item e)
  - $750,000 in construction administration costs (one-half of costs in line item f)
  - $0 in other costs
  - $0 in construction/implementation contingency costs
- In 2015, approximately $9.9 million in would be incurred, as follows:
  - $258,333 in direct project administration costs (one-third of total budget for line item a)
  - $0 in land purchase/easement costs
  - $0 in planning/design/engineering/ environmental documentation costs
  - $8.25 million in construction/implementation costs (one-half of costs for line item d)
  - $600,000 in environmental compliance/ mitigation/enhancement costs (one-half of costs in line item e)
  - $750,000 in construction administration costs (one-half of costs in line item f)
  - $0 in other costs
  - $0 in construction/implementation contingency costs

In total, $24.5 million in capital costs are reflected in Table 8-17 (PSP Table 16). No sunk costs have been identified and excluded from the budget as presented in Attachment 4. Operations and maintenance costs of approximately $8,000 per year would be expected to begin once construction is complete, in the year 2016. These costs include the following estimated annual costs for vegetation and graffiti removal.

Activity	Estimated Cost
Graffiti Removal	$ 7,040
Vegetation Removal	$ 469
Total per Year	$ 7,509
Total per Year (nearest 1000)	$ 8,000

Budget assumptions for each line item are presented below.

Floodwall Vegetation Removal Assumptions

Activity	Cost		
	$/1,000 feet	Feet	Cost
Weed Abatement	$666.67	700	$466.67
Herbicide Application	$3.79	700	$2.65
Mowing	$400.00	0	$-
TOTAL			**$469.32**

1. Costs provided by Judy Ingols, from FY09 work, West Valley watershed specific
2. Alternatives A, B, C, and D do not include levees. Assume no mowig required for this area.
3. Alternatives A, B, C, and D include floodwalls which will require vegation maintenance.

Vegetation maintenance as follows:
weed abatement on new floodwall (figures provided by Zach Mousli via telephone conversation, 08/22/2012)

For 1 trip:

labor rate for 2 man crew	220	$/hr
2 man @ 1 mile/8hrs	1,760	$/mile
	333.33	$/1,000 ft
herbicide application	10	$/mile
	1.894	$/1,000 ft

Assuming 2 trips per year:

2 man@ 1 mile/8hrs	666.67	$/1,000 ft
herbicide application	3.788	$/1,000 ft

Length of floodwalls	Reach								total
	2a	2b	2c	2d	2e	2f	2g	3	
Cost	400	0	300	0	0	0	0	0	700

Floodwall graffiti removal

Assume, graffiti removed 4 times per year from new floodwalls
Assume 1 worker to do job
Assume hourly rate for field ops including labor, benefits, and overhead = $110/hr

Location	Description	Average hours per Event	Times per Year	Total New Hours per year	Labor Rate ($)	Cost/Year
Reach 1	Bay to 101	8	0	0	110	
Reach 2a	101 to Newell	8	4	32	110	$ 3,520
Reach 2b	Newell to Unvi	8	0	0	110	$-
Reach 2c	Univ to Pope/Chauc	8	4	32	110	$3,520
Reach 2d	Pope/Chauc to Mid	8	0	0	110	$-
Reach 2e	Mid to El Camino	8	0	0	110	$-
Reach 2f	El Camino to Sand	8	0	0	110	$-
Reach 2g	Sand to 280	8	0	0	110	$-
Reach 4	280 to Sears	8	0	0	110	$-

As shown in Table 8-17 (PSP Table 16), this equates to a present value cost of $49.8 millionfor project implementation.

Table 8-17 (PSP Table 16). Annual Costs of Project

Table 16 – Annual Costs of Project (All costs should be in 2012 Dollars) Project: San Francisquito Creek Flood Protection Project										
	Initial Costs Grand Total Cost from Table 6	Adjusted Grant Total Cost(1)	Annual Costs (2)						Discounting Calculations	
			Admin.	Ops.	Maint.	Repl.	Oth.	Total	Disc. Factor	Disc. Costs
Year	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
2012		$0			$0			$0	1.000	**$1**
2013	$1,670,833	$1,670,833			$0			$1,670,833	0.943	**$3,341,668**
2014	$12,970,833	$12,970,833			$0			$12,970,833	0.890	**$25,941,668**
2015	$9,858,333	$9,858,333			$0			$9,858,333	0.840	**$19,716,668**
2016					$8,000			$8,000	0.792	**$16,001**

Table 16 – Annual Costs of Project
(All costs should be in 2012 Dollars)

Project: San Francisquito Creek Flood Protection Project

	Initial Costs Grand Total Cost from Table 6	Adjusted Grant Total Cost(1)	Annual Costs (2)						Discounting Calculations	
			Admin.	Ops.	Maint.	Repl.	Oth.	Total	Disc. Factor	Disc. Costs
Year	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
2017					$8,000			$8,000	0.747	**$16,001**
2018					$8,000			$8,000	0.705	**$16,001**
2019					$8,000			$8,000	0.665	**$16,001**
2020					$8,000			$8,000	0.627	**$16,001**
2021					$8,000			$8,000	0.592	**$16,001**
2022					$8,000			$8,000	0.558	**$16,001**
2023					$8,000			$8,000	0.527	**$16,001**
2024					$8,000			$8,000	0.497	**$16,000**
2025					$8,000			$8,000	0.469	**$16,000**
2026					$8,000			$8,000	0.442	**$16,000**
2027					$8,000			$8,000	0.417	**$16,000**
2028					$8,000			$8,000	0.394	**$16,000**
2029					$8,000			$8,000	0.371	**$16,000**
2030					$8,000			$8,000	0.350	**$16,000**
2031					$8,000			$8,000	0.331	**$16,000**
2032					$8,000			$8,000	0.312	**$16,000**
2033					$8,000			$8,000	0.294	**$16,000**
2034					$8,000			$8,000	0.278	**$16,000**
2035					$8,000			$8,000	0.262	**$16,000**
2036					$8,000			$8,000	0.247	**$16,000**
2037					$8,000			$8,000	0.233	**$16,000**
2038					$8,000			$8,000	0.220	**$16,000**
2039					$8,000			$8,000	0.207	**$16,000**
2040					$8,000			$8,000	0.196	**$16,000**
2041					$8,000			$8,000	0.185	**$16,000**
2042					$8,000			$8,000	0.174	**$16,000**
2043					$8,000			$8,000	0.164	**$16,000**
2044					$8,000			$8,000	0.155	**$16,000**
2045					$8,000			$8,000	0.146	**$16,000**
2046					$8,000			$8,000	0.138	**$16,000**
2047					$8,000			$8,000	0.130	**$16,000**
2048					$8,000			$8,000	0.123	**$16,000**
2049					$8,000			$8,000	0.116	**$16,000**
2050					$8,000			$8,000	0.109	**$16,000**

Table 16 – Annual Costs of Project (All costs should be in 2012 Dollars) Project: San Francisquito Creek Flood Protection Project										
	Initial Costs Grand Total Cost from Table 6	Adjusted Grant Total Cost(1)	Annual Costs (2)						Discounting Calculations	
			Admin.	Ops.	Maint.	Repl.	Oth.	Total	Disc. Factor	Disc. Costs
Year	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
2051					$8,000			$8,000	0.103	**$16,000**
2052					$8,000			$8,000	0.097	**$16,000**
2053					$8,000			$8,000	0.092	**$16,000**
2054					$8,000			$8,000	0.087	**$16,000**
2055					$8,000			$8,000	0.082	**$16,000**
2056					$8,000			$8,000	0.077	**$16,000**
2057					$8,000			$8,000	0.073	**$16,000**
2058					$8,000			$8,000	0.069	**$16,000**
2059					$8,000			$8,000	0.065	**$16,000**
2060					$8,000			$8,000	0.061	**$16,000**
2061					$8,000			$8,000	0.058	**$16,000**
2062					$8,000			$8,000	0.054	**$16,000**
2063					$8,000			$8,000	0.051	**$16,000**
2064					$8,000			$8,000	0.048	**$16,000**
2065					$8,000			$8,000	0.046	**$16,000**
2066								$0	0.043	
2067								$0	0.041	
Total Present Value of Discounted Costs (Sum of Column (j)) Transfer to Table 17, column (c), Proposal Benefits and Costs Summaries										**$49,800,017**
Comments: All costs are in 2012 dollars.										

(1) If any, based on opportunity costs, sunk costs and associated costs
(2) The incremental change in O&M costs attributable to the project

Proposal Benefits and Costs Summary

The benefits and costs for all projects in this proposal are summarized in Table 8-18 (PSP Table 17) below. As shown in this Table, present value benefits are approximately $64.8 million, compared to present value costs of approximately $49.8 million.

Table 8-18 (PSP Table 17): Proposal Summary

Proposal: San Francisquito Creek Flood Protection Proposal Agency: San Francisquito Creek JPA						
Project	Project Proponent	Total Present Value Project Costs (1)	Total Present Value Project Benefits			From Section D2 – Briefly describe the main Non-monetized benefits
			From Section D2 – Flood Damage Reduction (2)	From Section D3 – Monetized (3)	Total	
(a)	(b)	(c)	(d)	(e)	(f) = (d) + (e)	(g)
San Francisquito Creek Flood Protection Project	San Francisquito Creek JPA	$49,800,017	$64,643,536	$134,768	$64,778,304	Water quality beefits to San Francisco Bay associated with educed erosion nd sedimentation, reduced GHG emissions due to expanded sidewalk and bicycle lane usage, improved public health and safety associated with enhanced flood protection
TOTAL	$0	$49,800,017	$64,643,536	$134,768	$64,778,304	

(1) From Table 16 or RWMG method
(2) From Table 12 or RWMG method
(3) From Table 14 or RWMG method

APPENDIX 8-1: Draft Planning Study Report for the San Francisquito Creek Flood Protection Project

APPENDIX 8-2: San Francisquito Creek – Preliminary Flood Damage Analysis

Please see Appendix 7-2 in Attachment 7.

APPENDIX 8-3: West Bayshore Inlet 90% Percent Design Drawings

Please see Appendix 7-3 in Attachment 7.

APPENDIX 8-4: Local Disposal Rate Sheet

Please see Appendix 7-4 in Attachment 7.